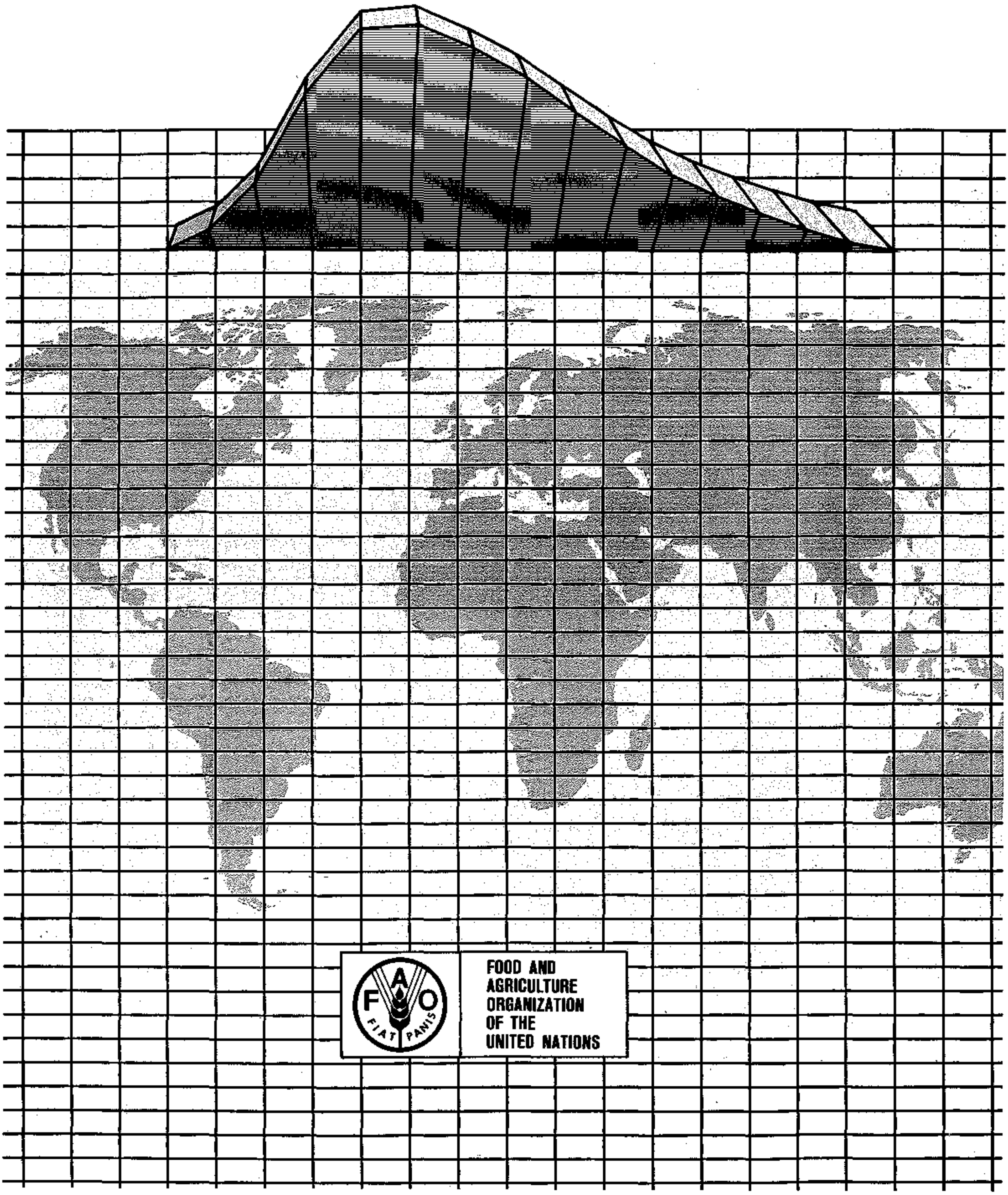
The fifth world food survey



FOOD AND
AGRICULTURE
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Foreword

One of the first tasks FAO undertook after its creation in 1945 was the preparation of a *World Food Survey*, published on 5 July 1946, less than nine months after the First Session of the FAO Conference in Quebec. The aim of this first survey was stated in its opening lines:

"It is well known that there is much starvation and malnutrition in the world. Millions of people never get enough to eat, and much larger numbers, not actually hungry, do not obtain the kind of diet necessary for health. Vague knowledge that this situation exists is not enough; facts and figures are needed if the nations are to attempt to do away with famine and malnutrition ..."

The first survey covered 70 countries, which then accounted for about 90 percent of the earth's population. Many of the data used, relating to the pre-war period, were recognized as being "highly imperfect", but despite its weaknesses the survey was a pioneering attempt to analyse the world food situation. It brought home the massive extent of malnutrition in the poorer countries and sketched out possibilities of action by the international community.

Successive world food surveys have been carried out roughly once a decade, in 1952, 1963 and 1977. In each there has been a marked improvement in the quantity and quality of the data and in the methodology adopted for measuring them. Significantly, however, the conclusions of each have been identical with those of the first: "There is much starvation and malnutrition in the world."

And indeed, recognition of this dismal fact is also a conclusion of *The Fifth World Food Survey*. But there is evidence of a turn in the tide. This survey indicates that, with accelerating growth in per caput food supplies in the developing market economies, the *proportion* of the population suffering from undernutrition has declined, even though the *absolute numbers* of the undernourished have increased, as a result of even more rapid population growth.

Among the developing regions, Africa has the slowest growth rate in per caput food supplies and also the largest increase in the number of the undernourished. As the current African food crisis has shown, widespread undernutrition can all too quickly turn into actual famine and starvation.

The causes of malnutrition are multidimensional. Many factors — economic, social, cultural and environmental — are involved, and their relative effects cannot be determined. Poverty, however, is beyond all doubt the most important cause, and almost all the factors weigh most heavily upon young children, who in general constitute a disproportionately large number of the undernourished population of the developing countries, those in rural areas appearing to be even more at risk than those in the cities and towns.

The war against malnutrition calls for equally multidimensional policies. While accelerated agricultural and general economic development, combined with a more equitable distribution of income, can provide the only long-term solution, much more needs to be done for those who will long continue to be bypassed by general growth and development. Suitable nutrition intervention programmes, targeted as closely as possible on the most deprived rural households, must be mounted on an enormous scale. Hand in hand with these programmes should go others for providing primary health care, sanitation and safe drinking-water, in view of the complex interactions between malnutrition and infectious diseases. The many roles that women play in the food systems of the developing countries — not only as mothers and housewives but also as farmers, labourers, traders and teachers — require that the status of women be raised and their education improved: this alone would have a telling influence on nutritional improvement.

In order to make the best use of limited financial and material resources, a due balance must be maintained between longer- and shorter-term measures, which should be fairly divided among rural and urban areas. In national policies and plans, concern for and priority to nutrition must receive stronger emphasis.

This fifth world food survey provides data and analyses that will assist national governments and international organizations in their joint attack on the basic causes of malnutrition, so that genuine food security may be guaranteed to all men and women everywhere.

It offers no grounds for complacency with regard to the current world food and nutrition situation, but it does hold out some hope for the future, if individual governments and the international community act to fulfil the expectations that were opened by the first *World Food Survey* when FAO was founded 40 years ago.

Edouard Saouma
Director-General

Contents

1. Introduction

One of FAO's earliest major publications was its first *World Food Survey*, issued in 1946. *The Second World Food Survey* followed in 1952 and *The Third World Food Survey* (FAO, 1963)[1] 11 years later. *The Fourth World Food Survey* (FAO, 1977a) was preceded by detailed reviews of the dimensions and causes of hunger and malnutrition in *The state of food and agriculture 1974* (FAO, 1974a) and in documentation prepared for the first United Nations World Food Conference (FAO, 1974b).

FAO's first estimates of the numbers of the undernourished appeared in the third survey. More detailed estimates published in *The state of food and agriculture 1974* (FAO, 1974a) and *Assessment of the world food situation, present and future* (FAO, 1974b) were revised in the fourth survey, and similar estimates are a feature of this fifth world food survey. They are based essentially upon the same methodology as that adopted earlier, but significant improvements have been introduced.

In the 40 years that have elapsed since the first survey was published, substantial advances have been made in the quantity and quality of the statistical data on which an analysis of the world food and nutrition situation can be based. Food balance sheets are now available for almost all countries, and while household food-consumption surveys have not yet been carried out in all the developing countries, their number has gradually increased.

At the same time, and while gaps and uncertainties persist, considerable progress has been made in the science of nutrition. Human nutritional requirements have been periodically reviewed and assessed by FAO and the World Health Organizatin (WHO), most recently in conjunction with the United Nations University (UNU); the latest assessment affords the main basis for improvements in estimating energy requirements. Where this work has not led to operational recommendations, it has been extended for the purposes of the survey, at times on the basis of more recent research.

This fifth world food survey is thus designed to provide as complete a picture as possible of the world food and nutrition situation as it evolved during the 1960s and 1970s, its causes and its policy implications. Chapter 2 reviews the evolution of world food supplies and consumption during the period, with the changes that occurred in per caput dietary energy supplies (DES) and in food consumption patterns.

The problem of nutritional adequacy is first discussed in Chapter 3, which presents FAO's latest estimates of undernutrition in the developing countries. The new estimates refer to the periods 1969-71 and 1979-81, thus making possible an assessment of changes during the 1970s; they are also compared with other indicators of malnutrition. Much of the chapter is given over to a discussion of the rationale underlying the methodology adopted in making the estimates, and an appendix contains a fuller technical exposition of the methodology.

Chapter 4 presents a tentative analysis of the complex, multidimensional causes of malnutrition, examining the impact on nutrition of a wide variety of economic, social, cultural and environmental factors. Special emphasis is laid on the impact these factors have upon young children (directly or indirectly, through their mothers), on rural/urban differentials and on the interaction between malnutrition and infectious diseases. To illustrate the views expressed, typical profiles of malnourished families are included.

The policy implications of the current world nutritional situation are discussed in Chapter 5, which begins with a brief examination of the likely dimensions of future policy problems, with emphasis on policies in the developing countries. Because the general policies that would lead to faster agricultural and economic development are already familiar ground, they are dealt with here only briefly. Rather, closer examination is devoted to policies more specifically concerned with nutrition, and especially to direct nutrition intervention programmes. The chapter also engages in brief discussions of income redistribution, food subsidies, women's programmes, population policies, the need for integrated policies and for further data and research as the basis for formulating improved policies. Policies in developed countries and at the international level, where those of developed and developing countries interact, are also envisaged briefly.

Finally, as already stated, the Appendix contains a detailed discussion of the methodology adopted for estimating the numbers of the undernourished, and an extensive Glossary defines numerous terms used throughout the survey. An asterisk (*) is used to indicate terms defined in the Glossary.

[1] For references, see p. 73.

2. Food supplies

Changes in per caput food-supply levels result from changes in food production, in net food imports, in feed and seed uses of food products, in food stocks and in population. These factors, in turn, are determined by weather, government policies, commodity markets, general economic growth, demographic trends and other technical, social and economic phenomena.

Per caput food supplies

World per caput food supplies*, measured as dietary energy, rose by 12 percent — from 2 340 to 2 630 kcal/day — during the 18-year period between 1961-63 and 1979-81 (see Table 2.1). Although the gap between developed countries and developing countries* remains wide, it has narrowed: at the beginning of the period, the per caput dietary-energy supplies (DES) of the developing countries stood at 64 percent of those of the developed countries, while by the end of the period the proportion had risen to 70 percent. During the 1970s the rate of increase of DES in the developed countries fell substantially, while there was only a slight deceleration in the higher rate of increase in the developing countries.

Per caput supplies increased in every developing region and economic group[1] during the 1960s and 1970s, although in the 1970s the situation was roughly stagnant in the least developed countries (LDCs)*. By far the largest increases were observed in the Near East and in the Asian centrally planned economies (ACPE), but there were also impressive improvements in the low-income countries*, even if these improvements were less remarkable during the 1970s than those of the middle- to high-income developing countries*. During the 1960s Africa saw the smallest increase, but some acceleration took place there in the 1970s.

Particularly significant is the comparison of performances during the 1970s among the group of the developed countries, the group of the middle- to high-income developing countries and the group of the low-income developing countries. The second of these groups having progressed more rapidly than the others, the gap between the first two closed in part (in 1969-71 the per caput DES of the middle- to high-income countries was only 70 percent of that of the developed countries, while by 1979-81 the percentage had risen to 76

[1] See Table 2.2 for the composition of regional and economic groups of developing countries and territories.

TABLE 2.1. **Per caput DES by region and economic group, 1961-63, 1969-71 and 1979-81**

Region or economic group	1961-63	1969-71	1979-81	Average annual rate of increase 1961-63 to 1969-71	1969-71 to 1979-81
	(kcal per caput/day)			(%)	
Developed countries	3 110	3 280	3 390	0.7	0.3
Developed market economies	3 090	3 260	3 380	0.7	0.4
North America	3 280	3 480	3 620	0.8	0.4
Western Europe	3 150	3 300	3 440	0.6	0.4
Oceania	3 160	3 270	3 150	0.4	–0.4
Eastern Europe and USSR	3 170	3 330	3 420	0.6	0.3
Developing countries	1 980	2 140	2 350	1.0	0.9
Developing market economies	2 060	2 160	2 320	0.6	0.7
Africa	2 120	2 170	2 260	0.3	0.4
Far East	1 940	2 020	2 160	0.5	0.7
Latin America	2 370	2 500	2 620	0.7	0.5
Near East	2 230	2 400	2 840	0.9	1.7
ACPE	1 830	2 100	2 430	1.7	1.4
Economic groups of developing countries					
Least-developed	1 980	2 060	2 070	0.5	0.1
Low-income food-deficit	1 920	2 070	2 270	1.0	0.9
Low-income	1 910	2 060	2 240	1.0	0.8
Middle- to high-income	2 150	2 310	2 590	0.9	1.1
World	2 340	2 470	2 630	0.7	0.6

percent), while the gap between the two latter groups widened (the respective percentages falling from 89 to 86 percent). The LDCs fell even farther behind the developed countries: in 1969-71 their per caput DES was only 63 percent of that of the developed countries, and by 1979-81 the gap had widened even farther to 61 percent. Expressed in simpler terms, this means that *the average inhabitant of the developed countries had nearly two-thirds more to eat in 1979-81 than the average inhabitant of the LDCs; and nearly half again as much to eat as the average inhabitant of the developing countries as a whole.*

An examination of changes in the situation of the 112 individual developing countries for which food balance sheets* have been published (see Table 2.2; FAO, 1984c) also reveals striking differences. In 26 of these countries, with 8 percent of their total population, per caput DES actually fell during the 1970s, and in 11 others, with 2 percent of the total population, there was virtually no change. In no less than 75 countries, on the other hand, there was at least some improvement (see Table 2.3). Its magnitude varied widely, as is evident from the country data presented in Table 2.4; in general, the largest increases occurred in the middle- to high-income countries, 14 of which, with an average per caput DES above 2 500 kcal/day in 1969-71, improved by 350 kcal/day (13 percent) by 1979-81.

Substantial changes have taken place in the distribution of the developing countries by per caput food-supply levels (see Fig. 2.1), and here again the shifts have been particularly large in the middle- to high-income countries.

Most of the decline in per caput DES took place in African countries, for the most part in the low-income category, whose supplies were already low. Of the 30 countries in this group whose daily per caput DES was 2 300 kcal or less in 1969-71, as many as 16 (14 in Africa) showed no improvement. In the middle- to high-income group, by contrast, only seven of the 34 countries in the same range of per caput DES in 1969-71 failed to show improvement by 1979-81.

Changes in per caput food-supply levels reflect differences in the growth rates of food supply and population. Table 2.5 summarizes the performance of the 112 developing countries already mentioned in DES growth as compared to population growth.

When the countries are divided into two groups according to their population-growth rates, it becomes evident that those with growth rates not exceeding 2 percent per year generally fared better than those with growth rates higher than 2 percent: about three-quarters of the countries (26 out of 35) in the former group, and two-thirds (49 out of 77) in the latter, had DES growth greater than population growth. The corresponding percentages in terms of the population in the countries concerned are about 95 and 85 percent respectively.

Figure 2.2 summarizes graphically the world food situation at the beginning of the 1980s. It shows individual countries according to their DES levels, their relative size on the map being proportionate to their populations rather than to their land area, as is particularly evident in the case of Africa, relatively less populated than the other continents.

TABLE 2.2. **Composition of regional and economic groups of developing countries and territories**

Region and country	Economic group: Least developed countries	Low-income food-deficit countries	Low-income countries	Middle- to high-income countries	Food balance sheets published
Developing market economies					
AFRICA					
Algeria				*	*
Angola		*		*	
Benin	*	*	*		*
Botswana	*			*	*
British Indian Ocean Terr.				*	
Burkina Faso	*	*	*		*
Burundi	*	*	*		*
Cameroon				*	*
Cape Verde	*	*	*		*
Central African Rep.	*	*	*		*
Chad	*	*	*		
Comoros	*	*	*		*
Congo				*	*
Côte d'Ivoire		*		*	*
Djibouti	*	*		*	
Equatorial Guinea	*	*	*		
Ethiopia	*	*	*		
Gabon				*	
Gambia	*	*	*		*
Ghana		*	*		*
Guinea	*	*	*		*
Guinea-Bissau	*	*	*		
Kenya		*	*		*
Lesotho	*	*		*	*
Liberia		*		*	*
Madagascar		*	*		*
Malawi	*	*	*		*
Mali	*	*	*		*
Mauritania		*	*		*
Mauritius				*	*
Morocco		*		*	*
Mozambique		*	*		*
Namibia				*	
Niger	*	*	*		*

Region and country	Economic group: Least developed countries	Low-income food-deficit countries	Low-income countries	Middle- to high-income countries	Food balance sheets published
Nigeria		*		*	*
Reunion				*	*
Rwanda	*	*	*		*
St. Helena				*	
Sao Tome and Principe	*	*	*		*
Senegal		*		*	*
Seychelles				*	
Sierra Leone	*	*	*		*
Somalia	*	*	*		*
Swaziland				*	*
Tanzania	*	*	*		*
Togo	*	*	*		*
Tunisia				*	*
Uganda	*	*	*		*
Western Sahara				*	
Zaire		*	*		*
Zambia		*		*	*
Zimbabwe				*	*
LATIN AMERICA					
Antigua-Barbuda				*	*
Argentina				*	*
Bahamas				*	*
Barbados				*	*
Belize				*	*
Bolivia		*		*	*
Brazil				*	*
British Virgin Islands				*	
Cayman Islands				*	
Chile				*	*
Colombia				*	*
Costa Rica				*	*
Cuba				*	*
Dominica				*	*
Dominican Rep.				*	*
Ecuador				*	*
El Salvador		*		*	
Falkland Islands (Malvinas)				*	
French Guiana				*	*
Grenada				*	*
Guadeloupe				*	*
Guatemala				*	*
Guyana				*	*
Haiti	*	*	*		*
Honduras		*		*	*
Jamaica				*	*
Martinique				*	*
Mexico				*	*
Montserrat				*	
Netherlands Antilles				*	*
Nicaragua				*	
Panama				*	*
Paraguay				*	*
Peru				*	*
Puerto Rico				*	
St. Kitts and Nevis				*	*
Saint Lucia				*	*
St. Vincent and the Grenadines				*	*
Suriname				*	*
Trinidad and Tobago				*	*
Turks and Caicos Islands				*	
Uruguay				*	*
US Virgin Islands				*	
Venezuela				*	*
NEAR EAST					
Egypt		*		*	*
Libya				*	*
Sudan	*	*	*		*
Afghanistan	*	*		*	
Bahrain				*	
Cyprus				*	
Gaza Strip				*	

Region and country	Economic group: Least developed countries	Low-income food-deficit countries	Low-income countries	Middle- to high-income countries	Food balance sheets published
Iran				*	
Iraq				*	
Jordan				*	
Kuwait				*	*
Lebanon				*	
Oman				*	
Qatar				*	
Saudi Arabia				*	*
Syria				*	*
Turkey				*	*
United Arab Emirates				*	*
Yemen Arab Rep.	*	*		*	*
Yemen P.D.R.	*	*		*	*
FAR EAST					
Bangladesh	*	*	*		*
Bhutan	*	*	*		
Brunei				*	*
Burma			*		*
East Timor				*	
Hong Kong				*	*
India		*	*		*
Indonesia		*		*	*
Korea Rep.				*	*
Laos	*	*	*		
Macau				*	*
Malaysia				*	*
Maldives	*	*		*	
Nepal	*	*	*		*
Pakistan		*	*		*
Philippines		*		*	*
Singapore				*	*
Sri Lanka		*	*		*
Thailand				*	*
OTHER [1]					
Bermuda				*	*
Greenland				*	
St. Pierre and Miquelon				*	
American Samoa				*	
Canton and Enderbury Islands				*	
Christmas Islands				*	
Cocos Islands				*	
Cook Islands				*	
Fiji				*	*
French Polynesia				*	*
Guam				*	
Johnston Islands				*	
Kiribati		*		*	*
Midway Islands				*	
Nauru				*	
New Caledonia				*	*
Niue				*	
Norfolk Islands				*	
Pacific Islands				*	
Papua New Guinea		*		*	
Pitcairn				*	
Samoa	*	*		*	*
Solomon Islands		*		*	*
Tokelau				*	
Tonga		*		*	*
Tuvalu				*	
Vanuatu		*	*		*
Wake Islands				*	
Wallis and Futuna Islands				*	
ASIAN CENTRALLY PLANNED ECONOMIES					
China		*	*		*
Kampuchea Dem.		*	*		
Korea D.P.R.				*	*
Mongolia				*	*
Viet Nam		*	*		

[1] Most of these countries and territories are in Oceania; a few are in North America and the Atlantic. Although they are included in the totals for the developing market economies, regional totals are not shown separately in the tables.

Developments during the early 1980s. In its comprehensive analysis of changes in the per caput DES situation, the survey concentrates on the long-term trends of the 1960s and 1970s, but preliminary data for 1981-83 make it possible to indicate trends of the early 1980s. These are summarized in Table 2.6.

While the developed countries' DES levelled off at about 3 390 kcal/day, that of the developing countries continued to improve during the early 1980s, with an impressive annual growth rate of more than 1 percent. This figure is however strongly influenced by the noteworthy performance of China; excluding that country's results from the calculations, the improvement is more than halved.

From the regional perspective, the Far East, the Near East and the ACPE countries (excluding China) all registered DES growth rates of about 1 percent a year, although the rate for the Near East

TABLE 2.3. **Distribution of 112 developing countries [1] by per caput DES in 1969-71 and change by 1979-81**

Economic group	Per caput DES in 1969-71			
	2 100 or less	2 101 to 2 300	2 301 to 2 500	More than 2 500
Low-income countries				
A. Per caput DES declined	Bangladesh Guinea Mali Mozambique Sierra Leone	Central African Rep. Ghana Kenya Malawi Somalia Togo Uganda Zaire	Gambia Sri Lanka Vanuatu	
B. Per caput DES approximately constant	Burkina Faso Haiti Nepal	Comoros	Madagascar	
C. Per caput DES increased	Burma Cape Verde China India Mauritania Niger Pakistan Rwanda Tanzania	Benin Burundi Sao Tome and Principe Sudan		
Middle- to high-income countries				
A. Per caput DES declined		Antigua-Barbuda Dominica Peru Solomon Is.	Grenada Panama	Bahamas Bermuda New Caledonia Uruguay
B. Per caput DES approximately constant	St. Kitts and Nevis	Honduras Zambia		Argentina Chile Hong Kong
C. Per caput DES increased	Algeria Bolivia Dominican Rep. Ecuador Guatemala Indonesia Lesotho Macau Philippines Samoa Saudi Arabia Zimbabwe	Botswana Cameroon Colombia Congo Kiribati Liberia Nigeria St. Lucia St. Vincent Senegal Swaziland Thailand Tunisia Yemen A.R. Yemen P.D.R.	Brazil Brunei Costa Rica Côte d'Ivoire Fiji Guadeloupe Guyana Jamaica Korea Rep. Libya Malaysia Martinique Mauritius Mongolia Morocco Netherlands Antilles Reunion Suriname Syria Trinidad and Tobago Venezuela	Barbados Belize Cuba Egypt French Guiana French Polynesia Korea D.P.R. Kuwait Mexico Paraguay Singapore Tonga Turkey United Arab Emirates

[1] For which food balance sheets are published.

TABLE 2.4. **Population, food supply and related data, for 112 developing countries and territories**

Country or territory	Population [1]		Per caput DES		Average annual growth rate: Population	Average annual growth rate: Per caput DES	Share of DES: Cereals		Roots and tubers		Pulses and nuts		Animal products		Sugar		Other foods	
	1970	1980	69-71	79-81	1970-80	1969-71 to 1979-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81
	(millions)		(kcal/day)		(%)		(%)											
A. Countries and territories where per caput DES declined between 1969-71 and 1979-81																		
1. Antigua-Barbuda	0.1	0.1	2 163	1 979	0.7	–0.9	46.7	50.2	1.5	1.1	0.4	0.3	19.0	21.2	15.3	13.1	17.0	14.1
2. Bahamas	0.2	0.2	2 529	2 200	3.1	–1.4	40.2	41.5	2.2	1.1	1.9	1.6	30.1	30.4	11.7	11.5	13.9	13.9
3. Bangladesh	68.3	88.2	1 992	1 837	2.6	–0.8	83.7	87.2	2.2	1.8	1.8	1.1	3.2	3.2	4.0	3.1	5.1	3.6
4. Bermuda	0.1	0.1	3 003	2 799	1.4	–0.7	21.3	22.6	2.6	2.1	1.2	1.5	40.7	39.8	17.2	13.7	17.0	20.3
5. Cent. Afr. Rep.	1.9	2.3	2 186	2 117	2.1	–0.3	18.6	15.9	52.3	52.0	10.4	12.0	4.6	5.4	2.0	1.6	12.1	13.1
6. Dominica	0.1	0.1	2 237	2 019	1.6	–1.0	26.6	28.3	12.7	15.0	6.8	8.3	16.8	17.7	20.0	7.6	17.1	23.1
7. Gambia	0.4	0.6	2 348	2 251	3.0	–0.4	63.0	63.4	2.1	1.2	8.1	6.6	5.0	6.5	6.7	7.3	15.1	15.0
8. Ghana	8.6	11.7	2 230	1 766	3.0	–2.3	29.4	34.5	37.5	37.5	5.5	3.6	5.6	5.1	4.3	2.1	17.7	17.2
9. Grenada	0.1	0.1	2 342	2 168	1.7	–0.8	31.2	30.0	4.0	3.4	10.2	11.1	17.3	22.0	16.9	11.9	20.4	21.6
10. Guinea	3.9	5.0	2 040	1 880	2.5	–0.8	41.4	42.5	21.0	19.7	5.0	5.1	2.4	3.9	1.6	2.6	28.6	26.2
11. Kenya	11.3	16.5	2 260	2 012	3.8	–1.2	60.3	56.4	8.5	8.4	8.1	5.7	9.5	10.1	7.1	9.6	6.5	9.8
12. Malawi	4.5	6.2	2 282	2 207	3.1	–0.3	71.2	69.3	1.5	2.3	13.3	13.1	3.9	4.1	2.9	3.4	7.2	7.8
13. Mali	5.4	6.9	2 065	1 790	2.6	–1.4	74.7	73.5	2.0	2.5	6.7	6.8	8.5	8.2	3.0	2.9	5.1	6.1
14. Mozambique	8.1	10.5	2 088	1 881	2.5	–1.0	36.9	39.4	39.7	36.3	6.3	3.9	3.4	3.1	5.2	5.8	8.5	11.5
15. New Caledonia	0.1	0.1	3 059	2 842	2.6	–0.7	43.6	45.8	7.6	6.8	4.2	3.9	18.0	17.4	9.4	8.8	17.2	17.3
16. Panama	1.5	1.9	2 444	2 304	2.5	–0.6	42.0	35.9	3.1	3.2	3.4	3.0	14.6	16.0	13.4	17.6	23.5	24.3
17. Peru	13.5	17.6	2 255	2 168	2.7	–0.4	31.0	35.6	16.0	10.9	4.3	3.2	15.8	14.9	14.6	16.8	18.3	18.6
18. Sierra Leone	2.7	3.5	2 071	1 955	2.6	–0.6	54.6	56.8	5.5	5.1	7.1	5.7	3.7	4.5	4.8	3.4	24.3	24.5
19. Solomon Is.	0.2	0.2	2 114	2 050	3.4	–0.3	23.1	25.6	45.1	38.5	11.8	11.9	6.7	9.5	3.6	3.2	9.7	11.3
20. Somalia	2.8	4.6	2 163	2 004	5.1	–0.8	43.1	56.9	1.2	0.9	2.8	1.8	36.8	26.2	7.7	5.8	8.4	8.4
21. Sri Lanka	12.5	14.8	2 308	2 250	1.7	–0.3	61.6	62.4	2.8	3.6	14.7	13.0	3.4	3.7	9.3	6.7	8.2	10.6
22. Togo	2.0	2.6	2 191	2 138	2.6	–0.2	40.3	42.8	40.7	34.5	6.0	6.3	3.2	3.5	1.9	3.0	7.9	9.9
23. Uganda	9.8	13.2	2 260	1 797	3.0	–2.3	28.6	30.4	15.2	18.4	15.4	14.0	5.8	7.5	6.9	2.9	28.1	26.8
24. Uruguay	2.8	2.9	2 982	2 834	0.4	–0.5	31.6	32.5	4.2	3.8	0.8	1.0	39.1	35.3	13.4	13.8	10.9	13.6
25. Vanuatu	0.1	0.1	2 407	2 126	3.2	–1.2	24.9	24.1	21.1	18.0	15.0	18.8	21.8	22.1	6.4	5.0	10.8	12.0
26. Zaire	21.6	28.3	2 221	2 130	2.7	–0.4	13.8	16.2	58.2	57.2	6.6	6.3	3.5	2.7	1.3	1.1	16.6	16.5
B. Countries and territories where per caput DES was approximately constant between 1969-71 and 1979-81																		
1. Argentina	23.7	27.0	3 351	3 367	1.3	0.0	29.9	29.2	6.2	4.4	0.7	0.8	29.6	32.7	12.3	12.0	21.3	20.9
2. Burkina Faso	5.4	6.9	1 987	1 964	2.4	–0.1	73.1	71.0	2.3	2.1	14.9	14.2	4.1	4.3	1.1	2.1	4.5	6.3
3. Chile	9.4	11.1	2 697	2 714	1.7	0.1	44.1	45.6	3.3	3.2	2.0	2.0	16.4	15.1	13.1	12.9	21.1	21.2
4. Comoros	0.3	0.4	2 223	2 220	2.8	0.0	37.4	39.9	33.9	32.5	11.0	10.1	3.7	4.9	2.8	2.8	11.2	9.8
5. Haiti	4.6	5.8	1 917	1 901	2.3	–0.1	42.5	40.2	12.6	11.4	8.7	10.7	5.9	5.9	13.4	14.3	16.9	17.5
6. Honduras	2.6	3.7	2 152	2 178	3.4	0.1	55.8	53.9	1.5	0.6	4.2	4.4	11.0	10.6	13.6	15.0	13.9	15.5
7. Hong Kong	3.9	5.1	2 754	2 770	2.6	0.1	43.0	35.0	1.4	1.2	4.6	4.0	27.2	30.5	8.3	8.7	15.5	20.6
8. Madagascar	6.8	8.7	2 469	2 491	2.5	0.1	61.0	60.0	16.9	17.1	3.3	2.7	7.6	7.0	3.9	4.7	7.3	8.5
9. Nepal	11.4	14.3	2 020	1 993	2.2	–0.1	83.5	83.0	2.0	1.8	1.9	1.3	6.9	6.8	0.8	1.4	4.9	5.7
10. St. Kitts and Nevis	0.1	0.1	2 053	2 038	1.3	–0.1	42.7	36.6	5.3	5.5	5.6	6.4	16.0	20.0	18.2	19.2	12.2	12.3
11. Zambia	4.2	5.8	2 167	2 145	3.1	–0.1	64.6	71.5	5.5	4.5	6.6	2.4	7.3	5.3	6.3	7.9	9.7	8.4
C. Countries and territories where per caput DES increased between 1969-71 and 1979-81																		
1. Algeria	13.7	18.9	1 826	2 608	3.2	3.6	62.3	56.8	1.6	2.2	1.5	2.2	9.7	10.6	9.6	11.7	15.3	16.5
2. Barbados	0.2	0.3	2 895	3 044	1.0	0.5	40.3	37.9	6.9	4.0	3.7	3.6	22.7	24.5	15.7	17.4	10.7	12.6

[1] Present-in-area (de facto) population based on United Nations estimates and projections as assessed in 1980.

Country or territory	Population [1]		Per caput DES		Average annual growth rate		Share of DES											
					Popula-tion	Per caput DES	Cereals		Roots and tubers		Pulses and nuts		Animal prod-ucts		Sugar		Other foods	
	1970	1980	69-71	79-81	1970-80	1969-71 to 1979-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81
	(millions)		(kcal/day)		(%)		(%)											
3. Belize	0.1	0.2	2 644	2 714	3.0	0.3	37.0	35.8	7.8	7.2	6.0	5.5	26.8	27.0	15.8	16.9	6.6	7.6
4. Benin	2.6	3.5	2 105	2 174	2.9	0.3	30.0	34.6	43.7	37.1	10.0	8.9	4.0	3.8	1.8	0.8	10.5	14.8
5. Bolivia	4.3	5.6	1 972	2 088	2.5	0.6	35.2	35.3	12.6	9.9	1.6	2.0	12.3	14.4	11.6	14.1	26.7	24.3
6. Botswana	0.6	0.8	2 176	2 398	2.6	1.0	58.6	53.1	0.9	1.0	7.4	8.0	17.2	18.0	7.9	9.6	8.0	10.3
7. Brazil	95.3	122.3	2 491	2 579	2.5	0.4	39.9	45.0	12.0	7.4	9.4	5.4	12.8	13.0	14.7	17.6	11.2	11.6
8. Brunei	0.1	0.2	2 307	2 552	5.4	1.0	50.7	50.6	3.9	2.7	2.8	2.6	12.8	16.6	16.5	12.5	13.3	15.0
9. Burma	27.7	35.3	2 035	2 289	2.4	1.2	77.0	81.3	0.2	0.3	4.9	3.9	4.3	3.8	3.4	2.1	10.2	8.6
10. Burundi	3.5	4.2	2 215	2 354	2.0	0.6	23.6	25.3	39.8	35.4	17.6	17.6	2.6	2.9	0.5	0.8	15.9	18.0
11. Cameroon	6.8	8.4	2 151	2 217	2.2	0.3	36.0	35.3	19.4	20.3	14.0	12.0	4.4	5.1	2.1	3.2	24.1	24.1
12. Cape Verde	0.3	0.3	1 994	2 704	1.9	3.1	58.0	60.7	7.5	4.7	7.3	7.6	9.4	8.5	9.8	9.7	8.0	8.8
13. China	823.9	977.7	2 071	2 416	1.7	1.5	65.6	66.7	15.0	12.2	4.5	3.5	8.9	10.1	1.2	1.7	4.8	5.8
14. Colombia	20.8	25.8	2 133	2 496	2.2	1.6	28.7	30.4	7.6	8.8	2.0	2.2	14.6	13.4	19.9	20.4	27.2	24.8
15. Congo	1.2	1.5	2 182	2 438	2.5	1.1	10.7	15.2	56.3	49.8	6.0	4.8	4.8	5.3	2.3	4.5	19.9	20.4
16. Costa Rica	1.7	2.2	2 409	2 653	2.5	1.0	38.0	34.3	1.3	1.0	5.2	4.1	15.4	18.8	22.2	24.3	17.9	17.5
17. Côte d'Ivoire	5.3	8.0	2 484	2 641	4.1	0.6	38.9	43.2	29.8	25.0	3.1	2.7	5.9	6.6	3.6	3.5	18.9	19.0
18. Cuba	8.6	9.7	2 573	2 831	1.3	1.0	53.3	51.9	4.1	5.1	3.7	3.7	17.7	17.8	15.5	14.8	5.7	6.7
19. Dominican Rep.	4.5	5.9	1 971	2 131	2.7	0.8	29.7	37.7	7.9	3.8	7.2	5.4	11.9	12.4	13.6	14.4	29.7	26.3
20. Ecuador	6.0	8.0	1 989	2 108	3.0	0.6	32.1	30.9	10.2	4.9	4.8	2.5	17.3	19.0	16.5	21.5	19.1	21.2
21. Egypt	32.8	42.0	2 561	3 178	2.5	2.2	64.3	62.1	1.0	1.5	4.2	2.7	6.1	6.4	7.8	9.8	16.6	17.5
22. Fiji	0.5	0.6	2 464	3 103	1.9	2.3	33.7	31.3	20.6	15.2	10.7	1.9	12.1	12.7	14.7	16.7	8.2	12.2
23. French Guiana	0.1	0.1	2 509	2 764	2.0	1.0	51.0	47.0	3.6	4.2	1.6	1.8	18.8	23.3	7.7	7.1	17.3	16.6
24. French Polynesia	0.1	0.1	2 842	2 894	3.0	0.2	35.4	36.2	10.6	9.1	4.9	4.7	19.6	21.4	11.4	8.8	18.1	19.8
25. Guadeloupe	0.3	0.3	2 330	2 491	0.0	0.7	56.8	51.9	4.6	3.2	2.3	2.8	13.5	19.1	7.7	7.7	15.1	15.3
26. Guatemala	5.4	7.3	2 063	2 109	3.1	0.2	62.4	57.9	0.2	0.5	5.5	5.3	9.1	9.8	13.3	15.6	9.5	10.9
27. Guyana	0.7	0.9	2 307	2 361	2.2	0.2	55.9	62.4	3.2	1.1	3.5	2.9	11.8	10.0	13.7	13.4	11.9	10.2
28. India	552.5	684.5	1 992	2 056	2.1	0.3	72.7	74.2	1.6	1.6	7.8	5.6	3.8	3.9	7.5	7.0	6.6	7.7
29. Indonesia	122.2	148.0	1 872	2 315	1.9	2.1	65.7	68.4	11.8	8.4	7.3	7.2	2.2	2.2	6.1	5.9	6.9	7.9
30. Jamaica	1.9	2.2	2 478	2 536	1.6	0.2	36.3	34.7	7.2	8.3	4.1	4.1	16.8	15.1	19.3	20.2	16.3	17.6
31. Kiribati	0.1	0.1	2 177	3 176	1.7	3.8	26.4	24.2	17.6	15.0	17.7	13.7	9.8	24.0	15.5	9.7	13.0	13.4
32. Korea D.P.R.	13.9	17.9	2 502	3 065	2.5	2.0	71.2	73.8	4.8	4.7	8.7	6.3	4.5	5.3	4.1	1.7	6.7	8.2
33. Korea Rep.	31.9	38.5	2 455	2 909	1.9	1.7	66.8	65.6	5.5	2.0	2.7	4.0	4.1	8.2	2.2	3.8	18.7	16.4
34. Kuwait	0.7	1.4	2 845	3 345	6.0	1.6	58.1	52.3	0.7	0.8	3.4	2.3	14.0	20.1	9.6	11.0	14.2	13.5
35. Lesotho	1.1	1.3	2 032	2 424	2.3	1.8	80.8	76.8	0.4	0.6	2.4	3.2	6.3	6.9	6.1	7.6	4.0	4.9
36. Liberia	1.4	2.0	2 167	2 281	3.5	0.5	43.7	49.5	29.0	22.3	2.2	2.0	4.8	4.9	2.0	2.5	18.3	18.8
37. Libya	2.0	3.0	2 385	3 812	4.1	4.7	46.5	40.3	0.4	1.5	4.3	4.2	12.8	15.3	13.6	11.2	22.4	27.5
38. Macau	0.2	0.3	2 035	2 417	1.6	1.7	58.4	51.9	0.7	0.6	1.9	2.5	18.3	23.4	6.7	6.2	14.0	15.4
39. Malaysia	10.9	14.1	2 407	2 519	2.6	0.5	54.8	51.0	2.4	2.7	2.3	1.6	11.1	14.0	13.4	13.5	16.0	17.2
40. Martinique	0.3	0.3	2 363	2 658	−0.2	1.2	35.8	33.0	5.6	4.8	3.1	3.3	18.0	20.0	13.4	15.7	24.1	23.2
41. Mauritania	1.2	1.6	1 974	2 076	2.7	0.5	50.3	57.2	0.6	0.5	7.0	5.9	30.2	22.3	7.9	7.4	4.0	6.7
42. Mauritius	0.8	1.0	2 344	2 767	1.4	1.7	54.4	49.9	0.9	1.1	3.4	3.4	7.5	11.2	17.2	15.1	16.6	19.3

Country or territory	Population [1]		Per caput DES		Average annual growth rate		Share of DES											
					Population	Per caput DES	Cereals		Roots and tubers		Pulses and nuts		Animal products		Sugar		Other foods	
	1970	1980	69-71	79-81	1970-80	1969-71 to 1979-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81	69-71	79-81
	(millions)		(kcal/day)		(%)		(%)											
43. Mexico	51.2	69.8	2 641	2 891	3.1	0.9	54.5	49.6	0.9	0.9	7.0	6.6	10.9	13.8	15.1	14.6	11.6	14.5
44. Mongolia	1.2	1.7	2 432	2 752	2.9	1.2	47.3	52.2	0.8	1.5	0.1	0.1	43.2	35.8	6.7	7.7	1.9	2.7
45. Morocco	15.1	20.3	2 454	2 629	2.9	0.7	67.3	63.0	0.8	1.3	2.3	2.6	7.5	7.0	11.2	12.6	10.9	13.5
46. Netherlands Antilles	0.2	0.3	2 448	2 743	1.4	1.1	31.5	29.8	2.7	2.3	1.2	0.8	30.4	30.8	15.0	15.8	19.2	20.5
47. Niger	4.0	5.3	2 074	2 441	2.8	1.6	74.5	68.7	5.9	4.1	6.1	12.5	9.5	7.5	1.3	1.9	2.7	5.3
48. Nigeria	56.3	77.1	2 255	2 446	3.1	0.8	40.2	44.6	31.5	24.1	7.2	5.9	3.4	4.3	1.2	4.3	16.5	16.8
49. Pakistan	65.7	86.9	2 029	2 180	2.8	0.7	74.5	75.5	0.4	0.4	2.5	1.7	7.8	7.0	9.7	8.6	5.1	6.8
50. Paraguay	2.3	3.2	2 753	2 832	3.3	0.3	30.4	30.0	18.9	15.7	5.4	8.3	20.5	20.1	7.6	7.5	17.2	18.4
51. Philippines	37.5	49.2	2 027	2 405	2.7	1.7	64.5	59.5	3.5	7.2	1.4	1.2	10.9	9.5	8.9	9.9	10.8	12.7
52. Reunion	0.4	0.5	2 497	2 782	1.7	1.1	54.0	48.3	1.9	1.7	5.4	4.1	16.8	17.4	9.9	9.8	12.0	18.7
53. Rwanda	3.6	4.8	2 049	2 274	3.0	1.0	10.6	10.4	28.2	41.9	25.1	18.2	1.9	2.1	0.5	0.7	33.7	26.7
54. St. Lucia	0.1	0.1	2 132	2 391	1.6	1.1	28.7	27.3	9.6	8.5	1.8	2.2	17.7	21.4	12.4	12.0	29.8	28.6
55. Samoa	0.1	0.2	2 088	2 552	1.1	2.0	9.3	9.8	21.4	20.8	17.3	14.6	17.7	23.0	13.9	13.0	20.4	18.8
56. Sao Tome and Principe	0.1	0.1	2 166	2 331	1.4	0.7	43.8	44.3	13.0	12.3	23.0	19.6	5.3	6.4	5.6	5.8	9.3	11.6
57. Saudi Arabia	5.7	9.0	1 914	2 940	4.4	4.3	59.5	45.3	0.3	0.7	3.4	3.4	12.2	18.0	8.4	9.5	16.2	23.1
58. Senegal	4.3	5.7	2 299	2 346	2.8	0.2	64.7	68.1	4.3	0.6	5.0	5.5	8.6	7.0	6.4	5.7	11.0	13.1
59. Singapore	2.1	2.4	2 682	2 962	1.4	1.0	49.1	45.5	1.3	2.9	2.2	2.1	17.1	21.6	17.7	13.7	12.6	14.2
60. St. Vincent	0.1	0.1	2 247	2 320	0.1	0.3	32.1	28.8	12.8	12.8	5.3	5.4	13.9	13.8	18.6	19.2	17.3	20.0
61. Sudan	14.1	18.4	2 102	2 312	2.7	1.0	54.8	51.7	2.6	1.8	5.2	4.6	13.6	12.5	8.4	10.5	15.4	18.9
62. Suriname	0.4	0.4	2 407	2 524	0.5	0.5	61.6	59.3	1.0	1.3	2.2	2.1	9.5	10.4	10.9	11.4	14.8	15.5
63. Swaziland	0.4	0.6	2 204	2.494	2.6	1.2	58.5	55.0	2.5	2.2	5.0	2.6	13.1	13.4	13.5	17.4	7.4	9.4
64. Syria	6.3	9.0	2 398	3 009	3.6	2.3	75.2	68.6	0.4	1.0	4.0	3.8	5.7	8.0	5.6	5.9	9.1	12.7
65. Tanzania	13.3	17.9	1 980	2 371	3.0	1.8	37.7	36.1	28.3	29.9	7.0	6.5	7.7	7.0	4.5	3.9	14.8	16.6
66. Thailand	36.5	47.1	2 160	2 308	2.5	0.7	72.5	66.4	2.3	2.7	4.5	3.3	7.4	6.1	6.7	12.4	6.6	9.1
67. Tonga	0.1	0.1	2 567	3 200	1.3	2.2	7.2	6.4	56.9	45.9	10.0	12.6	10.3	18.1	5.9	5.4	9.7	11.6
68. Trinidad and Tobago	1.0	1.2	2 385	2 839	1.3	1.7	43.2	40.9	2.7	3.3	5.4	5.6	16.1	18.9	16.4	14.8	16.2	16.5
69. Tunisia	5.1	6.4	2 265	2 763	2.2	2.0	58.8	54.9	0.9	1.2	2.7	4.1	7.5	8.5	8.4	9.0	21.7	22.3
70. Turkey	35.3	45.3	2 769	2 997	2.5	0.8	75.0	72.8	1.7	1.4	3.6	3.3	6.2	6.2	3.9	4.9	9.6	11.4
71. United Arab Emirates	0.2	1.0	3 103	3 225	15.3	0.4	43.2	31.3	0.2	0.9	0.9	3.4	29.4	30.0	15.3	12.4	11.0	22.0
72. Venezuela	11.0	15.6	2 335	2 567	3.5	1.0	49.3	47.0	3.0	2.1	2.7	2.7	13.7	17.1	13.4	14.1	17.9	17.0
73. Yemen Arab Rep.	4.8	5.8	2 161	2 475	1.8	1.4	69.9	65.1	0.4	1.3	3.6	5.5	6.8	10.2	4.4	5.9	14.9	12.0
74. Yemen P.D.R.	1.5	1.9	2 129	2 274	2.2	0.7	60.9	69.8	—	0.1	2.4	1.7	12.7	11.2	11.2	7.4	12.8	9.8
75. Zimbabwe	5.3	7.4	2 056	2 094	3.3	0.2	64.2	62.8	1.6	1.2	9.0	7.6	8.6	7.3	8.3	9.6	8.3	11.5

TABLE 2.5. **Changes in DES and population growth (112 developing countries) (1969-71 and 1979-81)**

Population growth (annual average)	Per caput DES decreased			Per caput DES approximately constant			Per caput DES increased			Totals		
	Countries (number)	Population (1980) (millions)	Population (%)	Countries (number)	Population (1980) (millions)	Population (%)	Countries (number)	Population (1980) (millions)	Population (%)	Countries (number)	Population (1980) (millions)	Population (%)
2% or less	6	18.1	1.4	3	38.2	3.1	26	1 194.8	95.5	35	1 251.1	100
Over 2%	20	220.2	12.3	8	50.7	2.8	49	1 526.3	84.9	77	1 797.2	100
Overall	26	238.3	7.8	11	88.9	2.9	75	2 721.1	89.3	112	3 048.3	100

slowed by about 0.5 percent as compared with the rate reached in the 1970s. When China is included in the ACPE figures, the annual gain in daily per caput DES rose from 1.4 percent during the 1970s to a striking 2.2 percent in the early 1980s. The positions of Africa and Latin America were less favourable: in the latter no growth was observed, while in Africa there was an actual decline, all the more serious in that during 1979-81 the per caput DES there stood at a low 2 260 kcal/day.

Analysing the performance of the developing countries by economic groups, it can be seen that the stagnating trend of the 1970s persisted in the LDCs, with per caput DES at the very low levels of 2 070-2 080 kcal/day, while the low-income food-deficit and low-income groups maintained the respectable growth rates achieved during the 1970s. On the other hand, the growth rate of the middle- to high-income countries fell by almost two-thirds.

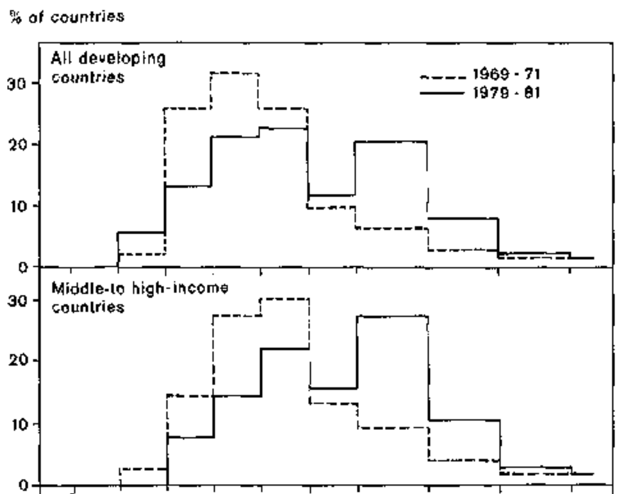
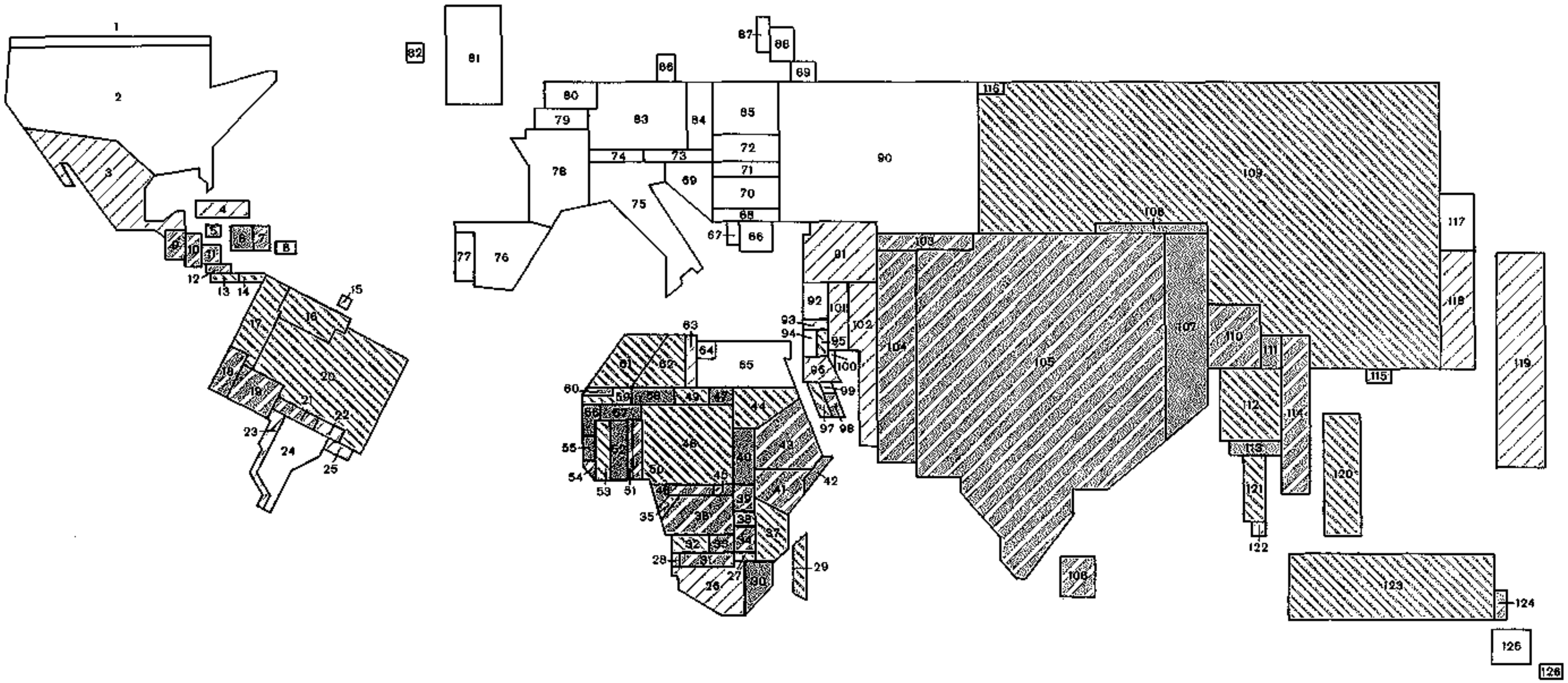


Figure 2.1 *Frequency distribution of developing countries by per caput DES, 1969-71 and 1979-81*

Food-consumption patterns

Table 2.7 summarizes changes in the contribution of the major food groups to DES, thus indicating changes in food-consumption patterns*. These changes have, generally speaking, been more perceptible in the developed than in the developing countries. In the developed market economies, the shares of cereals, roots and tubers and animal oils and fats fell, in favour of rises in the shares of vegetable oils and fats, alcoholic beverages and meat and offal. Most of these changes also took place, and to an even more marked degree, in Eastern Europe and the USSR: although the share of animal fats and oils there continued to increase, this trend was accompanied by a decline in the share of vegetable products as a whole, a corresponding rise in the share of animal products, and increases in the shares of sugar, vegetables and fruit, eggs and fish.

In the developing market economies, the principal changes were decreases in the shares of pulses, nuts and seeds and of roots and tubers, as against increases in the shares of sugar and vegetable oils and fats. The drop in the contribution of pulses, nuts and seeds was particularly sharp in the Far East, and that of roots and tubers in Latin America, while the rises in the consumption of sugar and of vegetable oils and fats were greatest in the Near East, where the share of cereals fell considerably. In the ACPE countries, on the contrary, the contribution of cereals to DES continued to rise, as did that of meat and offal; the region saw especially sharp drops in the shares of pulses, nuts and seeds and of roots and tubers. Trends differed very little between the low-income and the middle- to high-income developing countries, although the share of cereals in the former continued to rise.



Million population (1980)

Over 3 000 kcal/caput/day

2 701 - 3 000

2 301 - 2 700

2 001 - 2 300

less than 2 001

1. Canada
2. USA
3. Mexico
4. Cuba
5. Jamaica
6. Haiti
7. Dominican Rep.
8. Puerto Rico
9. Guatemala
10. El Salvador
11. Honduras
12. Nicaragua
13. Costa Rica
14. Panama
15. Trinidad & Tobago
16. Venezuela
17. Colombia
18. Ecuador
19. Peru
20. Brazil
21. Bolivia
22. Paraguay
23. Chile
24. Argentina
25. Uruguay
26. South Africa
27. Lesotho
28. Namibia
29. Madagascar
30. Mozambwe
31. Zimbabwe
32. Angola
33. Zambia
34. Malawi
35. Congo
36. Zaire
37. Tanzania
38. Burundi
39. Rwanda
40. Uganda
41. Kenya
42. Somalia
43. Ethiopia
44. Sudan
45. Central Afr. Rep.
46. Cameroon
47. Chad
48. Nigeria
49. Niger
50. Benin
51. Togo
52. Ghana
53. Côte d'Ivoire
54. Liberia
55. Sierra Leone
56. Guinea
57. Burkina Faso
58. Mali
59. Senegal
60. Mauritania
61. Morocco
62. Algeria
63. Tunisia
64. Libya
65. Egypt
66. Greece
67. Albania
68. Bulgaria
69. Yugoslavia
70. Romania
71. Hungary
72. Czechoslovakia
73. Austria
74. Switzerland
75. Italy
76. Spain
77. Portugal
78. France
79. Belgium-Luxembourg
80. Netherlands
81. UK
82. Ireland
83. Germany, Fed. Rep. of
84. German Dem. Rep.
85. Poland
86. Denmark
87. Norway
88. Sweden
89. Finland
90. USSR
91. Turkey
92. Syria
93. Lebanon
94. Israel
95. Jordan
96. Saudi Arabia
97. Yemen
98. Yemen, Dem.
99. United Arab Emirates
100. Kuwait
101. Iraq
102. Iran
103. Afghanistan
104. Pakistan
105. India
106. Nepal
107. Bangladesh
108. Sri Lanka
109. China
110. Burma
111. Laos
112. Thailand
113. Kampuchea, Dem.
114. Viet Nam
115. Hong Kong
116. Mongolia
117. Korea, Dem.
118. Korea, Rep. of
119. Japan
120. Philippines
121. Malaysia
122. Singapore
123. Indonesia
124. Papua New Guinea
125. Australia
126. New Zealand

Figure 2.2 *Distribution of world population by per caput DES, 1979-81*

TABLE 2.6. **Per caput DES by region and economic group, 1979-81 and 1981-83**

Region or economic group	1979-81	1981-83	Average annual rate of increase 1969-71 to 1979-81	Average annual rate of increase 1979-81 to 1981-83
	(kcal/caput/day)		(%)	
Developed countries	3 390	3 390	0.3	0.0
Developing countries	2 350	2 400	0.9	1.1
(Excluding China)	(2 320)	(2 340)	(0.7)	(0.5)
Developing market economies	2 320	2 340	0.7	0.5
Africa	2 260	2 230	0.4	–0.7
Far East	2 160	2 190	0.7	0.9
Latin America	2 620	2 620	0.5	0.0
Near East	2 840	2 900	1.7	1.1
ACPE	2 430	2 540	1.4	2.2
(Excluding China)	(2 320)	(2 380)	(0.3)	(1.2)
Economic groups of developing countries				
Least-developed	2 070	2 080	0.1	0.2
Low-income food-deficit	2 270	2 320	0.9	1.2
(Excluding China)	(2 160)	(2 180)	(0.5)	(0.5)
Low-income	2 240	2 300	0.8	1.4
(Excluding China)	(2 080)	(2 110)	(0.2)	(0.7)
Middle- to high-income	2 590	2 610	1.1	0.4
World	2 630	2 660	0.6	0.6

On the whole, then, there has been only a slight reduction in the wide differences in food-consumption patterns between the developed and the developing countries, and in the lesser differences between the patterns observed in the richer and poorer developing countries. The contribution of expensive animal products to DES in 1979-81 was as high as 32 percent in the developed market economies, but only 8 percent in the low-income countries and 11 percent in countries in the middle- to high-income category. By contrast, direct cereal consumption constituted 26, 58, 65 and 52 percent respectively in the four groups.

Nutrient content of diets. The impact of changes in DES levels and food-supply patterns on the nutrient* content of diets* — carbohydrates, total and animal protein, and total and animal fat — is shown in Table 2.8. Although some striking changes have taken place in the shares of these major nutrients in per caput DES, the principal interest of the table lies in the further light it throws upon differences in the diets of the developed and the developing countries and in those of the different developing regions and economic groups.

In the developed countries, the contribution of carbohydrates to DES fell from 59 percent in 1961-63 to 55 percent in 1979-81, while in the developing countries it remained practically constant (76 as against 75 percent). In the Far East it was still as high as 77 percent in 1979-81, as compared with 69 percent in Latin America.

Per caput protein supplies in the developing countries were still only 56 percent of those in the developed countries in 1979-81. The largest increases in these supplies were observed in the ACPE countries and the Near East, the latter having by far the highest level of the developing regions. Differences in animal protein supplies were even greater: in the developed countries, animal protein rose from 50 percent of total protein in 1961-63 to 57 percent in 1979-81, while by that period animal protein supplies in the developing countries still represented only 21 percent of those in the developed countries. Among individual developing regions and groups, only in Latin America, the Near East, the ACPE countries and the middle- to high-income group was there any great increase in animal protein supplies.

The per caput fat supply continued to rise in all regions. In the developed countries the share of animal fat in the total declined somewhat, from 67 percent in 1961-63 to 63 percent in 1979-81; there was a major decrease (–20 percent) in Oceania, and a smaller one (–4 percent) in North Africa. In the developing countries, despite large increases in several regions, total per caput fat supplies remained at only 31 percent of those in the developed countries, and animal fat supplies at only 18 percent.

The contribution of fish to food supplies

As can be seen from Table 2.7, the contribution of fish to DES is very small at the world level: slightly less than 1 percent, or about the same as eggs. There have however been small increases in the share of fish in each of the regions and groups covered in the table. By 1979-81, the range was from 0.4 percent of DES in the Near East and the low-income developing countries to 1.6 percent in the developed market economies, and higher proportions are found in some developed and developing countries.

The contribution of fish to dietary protein is however more important, even if major differences among the groups can be observed. In 1979-81, fish provided 5.3 percent of total protein supplies at the world level, 4.3 percent in the developing and 7.6 percent in the developed market economies. Their contribution to world supplies of animal protein reached 15 percent; although the figure for the developed market economies was lower (13 percent), fish contributed no less than 20 percent of the meagre animal protein supplies of the developing market economies.

TABLE 2.7. **Share of major food groups in total DES by region and economic group, 1961-63, 1969-71 and 1979-81**

Food group	Developed market economies			Eastern Europe and USSR			Developing market economies			Africa		
	1961-63	1969-71	1979-81	1961-63	1969-71	1979-81	1961-63	1969-71	1979-81	1961-63	1969-71	1979-81
						(% of total)						
Vegetable products	69.2	68.4	68.3	77.6	75.0	72.9	91.9	91.9	91.4	93.7	93.5	93.5
Cereals	31.1	27.4	26.4	47.2	41.4	37.5	58.1	57.9	57.7	46.4	45.8	46.7
Pulses, nuts and seeds	2.6	2.4	2.4	1.6	1.5	1.4	8.1	7.0	5.6	8.1	7.9	7.0
Roots and tubers	4.9	4.2	3.7	7.9	7.3	6.0	7.1	7.3	6.2	21.7	21.7	19.8
Sugar	12.6	13.5	13.0	10.0	12.0	13.0	8.5	9.2	9.7	3.6	4.1	5.2
Vegetables and fruits	4.6	5.0	4.8	2.7	3.0	3.6	4.1	4.3	4.4	5.4	5.2	4.8
Vegetable oils and fats	7.9	9.7	11.3	4.5	5.0	6.0	4.6	5.1	6.3	5.6	6.1	7.6
Stimulants and spices	0.7	0.8	0.8	0.2	0.3	0.4	0.5	0.4	0.4	0.8	0.6	0.5
Alcoholic beverages	4.8	5.4	5.9	3.5	4.5	5.0	0.9	1.0	1.1	2.1	2.1	1.9
Animal products	30.8	31.6	31.7	22.4	25.0	27.1	8.0	8.1	8.6	6.3	6.5	6.5
Meat and offal	12.8	14.3	15.3	7.1	8.2	9.9	3.0	3.0	3.1	3.1	3.0	2.8
Milk	9.1	8.6	8.5	8.6	9.3	8.5	3.1	2.9	3.1	1.8	1.9	2.0
Animal oils and fats	6.0	5.6	4.7	4.9	5.2	5.8	1.3	1.3	1.3	0.6	0.7	0.7
Eggs	1.6	1.7	1.6	0.9	1.1	1.5	0.2	0.3	0.4	0.2	0.2	0.2
Fish	1.3	1.4	1.6	0.9	1.2	1.4	0.5	0.6	0.7	0.6	0.7	0.8

Food group	Far East			Latin America			Near East			Asian centrally planned economies		
Vegetable products	94.6	94.6	94.2	83.5	83.8	82.9	90.0	90.2	89.3	91.7	91.2	90.0
Cereals	66.7	67.6	67.4	40.4	39.6	40.2	64.9	61.7	58.2	63.5	66.2	66.9
Pulses, nuts and seeds	9.2	7.4	5.9	6.4	6.3	4.9	4.8	4.4	3.8	6.6	4.5	3.5
Roots and tubers	3.3	3.3	3.0	7.4	7.9	5.6	1.6	1.6	1.8	15.6	14.3	12.0
Sugar	7.8	8.4	8.4	16.0	15.6	17.2	6.5	8.5	9.9	1.1	1.4	1.8
Vegetable and fruits	3.0	3.0	3.3	5.5	5.7	5.4	6.9	6.7	6.4	2.4	2.2	2.2
Vegetable oils and fats	4.0	4.1	5.3	5.2	6.0	6.7	4.8	6.7	8.4	1.6	1.8	2.6
Stimulants and spices	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.4	0.1	—	—
Alcoholic beverages	0.1	0.3	0.4	2.3	2.4	2.6	0.2	0.3	0.4	0.8	0.8	1.0
Animal products	5.4	5.4	5.8	16.5	16.3	17.1	10.0	9.8	10.7	8.3	8.8	10.0
Meat and offal	1.0	1.1	1.2	8.4	7.8	8.1	3.6	3.6	4.0	6.0	6.4	7.4
Milk	2.7	2.3	2.5	5.0	5.2	5.5	3.8	3.4	3.7	0.5	0.4	0.5
Animal oils and fats	1.0	1.1	1.1	2.2	2.1	2.0	2.2	2.3	2.3	0.7	0.8	0.9
Eggs	0.1	0.2	0.3	0.5	0.6	0.8	0.2	0.3	0.4	0.7	0.7	0.7
Fish	0.6	0.7	0.7	0.4	0.5	0.7	0.2	0.2	0.3	0.4	0.5	0.5

Food group	Least-developed countries			Low-income countries			Middle- to high-income countries			World		
Vegetable products	92.8	93.1	93.3	92.9	92.8	92.0	89.6	89.5	88.9	83.5	83.5	83.7
Cereals	65.8	65.1	65.0	63.0	64.7	65.4	53.5	52.8	52.4	50.1	49.6	50.2
Pulses, nuts and seeds	6.7	6.7	6.5	8.2	6.4	5.1	6.0	5.6	4.8	5.3	4.7	3.9
Roots and tubers	7.7	7.7	8.3	10.3	10.0	9.0	9.0	8.5	6.7	8.2	7.8	6.9
Sugar	3.1	4.0	3.8	4.5	4.7	4.6	9.4	10.0	11.3	8.5	9.0	9.1
Vegetables and fruits	4.4	3.9	3.8	3.0	2.9	2.8	5.1	5.1	5.0	3.8	3.7	4.0
Vegetable oils and fats	3.0	3.5	4.1	3.0	3.2	4.2	4.8	5.6	6.6	4.9	5.6	6.6
Stimulants and spices	0.6	0.7	0.5	0.3	0.3	0.2	0.4	0.4	0.4	0.4	0.5	0.4
Alcoholic beverages	1.5	1.5	1.3	0.6	0.6	0.7	1.4	1.5	1.7	2.3	2.6	2.6
Animal products	7.2	6.9	6.7	7.1	7.2	8.0	10.4	10.5	11.1	16.5	16.5	16.3
Meat and offal	2.8	2.8	2.7	3.5	3.7	4.4	5.0	4.8	4.9	6.9	7.3	7.6
Milk	2.7	2.5	2.5	1.9	1.6	1.7	2.8	3.0	3.1	5.0	4.7	4.4
Animal oils and fats	0.9	0.9	0.8	0.9	1.0	1.1	1.5	1.5	1.5	3.0	2.8	2.5
Eggs	0.1	0.1	0.2	0.4	0.4	0.4	0.4	0.4	0.6	0.8	0.8	0.9
Fish	0.7	0.6	0.5	0.4	0.5	0.4	0.7	0.8	1.0	0.8	0.9	0.9

Staple foods. One of the most significant differences in food-consumption patterns between developed and developing countries, among individual developing countries and among geographical zones concerns the staple food of the area.

By 1969-71, animal products had already practically overtaken cereals as the primary dietary energy source of the developed market economies as a whole (see Table 2.7).

There were, however, local exceptions: in Japan rice was still the staple by 1979-81, while in southern Europe and Eastern Europe and the USSR, wheat continued to be the staple food by the same period.

These data are based on national average diets, as compiled in food balance sheets. In the developed countries such averages are useful indicators, because any major local differences have

TABLE 2.8. **Supplies of major nutrients by region and economic group, 1961-63, 1969-71, and 1979-81**

Region or economic group	Carbohydrate as share of total dietary energy			Protein					
				Total			Animal		
	1961-63	1969-71 (%)	1979-81	1961-63	1969-71	1979-81 (g/caput/day)	1961-63	1969-71	1979-81
Developed countries	59	57	55	90	95	99	45	51	56
Developed market economies	56	54	52	89	94	98	48	54	59
North America	48	47	47	100	105	105	67	72	71
Western Europe	56	54	52	88	92	98	44	50	57
Oceania	52	54	55	96	97	95	63	63	62
Eastern Europe and USSR	66	64	61	93	97	101	37	45	51
Developing countries	76	76	75	50	53	57	9	10	12
Developing market economies	75	75	74	53	54	57	11	11	13
Africa	72	72	72	53	54	56	10	11	11
Far East	77	78	77	47	48	51	6	7	8
Latin America	70	70	69	62	65	67	24	25	28
Near East	72	71	69	67	68	78	14	14	19
Asian centrally planned economies	78	78	77	46	51	58	7	9	11
Economic groups of developing countries									
Least-developed	75	75	75	54	54	53	10	10	10
Low-income food-deficit	77	77	76	48	50	54	7	8	9
Low-income	77	77	76	49	50	54	7	8	9
Middle- to high-income	73	73	72	55	58	65	14	16	19
World	69	68	68	63	65	68	21	22	24

Region or economic group	Fat								
	Share of total dietary energy (%)			Total		(g/caput/day)	Animal		
Developed countries	29	32	33	101	114	126	68	75	80
Developed market economies	32	35	37	112	126	137	75	81	84
North America	40	41	42	145	159	167	105	106	102
Western Europe	33	35	37	115	129	142	74	82	90
Oceania	36	34	33	126	125	117	109	103	87
Eastern Europe and USSR	22	24	27	79	90	102	54	63	71
Developing countries	14	14	16	31	34	40	12	13	16
Developing market economies	15	16	17	35	37	42	12	12	14
Africa	18	18	19	38	40	43	9	9	9
Far East	13	13	14	28	28	33	7	7	8
Latin America	20	20	21	52	56	60	28	29	32
Near East	17	18	20	43	48	64	16	17	22
Asian centrally planned economies	12	12	14	24	28	37	13	16	21
Economic groups of developing countries									
Least-developed	14	15	15	29	30	30	9	9	9
Low-income food-deficit	13	13	15	28	30	36	10	11	13
Low-income	13	13	14	27	29	35	11	12	14
Middle- to high-income	17	17	18	40	44	52	16	17	20
World	21	21	22	53	57	63	30	31	33

generally been blurred in the process of economic and social development. In the developing countries, on the contrary, considerable differences survive among geographical zones, chiefly because of the continued prevalence of subsistence production, the pattern of which depends essentially on ecological and traditional factors.

Different parts of the developing world thus still depend, for their staple food, on numerous different crops: wheat, barley, maize, rice, millet and sorghum, cassava, sweet potatoes, yams, cocoyams, plantains, etc. Animal products are the staple food in parts of some developing countries, notably Argentina and Uruguay.

But large differences exist, even within the boundaries of a single country. In India, for example, rice is the staple food of the country as a whole according to food balance sheet data, but a national sample survey of 1972-73 (1982) indicated that this was in fact true in only 15 of the 24 Indian states, representing 53 percent of the total population; millets and sorghum were the staple in four states (25 percent of the population), wheat in four more (21 percent) and maize in one (1 percent). Similar differences are to be observed in China, where rice is also the staple food according to the national food balance sheet. But even in much smaller countries, particularly in Africa south of the Sahara, several distinct staple-food zones are to be found.

The principal recent changes in staple-food patterns in the developing countries is the decline in the role played by the traditional roots and tubers, especially in Latin America and Africa. This phenomenon is a result, at least in part, of rapid urbanization: the urban populations of the developing countries rose from 22 percent of their total population in 1960 to 30 percent by 1980, and in Latin America the figure actually reached 65 percent. Urbanization and rising incomes, often reinforced by increasing familiarity with foods consumed in industrialized countries and by the mounting internationalization of foods, are leading to changes in tastes, and urban diets are increasingly shifting from traditional local cereals, roots and tubers to wheat and rice.

3. The incidence of undernutrition and malnutrition

This chapter examines the nutritional consequences of changes in per caput DES that took place in the 1970s, and in particular contains estimates of the number of people in the developing market economies who suffer from undernutrition*.

The approach adopted is twofold. First, an attempt is made to look beyond the overall per caput aggregate, which merely shows how the average person has fared in each country, toward the distribution of food among separate groups within countries, in order to determine how many people do not have access to enough food to remain healthy. Second, nutrition survey* results, indicating the extent to which people show the measurable results of having to live on inadequate diets, are reviewed.

Both methods present major difficulties that arise not only from the inadequacy of the data but also from gaps remaining in the understanding of the complex relationships among food consumption, health, disease and nutrition*. The shortage of actual food-consumption data in most developing countries makes it necessary to continue to rely heavily on food-supply figures in national food balance sheets. The paucity of survey data on the nutritional status* of adults also makes it necessary to make abundant use of observations of malnutrition* in children as indicators of the nutritional status of the population at large.

However, considerable progress has been made in this regard. Actual measurements of household food-consumption, body weight and other anthropometric characteristics have become available for a growing number of developing countries, where a greater number of regular nutrition surveys and more regular monitoring of child growth provide more extensive and reliable information on the prevalence of malnutrition among children. Our knowledge of nutritional requirements* has also expanded, so that more confidence can be placed in the estimates of minimum requirements that underlie the analysis.

Among the most important areas of uncertainty outstanding is the fact that it is not yet possible to isolate the effects of lack of food from those of other factors, especially infectious diseases. The more that is learned about this relationship, the more it appears that hunger and sickness are inseparable, and that poverty is the underlying cause of both. Other matters that have not yet been fully investigated include the capacity of individuals to adapt themselves to varying dietary intakes, and a method of taking into account the great variety of physical work patterns in assessing dietary-energy requirements.

In the presence of these limitations, the objective here is to assess whether the numbers of the undernourished or malnourished in the developing countries increased during the 1970s. The analysis begins with a brief discussion of the nature of undernutrition and malnutrition and their relation to ill health. The methodological aspects of estimating the incidence of undernutrition are then examined in some detail, with particular emphasis on improvements in knowledge and methodology since the 1977 publication of *The Fourth World Food Survey*. In conclusion, the estimates of the incidence of undernutrition in the developing countries are set out, followed by other available evidence on the extent of malnutrition in those countries.

Undernutrition, malnutrition and ill health

A distinction is sometimes made between *undernutrition*, defined as being a result of insufficient food of whatever kind, and various forms of *malnutrition*, arising from deficiencies of specific nutrients or from diets based on the wrong kinds or proportions of foods. Under these definitions, undernutrition is caused primarily by an inadequate intake of dietary energy, whether or not any specific nutrient is a limiting factor, while conditions such as goitre, scurvy, anaemia and certain eye defects would be described as forms of malnutrition, caused respectively by inadequate intakes of iodine, vitamin C, iron, and vitamin A.

In practice, developing-country population groups suffering from undernutrition or malnutrition as defined in this way are likely to be more or less the same. Where signs of vitamin or mineral deficiencies are observed, they are almost always associated with low dietary-energy intakes, and where these intakes are sufficient, specific nutrient deficiencies (especially of protein) are seldom a problem. (The different question of developed-country malnutrition is examined in the Box.) Furthermore, the most common and reliable measurements of nutritional status are based on growth in children and body-weight changes in adults. Growth rates can be reduced and weight lost as a result either of specific nutrient deficiencies or of a lack of dietary energy, or of a combination of both.

The malnutrition of abundance

Although by far the most widespread and serious food problems are encountered in the developing countries, there are still some remaining pockets of undernutrition in the developed countries and a large incidence of malnutrition, and these are likely to have increased during the recent period of economic recession and rising unemployment.

The principal nutritional problems of the developed world, however, are currently created by overnutrition* and the improper composition of diets. As has been seen in Chapter 2, not only has the developed countries' average consumption of dietary energy increased to very high levels, but important changes in consumption patterns have also taken place. The consumption of such traditional staples as cereals and potatoes has declined; sugar, fats and alcohol have contributed a greater share of dietary energy (although in some countries the consumption of animal fats has fallen); the fibre content of the diet has gradually been decreasing; and salt intakes are believed to have risen. Many of these changes are closely associated with the growing role of highly refined processed foods.

Obesity* appears, despite the lack of a generally agreed definition of the condition, to be on the increase. It has been estimated (Abraham *et al.*, 1983) that in the United States 28 percent of males and 19 percent of females are obese, and (UK, 1983) that in the United Kingdom 39 percent of males and 32 percent of females are obese or overweight*.

For the purposes of this survey, the term "malnutrition" is used in a broader sense, referring to any physical condition implying ill health that can be brought about by an inadequate diet; it thus includes undernutrition as well as specific nutrient deficiencies. At the end of this chapter, the extent of malnutrition as thus defined is discussed in terms of a number of different indicators, based on birth weight, child growth and the incidence of anaemia*.

Undernutrition, which receives primary emphasis in this chapter, is defined as the fact of having a dietary-energy intake below certain minimum requirement levels, whether or not accompanied by inadequate intakes of protein or other specific nutrients. This emphasis on dietary energy as a general measurement of food adequacy seems pragmatically justified: increased dietary energy, if derived from normal staple foods, brings with it more protein and other nutrients, while raising intakes of such nutrients without providing more dietary energy is unlikely to be of much benefit to the individual. Thus, in most situations, increased dietary energy is a necessary condition for nutritional improvement, even if it is not always sufficient in itself.

Interactions with infectious diseases. At the same time, it is essential to recognize that undernutrition is not always exclusively a result of inadequate access to food. Adverse environmental factors (such as poor housing, poor sanitation, an inadequate or unsuitable water supply) and health considerations, often closely related, are also important. Infectious diseases in particular interact with nutrition in several different ways. While these matters are discussed in greater detail in Chapter 4, they are mentioned here because they have a bearing on estimates of the incidence of undernutrition.

Diseases such as diarrhoeas, malaria and measles may increase dietary-energy requirements* by raising the body temperature or the rate of catabolic nutrient losses. Such infections generally depress appetite, thus lowering food intakes. Diarrhoeas also reduce food-absorption efficiency, so that some dietary energy simply passes into the faeces and is lost.

These interactions make it difficult to distinguish clearly between undernutrition caused in the first place by food deprivation and that brought about by infection. The negative effect on appetite, in particular, indicates that some low food intakes may be a result of infection rather than of lack of food. When this occurs, nutritional improvement can result only from curing the infection: more food would not help. On the other hand, infections that increase food requirements or reduce food absorption may lead to undernutrition in subjects whose dietary-energy intakes would otherwise be adequate. If they could be induced to eat more, their health might improve.

In the present state of knowledge, dietary-energy requirements usually have to assume optimum or at least favourable environmental and health conditions. Since these conditions are in fact adverse in most developing countries, actual minimum requirements are likely to be higher than those specified. Thus, *the assessment of the extent of undernutrition is unable to include some individuals who are undernourished primarily because of adverse environmental and health factors.*

Methodology for estimating undernutrition

A full account of the methodological aspects of the survey and the principal changes and refinements introduced in the methodology since *The Fourth World Food Survey* (FAO, 1977a) will be found in the Appendix. The present section is designed to present the salient features of the methodology in non-technical terms, for the non-specialist reader.

The basis of the methodology is the construction, for the population of each country, of a distribution of dietary-energy intake; the population is then divided into two parts, using a cut-off point based on estimated minimum dietary-energy requirements*, and that part of the population whose intake is below the cut-off point is defined as undernourished.

The distribution of dietary-energy intakes is expressed in terms of household per caput averages, as estimated on the basis of available data from household surveys* of food consumption. The cut-off point, also in per caput terms, is based on minimum daily requirements of dietary energy, using national averages for the age and sex composition and body weights of the population. Since demographic and body-weight characteristics of individual household members are likely to diverge from these averages, the technique will inevitably lead to some misclassification errors, but the resulting error in the overall estimate of the incidence of undernutrition is unlikely to be large.

Minimum requirements and the cut-off point. The key issue in this approach is the establishment of dietary-energy requirements of individuals in different age and sex groups, to be used for deriving the cut-off point. A 1981 expert consultation (FAO/WHO/UNU, 1985) defined an individual's energy requirement as "that level of energy intake which will balance energy expenditure when the individual has a body size and composition and level of physical activity consistent with long-term good health, and which will allow for the maintenance of economically necessary and socially desirable physical activity". Thus, the energy requirement under this definition should include allowances not only for the maintenance of physical health but also for the performance of "economically necessary and socially desirable physical activity".

Including the latter would make it possible to know how many people are undernourished in the conventional sense and/or constrained in their ability to work or enjoy leisure as a result of the lack of food, i.e. the "food-constrained nutrition" problem (see Appendix, Section I).

Unfortunately, this is not yet a realistic proposition for all countries. Although energy-expenditure rates are known for many occupational and leisure activities, they vary widely among individuals and circumstances, as well as over time (in such seasonal activities as farming). Moreover, detailed occupational and time-allocation data, needed in calculating an approximate activity allowance, are not available for most developing countries. Some average figures could be assembled for a few populations, but even this would entail value judgements about norms of social behaviour, and the resulting estimates would be subject to such large statistical error as to be of little value for comparative purposes.

There is, however, a more readily determinable physical-activity level below which even maintaining health becomes impossible: the activity associated with eating, washing, dressing, etc. as well as minimum movement and other activity needed for communication. Sufficient evidence was not available in 1981 to enable the FAO/WHO/UNU Expert Consultation to formulate a definite operational recommendation on this "maintenance-requirement" concept, but the experts felt that until further information became available, *a figure corresponding to 1.4 times the basal metabolic rate* (1.4 BMR) should provide a guide.* More recent research on human calorimetry has tended to confirm this figure. Any shortfall in intake from the level of requirement thus established will necessarily lead to undernutrition (in the physical sense). However, as will be seen at the end of Section I of the Appendix, the measurement based on such a minimum requirement is likely to underestimate the actual incidence of undernutrition, because of the very low level of activity implied.

The group of experts further recommended that the average BMR ($\overline{\text{BMR}}$) for adults and adolescents in a given age and sex group be calculated according to body weight. This raises the question as to whether to use the actual body weight of the population, when known, or some estimate of desirable body weight. Research since the fourth world food survey indicates that there is a safe range within which individuals can adjust their body weight in response to changes in energy intake without danger to health. Body weights used in the present energy-requirement estimates therefore correspond to *the lower limit of the range of desirable weight* for a given height that are proposed by the Expert Consultation *for adults and adolescents.*

As regards children, research suggests that the growth paths along which they develop vary to a certain extent without known detrimental effects. The lower limit of the range of body weight for a given height has therefore been used for children as well. The minimum requirements for children have however not been based on BMR, since children also need energy for growth and for a minimal level of exploratory activity. *Requirements for children have been based rather on the Expert Consultation's recommended intakes per kg of body weight.*

Individuals can adapt to changes in energy intake and expenditure not only through changes in weight but also through changes in body composition and in the efficiency with which they can carry out metabolic and mechanical work. Here, however, there is less certainty as to the safe limits within which such changes can occur without detriment to health. Moreover, very little is known about changes in body composition, such as changes in the relative proportions of muscle and fat.

It is however generally accepted that maintenance requirements vary from one individual to the next. The coefficient of variation of the energy expenditure for maintenance for adults of the same body weight has been found to be about 7 percent, regardless of sex (see Appendix, Section III). It is also accepted that some differences also exist among ethnic groups.

Two different hypotheses have been advanced to account for the variability in maintenance requirements. The first suggests that it primarily reflects intra-individual variations in requirements and in the capacity of an individual to adapt to different intake levels. According to this view, an individual cannot be considered to be suffering from any health penalty as long as he or she is within the range of the observed variation, and the lower end of the range would constitute the safe limit. It can be calculated (see Appendix, Section II) that the minimum maintenance requirement under this hypothesis would be 1.2 $\overline{\text{BMR}}$.

The second hypothesis suggests that the observed variability is largely a result of fixed genetic differences among individuals. According to this view, any forced change would represent a departure from a desirable state and might result in some health penalty. The range of variation in maintenance requirements thus primarily reflects differences among individuals, and the choice of any level within the range would involve errors of miscalculation. To allow for this factor, and to balance the risks of under- and overestimation, the average of the range of observed variation is more appropriate than its lower limit. It can be calculated that under this hypothesis the minimum maintenance requirement is 1.4 $\overline{\text{BMR}}$.

Although there is some evidence to support the first hypothesis, no conclusive proof has yet been found for either of them. Because of the uncertainty thus created, 1.2 $\overline{\text{BMR}}$ and 1.4 $\overline{\text{BMR}}$ have been adopted as alternative estimates of maintenance requirements for *The Fifth World Food Survey*.

As already noted, these requirements refer only to adults and adolescents: data are not available on variations in requirements of children per kg of body weight. To arrive at average per caput requirements for the entire population, the two alternatives for adults and adolescents are calculated by age and sex, and combined with a single set of estimated minimum requirements for children under ten years of age, and a fixed allowance is made for pregnancy and lactation in women of reproductive age, on the basis of the age and sex distribution of the population. The two per caput figures finally used as alternative cut-off points thus reflect the application of the two interpretations of the observed variation in the maintenance-energy requirements of both adults and adolescents.[1]

Distribution of dietary-energy intakes. Whereas determining the cut-off point for estimating the incidence of undernutrition involves important conceptual as well as data problems, the principal difficulty in estimating the *distribution* of dietary-energy intakes, the other aspect of the question, arises from the shortage of satisfactory information. The only existing worldwide data on food consumption are the supply estimates derived from food balance sheets, of which much use has already been made in Chapter 2. Such sheets have been prepared for most developing countries, but they are published only for the 112 countries whose data are considered fairly reliable. However, they provide information only on national aggregates or average levels of food availability which are used as a proxy for actual food consumption.

Sample surveys, through which household-level data are collected on food consumption and related variables, serve as the main source of information on the distribution of food consumption within the country concerned. Such surveys are not available for all the developing countries, and they differ in their information content. Nonetheless, where they are available they can be used in conjunction with food balance sheets to provide approximate food-intake distributions within a country.

However, using them to estimate the incidence of undernutrition creates two main problems: the fact that very few such surveys provide data on the distribution of households by dietary-energy intake, and the fact that such surveys as are available seldom fall into either of the reference periods, at the beginning and end of the 1970s, considered in *The Fifth World Food Survey*.

It has therefore been necessary to assume a theoretical distribution of dietary-energy intakes and then to use the data available to estimate the distribution parameters (see Appendix, Section IV). This theoretical model serves both to standardize the intake distribution where the appropriate

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[1] It is obvious that under no circumstances should either figure be regarded as a *recommended* intake level for the population. As already pointed out, a range of acceptable body weight exists for any individual of a given height, and the requirements estimated here are based on the *minimum* of the range in order to provide a criterion for identifying individuals whose intakes are below a certain minimum level. Societies can of course set targets anywhere within the acceptable range of body weights, and recommend dietary intakes accordingly.

Similarly, the requirements for adults and adolescents defined here exclude any allowance for physical activity proper. It is not implied that the minimal activity on which they are based is in any sense appropriate for anyone: it is merely a tool for generating a consistent minimum requirement level, whose only justification is the lack of better data. Any recommended intake must obviously include an allowance for a desirable level of physical activity in both work and leisure, which can be based either on the present level or on a target level.

data are available, and to generate an intake distribution where there are gaps in the database.

The data on per caput DES, which as already noted are available for nearly all countries, have been taken as the average or mean of the distribution, while the household surveys were used to estimate the variability of intake among households (the coefficient of variation). It has also had to be assumed that the estimated variability, which actually referred to the periods covered by the surveys, was applicable to both reference periods adopted, and therefore that the distribution remained unchanged over the decade.

Unfortunately, the household surveys used differ widely in the information they yield. Some provide household-level information on dietary-energy intake, others only average intakes for broad income groups, and still others no intake data at all, limiting themselves to information on the distribution of other variables, such as food expenditure, total income or total expenditure. Maximum use therefore had to be made of any information that had a bearing on the distribution of intakes in each country, and thus the specific technique adopted differed among countries according to data availability.

Where detailed household-level or income-group intake data were available, the coefficient of variation of intake was estimated directly from the survey data; these countries account for as much as 64 percent of the total population of the 98 countries in the analysis. For another 16 percent of the total population, some distribution data, such as income or expenditure, were available. Where income distribution data alone were available, variation in intakes was deduced from variation in income by assuming a functional relationship between the two, and the income-related variation was then increased, on the basis of other countries' household surveys, to allow for residual factors other than income, which can account for 40-90 percent of the variation. An estimate of the extent to which dietary-energy consumption varies with income (income elasticity) was derived more or less directly according to the information available and used to convert variations in income to variations in intake.

Where even income or expenditure data were unavailable, the coefficient of variation of dietary-energy intake of a given country was assumed to be equal to the average for the region to which the country belongs. Since there were many countries in this category, the results for individual countries are not shown, but only those for regions and economic groups of countries. The ACPE countries were excluded not only for lack of suitable distributional data but also because their differences from the developing market economies are too great for assumptions to be made in their regard with any degree of confidence.

General considerations. By bringing together estimates of dietary-energy intake distributions and the two cut-off points, two alternative estimates of the proportion of the population whose food intake is inadequate are obtained; applying this proportion to the total population yields estimates of the corresponding absolute numbers. Before presenting the results of this analysis, however, it is necessary to recall or mention several points that should be borne in mind in using them as estimates of the incidence of undernutrition.

1) Dietary-energy requirements used to determine the cut-off points assume optimum — or at least generally favourable — environmental and health conditions other than food, such as are seldom found in developing countries. The presence of adverse conditions such as infectious diseases will generally raise per caput requirements, and thus the numbers of the undernourished.

2) The requirements calculated for adults and adolescents represent absolute minima in that they allow only for maintenance activity. To reflect reality, the minimum activity allowance would have to be higher, and this would again raise the numbers of the undernourished.

3) Estimates of dietary-energy intake distributions refer to households rather than to individuals. Within the household, intakes may not be distributed in accordance with actual individual requirements.

4) A low food intake does not immediately result in undernutrition: it initiates a process that leads to undernutrition only if it is continued. In other words, the observed intakes of individuals make it possible to say only whether they risk undernutrition if they continue to consume at the same rate and if their requirements are not reduced.

5) Intake variability has been assumed to remain unchanged between the two reference periods.

Points (1) and (2) imply that the methodology adopted may lead to underestimating the number of the undernourished.

Point (3) suggests that the number may exclude individuals who — at the very least — risk undernutrition, while (4) suggests that the estimated numbers include individuals who should be regarded as risking undernutrition as defined for the purposes of the survey, rather than being actually undernourished. The results are probably most affected by the fact that no consistent allowance for minimum desirable levels of physical activity was included in the requirements for adults and adolescents, in order to avoid making too many controversial assumptions on the basis of incomplete information. Although point (5) introduces an element of uncertainty in the estimated changes in the numbers of the undernourished, actual changes in variability, if any, cannot be large over a time span of only a decade. The resulting estimates should therefore provide a useful indication of the broad magnitude and direction of changes occurring during the 1970s.

Incidence of undernutrition in the developing countries

The total numbers of the undernourished in the developing market economies as a whole, estimated through the methodology outlined above and subject to all the foregoing reservations, are set out in Table 3.1, which also indicates the changes in the incidence of undernutrition between 1969-71 and 1979-81 according to the two alternative cut-off points. The global figures are summarized graphically in Figure 3.1.

The estimates under both alternatives indicate *a slight rise in the absolute numbers of the undernourished* during the 1970s. Under the more conservative Alternative A (dietary-energy requirements for adults and adolescents: 1.2 $\overline{\text{BMR}}$), they totalled 335 million in 1979-81 as against 325 million in 1969-71; under Alternative B (requirements: 1.4 $\overline{\text{BMR}}$) the corresponding figures were 494 and 472 million. In both hypotheses, however, *the proportion of the undernourished in the total population declined*: from 19 to 15 percent according to the more conservative estimate and from 28 to 23 percent according to the higher. The fact that the increases in numbers were, statistically speaking, so small implies that it was nonetheless possible to feed, fairly adequately, the vast majority of the 470-million increase in the population of the developing market economies during the 1970s.

According to the estimates, the numbers of the undernourished rose slightly during the 1970s in all the developing regions except the Near East, the greatest increase being observed in Africa. Because of the large populations involved, by far the greatest numbers of the undernourished are in the Far East (63 percent of the total of the developing market economies in 1979-81, under both alternatives). In terms of proportions of the total population, there was a fall in all regions, but by 1979-81 Africa had replaced the Far East as the region with the highest proportion of the undernourished.

Among the economic groups, the absolute numbers of the undernourished increased in all except the group of the middle- to high-income countries, where a substantial reduction took place. The undernourished proportion of the population, on the contrary, decreased in all groups except the LDCs, where it was as high as 28 and 36 percent in 1979-81, according to Alternatives A and B respectively. The low-income food-deficit countries contained 83 percent of the total undernourished in 1979-81.

The overall increase in the number of the undernourished in the developing market economies, despite the general rise in per caput DES and the fall in the proportion of the undernourished, reflects essentially the role of population growth. To illustrate this fact, Table 3.2 shows the growth rates for groups of the 98 developing countries,[1] their undernourished population and the proportions of the latter, classified according to the individual countries' growth rate of per caput DES.

The table brings out clearly the expected negative relationship between changes in per caput DES and in percentages of the population under-

TABLE 3.1. **Undernourished population of developing market economies by region and economic group, 1969-71 and 1979-81**

Region or economic group	Total population (millions)		Number of undernourished (millions)				Proportion of population undernourished (%)			
			Alternative A [1]		Alternative B [2]		Alternative A [1]		Alternative B [2]	
	1970	1980	1969-71	1979-81	1969-71	1979-81	1969-71	1979-81	1969-71	1979-81
Regions										
Africa	282	376	57	70	81	99	20	19	29	26
Far East	986	1 232	208	210	303	313	21	17	31	25
Latin America	278	357	36	38	53	56	13	11	19	16
Near East	159	210	23	16	34	25	15	8	22	12
Economic groups										
Least-developed	217	280	55	77	74	102	26	28	34	36
Low-income food-deficit	1 200	1 522	258	278	372	406	21	18	31	27
Low-income	913	1 153	199	237	288	343	22	20	31	30
Middle- to high-income	795	1 026	126	98	184	151	16	10	23	15
Total developing market economies (98 countries)	1 708	2 179	325	335	472	494	19	15	28	23

See text for basis of estimates. Economic groups are defined in the Glossary.

[1] 1.2 $\overline{\text{BMR}}$ for adults and adolescents; [2] 1.4 $\overline{\text{BMR}}$ for adults and adolescents.

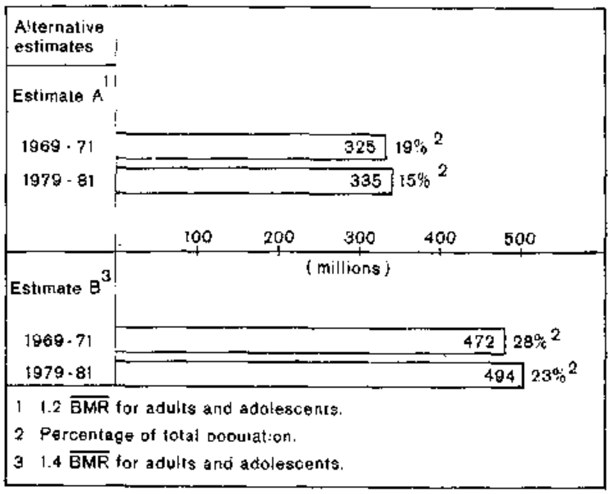

Figure 3.1 *Undernourished population of developing market economies according to two alternative estimates, 1969-71 and 1979-81*

nourished: the proportion of the undernourished increases when per caput food availability decreases, and vice versa. The trend is not reflected precisely in the numbers of the undernourished: the 19 countries where per caput DES increases least rapidly (up to 0.5 percent per annum) still show an increase in the absolute numbers of their undernourished, owing primarily to their 2.2 percent population-growth rate. With higher rates of increase in the per caput DES, the resulting greater decline in the percentage undernourished more than offsets population growth, so that the numbers of the undernourished also decrease. Such decreases which have occurred in a majority of the countries, have however not been sufficient to offset the increases in the countries where per caput DES either declined or increased slightly.

Indicators of malnutrition

Comparative data, referring for the most part to children and further indicating the extent of malnutrition, are available for a number of indicators of nutritional status other than food supplies and intake.

As mentioned above, one major — and easily measured — response of children to dietary changes or to the varying burdens of disease is an alteration in their growth pattern. Diets that are poor in terms of quantity or quality, and high rates of diarrhoea and other infections, lead to reduced growth rates and delayed maturity. Although — within limits — these responses are not known to cause any health penalty, it is clear that if growth is retarded to a certain extent the risk of permanent impairment of function, or even death, rises sharply. A severe shortage of protein, essential for growth, can impair a child's brain development, although it is still uncertain whether the damage is irreversible.

Weight and height data for individual children in different age categories below the age of five, compared with a reference growth-pattern (such as those established by WHO on the basis of measurements of well-nourished, healthy children), are used to assess the extent of malnutrition in a population. The most commonly used indicators are the numbers and proportion of children whose weight-for-age or weight-for-height are more than two standard deviations below the median value for the reference growth-pattern, and the proportion of births below an established standard weight.

The first of these indicators, children with low weight-for-age, is often used to measure the incidence of protein-energy malnutrition (PEM)[*]. However, a child who is underweight for his or her age may be so as a result of a recent episode of malnutrition ("acute" malnutrition) or of a sustained past episode or episodes ("chronic" malnutrition). One means of distinguishing between the results of acute and chronic malnutrition is to examine the second indicator, low weight-for-height, which in effect assesses the incidence of acute PEM. The third indicator, low birth weight, generally reflects an unsatisfactory nutritional status during pregnancy.

A further indicator of malnutrition is the incidence of anaemia in women, which partly reflects dietary inadequacies (primarily iron deficiency) but also the incidence of malaria and other parasitic infections that increase blood losses.

TABLE 3.2. **Per caput food-supply and population growth, 1969-71 and 1979-81 (98 developing countries)**[1]

Annual growth rate of per caput DES (%)	Number of countries	Average annual growth rate (%)		
		Total population	Undernourished population[2]	Percentage undernourished[2]
Under –1.0	7	3.0	8.5	5.5
–1.0 to –0.1	20	2.5	4.2	1.6
0.0 to 0.5	19	2.2	0.8	–1.4
0.6 to 1.0	23	2.8	–0.1	–2.8
1.1 to 2.0	20	2.4	–3.8	–6.3
Over 2.0	9	2.4	–8.4	–10.8
Average		2.4	0.3	–2.1

[2] Alternative A estimates.

[1] i.e. 112 countries for which food balance sheets are published, minus China and 29 countries with populations under 0.5 million, plus the following 16 countries: Afghanistan, Angola, Chad, Cyprus, El Salvador, Ethiopia, Gabon, Guinea-Bissau, Iran, Iraq, Jordan, Laos, Lebanon, Namibia, Nicaragua and Papua New Guinea.

Broad regional estimates relating to these four indicators, as compiled by WHO, are set out in Table 3.3. Although FAO's and WHO's regional classifications do not coincide, it is interesting to compare the WHO estimates with those of FAO in Table 3.1. The relative situations of Africa and Latin America appear to be roughly the same in both sets of estimates, particularly as regards FAO's Alternative B. On the contrary, for WHO's Asian region, which corresponds roughly with FAO's Far East region, the incidence of malnutrition shown in Table 3.3 is far higher than in the other regions, especially for low weight-for-age and anaemia. It is possible that the burden of infectious disease is greatest in Asia. Possibly, too, the reference standards for the body size of children, which are not differentiated by region, may be too high for the Asian region, where generally lower weights and heights may represent a long-term adaptation.

TABLE 3.3. **Indicators of malnutrition in developing regions**

Region	Children under 5 years: Low weight-for-age [1]		Low weight-for-height [1]		Low birth weight [2]	Anaemia in women
	(millions)	(%)	(millions)	(%)	(%)	
Africa	22	26	4	7	14	40
Asia	115	54	33	16	19	58
Latin America [3]	9	18	2	4	10	17

[1] More than two standard deviations below the median value for the WHO reference growth-pattern; [2] Below 2 500 g. [3] Excluding Argentina and Uruguay.
Sources: Keller & Fillmore, 1983; Royston, 1982; WHO, 1984a, 1984b.
The estimates are based on sample surveys taken at varying times between 1973 and 1983. The number of countries for which information is available being limited, they are not fully representative of the regional situations. Often the underlying sample-survey data cover only a few areas of a particular country.

Anthropometric studies of the nutritional status of adults are rare, partly because it is difficult to establish satisfactory reference standards. Direct comparisons of the incidence of malnutrition in children and in adults are therefore not currently possible. However, even bearing in mind their lack of comparability with the data in Table 3.1, those in Table 3.3 suggest strongly that the incidence is far greater among young children than among adults: the incidence among children under the age of five appears to be very much higher than the share of this age group (16 percent) in the total population of the developing market economies. More recent child mortality and nutritional status statistics suggest that the situation is worsening in some African and Asian countries.

4. Multidimensional aspects of malnutrition

The estimates of the incidence of undernutrition and malnutrition in Chapter 3 focus attention on the magnitude of the problem and indicate recent changes in the situation. In order to define suitable policies and adequate measures for nutritional improvement, it is necessary to go much farther, identifying the malnourished more precisely and determining why they are malnourished.

These are complex questions. Malnutrition does not have an equal impact on all population groups: in any society the poorest people, such as the unemployed and the landless, suffer most because they lack the resources for obtaining an adequate diet, and within the poorest groups, the young children and pregnant and lactating women are the most vulnerable because of their supplementary nutritional requirements. Preschool children are the most seriously affected, and their risk of malnutrition is often enhanced by one or more diverse factors: large family size, high dependency ratio, high birth order (e.g. four and above), illiteracy of parents, single parentage, age and stature of the mother, low per caput land availability, poor access to social services, etc.

The causes of malnutrition are thus multidimensional and include both food and non-food factors, which combine to form a web of biological, socio-economic, cultural and environmental deprivations. In a review of mortality and morbidity trends in Bangladesh between 1970 and 1975 (Mosley, 1979; p. 77), it was found that the crude mortality rate, the infant mortality rate and the childhood malnutrition rate fell and rose with improvements and deteriorations in food supply that were largely determined by political, economic, climatic and social factors. An inter-country (cross-sectional) simple correlation analysis summarized in Table 4.1 shows significant correlation among three indicators of malnutrition and a number of variables relating to income, food supply, environment, and social and health status. Evidently, some of these variables are themselves interrelated and do not necessarily indicate a cause-and-effect relationship, particularly at such a level of aggregation, but they demonstrate that in addition to income and food supply, many social, health and environmental factors influence the incidence of malnutrition. Thus, the infant-mortality and access-to-medical-care variables reflect general health status; access to sanitation and safe water reflect environmental quality; female illiteracy and per caput income reflect socio-economic status; while per caput dietary energy reflects the food supply.

Malnutrition, then, is more than a problem of poverty or food supply. While virtually all people suffering from a lack of food are poor, not all the poor are malnourished. On the other hand, even when a household has what ought to be an adequate food supply, some of its members may still be malnourished. The individual food entitlement within a household is affected by family size and many other socio-cultural variables, including intra-family food sharing, food preparation methods, socio-cultural determinants of food habits, and child-rearing practices. The type, quality, nutritional value and handling of the available food are also important. But in addition to food itself, there is another set of entitlements to goods and services, such as housing, water supply, sanitation, fuel, and health care which, as has been seen, can have substantial effects on food utilization and individual nutritional requirements.

The nutritional status of the individual that is the final outcome of all these processes determines, in turn, the amount of physical energy that can be invested in the system so as to sustain the level of entitlement and ensure healthy survival, i.e. the individual's working capacity. Nutritional status is thus an outcome of food entitlement and utilization, and at the same time an input for generating income.

Generally, a disfunction or breakdown in any part of this complex system will, if sufficiently prolonged, result in malnutrition. The time-lag before malnutrition sets in will, however, depend on the severity and duration of the incident and the level at which it occurs.

Within such a broad framework, this chapter explores the nature and impact of the many different factors that act as determinants of malnutrition, roughly classified as economic, food-production, social, cultural and environmental factors. Based on the results of many household surveys and other detailed studies, the analysis concentrates mainly on the situation of households and individuals.

At various points in the chapter, the human impact of the multidimensional aspects of malnutrition is illustrated by typical profiles of malnourished families, in order to shed light on the vulnerability of certain types of households. The data used for these profiles, drawn from developing countries representing a broad range of socio-economic settings, are based on available information, although the resulting families and households are constructed for the purpose of illustration and do not actually exist as such.

TABLE 4.1. **Intercountry correlations among indicators of malnutrition and other variables**

Other variables \ Indicators of malnutrition	Incidence of: Low height for age (stunting) [1]	Incidence of: Low weight for height (wasting) [1]	% of population undernourished [2]
	(coefficient of correlation) [3]		
Per caput dietary-energy supply	−0.5 (38)	−0.5 (38)	...
Illiteracy in women	[4]0.3 (38)	0.4 (38)	...
Infant mortality	[4]0.3 (21)	0.5 (21)	0.5 (98)
Household with access:			
to sanitary facilities	−0.5 (21)	−0.5 (21)	...
to safe water supply	−0.5 (21)	−0.6 (21)	−0.6 (80)
Population per medical doctor	...	...	0.5 (93)
Per caput income	−0.5 (38)	−0.4 (38)	−0.4 (98)

[1] In children 1 to 2 years of age; [2] Based on 1.2 BMR cut-off point (see Chapter 3); [3] Figures in brackets indicate number of countries in analysis; [4] Correlation not significant.
Sources: FAO and WHO estimates. Countries were selected on the basis of data availability.

Economic factors

In Chapter 2 it was seen that per caput dietary-energy supplies (DES) tend to be much lower in developing than in developed countries, and lower in low-income developing countries than in the middle- to high-income countries of the developing group. Similarly, the analysis in Chapter 3 brought out the heavy concentration of undernourished people in the low-income developing countries. Although it is increasingly recognized that the level of income is by no means the only cause of variability in food intake, it is clearly by far the greatest single cause, especially among the poorest sectors of the population. Moreover, even though income is not the only measure of poverty, many other social and environmental factors contributing to malnutrition are closely linked to the poverty of individuals or of countries.

At the community or village level, a number of studies confirm the tendency for malnutrition to be concentrated in low-income groups. Studies in Bangladesh (1983), Colombia (Wray and Aguirre, 1969), India (Levinson, 1977) and Iran (Hedayet, 1971) show an association between economic status (as measured by income or wealth) and indicators of malnutrition. Others in India (World Bank, 1980) and Nigeria (Simmons, 1976b) that examined food expenditure (proxy for dietary-energy intake) as a proportion of total expenditure (proxy for income) also confirm the link between income and nutrition.

In rural areas of developing countries, income from home-produced food and payments received in kind are generally more important than cash income (leading to food purchases) in determining food availability in a household, while in urban areas food availability is determined primarily by cash income.

It may perhaps appear self-evident that families with greater economic resources (higher and more assured income, and assets on which to rely in times of stress) should be at less risk of malnutrition. However, there are exceptions to this general rule, particularly in child malnutrition where, as is discussed later in this chapter, many non-economic variables can intervene. One example is the overriding influence of infection in large, rich households in areas of Nigeria where polygamy is common (Longhurst, 1980). Another is reported from Nicaragua (Wolfe and Behrman, 1982), where it was found that income is not an important determinant of child mortality, health and nutritional status: in urban areas, weights of children in families where the women obtain non-industrial employment, and are thus able to combine work with child care, were more adequate than in families where women work full-time in the formal sector.

Studies in India (Shah, 1980) and Tunisia (Périssé and Kamoun, 1981) also found that, even in the poorest income groups, some households could satisfy their dietary-energy needs better than others by reconciling food preferences with income through the purchase of cheaper food, while others were unable to meet their needs because they were imitating richer families or were otherwise unable to reconcile their food habits* with their economic status.

Income fluctuations are also important. Families with steady employment or salaried members are better able to plan commitments, especially large life-cycle expenditures such as marriages and births, and to store assets (cereals, livestock, body fat) against unforeseen contingencies. Income security, even at fairly low levels, helps people to avoid the fluctuations in nutritional status (e.g. body weight) that can be damaging to health when pushed to extreme limits. Such fluctuations are particularly dangerous in families with very low incomes, where they can precipitate malnutrition in those with marginal food intakes and aggravate the condition of those already victims of malnutrition.

There is generally a negative correlation between malnutrition and the availability of marketing facilities, which suggests that people living closest to markets enjoy lower prices, less severe seasonal fluctuations, and thus better nutrition. There is however one major exception to this general rule: evidence exists to show that people remote from marketing facilities but with a higher degree of self-provisioning are more dependent on ecology than on economics, and they often enjoy more traditional and complete diets (Schofield, 1979).

Food-production patterns

Climate, soil and vegetation largely determine the quantity, nutritional quality and types of food grown in a particular area. Some areas are more susceptible than others to yearly fluctuations in production as a result of natural calamities, such as droughts, floods, and severe outbreaks of plant and animal diseases, leading to widespread hunger and malnutrition. Over the long run, soil depletion and erosion, often induced primarily by population pressure and overgrazing, are decreasing the food-production potential of many areas, while in some, the soils are deficient in specific nutrients, such as iodine or iron. Everywhere, substantial — but reducible — post-harvest losses of food further diminish the possibility of adequate nutrition. Such factors clearly have their greatest impact where food intakes are already low.

Other important aspects of food-production patterns in relation to nutrition are seasonality and the extent to which subsistence cropping has given way to marketed production.

Seasonality. Recent research (Chambers, Longhurst and Pacey, 1981) has shown the importance of seasonality in food production as an essential factor in malnutrition. Where the annual rainfall is concentrated in a single rainy season, as in West Africa for example, the evidence suggests that malnutrition is most severe during the pre-harvest wet season, when food stocks have been depleted. Thus, the lowest seasonal food-intake levels coincide with high energy expenditure for farm work, high food prices and heavy indebtedness.

The harmful effects of seasonality are suffered by all: men, women and children. In the Gambia (Rowland *et al.*, 1981), adults lose up to 8-10 percent of their body weight during the pre-harvest period, and even women in their last three months of pregnancy have lost as much as 1.4 kg in a month. But children suffer most, because their body stores are usually lower, and they are more vulnerable to functional impairment: their nutritional status deteriorates and past weight-gains are frequently lost. Child mortality has been shown to peak in the pre-harvest period. Families headed by women, and those with large numbers of small children, are likely to be particularly vulnerable to seasonal changes.

In developing countries, seasonal stress is expected by rural people. As part of their household food security, they plan as far as possible to ensure that their food supplies will be sufficient to meet seasonal shortfalls, and contingency measures include mixed cropping to spread risks, selling livestock to obtain essential cash, and taking off-farm employment. While employment may be available on the larger farms, the terms of trade of cash receipts to energy expenditure are often unfavourable, and gifts of food may therefore be accepted from richer farmers in return for labour at a later season. Minor crops and the gathering of wild foods play a particularly important role in household food security of the poor during the pre-harvest season.

On the farm, seasonality is also related to the division of labour according to sex and, consequently, the amount of care that mothers can devote to their children. In many parts of the developing world, women carry a very heavy burden of farm work and, especially in Africa, they are the principal food producers. This often imposes severe constraints on child care, including abrupt weaning when the planting season starts: weaning foods* have to be hastily prepared at such times, and this increases the danger of contamination. Women suffer too from having to continue their regular domestic work of collecting water and firewood and preparing food, whatever the seasonal level of their farm work.

Where there are two rainy seasons in the year, as in East Africa and equatorial West Africa, seasonal stresses are less marked. The consequences of seasonality have also been limited in many areas by irrigation or by improvements in road communications, especially where irrigation has made multiple cropping possible.

Some of the effects of seasonality, and also of periodic drought, are illustrated by family profiles from Ethiopia and from Mali, in the Sahelian zone of Africa (see Boxes referring to these situations on p. 28).

Subsistence cropping and market production. The transition from subsistence farming to commercial agriculture provides opportunities for nutritional improvement and for better safeguarding the family's food availability. The overall impact of this conversion depends however on household income and food prices.

The impact of cash cropping on nutrition can be expected to be positive when the income it provides more than offsets not only the food production that is foregone, but also any rise in food prices resulting from the inability of the local market to meet the increased demand for purchased food. Cash cropping may also generate increased employment opportunities and thus help landless agricultural labourers to improve their nutrition.

A poor farm family in Ethiopia

A typical family of six lives in a 30-m^2, windowless, wood and mud hut with a thatched roof. They have no furniture, few possessions, and not even an external latrine. The women collect well-water daily on a 3-km round trip.

Sorghum and teff yields on their tiny plot have fallen more than 20 percent over the last four years, owing to overcultivation and drought. To compensate for this loss, the father has sought work on a state farm, but has only managed to get a few days' work a year, at a daily wage just sufficient to feed the family for one day. Husband and wife both work the home plot. The work is seasonal, and very strenuous: since the family has no machinery, weeding takes place by hand, and threshing by trampling. The recent sale of a goat fetched enough to feed the family for 28 days, but if they were forced to sell their invaluable pair of plough oxen, their viability as farmers would be destroyed. Depending on the yield, 70 percent or more of their food comes from their own production.

Their average dietary-energy consumption is 1 340 kcal per caput per day, or 8 040 kcal for the household. Since 7 800 kcal are needed to cover the children's total estimated requirements and the parents' basic maintenance needs, only 240 kcal remain to cover the parents' work activities. The wife weighs 45 kg and the husband 56 kg. The two older children (aged 12 and 10) are 20 cm shorter than the standard for their ages, and the two younger children are 1.5 to 2 kg underweight for their height. A first-born child died of measles, exacerbated by vitamin-A deficiency.

For such families, the situation is deteriorating. The soil is being rapidly eroded as the result of erratic rainfall, steep slopes, deforestation, overgrazing and overcropping, as population pressure causes further fragmentation of holdings. Between 1980 and 1982, the average crop production per household fell by 14 percent. Compensatory sales of livestock have reduced the average number of animals per household from 29-47 percent.

The situation is rendered even worse by crises which occur regularly. The famine of 1973-74 was the result of a seven-year drought, during the first five years of which crops fell by 60-70 percent of normal, while in the last two years virtually nothing was obtained. Currently, famine has struck again after at least four years of insufficient rain. In addition, civil war hinders communications and food distribution, and sporadic fighting may destroy entire crops.

The initial response to crisis is the flooding of the labour market, as workers search for alternative incomes. This is followed by the sale of livestock and other assets, and finally the migration of the family in search of relief. Land reform prohibiting the sale of land, those who migrate have the theoretical option of returning, but the experience of a continually worsening situation may convince many that if it is possible to survive elsewhere, there is little reason ever to return to their homeland.

A pastoral family in the Malian Sahel

A Fulani "noble" family of six lives in round huts built of dried stalks, which when new are rain-resistant. They have a herd of 24 cattle and ten goats; during the rainy season they grow a millet crop.

During the wet season they camp around rain-filled ponds, which dry out by November, when the young men, in cooperative groups from several households, leave with the main herd in search of better pastures. The remainder of the household, with their goats, weaker animals and some milch cows, camp during the cold dry season (November-February) on the edge of a village, buying or bartering for cistern water; during the hot dry season they move to camp around a well.

The adult men are responsible for the main herd and for most of the millet cultivation, especially weeding. Boys tend the goats and calves. The women and girls collect fuel and water for domestic use, help with the harvest, pound millet and they also prepare meals.

The household's maximum dietary-energy intake in October, after the harvest, is 14 700 kcal/day (65 percent from millet, 35 percent from milk); 9 105 kcal would cover the children's total requirements and allow the adults to maintain their body weights if they did no work, leaving 5 595 kcal for the adults' activities and weight gain. However, from December to June their intake is only from 7 840 to 8 820 kcal/day (9 to 20 percent from milk), so that the family is in a negative energy balance. During the rainy season they supplement their diet with gathered food. Their intake in June-July is from 9 996 to 10 740 kcal/day (43 to 50 percent millet, 8 to 12 percent milk, and 42 to 45 percent gathered food).

The man and the woman (172 and 163 cm tall respectively) are at their heaviest in November-December, when they weigh 55.3 and 49.6 kg respectively; the post-harvest period of abundant food and little work allows them to gain 2.3 and 0.7 kg respectively since July-August. During the dry season, decreasing food and increasing distances to walk for water and pasture cause weight losses of 2.2 and 1.5 kg respectively by May-June. Despite increased intakes during the rainy season, the labour demands of millet cultivation prevent their regaining weight until after the harvest.

The weight changes of the four children, aged 5 to 12, between July-August and November-December range from +0.6 kg to +1.5 kg; from November-December to July-August they range from −0.7 kg to +0.5 kg. Despite their poor growth during the dry season, their weight rarely falls below 80 percent of the standard for their height. Households with sufficient milk or grain for barter during the dry season are able to reduce livestock sales and their dependence on the market but, if a family's food supply runs out during the hot dry season, they may be forced to sell off young livestock below their full value.

Livestock sales accounted for 93 percent of the family's 1982/83 cash income; 68 percent of their total income was from barter of cereals, and 5 percent from barter of milk products. 50 percent of the family's cash expenditures went to purchases of cereals, and of their expenditures in kind 55 percent were for milk products.

Recently the situation has worsened because of deteriorating terms of trade, resulting from poor rainfall. A prime steer that in 1982 was worth the equivalent of 1 300 kg of millet was worth only 520 kg a year later, grain prices having doubled while livestock prices fell.

In 1973, after five years of drought, grain prices soared to nearly 1 000 Malian francs per kg,[1] while the emaciated livestock fetched only one-sixth to one-twelfth of their pre-drought prices. In that year alone, an estimated 100 000 people died, as did 40-60 percent of the livestock. Many pastoralists, forced to sell their animals, were reduced to dependence. Currently, while the majority have rebuilt their herds sufficiently to return to pastoralism, some have never regained former herd sizes and so are in a weaker market position, while others work as paid herders, tending animals bought in cheaply by profiteers during the drought.

[1] 426 MF = US$1 at 1 July 1973.

For a number of reasons, on the other hand, cash cropping may also have a negative impact. Subsistence production normally provides a fairly regular income flow in the form of food and a little cash, while income from cash cropping tends to come in large sums on one or a few occasions during the year. In many developing societies, this cash income is traditionally controlled by men, and as a result, consumption patterns favour non-food items, with less regard for family nutritional needs. Data from Colombia (Deere and de Leal, 1979) indicate that as families devote more resources to cash cropping, women are left without the means to feed the household, and other studies from Brazil (Williamson, 1982) and Kenya (World Bank, 1981) tend to confirm this disquieting conclusion.

Cash cropping may also increase the demand for the labour of both men and women, and the consequently increased dietary-energy requirements of adults in the household may be met by reallocating food at the expense of the children. Moreover, the time available to women for child-rearing and food acquisition and preparation would then be curtailed.

Unless offsetting measures are taken, all these factors can have profound negative impacts on nutritional status, particularly that of children. However, from the limited evidence available it is impossible to conclude whether transition from subsistence to cash cropping has a definite impact on nutrition, because most published studies have not been designed to measure the impact and they also did not take other intervening variables into account.

Social conditions

Rapid urbanization is the greatest social change in developing countries that has a major impact on nutrition. It has greatly altered the demographic structure of the population in many parts of the developing world. In Africa and the Far East, the dependency ratio (the numbers of the very young and the elderly directly supported by those of working age) has increased two- or threefold in rural areas, as the large cities attract ever greater numbers of the younger sector of the population. Thus, in many areas it is mainly the elderly and the women, along with the young children, who are left in the countryside to produce food and, as a result, not only is food production reduced, but the time for child care is still further curtailed.

Much depends on whether migrant workers send remittances home. Recent data from Zimbabwe (World Bank, 1983) indicate that, in rural families with an absent migrant worker, the incidence of child malnutrition is six times as high when remittances are not sent home, as when they are.

Nutrition in urban and rural areas. In urban areas, the brunt of nutritional deprivation appears to fall most heavily on the urban poor and unemployed recent migrants living in peri-urban slums and shanty-towns. A comparison of conditions in planned residential quarters and slum areas of Manila, the Philippines (Basta, 1977) showed that the incidence of low birth weight was five times higher in the latter, infant mortality three times higher, and the incidence of severe and moderate malnutrition and anaemia twice as high.

Food purchases of the urban poor are heavily dependent on competing demands of unavoidable non-food expenditures for their limited incomes. They seldom have access to central markets without the expense of using public transport — which they can ill afford — and are thus compelled to buy food in small quantities, at higher prices, from local shops and street vendors.

Since all the adults and older children are involved in money-seeking activities of one form or another, the urban poor generally have little time to prepare food. Sometimes they have no suitable space for cooking, or no money to buy fuel. They therefore rely heavily on pre-prepared or easily prepared foods, which are not only usually expensive but of low nutritional value. Moreover, these foods are often prepared by small vendors with little regard for food safety or hygiene regulations.

Some of the problems of the urban poor are illustrated in family profiles from Colombia and India (see Boxes on p. 30 and 31).

Separate data on food intakes of urban and rural populations are available for only very few coun-

A poor urban family in Colombia

A typical family of six lives in a shared, rented house in an unplanned marginal area of Bogotá. Bathroom and patio area are communal, but the family has a small private kitchen with a petrol stove. The house has electricity and running water, but is not connected to the sewer system. Infrequent refuse collection and the neighbourhood chickens and pigs contribute to poor environmental sanitation.

The parents, who grew up in a nearby village, had only three or four years of primary schooling; the father has since completed his primary education at nights, as this is his only hope for better employment. Only the eldest child, a girl, is of school age; while her education is free, matriculation fees, uniform and writing materials are expensive.

The father's work is heavy, involving carrying materials, digging, mixing cement, etc. The mother has to look after the three pre-school-age children, as well as doing domestic work for wealthier families and some street selling. Their total income rarely exceeds the minimum wage. 20 percent goes on rent, 70 percent on food, and the little that remains for transport, education, health services and recreation.

The family derives 29 percent of its dietary energy from cereals (rice, wheat and maize), 18 percent from sugar and 10 percent from potatoes and cassava. The average per caput dietary-energy intake of 1 400 kcal/day, or 8 400 kcal for the entire family, leaves only 600 kcal to cover the adults' work and other activities, 7 700 kcal being needed for the children's total requirements and the adults' minimum maintenance. The father has the highest intake, which is necessary for his extremely heavy work. His lunch at the building site costs 23 percent of his daily wage.

The man weighs 51 kg and the woman 47 kg. The 6-year-old daughter is 12 cm shorter than the standard for her age, but is not significantly underweight for her height. The 3- and 4-year-olds are also short for their age and weigh 12 percent less than normal for their height. The 10-month-old baby, having been fed mainly on thin soups and sweetened, diluted milk with cornflour since being weaned at 6 months, weighs only 7.1 kg, 25 percent less than expected for his age. He is prone to diarrhoea, as are the other children, along with respiratory infections and intestinal parasites. When serious illnesses occur, the family has been forced to pay for a private doctor, because the waiting-list for an appointment at the health centre is so long.

Since 1981, the cost of the official "basket" of basic goods has risen by 183 percent and the minimum wage by 198 percent. Wages are however increased only once a year, and are then eroded by an annual inflation of about 25 percent. Food prices have risen more steeply than those of other items.

Irregular employment in the building industry threatens the family's food security. When unemployed, the father has to spend time looking for work, although he may temporarily, along with other family members, do street selling and other informal work. Mothers are frequently forced to leave young children unattended for lack of subsidized nurseries. When the family income is lowest, the rent must still be paid, and food has to be bought on credit at a high-priced local store. A food-coupon scheme, started in 1980, has been discontinued, and the cheaper mobile markets are only useful if the family has cash in hand.

tries, but in each of 13 surveys covering countries in all developing regions (Basu, 1975; Brazil, 1977; Egypt, 1961; FAO, 1972a, 1974c, 1978; France, 1969; Korea, 1970; Pakistan, 1965, 1972; Tunisia, 1978; Van Ginneken, 1976, 1980), per caput dietary-energy intakes were higher in rural than in urban areas; for Brazil, India and Tunisia, data were available by income group, and this pattern was found to persist across these country surveys.

Comparative anthropometric data on nutritional status in rural and urban areas are also scarce, and almost all the existing surveys deal with children only. The results of eight recent surveys of the nutritional status of children are shown in Table 4.2. In each country for which data are available the incidence of child malnutrition, especially chronic malnutrition, is substantially higher in rural than in urban areas. Thus, the available evidence indicates that while food consumption tends to be lower in urban than in rural areas, malnutrition in young children is markedly worse among the rural population.

Although the causes of this paradoxical situation are not definitely known, a number of explanations may be put forward. In the first place, it is possible that the surveys cited were unable to take account of all food consumed outside the home in urban areas. It seems more likely, however, that the apparently lower urban food consumption may in fact cover the individuals' requirements more adequately, and the higher rural consumption less adequately, in view of the higher energy demand for physical activity in rural than in urban contexts (Périssé, 1982).

Food intakes of rural people also tend to be less varied and therefore more affected than urban diets by crop failure and seasonal scarcity. A particularly important factor may be the diversion of food to the productive members of rural households at times of peak seasonal labour demand, at the children's expense. Less adequate access to medical services may also help to explain why rural children appear to be more vulnerable to malnutrition than their urban cousins.

Among the rural population, the landless appear to be the worst off. In Bangladesh, for example, dietary-energy intakes of landless and near-landless households averaged 1 925 kcal/person/day, as against 2 375 kcal for households with more than 7 ha (Bangladesh Ministry of Planning, 1981). At the same time, the landless constitute a very large proportion of the rural poor: in 1975, they made up 43 percent of the total rural population in India (Ali *et al.*, 1980) and 32 percent in Bangladesh (Alamgir, 1980).

Some characteristics of landless rural families are illustrated by a typical family profile from the Philippines (see Box on p. 33).

Although the impact of "modernization" is most evident in the towns, it is also spreading rapidly in the countryside, where many nutritious traditional foods and drinks are being replaced by processed products such as bread baked from refined flour, highly milled rice, soft drinks and teas. But by far the most harmful effect of this kind is the decline in breast-feeding, which again is much more marked in urban areas. This problem is discussed below in the context of child-rearing practices.

Cultural factors

Food consumption in developing countries is still strongly influenced by complex socio-cultural factors affecting food behaviour, including customary systems of food-sharing within the family, cultural attitudes toward various foods, food-preparation methods and child-rearing practices.

Food-sharing within the family. Data on food distribution within the family are scarce, because most food-consumption studies report only the aggregate consumption at the household level. Qualitative evidence indicates that the distribution

A poor urban family in India

A typical extended family (five adults and five children) lives in a single windowless room 2.4 m by 1.5 m rented for Rs 100[1] a month in a dilapidated back-street terrace. They share a kitchen with two other families and at night use the hallway for sleeping-quarters. They have electricity but have pawned their electric fan. The women queue for water three nights a week from a street standpipe, and carry home full 20-litre vessels. A fetid open drain outside the house serves for defecation; during the rains the drain is blocked and overflows.

Of the two adult men, who are brothers, the elder, weakened by tuberculosis, mends post-office jute mail-bags for a piece-rate; his wife does domestic work in the postmaster's household and works several days a month as a stone-breaker. The younger brother has more strenuous work as a carrier; his wife, late in pregnancy, no longer works. The brothers' elderly, widowed mother works as a sweeper in the shops of three rice-merchants.

None of the elder couple's daughters attended school; their son did so for a year but is now apprenticed to a weaver. The younger couple's son will attend school when older.

The household's daily income varies from Rs 11 to Rs 35, but is sometimes nothing at all. On average, 80 percent of their expenditures go on food, and the rest must cover rent, clothing, medicines, education and, on rare occasions, alcohol and the cinema.

The government shop sells rice at Rs 2/kg, as compared to Rs 3.50 elsewhere, but it only opens once every two weeks and then will only sell the complete monthly ration of 5 kg; the family rarely has enough cash to buy this amount.

The family's average per caput dietary-energy consumption of 1 790 kcal (17 900 kcal for the entire family) leaves 3 600 kcal available for the work needs of the five adults, after their minimum maintenance needs, and the total requirements of the children, have been covered.

The widow is 15 cm shorter than the standard and weighs 38 kg. The other four adults are 11-13 cm shorter than the standard; the two brothers weigh 50 and 54 kg, the elder wife 45 kg and the younger 50 kg, having gained only 6 kg in nearly nine months of pregnancy.

The four elder children are all about 15 cm short for their age. The three girls (aged 7, 8 and 12) weigh just over 80 percent of the expected weight for their height, and the 10-year-old boy 90 percent of the standard for his height. The three-year-old is 12 percent shorter and 23 percent lighter than expected for his age, but weighs above 90 percent of the standard for his height. Another daughter died at 11 months after fever and diarrhoea. The other children are also prone to frequent bouts of diarrhoea, but although medical facilities are available, their high cost and the long queues discourage their use unless illness seriously affects the household's income.

Low, irregular incomes make households such as this one continually dependent on credit. A crisis such as the illness of one of the main wage-earners, loss of employment, the landlord insisting on his arrears or raising the rent, the unavailability of fuel dung-cakes, or exorbitant dowry demands for a daughter can force them deeper and deeper into debt, as they have no assets to sell. During a crisis, the number of meals will be reduced, the main earners reducing their intake the least and the female children the most.

[1] 9.53 rupees = US$1 at 1 January 1983.

TABLE 4.2. **Percentage of malnourished children under age 5, rural and urban areas, selected countries**

Country (date)	Low height-for-age[1]		Low weight-for-height[2]		Low weight-for-age[3]	
	Rural	Urban	Rural (%)	Urban	Rural	Urban
Brazil (Northeast) (1975)	21.9	16.6	2.2	2.3	[4]21.9	[4]16.6
Cameroon (1978)	22.4	15.5	1.1	0.7	23.0	12.2
Haiti (1978)	28.6	15.7	6.4	3.8	[4]29.5	[4]14.6
Lesotho (1977)	23.7	17.2	4.3	3.0	24.9	17.3
Liberia (1976)	20.2	13.8	1.6	1.7	25.5	...
Sierra Leone (1978)	26.2	17.4	3.2	3.2	32.4	24.3
Togo (1977)	20.4	11.4	2.2	0.8	[4]16.5	[4] 8.9
Yemen A.R. (1978)	42.1	33.0	6.7	2.1	[4]47.0	[4]22.8

[1] Below 90 percent of reference standard. Indicator of malnutrition of long duration (chronic); [2] Below 80 percent of reference standard. Indicator of recent malnutrion (acute); [3] Below 80 percent of reference standard unless otherwise specified. Indicator of acute, chronic or acute-on-chronic malnutrition; [4] Below 75 percent of reference standard.
Sources: Brazil. 1977; United States, 1976a, 1977a, 1977b, 1978a, 1978b, 1978c, 1979.

is generally related to hierarchical position, with the head of the household and its income-earning members receiving preference.

Recent quantitative information from Bangladesh (1983) and Papua New Guinea (Ferro Luzzi, Norgan and Paci, 1981), as well as earlier surveys in Ghana, Guatemala and Nigeria tend to confirm this observation indicating that mothers and young children generally receive a smaller share of the family's food in relation to their nutritional requirements. It is common for the diets of children to be 20-30 percent below their dietary-energy requirements.

In some traditional societies, it is common for young children to eat from a single bowl. This practice often puts the youngest and weakest children at a further disadvantage in family food-sharing.

In Bangladesh (Chen, Huq and D'Souza, 1981) and India (Mathur *et al.*, 1961), a bias against females in family food-sharing has been observed. In the former country, however, when body size, physiological factors, and activity are taken into account, the sex differentials in food consumption in relation to requirements disappear in adults but persist in young children (Abdullah, 1983). These findings are supported by more general data (Chen, Huq and D'Souza, 1981; De Sweemer, 1974) showing larger deficits in weights and heights, a higher incidence of protein-energy malnutrition and a substantially higher mortality rate in female than in male children. But the matter is complex, and the data are too scarce for a definite conclusion to be reached.

Cultural attitudes toward various foods. In many societies, some foods are culturally more highly prized than others, and no meal is considered complete without them. When the preferred food is a root or tuber, this custom may be disadvantageous to young children: a weaning diet based on roots or tubers is bulky and has a low concentration of nutrients, especially protein, and a young child with limited stomach capacity is unable to consume such foods in quantities sufficient to cover his or her requirements. Studies in Nigeria (Atoyebi and Hussain, 1985) and Uganda (Rutishauser, 1974) indicate that the bulkiness of the weaning diet may be an important cause of malnutrition in young children.

Cultural food beliefs and taboos, usually concerning foods of animal origin, often apply particularly to women and young children. In normal circumstances they may have little nutritional significance, but when a child is poorly grown, such cultural practices as withholding solids at the first sign of diarrhoea can precipitate PEM, as has been shown in Punjab, India (Taylor and Taylor, 1976).

The biological availability of some key nutrients, including protein, iron and carotene (the precursor of vitamin A), is lower in foods of vegetable than of animal origin. Thus, for iron, a person has to take about twice as much if the diet is predominantly vegetarian and, for carotene (of which only one-sixth is converted to vitamin A), about six times as much. Similarly, the biological availability of vegetable protein can be substantially improved by eating together cereals and pulses that are complementary in their amino-acid composition. Such combinations are indeed the basis of many traditional diets, whether in totally vegetarian societies or where animal products are scarce for economic or other reasons. This consideration provides further grounds for concern about the consequence of modernization of traditional diets in developing societies.

Food preparation. In most developing countries, cooking is the exclusive responsibility of women, and this responsibility extends to providing water and fuelwood, which are in increasingly short supply in many areas. The growing amount of time and energy that rural women are obliged to spend in this way further reduces their time available for farming and wage-earning activities, for cooking, and above all for child care.

Especially in parts of Africa south of the Sahara, families may live up to 13 km away from a permanent water source, and in East Africa some individuals — mainly women and children — spend up to five hours a day collecting water during the dry season (White, Bradley and White, 1972). Rapid fuelwood depletion is also causing women and children in many rural areas to walk very long distances for fuel.

Data are extremely scarce on the time allocations that would make it possible to calculate the nutritional cost of water and fuel collection. A recent study in Côte d'Ivoire (Lunven, 1983) indicates that a rural woman brings, on average, about 600 kg of water and wood into the kitchen every week, spending about 42 minutes a day in carrying water and 14 minutes collecting firewood. In many other areas, where fuel and water are scarcer, the time spent is certain to be much higher.

With the growing fuelwood shortage, the frequency of cooked meals has often been reduced, and foods cooked once are consumed over the entire day. Owing to the absence of proper storage facilities, this practice can often cause serious food-borne infections, particularly diarrhoea among children. Several foods, such as some cassava and bean varieties, have to be cooked to make them safe for human consumption, and many others to improve their digestibility and palatability or to reduce the danger of infection from parasites and other pathogens. Drinking-water, too, has to be boiled in many areas to ensure its safety. Other factors, including food scarcity and the workload of women, may reduce the number of daily meals, whether cooked or not. In such circumstances, young children who need four or five

A landless rural family in the Philippines

A typical landless household of six lives in an elevated bamboo and palm thatch house with about 8 m^2 of floor space. They have no electricity, and few possessions other than clothes, cooking utensils and a radio. Their only farm equipment consists of a sickle and a jute drying-mat. They use kerosene for lighting and pay P2[1] a month for drinking-water from a tap shared with nine other families.

They grow vegetables and keep a pig and a few ducks on their home lot, which is rented for P2.50 a month. Farm work is their sole source of income. Under the new *sagod* system, weeding a plot gives them the exclusive right to harvest it for a share (one-eighth to one-sixth) of the crop. While this system increases their security, it implies that for two to three months before the harvest the family has no income, since weeding is no longer remunerated directly, and wage employment (at P6/day) is usually available only earlier in the crop season.

During the two main harvests, the entire family works at harvesting, threshing and winnowing. For the rest of the year, the youngest boy attends elementary school, the older boys and their father search for farm work (clearing, transplanting, etc.), while the mother and daughter do much of the weeding, collect water and fuel, cook and do the other domestic chores.

Neither parent completed elementary school. Both elder sons studied technical subjects after completing elementary school, which the daughter also completed.

Of the family's gross annual income of P3 950 in 1976/77, 65 percent came from crop-share payments, 15 percent from cash wages, and 20 percent from the sale of a fattened pig.

Food comprises 66 percent of the family's expenditures, of which 40 percent for rice is derived mostly from crop-share payments. Other food items include vegetables, salt, milk, fish, and rarely meat. Other expenses include liquor and cigarettes (9-11 percent), clothing (6-7 percent), repairs, transport, fuel, water, education, gifts and celebrations.

The family's average per caput dietary-energy intake of 1 700 kcal/day (10 200 kcal for the household) leaves only 720 kcal to cover the work requirements of the parents and the three oldest children after the youngest boy's total requirements and the minimum maintenance requirements of the five others have been met. The husband weighs 50 kg, the wife 45 kg, the 17-year-old son 49 kg, the 16-year-old daughter 42 kg and the 10-year-old son 25 kg.

While the family gets by, their low, irregular income frequently forces them to incur debts — usually interest-free, short-term loans from friends and relatives who also on occasion borrow from them. They avoid long-term consumption loans except in a crisis, because the interest rates of 19-25 percent per month would be likely to force them further and further into debt.

Eighteen years ago the illness of the father forced the couple to sell their carabao at half its value to cover hospital expenses. If the family still owned the animal, they would be able to earn P10-12/day ploughing, instead of only P6. Recent flooding swept their house, leaving them still further in debt.

Despite the high opportunity cost of education, the boys see it as the only route to a better future and have set their hopes on employment outside farm labour.

[1] 7.4 pesos = US$1 at 1 January 1977.

TABLE 4.3. **Percentage of mothers breast-feeding, by age of child: rural and urban areas, selected countries**

Country	Child of 3 months			Child of 6 months			Child of 12 months		
	Urban well-off	Urban poor	Rural	Urban well-off	Urban poor (%)	Rural	Urban well-off	Urban poor	Rural
Chile	56	80	76	28	39	46	0	29	40
Ethiopia	59	87	100	35	81	100	—	76	98
Guatemala	29	76	97	4	73	97	0	29	82
India	84	95	100	49	88	100	33	83	99
Nigeria	96	100	100	32	97	100	0	97	97
Philippines	27	61	83	19	53	89	6	52	63

Source: WHO, 1981.

meals a day are unable to satisfy their nutritional requirements.

Traditional diets in developing countries are often monotonous combinations of vegetable foods, with few if any animal products. They are therefore generously spiced, especially with pepper, to improve their palatability. Such meals are not the most suitable for young children.

Other cooking practices can also have adverse nutritional consequences. In many cultures, as in Nigeria, for example, foods (and particularly vegetable foods) are meticulously washed, cut into pieces, soaked, overcooked, and then reheated before serving. Elsewhere, as in Bangladesh, the cooking-water from rice is discarded. Such practices can reduce the quantity of water-soluble, heat-labile vitamins (e.g. ascorbic acid, folic acid, thiamine) in the foods by 40 percent or more.

Child-rearing practices. Almost all the factors discussed thus far in this chapter appear to bear most heavily on the nutrition of young children, but child-rearing practices probably exercise the greatest of all the many influences on their nutritional status.

Although there has been a general decline in breast-feeding, Table 4.3 indicates that the percentage of mothers breast-feeding, and also its duration, are still normally much higher in rural than in urban areas in the few countries for which there are recent data. Breast-feeding alone is nutritionally adequate only up to four months, and in many rural communities the introduction of supplementary feeding is delayed too long. When it begins, too little food is offered, and the supplement is mostly based on diluted preparations of staples which are deficient in nutrients, high in water content, and inadequate for the young children's nutritional requirements. Their growth therefore falters, and the onset of serious malnutrition is often precipitated by adverse psychological, social or infective traumas.

The situation is different in urban areas. Here, breast-feeding is terminated abruptly because the mother has to work to help support the family. Bottle-feeding is introduced early, often — as WHO has deplored — under the influence of aggressive commercial advertising for expensive products. It has been estimated (Berg, 1973) that in some countries a low-income household would have to spend about half the wages of the head of the household in order to feed a young child adequately in this way. Because of this high cost, commercial milk formulas are often overdiluted, while for lack of facilities for cleaning and sterilizing utensils, together with the failure of many mothers to appreciate the importance of cleanliness in child-feeding, they are also usually unhygienically prepared.

Thus, a faulty weaning and supplemental-feeding process is not only costly to the family, but very dangerous for the child. Its almost inevitable consequences are gastro-enteritis, underfeeding, marasmus* and even death. In some urban communities, the large-scale introduction of bottle-feeding has already changed the type and age incidence of PEM, and marasmus has become more frequent among younger children in urban areas.

Environmental conditions

Housing, sanitation and water supply are the most important environmental conditions that affect food utilization and hence nutritional status. As already mentioned briefly in Chapter 3, their importance is a result of their link with infection and infestation.

Table 4.1 showed significant correlations among sanitation and water supply and different indicators of malnutrition. Studies from Colombia (Christiansen, Mona and Herrera, 1975), Fiji (Yee, 1983), Nigeria (Tomkins *et al.*, 1978) and St. Lucia (Henry, 1980) also report significant negative effects of overcrowding and poor sanitation and water supply on the growth of young children. In a study of mortality risks in Bangladesh (Chen, Alaudin Chaudhury and Hoffman, 1980), it was found that housing quality and the parents' educational level were as good if not better predictors of households in which children were likely to die of malnutrition than the actual presence of malnourished children.

Infectious diseases. Overcrowding leads to an increase in respiratory infections. The effects of poor sanitation and water supply are mutually reinforcing and increase the rate and severity of soil- and water-transmitted diseases. Although it is difficult to quantify the effects of improving sanitation or water supplies, it is clear that they must be provided together in order to maximize health and nutrition benefits. Experience from several developing countries, such as Costa Rica (Mata, 1983), indicates that when sanitation, water supply and health-care programmes are combined over a sufficiently long period, deaths of young children from infectious diseases, diarrhoea, and intestinal parasites can be substantially reduced, and growth and health improved.

Longitudinal studies from various developing countries show that infections are extremely common in young children: some of them are sick for one-third of the year, and the incidence of subclinical infections is even greater. Some infections tend to be seasonal. Diarrhoeas, for example, are more common during rainy seasons, and in some countries are partly responsible for faltering growth in young children and higher rates of PEM during the wet seasons (Rowland, 1983).

Infection interacts with nutritional status in a number of ways. It reduces appetite and may provoke dietary variations, and these effects may in turn be accentuated if certain foods are withheld or the consistency of the diet is changed. Dietary-energy intake may be reduced by 20-40 percent during an episode of diarrhoea (Hoyle, Yunus and Chen, 1980). Infection increases the breakdown of nutrients stored in the body, leading frequently to weight loss. It reduces the absorption of nutrients and, especially when it is associated with vomiting and diarrhoea, also causes nutrient loss. During an acute stage of diarrhoea, according to one report (Molla *et al.*, 1983), absorption of nitrogen was limited to 41 percent, as against a range of 62-77 percent for other nutrients.

Another important effect of infection is to divert nutrients to building defences against it. Some amino-acids, for example, are diverted to producing immuno-globulins and thus are no longer available as nutrients. Especially when it is associated with fever, infection raises BMR and hence dietary-energy requirements; a rise of 1° C in body temperature raises BMR by 10 percent to 15 percent (Keusch, 1977).

Thus, infection reduces food intakes and their effective utilization at the same time as it increases food requirements. Moreover, this malnutrition weakens the body's defences, so that the victim suffers more frequently and more severely from infections, although the consequences vary with different physiological circumstances. A vicious circle is thus closed, with children as usual the worst sufferers. Many studies suggest that a closely paced series of common childhood infections is the most important cause of malnutrition, retarded growth, and child mortality.

The nutritional "cost" of infection, in terms of calories, has not been determined with any certainty, but a recent calculation (Calloway, 1982) indicates that the dietary-energy cost of the average growth deficit from endemic infectious diseases in early life is about 20 kcal/day. Although this is within the acceptable range of variations in daily intake, to overcome it a child will have to eat about $1^1/_2$ times the normal quantity of food during convalescence. Since this does not normally happen, adequate catch-up growth is rarely achieved.

Reports from many countries indicate that not only severe PEM, but also vitamin A deficiency, are generally precipitated by common childhood infections. Monthly bouts of diarrhoea are associated with significant reductions in height and weight gains in the Gambia (Rowland, Cole and Whitehead, 1977).

It is difficult to distinguish between infectious diseases and malnutrition as causes of child mortality, but in Latin America more than half the deaths of children under five years of age have been assessed (Puffer and Serrano, 1973) as being directly or indirectly a result of malnutrition. In one Nigerian village, 15 percent of all child deaths were attributed to malnutrition (Omololu, 1972). The inadequacy of health services permits interactions between infection and malnutrition to continue unabated. This is all the more deplorable in that most common childhood diseases can be prevented by immunization, and that anaemia, the commonest condition affecting mothers, can also be prevented by antenatal care and nutritional supplements.

The emphasis in this section has been laid on the effects of infections upon children suffering from them. One further, indirect, effect should not be overlooked: when an infectious episode, such as malaria, in a working adult coincides with peak labour demand and food scarcity, the consequences can be very harmful for the nutrition not only of the victim but also on that of the entire family, who depend upon him or her for an essential part of their own nutrition.

5. Policy implications

In the preceding chapters were indicated some of the main characteristics of the policies that are needed if the incidence of malnutrition is to be reduced. Macro-level policies designed to increase effective market demand for food have to be supplemented by micro-level policies in favour of those who cannot benefit from improvements stimulated by overall socio-economic development, and these policies should be integrated, especially as regards nutrition and health programmes. Limited resources must be concentrated on the obvious priority areas of the poorest countries, and the poorest — or otherwise most vulnerable — people within them. This implies a particular focus on poor rural children, either directly or, more often, through their mothers.

This chapter begins with a brief examination of the possibility of feeding the rapidly growing populations of the developing countries more adequately in the future, followed by a reflection on the macro- and micro-level policies needed in those countries. Nutrition policies in the developed countries are touched on rapidly, and the chapter concludes with a short discussion of interactions between developed- and developing-country policies at the international level.

Dimensions of future policy problems

In assessing the possibilities for future nutritional improvement in the developing countries, a basic consideration is the ultimate population-supporting capacity of their agricultural land, but it is also necessary to consider whether this potential can be realized as rapidly as their population and food requirements increase, and what progress can be achieved in a given time, for example by the end of this century.

The first detailed evidence concerning the number of people who could be adequately fed has recently become available in an FAO study of the potential population-supporting capacities of lands in the developing world. Three reports on this study have been published: the basic technical report (FAO/UNFPA/IIASA, 1982), a summary document intended for the 1983 session of the FAO Conference (FAO, 1983c) and a popular version (FAO, 1984d). Subsequent unpublished work has concentrated on a comparison of the results of the study with alternative and long-term population projections. The following discussion draws heavily on this effort.

The study is a complex one and involves a number of broad assumptions that are inevitable in a pioneer undertaking of such scope. The most fundamental assumption is that all the potential agricultural land would be used for food production, either by means of optimum combinations (in nutritional terms) of 15 major food crops or, where cropping is impossible or undesirable, the grassland production of livestock. This approach excludes any land needed for non-food crops and confines forestry, with its essential protective as well as productive functions, to land considered unsuitable for cropping or grazing. Detailed country studies, several of which are already under way, are needed if these and other limitations are to be overcome. In the meantime, it has been suggested (FAO, 1984d, esp. pp. 34-40) that a one-third deduction should be applied to the estimated potential supporting capacities to allow for the various factors that could not be envisaged in the study.

Even with this large deduction, the global results are encouraging. The 117 developing countries covered in the study, which include all the developing world except eastern Asia (mainly China) and a few very small countries, could, as a group, feed almost twice their populations projected to the year 2025, even under the United Nations "high-population" variant, by producing at the intermediate of the three levels of technology and input use envisaged in the study. The same input level would also suffice for the highest numbers (again according to the latest UN projections) at which their populations may be expected to be stabilized toward the end of the next century. At the high-input level, the food-production potential would be more than double the potential at the intermediate input level.

The results for certain individual countries, however, are much less encouraging. Already in 1980 there were 15 countries that could not have fed their populations from domestic production even with high inputs, and by 2025 their number would rise to 27 at the low-population variant and 33 at the high. A one-third deduction is too indiscriminate an instrument to apply at the country level, but if suitable deductions were made, these numbers would obviously be even higher.

Because of the very uneven distribution of the present, and likely future, populations in relation to the potential supporting capacity of the land in their respective countries, the international movement of food is certain to play an increasing part in the food supplies of the developing countries. This means, on the one hand, that the actual or potential food-deficit countries will have to generate sufficient export earnings to pay for the food they require but, on the other hand, that substantial export-earning possibilities will be created for the many developing countries that will have a large potential food surplus for export.

That a certain level of population could eventually be adequately fed at a certain level of input is a most important element in future food-supply prospects. However, the time element is also crucial, since it is essential that the potential supporting capacities be realized by the time the populations requiring them materialize. Many high-potential countries have failed in recent years to increase their food production rapidly enough to keep pace with their population growth, let alone increasing supplies on a per caput basis.

FAO's perspective study, *Agriculture: toward 2000* (FAO, 1981), often referred to as "*AT 2000*", indicates the speed at which agricultural production in the developing countries could and should increase in the future. If past trends continue, the rate of increase in agricultural production in the 90 countries studied would be only 2.8 percent a year from 1980 to 2000, while under two normative scenarios this rate could be raised to 3.1 or 3.7 percent.

It appears from the *AT 2000* study that even a very rapid increase in the aggregate demand for food, stemming from accelerated agricultural and overall economic development, could still leave large numbers of people undernourished by the end of the century. Their nutritional status could however be improved by additional measures that would result in those with inadequate intakes obtaining a larger share of the growth in total food supplies. For example, changes in income distribution in favour of the poor would imply a reduction in the variability of food intakes among households. Again, nutrition intervention programmes can be used to raise inadequate intakes.

The experience of the developed countries indicates that there are likely to remain some pockets of undernourished people requiring special assistance, even in the most affluent societies. If, however, by a combination of accelerated development and more equitable income distribution, undernutrition in the developing countries could be reduced to about the same level as in the developed countries, the nutritional problems of the remaining undernourished people would presumably be manageable through nutrition intervention and related programmes.

In order to obtain a rough indication of what might be required to reduce the incidence of undernutrition from 15 or 23 percent of the population, as estimated in Chapter 3 for 1979-81, to 2.5 percent by the year 2000, theoretical calculations have been made according to the distributional analysis in Chapter 3. (In essence, they involve determining the average per caput dietary-energy intakes that would reduce to 2.5 percent the proportion of the population below the cut-off points, the difference between which and the actual 1979-81 average intakes indicating the required growth in terms of per caput supplies. This was translated into total supplies by applying the medium variant to the UN population projections for the year 2000. In addition to the coefficient of variation of household dietary-energy intakes used in Chapter 3, which ranged from 0.24 to 0.59, two alternative calculations assumed reductions of 10 and 20 percent in this coefficient.) Table 5.1 shows the rates of growth of DES that would be required in order to attain the target per caput dietary-energy intake, on the basis of the two alternative cut-off points, and with the variability in intake distributions unchanged or reduced.

With the same coefficient of variation as was used in Chapter 3, i.e. assuming no change in distribution, and on the basis of the cut-off point of 1.2 $\overline{\text{BMR}}$, it is estimated that the total DES of the developing market economies would have to grow at an average annual rate of 3.8 percent from 1980 to 2000 if the undernourished population was to be reduced to 2.5 percent by the latter date. On the basis of the 1.4 $\overline{\text{BMR}}$ cut-off point, the required growth rate would be raised to 4.3 percent a year for the developing market economies as a whole.

Since these calculations assume no change in the variability of intake distributions, they imply equal rates of increase for each household, regardless of its actual intake level. However, there is an implicit upper limit or saturation point for household dietary-energy intakes, so that as the average per caput intake increases, there is already likely to be some reduction in the interhousehold variability. This fact is probably of little importance in the context of small increases in average intakes, involved in the analysis in Chapter 3, but it could be of some significance in the context of a 20-year period and the much larger growth rates and higher supply levels considered here. From the policy standpoint, this consequential reduction in variability can be further enhanced by measures leading to income redistribution favouring the poor, and thus to higher effective demand for food by those whose intakes are restricted by the inadequacy of their income.

A reduction in the interhousehold variability could substantially lower the rate of increase in DES required to reach the target of a 2.5 percent incidence of undernutrition by the end of the century. Thus, Table 5.1 shows that if the variability (coefficient of variation) could be reduced by 10 percent by the end of the century, the required rate of increase for the developing market economies would be lowered to 3.4 or 3.9 percent a year, according to the cut-off point chosen. If the decrease could be 20 percent, the corresponding rates of increase in supplies would be lowered still further to 3.1 and 3.5 percent respectively. Figure

TABLE 5.1. **Rate of increase in DES required to reduce incidence of undernutrition to 2.5 percent of population of developing regions by the year 2000 (alternative requirement estimates; intake-distribution variability unchanged and reduced)**

Region	Annual rate of increase of DES required					
	Target based on estimate A (1.2 $\overline{\text{BMR}}$)			Target based on estimate B (1.4 $\overline{\text{BMR}}$)		
	Variability					
	Constant	Reduced 10%	Reduced 20%	Constant	Reduced 10%	Reduced 20%
	(%/year)					
Africa	4.9	4.5	4.1	5.4	5.0	4.6
Far East	3.6	3.2	2.8	4.1	3.7	3.3
Latin America	3.5	3.2	2.8	4.0	3.6	3.2
Near East	3.3	3.0	2.8	3.8	3.4	3.1
All developing market economies	3.8	3.4	3.1	4.3	3.9	3.5

5.1 illustrates the possible impact of a policy designed, at the same time, to increase per caput DES and reduce intake variability, on the percentage of undernourished in a population.

The growth rates shown in Table 5.1 refer to the calorie equivalents of food consumed directly. Since higher calorie-consumption levels also imply a shift to more expensive foods, the required growth rates in terms of total monetary value of demand are likely to be higher. Moreover, the growth rate of total demand for food commodities is likely to be even higher, because at higher levels of consumption the share of such commodities used indirectly (e.g. for feed) also increases. Thus, it is estimated that the monetary-demand growth rates corresponding to the calculated growth rates in calories, based on the 1.2 $\overline{\text{BMR}}$ cut-off point, and unchanged variability (column 1 in Table 5.1), are about 5.4 percent for Africa, 4 percent for the Far East, 4.2 percent for Latin America, 4.3 percent for the Near East, and 4.3 percent for the developing market economies as a whole.

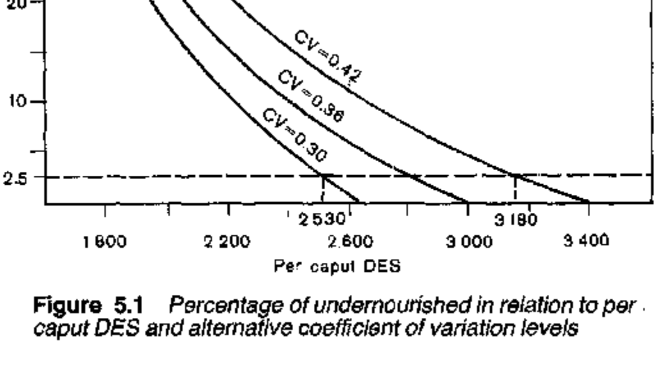

Figure 5.1 *Percentage of undernourished in relation to per caput DES and alternative coefficient of variation levels*

Another useful indication of the dimensions of future policy problems may be obtained by the "dietary-energy gap". This is estimated by multiplying the difference between the actual (1979/81) and the target per caput dietary-energy intake by the population in 1980. The gap indicates the additional amount of food required, on the basis of the 1980 population. The estimated amounts, expressed in cereal equivalents, are shown in Table 5.2. Thus, under the targets based on the 1.2 $\overline{\text{BMR}}$ cut-off point, the requirement for the developing market economies would range from 186 million tonnes of cereals a year with unchanged variability to about half this quantity with a 20 percent reduction in variability. Under the targets based on the 1.4 $\overline{\text{BMR}}$ cut-off point, the range would be from 260 to 152 million tonnes of cereals per year. The target per caput dietary-energy intakes associated with these estimates for the developing market economies as a whole are shown in Figure 5.2.

These estimates are based on the total increases in national food supplies that would be required to ensure that the intakes of the undernourished would be sufficiently raised. If however the additional food could be targeted directly to the undernourished — for example, through food aid used in nutritional intervention programmes — the additional requirements would be much lower: only 8 million tonnes of cereals a year would have been enough in 1979-81 to raise the dietary intakes of the undernourished to 1.2 $\overline{\text{BMR}}$, and 14 million tonnes to raise them to 1.4 $\overline{\text{BMR}}$.

Policies in developing countries

Although their efforts can be significantly assisted or impeded by policies in the rest of the world, it is primarily what the developing countries themselves do that will affect the speed with which malnutrition is reduced. The foregoing analysis of the dimensions of future policy problems suggests that the policies of these countries should generally

TABLE 5.2. **Additional food required in 1979-81 to reduce incidence of undernutrition to 2.5 percent of population of developing regions (alternative requirement estimates; intake-distribution variability unchanged and reduced)**

Region	Required increase in DES					
	Target based on estimate A (1.2 $\overline{BMR}$)			Target based on estimate B (1.4 $\overline{BMR}$)		
	Variability					
	Constant	Reduced 10%	Reduced 20%	Constant	Reduced 10%	Reduced 20%
	(million tonnes cereal equivalent/year)[1]					
Africa	38	29	20	52	41	31
Far East	110	83	58	150	121	93
Latin America	28	20	13	41	30	21
Near East	10	6	3	17	12	7
All developing market economies	186	138	94	260	204	152

[1] Assuming 100 g of cereals yield 360 kcals dietary energy.

include a combination of at least four types of measures: (1) measures to increase overall food demand and supplies; (2) measures to improve income distribution and thus the effective demand for food among the poorest groups; (3) direct nutrition-intervention programmes; and (4) the introduction of nutritional considerations into rural and agricultural development programmes. Most important of all is to accelerate economic development, so as to increase effective market demand for food, and to promote economically efficient domestic production to play the leading role in meeting this demand. Only in this way can any enduring solution to the problems of malnutrition and long-term food security be found.

The policies required for this purpose have already been extensively dealt with in other FAO publications, and are summarized here only briefly. This section, instead, takes a closer look at policies specifically concerned with nutrition, including direct nutrition-intervention programmes to meet the needs of many people whose access to food is unlikely to be raised sufficiently as the result of accelerated economic and agricultural development, and the orientation of agricultural and rural development programmes toward meeting nutritional needs. This follows from the realization that nutritional problems cannot be solved in isolation, and that solutions depend very much on agricultural and rural development. Further, this section presents brief discussions of food subsidies, women's programmes, population policies, the need for all these measures to be as fully integrated as possible, and finally the need for research and data on which to ground improved policies.

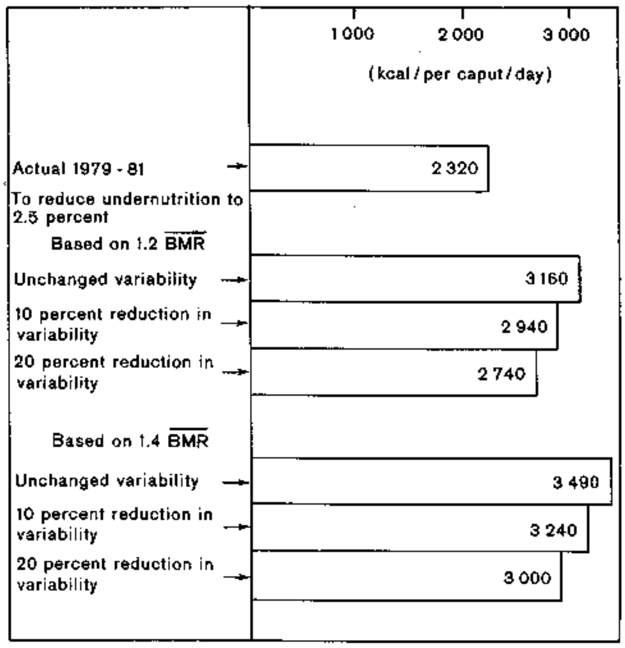

Figure 5.2 *Average per caput dietary-energy intake in developing market economies: actual and those required to reduce incidence of undernutrition to 2.5 percent of population with unchanged and reduced variability in intake distributions*

Increasing food demand and production. The accelerated income growth and slightly slower population growth assumed in the optimistic scenario of *AT 2000* (FAO, 1981) would lead to an expansion of 1.3 percent a year from 1980 to 2000 in per caput demand and 3.7 percent a year in total demand for food in the 90 countries covered in the study. Since in most of these countries the food and agricultural sector is responsible for a large share of the total income and generates substantial employment opportunities in other sectors, an increase in food production itself leads to growth in income and food demand.

Because potentially cultivable land is already scarce in some countries, and since even in the land-rich countries much of the remaining area is difficult of access and costly to open up, only about a quarter of the total increase in crop production by 2000 is likely to come from area expansion. About 15 percent would come from greater cropping intensity (through less fallow and more multiple cropping), and as much as 60 percent from higher yields.

The necessary yield increases will require a very rapid expansion in the use of modern production inputs. Thus, *AT 2000* estimated that irrigated areas would have to be expanded by 1.7 percent per year, chemical fertilizer use by 8.7 percent a year, and the number of tractors used in agriculture by 8.9 percent a year.

The accelerated increase in food production that is required could create serious threats to the environment. If sufficient food production is to be sustainable for future generations, strict land-use policies must be formulated, not only to limit the haphazard destruction of forests, that have such an important protective as well as productive role, but also to prevent productivity losses in both existing and new agricultural areas, through soil- and water-conservation measures.

Many "delivery systems" are needed, to provide a wide range of essential services for farmers: research must develop less costly production technologies, and extension must bring them down to the farm level; more efficient marketing systems are indispensable; adequate and timely input supplies must be ensured; credit, transport, storage and processing facilities must be made available. Delivery systems in most countries need to be made more responsive to the requirements of poor small-farmers, and especially to farm women. Programmes must be undertaken to eliminate, or at least reduce, major losses in food supplies through avoidable waste during and after the harvest. More attention also needs to be given to secondary or traditional cropping in addition to the major cereals, particularly for their importance in alleviating seasonal hunger and malnutrition.

The formulation and implementation of a realistic farm price policy constitute an essential part of governments' responsibility in the expansion of food production. To provide a sufficient incentive for the farmer, a price policy must ensure a profitable relationship between input and output prices. At the same time, however, most governments are under strong pressure to keep consumer food prices as low as possible, especially for their politically articulate urban populations. One means of strengthening incentives would be to use price and related policies to stem the tendency for urban consumers, encouraged by food aid and multinational food-processing corporations, to shift from local staples to imported products that cannot be grown domestically. Such policies can also be used to shift consumption away from foods that are less nutritionally valuable and toward more nutritious ones (FAO, 1984b; 1985).

Much of the necessary investment in agriculture has to be made by the farmers themselves, but the governments of the developing countries also have a crucial role to play in achieving the necessary levels of investment. The more rapid expansion of food production and the introduction of good cropping and animal husbandry policies will obviously cost much more than they have hitherto spent on agriculture. Most governments still need to give higher priority to agriculture in both their current and their development budgets if they are to avoid food emergencies and ensure long-term food security and adequate nutrition. On the other hand, although total costs will clearly rise, there is much scope for reducing unit costs of production.

Many countries can produce agricultural commodities for export, in some cases importing part of their own food supplies in return. This approach is sometimes criticized, but it must remain an important policy option, since some countries have no other means of earning foreign exchange. These options must be carefully assessed in the light of the world market and local conditions. Producers of export crops may endanger their food security by growing less food for their own consumption and relying increasingly on market supplies. It is essential that imports financed by export crops include any food that is required to compensate for the food production foregone, that rural as well as urban people have access to these food imports, and especially that farmers' incomes from export crops not be reduced by over-valued exchange rates and commodity taxes so that they cannot afford to purchase the food they need (Pinstrup-Andersen, 1983).

As already indicated, there are other countries where a significant share of their additional supplies of food for their growing populations will have to be imported. In such countries, the development of non-agricultural sectors to generate increased foreign-exchange earnings will be a crucial element of policies to ensure adequate access to food.

Improving income distribution. Earlier in this chapter it was noted that even fairly moderate improvements in income distribution could have a marked impact on the incidence of malnutrition. In urban areas, income redistribution could be promoted through such measures as incentives for using labour-intensive production methods, minimum wage legislation, and effective progressive taxation of income, although the two latter measures are not easy to administer in developing countries. In some cases, food rationing, even if administratively difficult, may offer an alternative if malnutrition is to be overcome through improved distribution of the available food supplies in relation to nutrition requirements.

In rural areas, more active measures are required to implement the poverty-oriented approach to rural development advocated by the 1979 World Conference on Agrarian Reform and Rural Development (WCARRD), (FAO, 1979b). In addition to better access to delivery systems for poor and small farmers, measures recommended by the WCARRD include land-tenure reforms to provide more equitable access to land, water and other production resources, greater people's participation in all development programmes and projects, the integration of women in rural development, and the promotion of non-agricultural employment opportunities, especially for the landless, through labour-intensive rural industrialization and public works projects, which can often be partly financed by food aid; this should be followed up by regular monitoring and evaluation of progress.

Food subsidies. Food subsidies are in use in many developing countries. In 31 of the 37 developing countries covered in a recent FAO survey of price policies (FAO, 1984b), consumer food-subsidy programmes were found to have been introduced or continued during the period 1968-80.

Such programmes may take several different forms. In some countries, especially in the Far East, there are dual-price systems under which foodstuffs are available at less than market prices in "fair price" or ration shops. Particularly in Africa, the marketing of the major staple-food crops is often a government monopoly, subsidies being provided either explicity or implicitly, by financing marketing-board losses.

General, untargeted subsidies, administered through government marketing agencies or through payments to flour- and rice-mills and other food processors, are the most widespread, but they have a number of disadvantages that are being increasingly recognized. Controlled consumer prices may reduce producers' incentives if they are set too low. They chiefly benefit urban consumers, who purchase all of their food. Above all, they are wasteful, in that their benefits go to the better-off sectors of the population as well as to the poor.

Even such general subsidies can be rendered to some extent "self-targeting" by being applied to commodities consumed principally by the poor. Dual-price systems, on the other hand, can limit access to the lower price by locating outlets in the poorest areas and/or issuing access or ration cards to eligible groups, as well as by supplying lower — but nutritionally adequate — qualities of the subsidized commodities.

Food-stamp programmes, under which a stamp or coupon has a monetary value and can be exchanged for certain food items, are another means of limiting access to needy groups but so far there is little experience with food stamps in the developing countries. They have recently been introduced in Colombia (where the programme was subsequently abandoned), Jamaica and Sri Lanka (to replace a long-standing rationing scheme).

Food subsidies can be extremely costly. Although information is scarce, data for nine countries assembled in an FAO survey (FAO, 1984b) show that in 1973-75, their cost ranged from 3 percent of total public expenditure (in Mexico) to 17 percent (in Sri Lanka), and even more in China. Data covering 15 countries for one or more years in the period 1978-80 show a range of less than 1 percent (in Colombia) to almost 13 percent (in Egypt). In each country for which these data were available for the two periods, a substantial reduction — broadly by half — in the percentage of expenditure was brought about by 1978-80, except in Egypt, where there was little change.

Although the programmes were particularly costly in Egypt and Sri Lanka, in both countries they appear to have effectively reached the poor. In Egypt, it is estimated that the income transferred by the programme was equivalent to 16-17 percent of that of the poorest groups, and that the rural poor benefited as much as, or even slightly more than, the urban sector.

A major disadvantage of food subsidies is that once they have been introduced, they tend to be regarded as a permanent right. With rising costs and economic recession, a number of governments have recently sought to curtail them but — not unexpectedly — this has been found to be politically difficult. Governments are therefore searching more and more for flexible, cost-effective systems that do not prove to be open-ended. Although some evaluations of the cost-effectiveness of different approaches have been attempted, they have thus far been inconclusive.

The emphasis is being increasingly placed on more sharply targeted approaches, which have the added advantage of not damaging producers' incentives, but on the contrary may actually stimulate them by increasing the total demand for food. Most targeted approaches being more demanding administratively than general food subsidies, the feasibility of using the administratively simple "self-targeting" approach should always be considered when alternative means of targeting are being examined. These include means-testing, the use of exclusion criteria, the consideration of the visible characteristics of households or individuals (e.g. age or unemployment), and geographical location (e.g. residence in poor neighbourhoods). Targeting may also be achieved by using institutions such as cooperatives, mother- and child-health centres, schools, and places of work for the distribution of free or subsidized food. These approaches are however mainly directed to the traditionally vulnerable groups: young children and pregnant and lactating women. It seems important that other food-subsidy programmes be maintained in favour of other poverty groups.

Since a main impact of food subsidies is to improve the real income of the poor, and only part of the improvement will be used to raise their food consumption, more directly productive income-generating programmes may also offer an alternative in certain circumstances. Finally, because food subsidies have generally benefited urban more than rural populations, although the largest numbers of the very poor are in the latter sector, every effort must be made to extend targeted subsidies to rural people. Food-for-work schemes appear to be the most useful approach.

Nutrition intervention programmes

The most direct way of making progress toward meeting the needs of those who are by-passed by accelerated agricultural and economic development, with inadequate access to food of the right quantities and qualities, is through specific nutrition intervention programmes targeted directly at them. Although the scale of such programmes can be diminished as rising incomes gradually lift more people out of poverty, the experience of even the wealthiest of the developed countries suggests that they are likely to remain indispensable for the foreseeable future. Since they are less well known than the more general measures required to increase the market demand for food and its domestic production, they are discussed here at some length.

While there are many different types of nutrition intervention programmes, most fall into one of four main categories: (1) nutrition education; (2) special feeding programmes; (3) promotion of breast-feeding and formulation of home- or village-level weaning foods; and (4) food fortification and the distribution of specific nutrient supplements. In most situations, a combination of two or more of these is desirable.

During the 1950s, intervention programmes were combined with applied nutrition programmes, as an interdisciplinary concept, developed by FAO, WHO and UNICEF, designed to educate and encourage rural communities to grow and eat foods that would improve their diets, and especially those of mothers and children. Many of these programmes suffered from inadequate integration with other agricultural and rural development programmes and lack of coordination among the various participating disciplines and, by the 1970s, it was realized that in isolation they were not sufficient to improve the nutrition of the rural poor: other measures also had to be taken to improve their access to food. Further, nutrition interventions were found to be most effective when combined with primary health-care programmes, providing basic health care (especially oral rehydration therapy to treat diarrhoea), growth monitoring, immunization, environmental sanitation, and safe drinking-water. Many such programmes being easier to manage in urban than in rural areas, partly thanks to the existence of better infrastructures and the physical concentration of target groups, it is necessary to guard against urban bias in planning and implementing them.

Nutrition education. Nutrition education, a basic component of most intervention programmes, is designed to motivate people to change their food behaviour in order to make better use of available and potentially available food resources. It can be used to diffuse simple, general nutritional information, or for such more specific purposes as promoting breast-feeding and other better infant- and child-feeding practices, encouraging the preparation and use of suitable weaning foods, improving intra-family food-sharing, and promoting the consumption of seasonal foods such as fruit and vegetables. It can be directed either at the general public or at target groups. Although it is obviously less valuable where malnutrition results solely from inadequate purchasing power, it can be of help even here by teaching people, especially the urban poor, to make the best use of their limited incomes by purchasing the cheapest combinations of nutritious foods.

Nutrition education must always be tailored to the specific situation and call on the most appropriate combination of communication methods. For its effects to be long-lasting, it should be integrated with formal education, especially in primary-school curricula and teacher-training, and should concentrate on the foods available in the home.

Closely related to nutrition education, and often integral parts of it, are programmes to improve food handling, preservation and preparation at the village and household levels. These can substantially increase food availability by reducing losses, and at the same time provide greater food-safety insurance (e.g. safer food-preservation methods can contribute conspicuously to reducing food-borne infections). Improved food-preparation methods can not only reduce waste and spoilage, but also enhance the nutritional value of foods by making certain nutrients more available or by conserving others, such as vitamin C. Speedier preparation and cooking methods can greatly reduce the drudgery of the housewife. Better cooking utensils and methods make it possible to economize on the use of precious firewood and other fuels.

Promoting home and community gardens and small-livestock production is also an educational task, whose purpose is to stimulate small-scale production of foods — often minor ones — that can provide essential nutrients in the staple diet: dark-green leafy vegetables for vitamin A; soybean and pulses for protein; citrus and other fruits for vitamin C; and poultry and other small animals for animal protein. In general, the results of such programmes have been disappointing. Poultry-raising has tended to be more successful than home gardens, but perhaps because the product has been sold rather than used for family consumption. Agricultural extension workers have rarely been able to furnish adequate support. Community gardens have encountered many problems except where there is a tradition of cooperative activities, and school gardens too have failed to fulfil their potential. There have, however, been some successes, and home food-production may still be a viable intervention where vegetables, fruit and farm-yard animals find a ready market.

Special feeding programmes. Special feeding programmes are a more direct form of nutrition intervention. They include supplementary-feeding programmes for mothers and pre-school children, nutrition rehabilitation programmes, and school feeding programmes. Some of these, carried out on a large scale, are usually supported by food aid.

Supplementary-feeding programmes may provide meals on-site or distribute rations from a central point at regular intervals for use at home. They generally cover the vulnerable groups, such as women during the last three months of pregnancy and for six months during lactation, and children of six months to five years of age. On-site programmes call for a greater infrastructure and therefore cost more, but they ensure that the beneficiaries actually consume the food: take-home programmes can potentially cover wider areas and reach more beneficiaries, but leakage takes place through sharing with other family members and sometimes the sale or exchange of all or part of the ration. Other problems include poor participation and sporadic attendance when the ration fails to provide a sufficiently strong incentive or when distribution centres are too distant; the difficulty of targeting the programme to the people who need it most; and, at times, failure to respect the size of the ration. Costs vary widely from country to country, but are usually quite high: the cost of a supplementary-feeding programme to provide an additional 300-400 kcal/day per recipient can range from US$10-30 per year per person, the food supplied accounting for 50-90 percent of the total cost.

In general, supplementary-feeding programmes are likely to be cost-effective if they are targeted to the most malnourished, to pregnant and nursing women, and to children of six months to three years of age; if the food supplement is sufficient to provide a substantial part of the individual's daily requirements (say, one-third to one-half), and thus the incentive for regular participation; if the intended beneficiaries actually consume the food supplement; if criteria are established for entry into, and exit from, the programme on the basis of the degree of malnutrition and response to feeding; and if the programme is integrated with other inputs, including health and nutrition education and primary health care.

Nutrition rehabilitation programmes are designed to rehabilitate moderately malnourished infants and young children by providing them with an adequate diet based on locally available foods. (For severe cases of malnutrition, such programmes are insufficient: hospital treatment is usually necessary.) At the same time, their mothers are taught how to prepare this diet so that they can continue it at home when the child recovers. Originally, these programmes were carried out at residential centres, usually attached to hospitals, with mothers and children in attendance for up to four weeks. Since mothers could seldom stay so long, more recent alternatives have included day-care centres; on-site feeding and food-preparation lessons at a convenient central point; and rehabilitation in the home, with visiting health or nutrition aides teaching the mother in her own environment. Well-run residential centres have proved to be inexpensive and effective, but the good results achieved through rehabilitation in the home suggest that this method may be preferable.

Nutrition rehabilitation is a temporary, emergency intervention. It can have lasting results only if the families have the resources and motivation to pursue the improved feeding practices after rehabilitation. It should always be followed up as soon as possible by integrated nutrition and primary health-care programmes, which are preventive as well as curative and offer greater long-term benefits.

In many countries, *school feeding programmes* reach more beneficiaries than supplementary-feeding programmes for mothers and pre-school children, primarily because they are logistically much easier to organize. However, the scarce information available on their effectiveness does not provide a definite answer to the question of their nutritional impact, although there is some evidence to show that catch-up growth in previously undernourished pre-school children can be achieved if sufficient food supplements are provided in the first primary-school years. Teachers also regularly report increased school enrolment and attendance, and increased alertness, attentiveness and performance by the children. On the other hand, the poorer children, most in need of the programme, are the least likely to attend school and the most likely to drop out, and in any case the programmes can operate for only part of the year.

If a school lunch is served, it may replace lunch at home (which may or may not be better), but it ensures at least one good meal a day for children who, especially because of the heavy burdens on rural women, might not otherwise get one. For this reason alone, school feeding programmes are an effective and important nutrition intervention.

Like other supplementary-feeding programmes, they may also release a larger share of the limited household food-supplies for the rest of the family. They are a useful vehicle for nutrition education and for instruction in school gardening and home food-production, provided that there is sustained interest from teachers and adequate participation from parents.

Promotion of breast-feeding and formulation of home or village weaning foods. The promotion of breast-feeding and of the formulation of home weaning foods is particularly important in preventing and controlling child malnutrition, since the weaning period is, nutritionally speaking, the period in the life of the child when he is most vulnerable. As was seen in Chapter 4, the practice of breast-feeding is rapidly declining in urban areas, and suitable weaning foods are often unavailable in the developing countries. Initially, commercial weaning foods received considerable attention and funding, but they proved too expensive for the poorest groups, and also positively dangerous when overdiluted and/or unhygienically prepared. More recently, therefore, most attention has been concentrated on home- or village-prepared weaning foods, in which the local cereal or root staple is combined with locally produced protein-rich foods, together with oils or sugar to provide extra energy without adding to bulk.

Mothers themselves can prepare these weaning foods by introducing only minor modifications into the usual family diet. Once the proper formulation has been established and tested for nutritional value, its preparation and use can be easily taught to mothers. Since most of the ingredients are by definition readily available, this approach is cost-effective and readily acceptable.

Food fortification; distribution of nutrient supplements. The elimination of specific nutrient deficiencies should be among the easiest and least costly (see the Box) nutrition interventions, because their occurrence is often localized geographically. They include deficiencies of iodine (causing goitre), of iron and folic acid (causing anaemia), of vitamin A (a cause of blindness in children) and of vitamin D (a cause of rickets when combined with insufficient exposure to sunlight). Food fortification consists in adding the necessary nutrients to foods in order to alleviate nutritional deficiencies caused by inadequacy in the intake of a particular nutrient.

Salt iodization is the most widely used and successful example of fortification. Vitamin A fortification of sugar or monosodium glutamate has also proved feasible. Bread has been fortified with iron in several countries, and dairy products are being fortified with vitamins A and D. On the other hand, the fortification of cereals with synthetic amino-acids to improve protein quality has not so far shown any immediately detectable nutritional benefits.

The success of a fortification programme depends essentially on the choice of a carrier that is regularly consumed by the target group, on obtaining a product that is no less acceptable than the untreated carrier (if there is a price difference, it may have to be covered by subsidies), and on properly controlled — usually centralized — processing.

As an alternative to, or in addition to, food fortification, iodine, vitamin A, iron and folic acid can also be distributed directly in tablet, capsule or injectable form. Direct distribution is desirable when the nutrient has to be targeted to specific population groups (e.g. for iron and folic acid, young children and pregnant women) or a limited geographical area. The main constraint in most countries appears to be the lack of a health infrastructure adequate for reaching enough members of the target group. These programmes should therefore accompany other interventions, such as the promotion of home gardens or integrated nutrition and health programmes.

The distribution of vitamin A capsules to prevent blindness in young children is particularly important. The required dose should be administered regularly, every four to six months, to infants and children up to six years of age, and a similar dose should be given to mothers immediately following delivery in order to increase the vitamin A content of their milk. Such programmes have been used with considerable success in national prevention programmes in Bangladesh, India and Indonesia.

Annual costs of some nutrition intervention programmes

Iodization of salt: US$0.002 per individual consumer, or US$0.008 per deficient individual.

Iron fortification: US$0.11 per anaemic individual (Latin America).

Vitamin-A fortification:
— of sugar: US$2.20 per deficient child treated (Guatemala);
— of monosodium glutamate (MSG): US$1.64 per deficient child treated (the Philippines).

Fortification of cereals with amino-acids or protein concentrate: about US$2.50 per person (depending on relative costs of fortifying substance and staple cereal).

Source: Austin and Zeitlin, 1981.

Integration of nutritional considerations into agricultural and rural development programmes

The experience of past decades has shown that the impact of direct nutrition intervention programmes has been limited because they have been essentially palliative and have failed to address the underlying causes of malnutrition.

In recent years, it has been increasingly recognized that nutritional problems should not be seen in isolation, but that they should be tackled by introducing nutritional considerations into national development strategies and programmes (FAO, 1979a; 1979b). Since the greatest numbers of the malnourished are to be found in the rural areas of the developing countries and depend directly or indirectly on agriculture, this approach is logical if improvements in food consumption and nutrition are to be realized and sustained. As a means of translating development benefits into long-term improvements in nutrition, agricultural and rural development projects should contain components designed to increase income and promote subsistence food production, to ensure access to food at all seasons and to improve the environment in order to reduce the incidence of disease.

FAO's methodology for incorporating such considerations into project planning, design and implementation involves, first of all, identifying projects likely to have a nutritional impact; determining the nature, extent, type and causes of malnutrition in the project context and the target groups to be addressed; and assessing project design to determine what can be done to improve the nutritional impact of the project within its overall social and economic goals. Priorities for nutritional improvement can be established at moderate cost in terms of data collection and analysis. Project components can be designed or modified in that light, or changes in project beneficiaries can be indicated. Potentially negative project, or component, effects can be identified in good time and counteracted. Current management and future expansion can be influenced through the continuous surveillance and monitoring of the projects' effects on the nutritional status of the beneficiaries; such monitoring can also make it possible to determine whether specific nutritional interventions are needed, and which ones are likely to be cost-effective in that they can be targeted as accurately as possible on the people most in need and timed according to peak vulnerability.

Testing of these guidelines in field case-studies in six countries has demonstrated that there is considerable scope for improving the nutritional impact of agricultural and rural development programmes. They are therefore being used by an increasing number of bilateral and multilateral donors, with encouraging results.

Population policies. In Chapter 3 it was seen that, owing to high rates of population growth, the number of the undernourished in the developing market economies as a whole continued to rise, although there was a decline in the percentage of the undernourished. It is clear that reducing these growth rates in countries where there is heavy population pressure on resources will ease their food problems.

Family-planning programmes designed to lower population-growth rates are therefore of great importance for the nutritional welfare of these populations. Spacing of pregnancy is particularly important for nutritionally vulnerable mothers and children, in that it leaves more time to mothers for nutritional recuperation and raises the survival prospects of young children by making more time available for their care. It is widely agreed that improved prospects for child survival may be a major prerequisite if parents are to begin thinking in terms of smaller families.

Programmes to give rural families the knowledge and means of family planning are sadly lacking in most countries, and there is considerable scope for rural services that combine family-planning advice with primary health care, nutrition education and other nutrition interventions. In some countries, contacts between rural agricultural people and home-economics extension workers have proved useful vehicles for family-planning advice.

Other important aspects of population policies as they relate to food problems concern urbanization. Their relationship with, and impact on, nutritional status have already been alluded to in Chapter 4. Urbanization is an inevitable consequence of economic development, and the main policy need is not to prevent it but to channel it, as far as possible so that it grows no faster than employment opportunities, social infrastructures, and services in urban areas. This depends principally on the expansion of rural employment, combined with other measures to increase the attractiveness of rural life as compared with that in urban areas. It is also desirable to attempt to reduce the concentration of rural/urban migration to a few large metropolitan centres through such measures as promoting the development of small rural market-towns.

Women's programmes. In addition to the need to select the most relevant forms of nutrition intervention programmes, to target them as accurately as possible on the people most at risk, and to integrate them with other agricultural and rural development initiatives and with primary health-care programmes, a further essential for their success is that they be formulated and implemented with the full participation of their intended beneficiaries: chiefly, women at the vulnerable periods of pregnancy and lactation, especially those with young children in their care. Women are therefore the people who most need to be consulted.

Women play a crucial role in nutritional improvement, not only as mothers but also because of their great importance in the production, processing, marketing, preparation and cooking of food. The burdens on women, and especially rural women, in the developing countries are extremely heavy. The greatest sufferer is generally the child, since the burdens on mothers affect the amount of time they are able to spend caring for their children, including breast-feeding and the careful preparation of weaning foods. Thus, anything that can lighten their drudgery should, in addition to improving the quality of their own lives, lead to better nutrition as well. The many measures that could help include increasing access to water and fuel, labour-saving methods, improving equipment for food preparation and cooking and, — most of all — a more equitable division of labour with men.

Notwithstanding their close concern with development, women are still hardly ever involved in the planning and implementation of any of its aspects. Government officials, predominantly men, tend to assume that consultation with women is not necessary, and development programmes and projects therefore seldom take much notice of their often special needs.

This situation is unlikely to be reversed without a general raising of the status of women in society as a whole, and the elimination of discrimination against them. Thus, the broad recommendations of WCARRD on the main policy requirements for the better integration of women in rural development (FAO, 1979b, esp. pp. 1-11) are relevant to nutritional improvement: equality of legal status, women's access to rural services, women's organizations and participation in educational and employment opportunities.

Policy integration. This survey of the principal nutritional policy requirements in the developing countries brings out, above all, the very wide range of different measures involved in nutritional improvement. Because of this variety, the effective integration of measures administered by several different government departments is itself a major policy requirement. Reference has already been made to the need to integrate nutrition intervention programmes not only with primary health care but also with other agricultural and rural development intiatives, but the need for properly integrated policies goes much farther.

Required actions combine both short-term measures, such as many of the specific nutrition interventions, and long-term undertakings such as increasing employment, income and production. The two are interdependent, since the extent to which the first are needed depends inversely at least in part, on the success and speed with which the second can be implemented. They also compete for the limited financial and other resources available. It is therefore essential that the best balance between them be established, maintained and regularly assessed in each country; a suitable urban/rural balance is also imperative. In a number of countries, such options have unfortunately been pre-empted to some extent by the need for emergency and rehabilitation measures, but this must not be allowed to lead to the further neglect of the essential long-term measures.

A need closely related to that of better integration of all policies for nutritional improvement is that of emphasizing the importance of nutrition in national planning and policy-making. In the past, it was seldom given much weight, except for generally small, *ad hoc* nutrition interventions: it tended to be assumed that development projects were bound to have beneficial effects on nutrition, although the actual results often turned out otherwise. In particular, subsistence production, including the growing of traditional or secondary crops that are of prime nutritional importance, has been neglected in development programmes and projects, which have often led to the elimination of such food crops and to increased malnutrition, even where general levels of living have apparently improved.

A good means of achieving better integration and enhancing the importance of nutrition is the preparation of a national food strategy and programme, embodying a detailed diagnosis of the country's food problems and a full set of measures for resolving them. But, as already stated, nutrition should not be confined to the food plan alone: it should be a major consideration in all planning and project formulation.

Although poverty is the main cause of malnutrition, Chapter 4 has made it clear that there are many other complex, and often interacting, causes. Thus, any part of the food system may be the most relevant in a particular case, ranging from international markets, ecological conditions, and access to land and other production inputs, all the way to food handling and preparation methods, utensils and food sharing at the household level, and time elapsing between food preparation and consumption. A part of the food system that has recently come into prominence is the supply of firewood and other cooking fuels (see Box on the following page).

Research and data requirements. Substantial improvements in available data are required for more effective nutrition policy formulation and planning. At the most fundamental level, it is apparent from Chapters 3 and 4 that knowledge is far from complete on human metabolism, its varia-

Fuel for cooking

Fuelwood (firewood and charcoal) is the principal fuel used for cooking and also for much simple food preservation and processing in most developing countries. However, fuelwood supplies have been rapidly depleted, and in many areas rural people, usually women, now have to walk very long distances to collect and carry fuelwood. Often the frequency of cooked meals has been reduced.

It is estimated that in 1980, almost 100 million rural people in developing countries were living in areas with an acute fuelwood scarcity, a further 1 000 million were living where current levels of use could no longer be sustained, and another 300 million were living where there was a prospective deficit. By the year 2000, if past trends continue, as many as 2 400 million people will be in areas of acute scarcity or unsustainable levels of use.

Source: FAO, 1983b, esp. p. 22.

tions, and dietary-energy and other nutritional requirements. More research on energy expenditure in different types of physical activity, in both work and leisure, is particularly needed. The complex causes of malnutrition, and especially its interactions with infectious diseases, are also incompletely understood.

While national food balance sheets have been steadily improved, they need further strengthening, and should be complemented by many more detailed food-consumption and budget surveys, more of which should examine the seasonal aspects of food intake. At least some surveys should attempt to tackle the difficult question of individual food consumption within households, and the anthropometric assessment of the adult nutritional status. Better data are also needed on income distribution and time allocation.

More project evaluations are needed, dealing with actual nutrition impacts and the relative costs of different policy measures, such as specific nutrition interventions and various food-aid uses. It is particularly important that the countries concerned establish nutrition surveillance and monitoring systems, as well as early-warning systems to predict impending food shortages and emergencies.

Agricultural research is also highly relevant to nutritional improvement. In particular, plant-breeding research should concentrate more on such questions as nutritional quality, digestibility, palatability and acceptability to consumers, preparation requirements, preservation and introduction of improved varieties of staple food crops in traditional farming systems, and on improving secondary crops of nutritional importance. There are also many other ways in which agricultural research can deal with matters of nutritional concern under the aegis of the International Agricultural Research Centres and other institutions (Pinstrup-Andersen, Berg and Forman, 1984).

Policies in the developed countries

As was observed in Chapter 3, there is a growing realization in the developed countries — where large pockets of malnutrition and even some undernutrition persist — that not only overnutrition and obesity but also wrongly composed diets are major causes of ill health and premature death.

Some Scandinavian countries have adopted agricultural production policies designed to provide a healthy diet for their populations. Both the United Kingdom and the United States have recently conducted government inquiries into the state of the national diet and proposed desirable changes. Although our knowledge of nutrition is still evolving, it is generally agreed that the diets of most people in the developed countries should contain less sugar, salt and alcohol, fewer animal fats and more fibres and vegetable fats, as well as certain minerals and vitamins.

However, many consumers in the developed countries do not know what they are actually eating, because they consume so much highly processed food, which accounts for much of their sugar, salt and fat consumption. A major policy need, therefore, is to induce the food-processing industries both to reduce the content of such nutrients in their products and also to label those products in simple ways that make it possible for the average consumer — and not only the scientific expert — to understand their nutrient composition.

Policies in the developed countries can also influence the success of efforts to improve nutrition in the developing countries, although this is unrelated to the policies briefly mentioned above. Except for a discussion of the link that is sometimes alleged to exist between overnutrition in rich countries and undernutrition in poor ones (see Box opposite), these aspects are discussed below, in the context of international policies.

Finally, it may be recalled that the developed countries have a long history of nutrition interventions, including food-stamp programmes, the fortification of milk, bread and other foods, and free or subsidized school milk and meals, as well as wartime food-rationing. The experience acquired in the course of these interventions could be of value to the developing countries.

International policies

The trade as well as development-assistance policies of the developed countries can affect materially the nutritional situation of the developing world.

Trade will play a very large part in future world food supplies, and here the developed countries have a dual role to play. First, they should be prepared to produce a large part of the food that developing countries will have to import. Second, they should remove the trade restrictions that hamper the efforts of the developing countries to earn the foreign exchange they need in order to pay for food and other essential imports.

The first of these roles is of advantage to the farm populations of the developed countries, but it is likely to be temporary: eventually, these countries will have to make substantial adjustments in their agricultural sectors. The second role, too, calls for major adjustments, but here they are needed immediately, and in the non-agricultural as well as the agricultural sectors. They should nonetheless still be of benefit to the developed countries themselves, by leading to lower consumer prices and expanding export markets.

Overnutrition in the rich and undernutrition in the poor countries

Policies designed to reduce overnutrition would certainly improve both the health and the social well-being of people in the developed countries. Unfortunately, however, there is no evidence to substantiate the claim, occasionally put forward, that they would also contribute to reducing undernutrition in the developing countries.

The link between the two is assumed to be the large quantities of cereals fed to livestock in the developed countries. But in the absence of a demand for their use as feed, these cereals, which are grown in the developed countries themselves, would probably never be produced: since the greater part of the undernourished population is poor, there would be no alternative market demand for them.

Although the feed demand for cereals could theoretically harm the poorer importing countries by pushing up world prices, this possibility is very remote, because of the high price elasticity of demand both for meat and for cereals for use as feed. When there was a world shortage of food, and prices rose sharply, in the early 1970s, an immediate result was a substantial reduction in the feeding of cereals.

The cereals fed to livestock could in fact be regarded as a supplementary famine reserve, much larger than ordinary reserve stocks, which at times of need can be diverted to direct human consumption, either by changes in market-price structures or through government policies. But this potential increase in the availability of cereals would take place almost entirely in developed countries: they would add to the food supplies of the developing countries only if enlarged food-aid transfers could be financed and transported.

International financial and technical assistance are likely to remain, for a long time to come, essential inputs in the efforts of the developing countries to improve their nutritional situation. It is of the utmost importance that the recent decline in this assistance be speedily reversed. A large proportion of the assistance should go to the poorest countries, especially in Africa, where the nutrition situation is the worst. Policies and projects that not only stimulate and expand production growth but also alleviate poverty and improve nutrition in the most effective ways should receive the priority attention of donors and the international community.

The current trends in international development-assistance policy — to require implementation of adjustment policies in beneficiary countries, to improve payment balances, or to reduce budget expenditures at the cost of aggravating the poverty and nutritional status of the poor and vulnerable groups — need to be urgently and seriously reassessed. Such a reassessment is necessary not only to preserve past gains in the field of improved nutrition policy and interventions, but also to ensure that adjustment to changed financial and commercial circumstances is achieved consistently with the maintenance and improvement of measures to alleviate poverty and promote nutrition.

Recent findings appear to justify some increased emphasis on subsistence food-production and on more direct actions for nutritional improvement. The latter might include increased financing and evaluation of specific nutrition interventions, promoting and financing national nutrition surveillance and early-warning systems, and integrating food-consumption and household-budget surveys. In general, the national food plans and development strategies recommended above would make it easier to plan international assistance for nutritional improvement, to integrate it properly with domestic efforts and to coordinate assistance from different sources.

Another important aspect of international efforts to improve nutrition in the developing countries concerns the work of a number of inter-agency bodies within the United Nations system. Successive expert committees convened jointly by FAO and WHO have reviewed the growing body of scientific knowledge of nutritional requirements and other factors affecting food safety. A number of bodies (principally within FAO) have elaborated the concepts of food and nutrition planning, and the introduction of nutrition as a major consideration in all planning and project formulation. The FAO/WHO Codex Alimentarius Commission has worked for many years on international food standards. The Sub-Committee on Nutrition (SCN) of the United Nations Administrative Committee on Coordination (ACC), a new institution established in response to the recommendations of the World Food Conference, has promoted increased emphasis on nutrition in the work of the United Nations system. Among its more specific activities, it has reviewed the state of the art for different nutrition interventions, and it is currently developing a ten-year plan for the control of vitamin-A deficiency, with FAO and other United Nations agencies making important contributions in their respective fields.

Food aid. The complex and important subject of food aid can be dealt with only briefly here. For the most comprehensive recent analysis, readers' attention is invited to the reference FAO, 1985.

Food aid is perhaps the most controversial of the international policy areas involved in nutritional improvement. There is however widespread agreement that, properly handled and within an appropriate policy framework for food and agriculture, it can make a highly positive contribution. That it is essential in emergency situations is not disputed. Much larger quantities should however be earmarked for such situations, particularly through the International Emergency Food Reserve (IEFR). Reserve stocks, positioned as near the vulnerable areas as possible, are another requirement for food security and year-to-year supply stability, as well as for meeting emergencies, and in many of the poorest countries, such stocks can be built up only through food aid. If only for this reason, food aid should be increased above current levels, at least in the near future, to meet the needs of the low-income food-deficit countries (or at least the poorest among them), and it should be provided on a more continuous and assured basis.

It is other aspects of food aid that have been subjected to the greatest criticism. The principal claim is that it can have disincentive effects on domestic food production, both directly by lowering prices and indirectly by enabling governments to neglect agriculture and thus, in fact, increasing the danger of the emergency situations it can be so effective in meeting. However, a detailed survey of food-aid studies (WFP, 1978), commissioned by the United Nations/FAO World Food Programme, found that where a case has been made for such short-term effects, they have been far outweighed by the general advantages of food aid, if the opportunities it offers are properly utilized.

The alleged disadvantages are not inherent in food aid itself: financial assistance or commercial imports could have similar effects. But the actual impact of food aid depends above all on the policies of receiving governments and the ways in which they and the donors handle it. Many governments have now not only accumulated greater experience and skill in this area, but are also giving higher priority to agriculture than in the past. Especially in the Far East, a few countries which previously relied heavily on food aid have managed to make themselves virtually independent of it.

The effect of food aid on commercial markets can be limited by managing its distribution in the ways described earlier in this chapter, in the discussions of food subsidies and nutrition intervention programmes. If counterpart funds from the sale of food or other government resources are used to provide inputs or for other measures to reduce agricultural production costs, any short-term downward pressure on farm prices can be offset, at least in part. "Food-for-work" programmes, under which all or part of the wages are paid in kind, not only make possible non-inflationary increases in employment, especially for the landless, in food-shortage conditions, but can also contribute to expanding food production by constructing and maintaining essential infrastructures, such as irrigation facilities and feeder roads.

FAO's latest study of food aid (FAO, 1985) makes a number of important proposals for improving the contribution of food aid to food security, and hence — directly and indirectly — to better nutrition. Among other measures, it suggests that receiving countries should aim to integrate better food aid into their national food security programmes; develop national preparedness plans, including early-warning systems, to cope with major food shortages; give high priority to food-security objectives in the use of counterpart funds; and, where possible, commit greater shares of local resources to food-aid projects.

Donor countries, in turn, should undertake multi-year country food-aid programming; improve the timeliness and coordination of their response to changing requirements, including the pre-positioning of stocks; provide more financial and technical assistance complementary to food-aid; and promote triangular transactions of various kinds to diversify food-aid commodity composition.

At the multilateral level, with the renewal of the Food Aid Convention (FAC) in the course of 1986, its guarantee provisions should have been enlarged and improved, and responsiveness to large-scale food shortages enhanced through such measures as additional stand-by resources for the IEFR, guaranteed increases in food aid to countries experiencing food deficits of a certain magnitude, and an interim system of national food reserves (or funds) in donor countries to back up their food-aid commitments.

APPENDIX
Methodology for estimating the incidence of undernutrition

This Appendix discusses in detail certain conceptual issues and technical procedures involved in estimating the incidence of undernutrition. Energy requirements and the interpretation of the measure of undernutrition based on dietary-energy intake are examined in Section I. Section II discusses variability in requirements and the statistical technique for comparing intake with requirements. Detailed procedures for estimating energy requirements for different age and sex groups are described in Section III. Section IV sets out procedures for estimating dietary-energy intake distributions. Section V points out certain limitations imposed by the basic data used in the survey, while Section VI summarizes methodological changes between the fourth and fifth world food surveys.

I. Dietary-energy requirements and the meaning of the measure of nutritional deficiency based on the dietary-energy intake approach

Energy requirements. The human body requires dietary-energy intake for its expenditures of energy, which in turn have several components:

a) the basal metabolic rate (BMR), i.e. energy expended for the functioning of the organism when the individual is in a state of complete rest. The BMR is calculated by measuring the expenditure of energy by the body when lying quietly in a comfortable environmental temperature, relaxed but awake and without food (12 to 15 hours after the last meal);

b) the energy cost of digesting and metabolizing food;

c) energy required for performing physical activities, both "work" and (optional) "non-work";

d) energy required for child growth, for the deposition of tissue during pregnancy, and for secretion of milk during lactation.

When an individual's energy intake equals his total energy expenditure, he is said to be in a state of energy balance. Either increasing or reducing energy intake from an initial state of balance sets in motion a process of adjustment of the factors determining energy expenditure until a new balance is attained. This process of moving from one energy-balance level to another in response to variation in intake is called *adaptation*.[1]

Adaptation may be of three different types: social/behavioural, biological/genetic, or metabolic. When energy intake exceeds energy expenditure, individuals may decide to raise their level of physical activity, thereby increasing energy expenditure and attaining a new, higher level of energy balance: this is an example of *social/behavioural adaptation*. If, on the contrary, they fail to modify their level of activity, the excess energy will be stored in their body, the resulting increase in the body weight will raise the BMR, and energy expenditure will thus be brought into balance with intake; this is the prime example of *biological adaptation*. It may also be possible to achieve an energy balance without change either in activity or body weight, through a change in the metabolic efficiency of energy utilization. The extent to which such *metabolic adaptation* is possible is a highly controversial issue which will be further discussed below.

An individual can achieve an energy balance at many different intake levels through these adaptation mechanisms, but the balance can be achieved only within a certain range. At very low intake levels, it may not be possible to achieve a balance, and the body may continue wasting away, eventually to the point of death. Similarly, very high intakes may lead to extreme obesity and death. Thus there may be two thresholds of survival within which an energy balance can be achieved. The question of defining the requirement is therefore a question of selecting a particular level of energy balance from within the continuum of attainable levels. In other words, the requirement is that level of energy intake that will enable the individual to achieve the chosen level of energy balance.

The key to this choice lies in the fact that adaptation is not necessarily costless, and different energy-balance levels may be associated with different kinds and degrees of cost. Thus, if too low a level is maintained through behavioural adaptation (i.e. reduced activity), this may involve a social cost: the resulting activity level may be incompatible with the individual's occupational

[1] This study is concerned with the short-term process of individual adaptation but not with *inter-generational adaptation*, a long-term process whereby biological species adapt themselves to environmental changes through generations.

needs or his need of leisure activities necessary for a decent quality of life. Similarly, if recourse is had to biological adaptation by allowing body weight to fall to too low a level, cost of a somewhat different kind may be involved: too low a body weight (or, for children, too low a growth rate) may lead to reduced work efficiency, susceptibility to disease, morbidity and mortality, while adaptation to too high a body weight (i.e. too high an energy-balance level) may lead to obesity, cardio-vascular diseases and reduced work efficiency.

Obviously, an energy balance should be chosen in such a way that none of these costs are incurred, and therefore the 1981 FAO/WHO/UNU Expert Consultation on Energy and Protein Requirements defined the human energy requirement as follows:

"The energy requirement of an individual is the level of energy intake from food that will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long-term good health, and that will allow for the maintenance of economically necessary and socially desirable physical activity. In children and pregnant or lactating women the energy requirement includes the energy needs associated with the deposition of tissues or the secretion of milk at rates consistent with good health" (FAO/WHO/UNU, 1985).

This definition includes several notable features. First, the requirement is defined as a function of two sets of considerations: physical health, as represented by body size and composition, and physical activity. In other words, the requirement is not defined on the basis of physical health alone.

Second, determination of the requirement involves maintaining both body size and activity at a "desirable" level. This follows from the concept of the requirement as a level of intake leading to a "costless" or "desirable" energy balance, i.e. a balance that can sustain a body size and composition that are desirable from the point of view of physical health, and an activity level that is desirable from the point of view of both physical health and social/occupational need. This implies that energy requirements cannot be inferred from the actual body size and composition and the activity of any one individual, since such an inference would imply that the individual's existing energy balance is a desirable one, and this may or may not be true.

A third implicit feature is the fact that the definition will not yield a unique requirement figure, since different intake levels may be necessary to ensure the same expenditure level, and hence energy balance, under different conditions of environmental hygiene and sanitation: energy available for expenditure depends on the effective absorption of the intake, and absorption depends, *inter alia*, on environmental and health conditions (see Chapter 4). The energy requirement thus becomes a function of these "non-food" factors.

In fact, factors other than food may lead to a more serious problem than variability of the energy requirement. This variability implies that food and non-food factors are substitutive of each other, i.e. that a worse non-food condition can be compensated for by a greater food intake. But this will no longer be true when the non-food conditions impose such absolute limitations on the individual's ability to absorb food that no amount of food can cover the desired energy expenditure. The relationship between food and non-food factors then becomes complementary: both must be improved simultaneously.

This complementarity may also arise from factors other than absolute limits to absorptive capacity, when adverse non-food conditions bring down the food intake itself. For example, there may be a loss of appetite during infectious disease, or a conscious decision may be taken to reduce food intake during illness, on the assumption that the body cannot absorb the normal intake or tolerate a normal amount of food. Here again, food intake can only be increased along with an improvement in non-food conditions, and in such cases it is not possible to define the requirement for a given non-food condition.

In sum, the interactions between food intake and non-food conditions are such that no intake-requirement figure can be stipulated independently of the non-food factors. Either different requirement figures must be established for different non-food environments, when the relationship is one of substitution, or an energy requirement can be meaningfully cited only in conjunction with a requirement level for non-food conditions, when the relationship is one of complementarity.

In practice, requirement estimates arrived at by expert groups refer to ideal or near-ideal environmental and health conditions. The samples of individuals on which the estimates are founded are generally drawn from western developed countries and/or the wealthier segments of the population of developing countries, often under controlled laboratory conditions, with environmental and health conditions at a highly satisfactory level.

Thus, two important features of the definition of the energy requirement that have significant bearings on the interpretation of the measure of nutrition deficiency based on a comparison between dietary-energy intake and energy requirements are that (i) the requirement is established on the basis of *desirable* body size and composition and activity level, and (ii) the requirement is established on the basis of *ideal* non-food conditions, but applied to a world where such conditions are often far from ideal.

Interpretation of the measure of nutritional deficiency based on dietary-energy intake. The number of individuals whose intakes fall short of their requirements has traditionally been interpreted as a measure of the incidence of undernutrition. Conventionally, however, undernutrition refers to the physical manifestation of the consequences of nutritional inadequacy, as measured by significant deviations of anthropometric parameters, such as body weight, from reference values. Thus, an output-based concept is measured by the input-based concept of inadequate energy intake. There are two reasons why this input-based concept does not provide an accurate measure of the magnitude of physical undernutrition.

First, an inadequate food intake need not always lead to physical undernutrition. If an individual establishes an energy balance at less than his ideal body size and composition, through biological adaptation, he will suffer from physical undernutrition only if he maintains his prior level of activity. By reducing his activity level through behavioural adaptation, he brings into play an alternative mechanism for reducing expenditure and achieving an energy balance at a lower level of intake. By reducing his activity sufficiently, he may be able to cover the energy expenditure demanded by an ideal body size and composition, and in this case no physical manifestation of undernutrition will appear.

Many empirical investigations have shown that lowering the activity level is indeed one mechanism through which individuals adjust to low food intake. For example, Rutishauser and Whitehead (1972) "described a Ugandan child population in which physical growth rates had been maintained at reasonable levels in the face of apparent low food intake. Further examination of the community suggested that one way in which this had been achieved was a very low level of play activity" (Beaton, 1983). Thus, when food intake falls short of requirements, the outcome may be either undernutrition in the physical sense, or less than the desirable level of activity, or a combination of both: examining only the shortfall does not permit the determination of the final result. For this reason, the number of individuals whose intakes are below their requirements is likely to include some who are not undernourished in the conventional sense.

Second, physical undernutrition can occur even when food intake is above the requirement level. This is a necessary consequence of defining the requirement with reference to ideal non-food conditions, since when food and non-food factors can be substituted for each other, an individual will require more food if he is living in adverse non-food conditions than if the contrary were true. It is therefore quite conceivable that a situation can arise in which the individual's intake is greater than the requirement established on the basis of ideal conditions, but is still less than what he actually requires in his prevailing environment. In this case, if he achieves an energy balance through biological rather than through behavioural adaptation, he may become physically undernourished, even though a comparison between his intake and his requirements under ideal conditions indicates that his intake is adequate. It is therefore not surprising that many empirical studies have concluded that a major cause of undernutrition in the developing world, especially among children, lies in such environmental and health conditions as the prevalence of infectious diseases, poor sanitation and contaminated drinking water rather than in the lack of food. Thus, in a study of Guatemalan children, Mata *et al.* (1983) conclude that infectious disease was the single most important cause of malnutrition in the children studied. Similarly, in India, Sukhatme (1982) blames earlier worm-loads and infections for most of the anthropometric lag of 2- to 3-year-old Indian children behind their counterparts in the United States.

A measure of nutritional deficiency based exclusively on dietary intake is thus likely to include individuals who are not undernourished in the physical or conventional sense and exclude others who are.

Inadequate intake entails a *nutritional problem* in that it may lead either to physical signs of undernutrition, or to less than a desirable level of activity, or to both. Traditionally, interest in the problem has remained confined to its physical dimension, but — the concern being with the nutritional adequacy of food intake — there is no reason why one manifestation of inadequacy should be considered a greater problem than the other. If an individual whose intake is inadequate escapes physical undernutrition by maintaining a lower level of activity, he incurs a cost, whether in terms of lower income or in terms of a worsened quality of life. If on the other hand he maintains his activity level and thereby becomes physically undernourished, he incurs a cost in terms of ill health. In either case, inadequate food intake entails a cost, and in this sense every individual whose intake falls short of his requirements can be said to have a nutritional problem.

However, since the dietary-intake approach excludes individuals who are undernourished because the conditions in which they live are not the ideal non-food conditions underlying the definition of requirements, it is necessary to define the subset of the individuals actually captured, and to show how its characteristics differ from those of the subset excluded: in short, to define the meaning and significance of the measure. Figure A.1 will assist in examining this question.

In the figure, food intake is measured on the

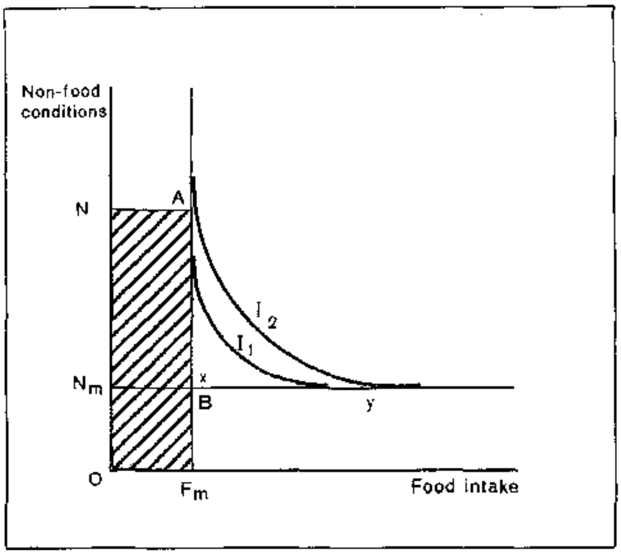

Figure A.1 *Food intake and non-food environment effects on nutritional status*

horizontal axis and non-food conditions on the vertical axis. The combination of an individual's food intake and non-food environment is represented by a point in the positive quadrant. The curves I_1, I_2 ... may be described as "isonutrition contours", all points on a curve denoting the same level of energy expenditure, and a point on a higher curve denoting a higher level. Curve I_1 is assumed to represent the minimum level of expenditure consistent with desirable nutritional status, that is to say that any point below the curve denotes the existence of a nutritional problem in the broad sense. (The shape and position of the curve are arbitrary; smoothness and convexity to the origin are not necessary to the argument.)

All points on I_1 indicate the combinations of food and non-food factors just adequate to cover the minimum necessary expenditure of energy, so that for any given level of non-food conditions the appropriate food requirement can be read from the curve, and vice versa. As drawn, the curve implies that within a range, food requirements are higher at lower levels of non-food endowments, so that food and non-food determinants can be substituted for each other up to a point. (The argument is not however affected by drawing the curve so as to show complete complementarity.) But there is a minimum level of non-food conditions (N_m) below which no amount of additional food can ensure achievement of the minimum nutritional status, and also a minimum level of food intake (F_m) that must be maintained even in ideal non-food environments. Curve I_1 will therefore either coincide after some stage with the straight lines originating from points F_m and N_m, as shown in the figure, or approach them asymptotically.

If N is taken to be the ideal maximum non-food level with respect to which the energy requirement is measured, and it is assumed, for the sake of simplicity, that all individuals have the same requirement level, this level will correspond to the minimum necessary food intake (F_m); all individuals whose food intake is below F_m will then be identified as having a nutrition problem. This group is represented by the shaded rectangular area OA. However, it follows from the definition of curve I_1 that the entire area lying below the curve represents the set of individuals whose nutrition is inadequate. This is the formal demonstration of the point made above, to the effect that comparing intake and requirements underestimates the magnitude of the nutrition problem, when the role of non-food factors in determining nutritional status is recognized.

On the other hand, the subset captured by the measurement has a distinctive feature that sets it significantly apart from the subset excluded. The latter can itself be divided into two parts: area Y, lying to the right of F_mA and below N_mB extended, and area X, lying below curve I_1 and bounded by F_mA and the extension of N_mB. For people whose status is included in area Y, the only way to ensure adequate nutrition is to improve their non-food conditions; no amount of extra food will help them. For an individual whose status is included in area X, on the contrary, adequate nutrition can be ensured either through more food, or through improved non-food conditions, or through a combination of both: additional food is not, for him, an absolutely binding requirement, since his problem can be eliminated by operating on the non-food factors alone.. For people whose status falls in rectangle OA, more food is absolutely essential to bring them to curve I_1. More food alone may not be enough, if their status lies in the smaller rectangle OB, and even when it is (i.e. when status is described by rectangle N_mA), their requirements can be reduced by improving the non-food conditions; in any case, their intake must be improved in order to redress the situation. More food is thus a binding requirement for the set of individuals captured by the measurement, in a manner that does not apply to those excluded. Therefore, although the measurement fails to capture the entire set of individuals with a nutritional problem, it does capture those with a truly *food-constrained nutritional problem*. This is the true interpretation of the measurement, and in the context of analysing the problem of nutrition from the point of view of *food adequacy*, it appears to be a particularly relevant concept.

The relationship between the three concepts — the nutritional problem in the broad sense, the food-constrained nutritional problem, and undernutrition in the physical sense — can now be clarified with the help of Figure A.2, in which circle ABCD represents the complete set of individuals with a nutritional problem in the broad sense, corresponding to the area below curve I_1 in Figure

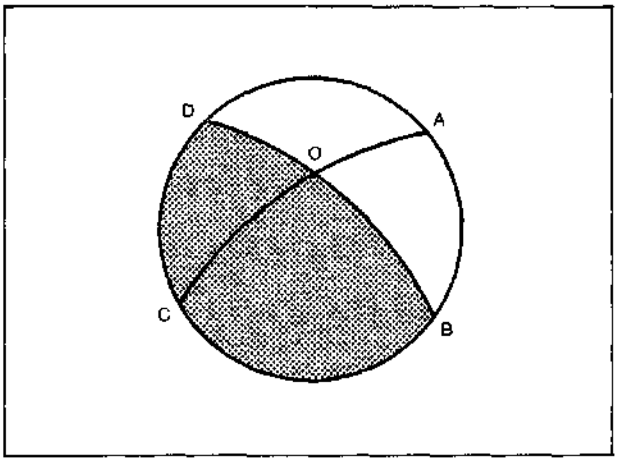

Figure A.2 *Breakdown of nutritional problems*

A.1. Segment DCB represents the subset of individuals facing a food-constrained nutritional problem and corresponds to rectangle OA in Figure A.1. Segment DAB includes the members of the nutritionally deficient population whose intakes are incompatible with their actual non-food conditions but are greater than the requirement norm based on ideal non-food conditions: it combines areas Y and X of Figure A.1. In each of these segments, the nutritional problem will manifest itself in physical undernutrition for some individuals and in reduced activity for others. Thus, the subset of the physically undernourished (who may or may not also have less than desirable activity) can be represented by a segment such as ABC, while segment ADC represents individuals whose nutritional problem is manifested only in less than desirable activity, without any occurrence of physical undernutrition.

It is evident then that the food-constrained nutritional problem (segment DCB) and physical undernutrition (segment ABC) are both subsets of the overall nutritional problem. They are in general two distinct subsets, although there is likely to be an overlap, such as segment COB, between them. This distinction disappears, however, when the requirement adopted allows only for an absolute minimum of activity, i.e. the maintenance requirement. In this case, as pointed out in Chapter 3, any shortfall in intake from the established level of minimum requirement will necessarily lead to physical undernutrition.

However, the measure based on the maintenance requirement is likely to underestimate the actual incidence of undernutrition, for two main reasons. First, the activity allowance in this maintenance concept is so low that it will exclude from the numbers of the undernourished some individuals who, for any reason, are unable to reduce their activities to the necessary extent (through behavioural adaptation) and as a result will be physically undernourished even though their intake is above the established minimum. Second, as already stated, the definition of the requirement with reference to ideal non-food conditions excludes some of the individuals who are undernourished as a primary result of unfavourable conditions of this kind. Nevertheless, the measure has the advantage of referring to a homogeneous group: the undernourished in the conventional sense.

II. Variability of requirement and the procedure for comparing intake with requirement

Energy requirements are not the same for every individual: they vary with the age, sex and activity of the individual concerned. As a result, there will generally be a distribution of requirements among the population, just as there is a distribution of energy intakes. If the joint distributions of intake and requirements were known, the extent of nutritional deficiency could be estimated fairly simply. With (x) representing an individual's intake, (y) requirement, and (g (x, y)) the joint density function of intake and requirement, the proportion of individuals with inadequate food intakes (F) would be given by

$$F = \int_{x<y} g(x, y)\, dx\, dy \qquad \ldots (1)$$

In practice, however, the informational requirements for specifying this joint distribution for individuals are much too stringent to be of any practical use: national surveys that provide data on food consumption or intake of individuals are almost non-existent, and the data from those that exist refer generally to the household or family, which groups a few individuals of different ages, sexes, body weights and activities or occupations. The available data therefore allow the assessment of the consumption levels — and hence nutritional adequacy — of households rather than individuals. For the sake of convenience, the household intake and requirement data are expressed on an individual (per caput) or consumer-unit basis by dividing them by the relevant number of individuals or consumer units, but this does not alter the fact that the assessment is essentially household-based. In generalizing from households to individuals, it is assumed that within the household, intakes are distributed proportionately to the individual members' requirements, so that if the household's total intake falls below its total requirement, all its members are food-deficient. In other words, any inequitable distribution that may exist within the household is ignored.

In the context of household-level analysis, the total household-requirement figure can be determined by taking into account each member's age, sex, body weight and activity or occupation. Owing to differences among households with regard to these factors, this technique will clearly lead to variations in household requirements. This type of variation, which poses no serious conceptual problem, is discussed in the latter part of this section.

However, other types of variation have a profound significance for the very concept of requirement, and in recent years they have been the occasion of warm debate within the scientific community. Since they have implications both for estimating requirements and for the technique adopted to estimate the incidence of undernutrition, it is first necessary to examine these issues.

Inter- and intra-individual variation in requirements. Traditionally, requirements are derived from the dietary-energy intake of a sample of healthy, active individuals of a given age and sex, with similar body weights and activities, on the assumption that in view of their good health, their requirements can be taken as equal to their intake. Since, however, the observed intakes vary among individuals, it is accepted that requirements can also vary, even among apparently identical individuals. For example, Widdowson's data (1947) indicate that in a healthy, active population of specified age and sex engaged in similar work, the coefficient of variation for mean weekly intake was about 16 percent; correcting for differences in body weight by standardizing intake to "reference" weight, the coefficient was still about 13 percent (Sukhatme and Margen, 1982). To explain this variation, Widdowson suggested that some individuals are more efficient metabolic machines than others, i.e. that through greater efficiency of energy utilization some individuals can make do with a lower intake, and hence their requirement is lower than that of others, the efficiency of the same individual, and hence requirements, being assumed to be fixed.

Sukhatme and Margen (1982) have however argued that an individual's requirements cannot be assumed to be fixed, since the efficiency of energy utilization is not fixed for him or her. In their view, every individual possesses, within limits, the ability to regulate his or her energy-utilization efficiency in response to varying levels of intake. Their concept of this efficiency can be summarized as follows: when the body needs energy for any of its functions, it takes it not directly from food consumed but from that part of the energy consumed that is mediated through adenosine tri-phosphate (ATP) and other high-energy bonds. In this process, like all systems that convert energy from one type to another, the human body loses some energy in the form of dissipated heat, and this waste of energy is the measure of the metabolic efficiency of energy utilization. In the authors' view, when the intake is low the body wastes more heat (i.e. utilization efficiency is low), and when intake is low it wastes less (i.e. efficiency is high), and through this homeostatic process, the body can accommodate different intake levels without change in size or activity.

It is of course recognized that this human capacity to regulate energy-utilization efficiency is not unlimited: at low intake levels, when efficiency is already very high, the body may not be able to accommodate any further reduction in intake through further reduction in heat dissipation, and in that case the individual must either reduce the activity to accommodate the lower intake, or else provide extra energy by burning up the adipose tissue, thereby decreasing the body mass. Similarly, there is an upper limit to the intake the individual can accommodate without gaining body weight at a given activity level. But within these limits it is postulated that there exists a range of homeostasis within with any intake is compatible with a given body weight and activity, without entailing any functional cost. The individual's requirements are thus not fixed, but are variable within the homeostatic range.

Sukhatme and Margen further argue that such intra-individual variations are empirically more important than any innate inter-individual differences. They consider that variations in intakes, and hence in requirements, observed among apparently identical healthy individuals arise not, as Widdowson supposed, from innate differences of individually fixed metabolic efficiency, but from the fact that different individuals are operating at different levels within the intra-individual range of costless adaptation, the role of innate differences being so small that the observed inter-individual variation in requirements is explained largely in terms of intra-individual variation.

Such differences in views have a significant bearing on the choice of the appropriate statistical methodology for estimating the nutritionally deficient population. For supporters of Widdowson's view, the ideal manner of taking into account the observed variability among individuals is to use a bivariate distribution approach and to estimate the prevalence of nutritional inadequacy through a formula such as (1), but with reference to individuals similar in age, sex, body weight and activity. In the absence of knowledge about the bivariate distribution, the procedure can be approximated by taking the average requirement (μ) for the group of similar individuals as a cut-off point on the intake distribution, i.e. taking the proportion of individuals with intakes below the average requirement as an approximation of the prevalence of nutritional inadequacy. This approximation is based on the assumptions of independence between intakes and requirements, and normality or symmetry in the requirement distribution. The assumption of independence, which is crucial, is not unreasonable, since the individuals are supposed to be similar with respect to age, sex, body weight and activity, so that the variation in requirement is attributed solely to differences in metabolic efficiency, while that in intakes is likely to be largely due to socio-economic, cultural or environmental differences.

The range of variation in requirements in this context reflects variations among the individuals, and the choice of any figure within the range, as a cut-off point, will involve errors of misclassification. Some individuals whose intakes are less than the cut-off point may be wrongly classified as nutritionally deficient, since their requirements may be even less than their intakes, creating a risk of overestimation and vice versa. The use of (μ) as the cut-off point is based on the argument that at this point, thanks to the assumption of symmetry in the distribution of requirements, the two risks will be more or less equal and the errors will largely cancel each other out.

On the other hand, the Sukhatme-Margen view is that the use of average requirements as a cut-off point, or even the bivariate distribution approach, will inevitably overstate the incidence of food inadequacy. The existence of intra-individual variations implies that an individual can be said to have an inadequate food intake only when his intake falls below the lower limit of the range of intra-individual variation or costless adaptation. On the strength of the argument that the observed variation in requirements among similar individuals is mainly a reflection of the intra-individual variation, i.e. that the real inter-individual variation can be ignored, the average requirement of each individual is approximated by (μ) and the intra-individual variance by the observed inter-individual variance (σ^2). Hence, assuming normal distribution for the individual requirements and adopting the usual 95 percent confidence interval, ($\mu \pm 2\ \sigma$) is suggested as a plausible estimate of the range of intra-individual variation. Accordingly, the more appropriate cut-off point is ($\mu - 2\ \sigma$) and not (μ).

There is still uncertainty concerning which of the two types of variation really predominates, since appropriate data sets proving or disproving either hypothesis do not exist. It will be necessary to collect continuous long-term data sets encompassing parameters related to intake, expenditure and body composition (Beaton, 1983), and until such data sets become available, deciding between the two approaches will be impossible. But because available evidence does not justify rejecting the hypothesis of costless intra-individual variation, the approach taken in *The Fifth World Food Survey* is to derive requirement levels and cut-off points reflecting both points of view.

It will be recalled that the foregoing discussion refers to variations in the requirements of individuals of a fixed body weight, that is to say that the requirement is defined on a per-kg-of-body-weight basis, and a desirable body weight needs to be specified before establishing the requirement. It can however be argued that there is no single desirable body weight for any individual, since weight can be adjusted to variations in intake through the process of biological adaptation. It is possible that such adaptation, within a certain range, is costless in terms of health, and if so, any body weight within the range can be considered desirable, and the requirement calculated thereon. The process of costless biological adaptation may thus give rise to intra-individual variations in requirements.

Although there is some uncertainty regarding the range of such variations, the concept of costless biological adaptation is generally accepted (FAO/WHO/UNU, 1985). *The Fifth World Food Survey* therefore allows for them by estimating energy requirements on the basis of the minimum value of the range of acceptable body weight for given height. Only when food intake falls below such a minimum requirement will the body be unable to sustain a weight within the acceptable range. (The empirical basis for selecting the minimum weights is discussed in Section III.)

The question of the treatment of children in this context must be examined separately. It is generally believed that their growth potential is roughly the same everywhere, and this belief frequently leads to the conclusion that children everywhere should receive enough nutrients to enable them to achieve the maximum of their potential, and this view implicitly rules out the notion of costless adaptation in the growth process.

There is however a growing body of evidence (Seckler, 1982) to support the view that a growth rate below the genetic potential is not necessarily harmful. Even in a healthy, privileged population, there is a wide range of variation in children's sizes, with no indication that the differences *per se* are related to health, well-being or physiological function (FAO/WHO/UNU, 1985). A number of experimental results show that smaller children in developing countries are not always at a disadvantage as compared to their counterparts in more privileged societies. In a longitudinal survey of children in rural areas of Bangladesh (Chen, Chaudhury and Hoffman, 1980), little difference was found (in terms of susceptibility to childhood diseases) for body weights as low as 35 percent of the Harvard median standard. There is also no evidence to show that within limits, stunted growth carries any disabilities into adult life.

These considerations point to the possibility of costless biological adaptation in children as well as in adults. No single growth curve is appropriate for them: there is roughly a band, and adaptation to any curve within the band is functionally costless. Accordingly, there is in principle a range of acceptable body weights for every child, leading thereby to intra-individual variations in requirements through costless biological adaptation, as for adults. For this reason, the minimum desirable body weight for height has been taken for calculating the requirements of children as well as of adults.

The true significance of a requirement figure based on the lower limit of the range of acceptable weight for height should be clearly recognized. It is not implied that societies should be satisfied with the minimum acceptable body weight for adults, or growth for children. Since any body weight within the range is costless, the target can be set at as high a point in the range as possible, depending on the resources available, and this target level can be described as a *recommended* intake to distinguish it from the concept of *minimum* requirement used in *The Fifth World Food Survey*. This divergence arises only because of the existence of a range of costless energy balance; if costless balance could be achieved at a unique intake level, the two concepts would coincide.

The function of the requirement concept in the present context, then, is not to set a target that societies should attempt to achieve, but to provide a criterion for separating the individuals whose intake is insufficient for a costless energy balance from those whose intake is sufficient for that purpose. This is best done by setting the criterion at the lower limit of the range of costless adaptation.

Variations in requirements due to demographic, anthropometric and activity factors. The preceding discussion dealt only with the problem of taking into account the variations in requirements of individuals of the same type (age, sex, body weight and activity). But different individuals in a population will have different requirements insofar as they differ in the characteristics defining a type, and such variations must also be taken into account in comparing intakes with requirements. Since, as stated above, the intake data available from food-consumption surveys normally refer to households rather than to individuals, the statistical methodology must deal with these problems in the context of the household as the unit of analysis.

For this purpose, let (X) represent the aggregate household dietary-energy intake. If the age, sex, appropriate body weight and activity characteristics of its members are known, then — given the requirement figures of the different types of individuals, either in terms of the average or of the lower limit of the range — the total requirement of the household can be calculated and represented by (Y). Since household composition in terms of types of individuals will vary from household to household, (Y) will also vary. There will thus be a joint distribution of dietary-energy intake and requirement given by, say, g (X, Y) in a population.

The estimated proportion of households suffering from inadequate energy intake is then

$$u = P\,(X < Y) = \int_{X<Y} g\,(X, Y)\,dX\,dY \qquad \ldots (2)$$

which can also be expressed as

$$u = P\,(X/Y < 1) = \int_{X/Y<1} h\,(X/Y)\,d\,(X/Y) \qquad \ldots (3)$$

Expression (3) has the advantage of working with a univariate distribution, the variate being a household's energy-adequacy ratio (X/Y). Through a few simple manipulations it is possible to obtain an equivalent univariate formulation of (3) in terms of intake and requirement per consumer unit, i.e. a "reference type" individual (Sukhatme, 1961). If (C) represents the requirement per "consumer unit", (x_c) the intake per consumer unit in a household, and (N_c) the number of consumer units in the household, then, since $N_c = Y/C$ and $x_c = X/N_c = C\,X/Y$, the intake distribution per consumer unit can be written as

$$f\,(x_c) = f\,(CX/Y)$$

Since the proportion (u) in (3) remains unchanged if the expression is multiplied throughout by the constant (C), (3) can be written as

$$u = \int_{CX/Y<C} h\,(CX/Y)\,d\,(CX/Y) \qquad \ldots (4)$$

It is evident that the consumer-unit conversion does not improve on what is already achieved by the ratio in (3), but it serves the convenient purpose of expressing the distribution in terms of meaningful units comparable to the consumer-unit requirement. A similar conversion into per caput rather than per-consumer units can be obtained, given a per caput requirement (z), as follows:

$$u = \int_{zX/Y<z} h\,(zX/Y)\,d\,(zX/Y) \qquad \ldots (5)$$

In the current data situation, the distribution of households by per caput energy intakes is available or can be estimated, but the data pertaining to the characteristics of the individuals in each household needed for calculating the corresponding requirement (Y), are not available. The national average per caput requirement (z) can however be calculated on the basis of total population data by sex and age, derived average body weights and assumed average activity levels. An approximation method is therefore used: (u) is approximated by taking (S) to be the size of a given household and (zS) the household's requirements. Then

$$u' = \int_{X/S<z} h\,(zX/zS)\,d\,(zX/zS)$$

Representing (X/S), the household per caput intake, by (x), the expression can be simplified as:

$$u' = \int_{x < z} h(x)\,dx \qquad \ldots (6)$$

The proportion of households with inadequate energy intakes is thus estimated by using the household per caput intake distribution and taking the national average per caput requirement as the cut-off point.

To judge the nature of the error likely to be involved in this approximation, (5) and (6) may be compared. Both refer to per caput units and have (z) as the cut-off point, but while (u) in (5) is derived from the distribution of (zX/Y), (u') in (6) is based on the distribution of (X/S) = (x). The difference in magnitude of (u) and (u') will depend on the dispersions in the distribution of (x) and (zX/Y). In general, greater dispersion in (x) would mean that (u') is larger than (u) and hence overestimate the true incidence of inadequate intakes. As is pointed out below, there are good empirical reasons for believing that (x) usually has a larger dispersion than (zX/Y). This can be shown by comparing the coefficient of variation (CV) of the two distributions.

Since (zX/Y) and (X/Y) have the same coefficient of variation, and since x = X/S and X/Y = (X/S)/(Y/S), the comparison of CV between (zX/Y) and (x) can for the sake of simplicity be reduced to the comparison of (CV(X/Y)) and (CV(X)).

An approximate formula for the variance of (X/Y) is given by

$$\mathrm{Var}\ (X/Y) \simeq \frac{\mu_x^2}{\mu_y^2}\left[\frac{\sigma_x^2}{\mu_x^2} + \frac{\sigma_y^2}{\mu_y^2} - 2\varrho\frac{\sigma_x\,\sigma_y}{\mu_x\,\mu_y}\right]$$

where (μ_x) and (μ_y) are the expected values of (X) and (Y) respectively; (σ_x^2) and (σ_y^2) are the variances of (X) and (Y) respectively, and (ϱ) is the coefficient of correlation between (X) and (Y). If the further approximation that the expected value of (X/Y) is equal to (μ_x/μ_y) is made, then a few simple manipulations show that the relative variance, or $(CV)^2$, of (X) will be greater than that of (X/Y), if

$$2\varrho \cdot \frac{\sigma_x}{\mu_x} \cdot \frac{\sigma_y}{\mu_y} > \frac{\sigma_y^2}{\mu_y^2}$$

or,

$$\varrho > \frac{1}{2} \cdot \frac{\frac{\sigma_y}{\mu_y}}{\frac{\sigma_x}{\mu_x}} = \frac{1}{2} \cdot \frac{CV\ (Y)}{CV\ (X)} \qquad \ldots (7)$$

If the CV of (Y) is equal to the CV of (X), it can be seen that the condition for greater variability in (X) as compared to (X/Y) is $\varrho > 0.5$.

CV (Y) can however be expected to be lower than CV (X), since requirements usually have a smaller range of variation than intakes. A correlation coefficient of even less than 0.5 may be sufficient for (X) to have greater variability. In general, a positive correlation between intake and requirements is likely to be found. Ideally, if individuals were aware of their requirements and had no purchasing-power constraint, the correlation between (X) and (Y) would be close to unity, but since neither of these conditions is likely to hold true, the correlation will in fact be less than unity. Nevertheless, since household intakes and requirements both vary, at least in part, owing to variations in a common set of factors such as household size, age-sex composition, body weights and activities, there is likely to be a significant positive correlation between the two. It is therefore quite possible that the dispersion of (X) will be greater than that of (X/Y), implying a greater variability in (x) as compared with (zX/Y).

There is also some empirical support for this conclusion. The evidence is in terms of the dispersion between (x) and (x_c), the per-consumer-unit intake, but [(x_c) = (CX/Y)] and (zX/Y) have the same dispersion after adjustment is made for scale. Using detailed information on the intake as well as demographic, anthropometric and occupational characteristics of individual members of each household, an unpublished study on Tunisia (1978) found that the standard deviation of the logarithm of the household per caput intakes was about 1.0, while that of household per-consumer-unit intakes was about 0.8. In terms of a comparison between (5) and (6), this shows the consequence of replacing (Y) by (zS) as the requirements of a household.

The lower variability in per-consumer-unit intakes is due to the elimination of the effects of demographic, anthropometric and occupational differences among households through the application of the energy-adequacy ratio (X/Y). A similar unpublished analysis of six regions in Brazil, based on the results of a 1974 food consumption survey, showed that the contribution of differences in demographic factors is relatively small. The contribution of differences in body weight was not captured, but since body weight is likely to be closely correlated with demographic factors, and the concept of desirable rather than actual body weight is used, the combined effects are not likely to be much greater than that of the demographic factors alone. This suggests that differences in activity levels are the factor mainly responsible for the difference in the dispersions of (x) and (zX/Y), and hence for the upward bias in (u').

In the Tunisian example cited above, the *actual* activity or occupational levels of the individual household members were considered, but for the purposes of *The Fifth World Food Survey* energy requirements have been defined with reference to a *desirable* level of activity which may be totally unrelated to the actual level. Nevertheless, it would appear that as long as differences in household activity levels are related to differences in intakes, the approximation of (u) by (u') may lead to exaggerating the incidence of inadequate intakes. This risk can be minimized by allowing for a lower-than-average activity level in estimating the national per caput requirement figure, i.e. the cut-off point (z).

III. Deriving energy requirements and the cut-off point

The 1981 FAO/WHO/UNU Expert Consultation on Energy and Protein Requirements recommended (FAO/WHO/UNU, 1985) certain important methodological innovations in the establishment of energy requirements, as compared with earlier reports. Requirements for the purposes of *The Fifth World Food Survey* have been calculated on the basis of those recommendations.

There are two basic methods for estimating requirements: the intake approach and the expenditure approach. The former assumes that the quantity of food consumed by healthy individuals living a normal life represents their requirements. The latter calculates the requirements of a typical individual factorially by adding up the actual daily energy expenditure on various types of activity such as sleep, work and recreation. The 1971 FAO/WHO Expert Committee (1973) relied primarily on the first method, but the 1981 group considered that determining requirements from observed intakes constitutes, to a large extent, a circular argument, since (whether in developed or in developing countries) actual intakes are not necessarily those that maintain desirable body weight or optimal physical-activity levels, and hence health in its broadest sense (FAO, WHO, UNU, 1985). Accordingly, the group emphasized that energy-requirement estimates should as far as possible be based on estimates of the components of energy expenditure. The application of this expenditure, or factorial, approach has become possible in recent years by the generation of a considerable set of new energy-expenditure data. The group was however able to pursue this approach only for adults and adolescents; for children up to ten years of age, the intake approach was used as by the 1971 Expert Committee but a new data set was used for the purpose.

Requirements of adults and adolescents. The major determinant of energy expenditure being the basal metabolic rate (BMR), all other components are for the sake of convenience expressed as multiples of BMR, so that the total requirement can itself be expressed as a multiple of BMR.

The 1981 Expert Consultation brought together a large set of BMR data collected from samples of individuals of different ethnic groups in both developed and developing countries. These data were used to derive predictive equations for estimating the BMR for different types of individuals. Since the BMR is known to depend, among other factors, on age and sex, separate regression equations were estimated for different age-sex groups, and it was found that for each such group, body weight alone could predict BMR fairly accurately: height had no significant independent effect except for the very young and the very old.

It was therefore necessary to select a desirable body weight for individuals in the various age-sex groups, but this is itself a function of height. In determining the desirable body weight for a given country, actual heights obtained in that country were used; for countries where data on actual heights did not exist, heights were estimated by using growth curves for ethnically comparable countries.

As discussed in Section II of this Appendix, recognition of costless adaptation in body weight requires that BMR be based on the minimum desirable weight for height. Age, sex and height being specified, this weight was estimated on the basis of two sets of standard tables referring to the acceptable range of body weights for height: for adults (i.e. individuals of 19 years of age and above), the table of the Metropolitan Life Insurance Co. of New York, and for adolescents aged ten to 18, the Baldwin table (FAO/WHO/UNU, 1985). The lower limit of the range of acceptable weights for height in the former table was taken as the minimum desirable weight for adults. As regards adolescents, although the Baldwin table gives the median acceptable weight rather than the range, it is generally recognized that the median plus and minus one standard deviation (SD) can be taken as the range; the minimum desirable body weight was therefore established at one SD below the median value given in the Baldwin table. The SD was estimated on the basis of a survey in Brazil, where the median weights for height are comparable to those of the Baldwin table. Applying this resulted in fixing the minimum desirable body weights for adolescents at about 90 percent of the median body weights.

Two features of the standard tables should be emphasized. First, they are based essentially on studies in Western developed countries, and the suitability of their application in developing countries may be open to question. But the minimal nature of this approach should be noted: neither average heights nor average weights-for-height are applied, but only the minimum desirable weights for height. It is of course possible that the minimum weight for a given height may be different for different ethnic groups, but in the absence of new data covering different parts of the world, this limitation cannot be overcome. (It also arises elsewhere in the process of estimating requirements. For example, the estimating equations for calculating $\overline{\text{BMR}}$ were themselves derived from data originating for the most part in the developed countries.)

Second, the range of body weights in these tables refers to variations among individuals. The range of inter-individual variation has thus been assumed to represent the range of intra-individual variation. Further refinements in the handling of these questions must await the availability of new data, and in the meantime, readers should be aware of these limitations.

The minimum desirable weight (W) having been estimated, the average BMR ($\overline{\text{BMR}}$) for each age-sex group was estimated on the basis of the following predictive equations (FAO/WHO/UN, 1985):

Age range (years)	Male (Kcal/day/caput)	Female
10-18	17.5 W + 651	12.2 W + 746
18-30	15.3 W + 679	14.7 W + 496
30-60	11.6 W + 879	8.7 W + 829
60+	13.5 W + 487	10.5 W + 596

The next component to be added after calculating the $\overline{\text{BMR}}$ is the energy required for digesting and metabolizing a meal. The energy expenditure involved in this component is however difficult to measure in isolation of any activity, since the very act of eating involves some activity. What is instead measured is a composite energy expenditure which, in addition to dietary thermogenesis, also includes the energy cost of minor movements and activities such as eating, dressing and washing, and some allowance for increased muscle tone.

Enough evidence was not available in 1981 to enable the FAO/WHO/UNU Expert Consultation to make a definitive operational recommendation concerning this maintenance-requirement concept, but the group felt that a figure corresponding to 1.4 $\overline{\text{BMR}}$ (i.e. the basal metabolic rate + 0.4 of the rate to allow for minimal activity) should provide a guide until further published information was available. Research on human calorimetry has recently confirmed this figure: in a study in which 16 males and 11 females adhered to the activity programme set out below, under laboratory conditions, it was found that the corresponding mean energy-requirement level for both males and females was 1.4 $\overline{\text{BMR}}$, with a coefficient of variation of 7 percent (Garby, 1985).

Time allocation in a minimal-activity programme

Activity	Time (minutes/ day)
Sleeping	450
Resting, lying	95
Sitting awake	815
Washing, dressing	10
Walking and moving weights	5
Standing	10
Walking with intermittent knee-bending	55
Total	1 440

The maintenance requirement representing an energy level which the individual will require in the absence of any economic or discretionary activity proper, a factor covering the energy necessary for such activity should in principle be added to determine the individual's real total energy requirement. Since the total to be specified is in any case designed to be an average for the population in a given age-sex group, this activity allowance should also reflect the average level for the group, rather than that for a particular occupational category or type of activity. Moreover, to be consistent with the definition of requirements discussed in Section I, it should correspond to the notion of desirable activity.

It is however extremely difficult to specify, in any reasonable manner, the desirable average activity allowance of individuals in different age groups in different parts of the world. Part of the problem lies in the fact that defining this level involves value judgements, but that is not the only difficulty. Although the energy-expenditure rates of many occupational and leisure activities are known, their range varies widely according to circumstances, for different individuals, and over time. Moreover, their application should take account of factual data on the occupational structure of the population and the conditions in which they live and work: how far a labourer has to walk to reach his place of work, how far a housewife has to walk to fetch water or gather firewood, etc. Clearly, such information is almost impossible to obtain with any reasonable degree of accuracy, especially in the context of global estimates such as those attempted in *The Fifth World Food Survey*.

The problem is rendered even more complex by the fact that the likelihood of a significant correlation between household energy-intakes and the activity levels of the household members, discussed in Section II, creates the danger that the use of an average requirement level incorporating the proper average-activity allowance as the cut-off point will tend to overestimate the true incidence of inadequate intakes. The appropriate cut-off point would appear to lie somewhere between the requirement based on the average-activity allowance and that based on maintenance activity only.

Since, then, it is practically impossible to determine an appropriate activity allowance, and since that level, whatever it may be, cannot in general be less than the absolute minimum maintenance level, the lower limit — corresponding to 1.4 $\overline{\text{BMR}}$ — was adopted for estimating the minimum level of basic requirement for adults and adolescents. As was stated at the end of Section I of this Appendix, the application of such a low requirement concept has the advantage of referring to a homogeneous group — the undernourished in the conventional sense — but the resulting measure of incidence must be regarded as conservative.

Next to be taken into account is the variability of requirement for individuals of a given age, sex, body weight and activity level. It was seen in Section II of this Appendix that for the purposes of *The Fifth World Food Survey* it was decided to derive requirement levels accommodating the two reasons put forward to account for this variability. Thus, if the hypotheses of intra-individual variation and "costless" adaptation are accepted, the lower limit of the range of variation in the maintenance requirement is the appropriate level to use. As already reported, results of recent measurements of energy expenditure over 24 hours with a specified minimal-activity programme showed a coefficient of variation of about 7 percent in both male and female subjects of the same body weight (Garby, 1985). Assuming normal distribution and taking the usual 95 percent confidence interval as the range of intra-individual variation, the lower limit of the maintenance requirement corresponds to the average (i.e. 1.4 $\overline{\text{BMR}}$) minus twice the standard deviation. On this basis, the lower limit to account for variability under this hypothesis is $1.4\ \overline{\text{BMR}} - (2 \times 0.7 \times 1.4\ \overline{\text{BMR}}) = 1.2\ \overline{\text{BMR}}$. If, on the other hand, the view is accepted that variability largely reflects fixed inter-individual genetic differences, 1.4 $\overline{\text{BMR}}$ would be the appropriate level to use.

Additional requirements for pregnancy were based on an allowance of 280 kcal/day for nine months recommended by the 1981 FAO/WHO/UNU Expert Consultation (1985). This figure, when applied to the distribution of pregnancies by month during a calendar year, results in an average allocation of 138 kcal/day on a calendar year basis. The total number of pregnant women was estimated indirectly on the basis of the crude birthrates estimated by the United Nations Population Division. When applied to the total population figure, it yields a reasonable estimate of pregnancies resulting in live births. The total number of pregnancies was calculated by adding to this figure an estimate of stillbirths, found in empirical studies to be of the order of 40 per thousand live births. Data are scarce concerning the proportion of lactating women, the duration of the lactating period, progressive and abrupt weaning, etc. and therefore no attempt was made to estimate a lactation allowance. The requirement is however incorporated in the requirements for infants.

Requirements of children under ten years of age. In young children, the requirement of energy for growth is a substantial component of the total requirement, and there are wide variations, within its normal range, in the rate of growth and probably also in the composition of tissue developed. For this reason, the requirement for children is derived not on the basis of the BMR, but from the observed intakes of healthy children growing normally. A requirement so calculated naturally includes an allowance for normal activity, i.e. the play and other activities in which the children in the samples were engaged; this contrasts with the minimum-activity approach adopted for adults and adolescents.

The sample of intakes of children up to one year of age consisted of some 4 000 observations drawn from Canada, Sweden, the United Kingdom and the United States; results from developing countries were not included in the analysis to ensure that the intakes represented those of groups of children who, on average, were growing along the 50th percentile of the WHO reference standard. For children over one year of age, observations of intakes of 6 000 males and 6 500 females were drawn both from developed countries and from the more affluent population sectors of developing countries.

On the basis of these samples, the 1981 FAO/WHO/UNU Expert Consultation calculated energy requirements per kg of body weight; multiplying these by the appropriate weight yields total requirements for each age group. The daily energy requirements per kg of body weight are shown below by sex and age group.

Age (years)	Males (kcal/kg/day)	Females (kcal/kg/day)
0-1	103	103
1-2	104	108
2-3	98	102
3-4	99	95
4-5	95	92
5-6	92	88
6-7	88	83
7-8	83	76
8-9	77	64
9-10	72	62

Traditionally, weights and heights observed in developed countries are considered appropriate indicators of desirable growth, but in the light of the possibility of costless adaptation in growth (see Section II), such an approach would overestimate the requirements of children. As for adults and adolescents, a minimum desirable weight should furnish the necessary criterion, and this can be obtained by determining the average height for age and then selecting a range of acceptable weights for height.

Unlike the position with regard to adults, however, there may be a danger in using actual heights, since serious stunting may be harmful to young children. A WHO document (WHO, 1983b) suggests that a cut-off point corresponding to two SD below the reference median height for age would indicate serious stunting, but the estimated average height for age in countries covered by the study is found to be above this cut-off point, and those estimates were accordingly used in *The Fifth World Food Survey*. For countries for which height data were not available, estimated growth curves of ethnically similar countries were used.

Given height for age, the median of acceptable weight for height is obtainable from WHO tables. As for adolescents, the minimum desirable body weight was taken as one SD below the median, subject to the same reservations as those expressed on page 61 with regard to estimates of adults' minimum body weights.

Per caput energy requirements. Requirements estimated for each age-sex group were finally combined into a single per caput requirement figure, weighted through the use of United Nations population estimates by age and sex. The adoption of two alternative requirement estimates for adults and adolescents leads to two alternative per caput requirement figures, which were finally used as cut-off points (z) on the per caput energy-intake distribution in determining the percentage of the undernourished population.

IV. Estimation of dietary-energy intake distribution

The only available sources of information on the distribution of food consumption within countries are the results of sample surveys in which household-level data on food consumption and/or related variables are collected. These surveys differ both as regards definitions of food consumption adopted and as regards measurement approaches, and their results, in turn, differ from the aggregate consumption estimates obtained through food balance sheets, owing partly to measurement errors and partly to problems of concepts and definitions (FAO, 1983a). Nonetheless, it is possible to piece the data together to obtain a picture of food-intake distribution among households.

On the other hand, the surveys providing information on the distribution of households by levels of energy-intake or related variables cover periods spread throughout the decade of the 1970s rather than relating to the reference periods of *The Fifth World Food Survey*, i.e. the two ends of the decade. For these reasons, the general approach was to assume a theoretical frequency curve for the distribution of household per caput dietary-energy intake and to use the data available to estimate the distribution parameters. The theoretical model serves to standardize the intake distribution data when they are available, and to provide the framework of "generating" them where they are lacking.

In this context, per caput DES data from food balance sheets, available for practically all countries, are assumed to reflect the mean or average of the per caput intake distribution in the reference period. This approach reduces the role of the household surveys to that of providing information on the variability of per caput intakes among households (inter-household variability). The problem of the difference between survey periods and reference periods was solved assuming that the estimated variability in the former also applied to the latter.

The theoretical frequency distribution. On the basis of the few household surveys providing data on the distribution of households by levels of per caput dietary-energy intakes (from as wide a range of countries as Brazil, Egypt, Indonesia, Republic of Korea, the Sudan, Thailand and Tunisia), three theoretical frequency curves were tested: the normal, the two-parameter log-normal, and the Beta distributions. Goodness of fit was measured by $G = \Sigma D^2$, where (D) is the percentage difference between the observed and theoretical frequencies. In each case, the (G) for the log-normal curve was by far the lowest: on average it was about 20 percent of the (G) for Beta and 17 percent of the (G) for normal distribution. The log-normal was therefore chosen to represent the distribution of household per caput dietary-energy intakes.

Given the parameters of the log-normal distribution (μ = the mean, and σ = the variance, of the logarithm of the variable), the proportion of the population below the cut-off point (z) can be obtained from the normal distribution as follows:

$$u' = P(x < z) = 1 - \Phi \left[\frac{\log_e z - \mu}{\sigma} \right] \quad \ldots (8)$$

The parameters (μ) and (σ) can themselves be estimated directly from the mean and standard deviation of per caput energy intakes ($\bar{x}$ and σ_x) through the following equations:

$$\mu = 2 \log_e \bar{x} - \frac{1}{2} \log_e (\sigma^2{}_x + \bar{x}^2)$$

and

$$\sigma^2 = \log_e (\sigma_x^2 + \bar{x}^2) - 2 \log_e \bar{x}$$

The "fitting" of a log-normal distribution to each country thus requires the estimation of the mean and the standard deviation (SD) of the per caput calorie intake. The mean was approximated by the per caput calorie-supply data in the national food balance sheets. An estimate of the SD could be obtained by applying the coefficient of variation (CV) to the independently determined mean.

Estimating the coefficient of variation in energy intake. Available surveys differ widely in their information content. Some provide household-level information on energy intake, some only the average intake for broadly classified income groups, and some no energy-intake data at all, but information on the distribution of another variable, such as food expenditure, total expenditure or total income. The general strategy adopted for the purposes of *The Fifth World Food Survey* was to make maximum use of the available information that had a bearing on the variation of caloric intake among households of each country. Since information availability varied from one country to another, the techniques utilized also varied; this differential approach was expected to minimize approximation errors, given the existing informational constraints.

The countries were classified in the following five categories, arranged in the descending order of the richness of the data available for them:

Category A: Countries for which, in addition to food balance sheets, household-level data were available on energy intake, food expenditure and total income or expenditure;
Category B: Countries for which data similar to those for Category A existed, but where the energy-intake data were given only for groups of households classified in terms of income or expenditure;
Category C: Countries for which no energy-intake distribution data were available, even for groups of households, but for which the rest of the information characterizing Category B was available;
Category D: Countries for which there were no data on the distribution of energy intake or food expenditure, but for which data were available on income or total expenditure distribution;
Category E: Countries for which no data except food balance sheets existed.

For countries in Category E, there was hardly any satisfactory basis for estimating the distribution parameter; their CV was therefore set equal to the weighted average CV for their respective regions. For Categories A through D, however, some form of distributional data existed: either the energy-intake distribution itself, or data on food-expenditure distribution, or, at the least, the distribution of income or total expenditure. Maximum use was made of these data to infer the variation in energy intake. The required CV was calculated directly for Category A countries from household-level data on energy intake, while for the other three categories recourse was had to indirect methods, progressively more indirect as the data became scarcer.

The basic approach to estimating was based on the observed fact that energy intake is positively correlated with income or with total expenditure, taken as a proxy for income. On this ground, variations in energy intake were deduced from variations in income for Categories C and D, for which there were no data at all on energy-intake distribution. But various non-income factors also affect the household energy-intake level, and indeed, a number of empirical studies have shown that, especially at higher income levels, the relationship between income and energy intake becomes weak: regression analyses of household-level bivariate data from surveys for a few countries indicate that the share of the variation not explained by income can range from 40-90 percent. The interhousehold energy-intake variation will therefore be underestimated if it is deduced solely from income variation.

A similar underestimation will occur even for Category B countries. Here the energy-intake distribution does not have to be deduced from income distribution, because it is reported directly. But since the intake data are reported only for broad household groups, classified in terms of income or expenditure, the non-income influences on energy-intake variation are largely eliminated, and the remaining variations are essentially income-induced.

It was therefore necessary to increase the income-induced variation to account for the non-income factors. This was done by estimating the relationship between total energy-intake variation and the income-induced share of the variation, from the data of the countries referred to in Category A.

An Engel's curve was fitted to the data on household per caput energy intake and income. Four functional forms were tested: semi-log, double log, log reciprocal and double reciprocal, and of these both the semi-log and the log reciprocal performed reasonably well. Since the number of cases was too small to make possible a judgement of their relative superiority, the semi-log function was chosen on practical grounds: it is easier to manipulate mathematically and, as will be seen below, its use leads to a simple formula through which the income-induced variation can be adjusted for non-income factors.[1]

This relationship is expressed as follows:

$$x = A + B \log v + e \qquad \ldots (9)$$

where (x) represents the household per caput dietary-energy intake, (v) the household per caput income, and (e) the error term representing the composite effect of the non-income determinants of energy intake, and (A) and (B) are constants.

It follows from (9) that

$$\sigma_x^2 = B^2 \sigma^2_{\log v} + \sigma_e^2 \qquad \ldots (10)$$

The elasticity (E_x) of calorie intake with respect to income can be shown to be given by

$$E_x = B/\bar{x} \qquad \ldots (11)$$

Taking the elasticity of the mean energy intake ($\bar{x}$), and using relationship (11), expression (10) can be written thus:

$$\sigma_x^2 = (\bar{x} \cdot E_x)^2 \sigma^2_{\log v} + \sigma_e^2 \qquad \ldots (12)$$

Denoting the coefficient of determination between energy intake and income as (r^2), and using (10),

$$r^2 = B^2 \sigma^2_{\log v}/\sigma_x^2 \qquad \ldots (13)$$

so that

$$\sigma_x = \frac{1}{r} (B \, \sigma_{\log v})$$

Using (11),

$$\sigma_x = \frac{1}{r} (\bar{x} \cdot E_x \, \sigma_{\log v}) \qquad \ldots (14)$$

Therefore, the coefficient of variation of energy intake is given by

$$CV(x) = \sigma_x/\bar{x} = \frac{1}{r} (E_x \, \sigma_{\log v}) \qquad \ldots (15)$$

An examination of relationship (12) shows that the subexpression ($E_x \, \sigma_{\log v}$) in (15) is simply the income-induced component of the variation in (x). The multiplicative factor ($\frac{1}{r}$), through which it is converted into total variation, reflects the effect of non-income variables. Since (r) is the coefficient of correlation between energy intake and income, greater influence of non-income variables will imply a lower value of (r) and hence a higher value of the adjustment factor ($\frac{1}{r}$).

In order to estimate the coefficient of variation of energy intake given by expression (15), three estimates are needed: the standard deviation of logarithms of income ($\sigma_{\log v}$), the coefficient of correlation between energy intake and income (r), and the elasticity of energy intake with respect to income at the mean intake level (E_x).

($\sigma_{\log v}$) can be estimated directly from survey data, since surveys for all countries in Categories A, B, C and D report household distribution of income or its proxy, total expenditure. The same however is not true for (r), since no bivariate household data on energy intake and income (or total expenditure) are available for Categories C and D, while for Category B they are available only in grouped form, which fails to reflect the true correlation between household energy-intake and income. An equation to estimate (r) was therefore derived from the relevant household-level data available in the surveys of Category A countries.

(E_x) and (r^2) are inter-related, inasmuch as both include the covariance factor (in (E_x) through the regression coefficient (B)). This relationship was estimated for Category A countries through regression analysis (cross-sectional), yielding the following empirical equation:

$$r^2 = -0.04 + 1.09 \, E_x \qquad \ldots (16)$$
$$(R^2 = 0.96)$$

Using (15), (16) and the calculated values of (E_x), r and ($\sigma_{\log v}$), the CV of energy intake was estimated for each of the Category A countries, and the observed CV was also calculated from the survey data; the difference was found to be slight in each case. Expression (16) was therefore used to estimate (r) for the countries in Categories B, C and D.

Estimating the income elasticity of per caput dietary-energy intake (E_x). For countries in Category B, survey results were available for dietary-energy intakes by income class, so that the elasticity could be estimated directly from the appropriate Engel function fitted to the grouped data. In general, the semi-log function performed as well as, or better than, the other functions, and it was therefore chosen for calculating the elasticities at the average-intake level.

No data on the distribution of energy intake by income groups were available for the Category C countries, but the food-expenditure distributions

[1] It is true that the log reciprocal function has theoretically more attractive properties, allowing an upper asymptote to energy intake and ensuring a positive energy intake at all positive incomes, however small. Neither of these properties is allowed by the semi-log, but they relate only to the extreme ends of the income-distribution scale, and since most household surveys fail in practice to capture the very high- and the very low-income levels, their absence does not seriously affect the goodness of fit of the semi-log function. This view was corroborated by the impressive goodness of fit obtained for the semi-log function in the course of the procedure being examined.

were known. A certain correlation is expected between food expenditure and energy intake, and this would give rise to a relationship between the elasticity of energy intake (E_x) and the elasticity of food expenditure (E_f) with respect to income. If this relationship is known, then (E_x) can be easily estimated from the values of (E_f) that can be calculated for each of the Category C countries. Generally speaking, the relationship between the two elasticities can be expressed as

$$E_x = F(E_f, T) \quad \ldots (17)$$

where (T) is a vector of variables likely to affect the relationship between (E_x) and (E_f). Alternatively, it is possible to write

$$K = E_x/E_f = G(T) \quad \ldots (18)$$

(K) is the elasticity of energy intake with respect to food expenditure. Its value depends on the degree of substitution of cheaper energy sources by more expensive ones as consumers raise their food expenditure: the costlier such substitutions, the lower the value of (K). Any variable affecting this substitution process is therefore suitable for inclusion in the vector (T).

Income itself is evidently one such variable: at progressively higher income levels, people move toward increasingly costly dietary-energy sources. Moreover, a country's average elasticity is affected not only by the average income level but also by the income distribution: given an average income, a higher degree of inequality leads to a decrease in (K), because the costlier substitutions are likely to occur at the upper end of the income scale. The value of (K) can also be affected by price differentials between different dietary-energy sources, and other variables are also conceivable.

On the other hand, however, introducing too many variables creates the practical problem of the insufficient degree of freedom: estimates of both (E_x) and (E_f), forming the basis for an estimation of relationship (18), were available for only 12 countries. A single variable which could be taken as a reasonable proxy for the major underlying variables was therefore used, and the ratio of food expenditure to total expenditure (F) was chosen for this purpose, since according to Engel's law it varies inversely to income. It also depends on income distribution: the more skewed the distribution, the lower the ratio. Finally, it is also affected by the price structure of dietary-energy sources.

On these grounds, the ratio (K) was regressed on the single variable (F), and the following third-degree equation was consequently found to give the best fit:

$$K = 8.40 - 43.98\,F + 76.98\,F^2 - 42.17\,F^3 \ldots (19)$$
$$(R^2 = 0.94)$$

Using this equation, (K) was estimated for the Category C countries, and then E_x was estimated as

$$E_x = K \cdot E_f \quad \ldots (20)$$

Since food-expenditure distributions were not available for the Category D countries, the foregoing procedure was modified to permit the utilization of equation (20) with an indirectly obtained estimate of (E_f). For this purpose, an estimating equation relating (E_f) to a number of variables was set up.

The most important variable is the per caput income level. According to Engel's law, the higher the income level, the lower the value of (E_f). A corollary to this law is that the degree of inequality in income distribution is also a potential determinant of (E_f): the greater the inequality, the lower should be the value of (E_f). For reasons set out above, both the average income level and its distribution can be proxied by a single variable (F), and this ratio was therefore also used in a separate regression. A higher urban/rural income ratio can also lead to a reduction in (E_f), since the urban population has greater scope and encouragement to devote a larger proportion of its incremental income to non-food expenditure. The breakdown between urban and rural incomes not being available for most countries, this variable was proxied by the urban/rural population ratio. A final variable was the proportion of relatively inexpensive energy sources in the total energy intake, which was used to capture the effect of price differentials among different dietary-energy sources on the food-expenditure elasticity.

The regression was run on data for the countries in Categories A, B and C, for all of which (E_f) could be calculated from survey data. A stepwise regression analysis was undertaken in order to limit the explanatory variables to those that significantly contributed to increasing the explained variation.

It was found that only the ratio of food expenditure to total expenditure (F) and the proportion of cheaper energy (as measured by the percentage of total calories provided by cereals, roots and tubers) (P) significantly contributed to explaining the total variation. The following equation thus emerged:

$$E_f = 0.2339 + 0.0033\,P + 0.5054\,F \quad \ldots (21)$$
$$(R^2 = 0.79)$$

Using this equation, (E_f) was estimated for the Category D countries, and this estimate was then used in equation (20) to estimate (E_x). The other variable, (K), in equation (20) was estimated by using relationship (19), as for the Category C countries.

V. Summary of major survey limitations

Readers of Chapter 3 and of this Appendix will have observed the frequent warnings that certain procedures and conclusions of the Survey are subject to caution, approximations necessitated by the limitations of the available data having an inevitable effect upon the estimates of the incidence of undernutrition and their interpretation. As a matter of principle, approximations leading to underestimations were preferred throughout to those which might have tended to exaggerate the incidence of undernutrition in the developing world. For the convenience of the reader, some of the major conceptual limitations imposed by the basic data available are summarized here.

1. Since the available data on intake distribution refer to households rather than to individuals, the methodological framework assumed an assessment based on household per caput averages. The subsequent generalization to individuals therefore involved an element of bias, because intakes may not always be distributed proportionately to individual requirements within households.
2. Since the demographic and anthropometric data needed for estimating requirements of individual households are generally not available, the national average per caput requirement had to be used as a common requirement level for all households.
3. The per caput DES data from food balance sheets had to be used as the mean of the per caput intake distribution for each country. Although intakes are probably quite close to supply among the undernourished, this approximation introduces a bias in the estimation process.
4. The cut-off points combine concepts of requirements that differ for children and the rest of the population. First, the requirements for adults and adolescents allow only for an absolute minimum activity, whereas the requirements for children, being based on observed intakes of healthy children growing normally, include an allowance for normal activity. Second, owing to the lack of data on the variation in requirements for children, only one set of requirement levels was adopted for children in different age/sex groups. This lack of uniformity would appear to complicate the interpretation of the incidence estimates obtained. Nevertheless, since the bulk of the per caput requirement is contributed by adults and adolescents, the cut-off points are not substantially modified by the different treatment of the requirement for children. Thus, the estimates resulting from the application of the two cut-off points should refer essentially to the *undernourished in the conventional sense* rather than the broader concept of the food-constrained nutrition problem.
5. Finally, low food intake does not immediately result in undernutrition: it merely begins a process that, if continued, leads to undernutrition. In other words, the intake data should cover a sufficiently long period to make it possible to determine whether a nutritional problem is involved. Although the average per caput supply data from food balance sheets refer to a three-year period, the estimates of interhousehold variability were in some cases based on observed differences in energy intakes or related variables among sample households, referring to different time points during the reference period of the survey. The variability may therefore also reflect unknown effects of seasonal variations in food availability and intakes.

The total effects of these biases on the estimates of the undernourished will differ depending on circumstances in different countries. However, since the errors may to some extent cancel each other out, the net effect may not be significant.

VI. Essential differences between earlier and current survey methodologies

FAO's first attempt to measure the incidence of undernutrition was made in *The Third World Food Survey*, published in 1963. More detailed estimates (FAO, 1974b) were published as part of the documentation for the UN World Food Conference, and revised estimates for 1969-71 and 1972-74, covering the developing market economies, were included in *The Fourth World Food Survey* (FAO, 1977a). The 1981 study, *Agriculture: toward 2000* (FAO, 1981), updated the estimates for 90 developing countries to 1974-76.

The basic principle underlying the estimates, which is to calculate the number of people whose dietary-energy intakes are below defined minimum requirements, was the same in *The Fifth World Food Survey* as in these earlier studies, but significant refinements and improvements were introduced into the methodology for determining both the minimum requirements (cut-off points) and the distribution of dietary-energy intakes. For this reason, the new estimates for 1969-71 and 1979-81 are not directly comparable with those published earlier.

Cut-off point and minimum requirements. *The Fourth World Food Survey* used a single cut-off point based on a conservative estimate of the maintenance requirement (1.2 $\overline{\text{BMR}}$) for the entire population, and it thus yielded a single estimate of the undernourished. In the fifth survey two alternative estimates were obtained, based on two different cut-off points. In both of these, the same recommended intakes for children up to the age of ten, which allow for normal physical activity, were used. These were then combined with two alternative estimates of the maintenance requirements of adults and adolescents, based on different interpretations of the observed variation in this requirement.

In the fourth survey, the value of 1.2 $\overline{\text{BMR}}$ was used directly only for the "reference male" of a given age and weight. Per caput equivalents were obtained by applying a conversion factor to this reference value for each country, calculated as a ratio between per caput and "reference male" requirements based on the moderate-activity scales recommended by the 1971 FAO/WHO Expert Committee (FAO/WHO, 1973). In the fifth survey, in accordance with the recommendations of the 1981 FAO/WHO/UNU Expert Consultation (FAO/WHO/UNU, 1985), requirements of children up to the age of ten and the values of 1.2 and 1.4 $\overline{\text{BMR}}$ for the rest of the population were calculated directly for different age and sex groups on the basis of body weights.

In the earlier approach, requirements were based on *actual* body weights of the reference population. In the new approach, both the BMR-based requirements of adults and adolescents and the requirements of children were based on *minimum desirable* body weights. In addition, the value of BMR was estimated from a much wider set of experimental data than was available before, and therefore even the reference BMR differs from that of the earlier estimates.

As examples, the actual values of cut-off points used for selected countries in *The Fifth World Food Survey* are compared below with those used in the fourth survey.

Country	*The Fifth World Food Survey*		*The Fourth World Food Survey*
	1.2 $\overline{\text{BMR}}$	**1.4 $\overline{\text{BMR}}$**	**1.2 $\overline{\text{BMR}}$**
	(kcal/day)		
Bangladesh	1 401	1 553	1 512
Brazil	1 518	1 683	1 545
Egypt	1 546	1 716	1 557
India	1 447	1 608	1 486
Indonesia	1 402	1 557	1 507
Sri Lanka	1 448	1 615	1 504
Sudan	1 491	1 648	1 526
Thailand	1 388	1 539	1 511
Tunisia	1 475	1 636	1 514

Distribution of dietary-energy intakes. Major improvements were also introduced into the second part of the survey procedure, concerning the estimation of the distribution of dietary-energy intakes within countries. In both the earlier and the current methodologies, the intake distribution was represented by a theoretical distribution function, whose mean value was taken from food balance sheets and whose other parameters were estimated from other available sources. There have been, however, some important differences in the approach.

Whereas the Beta function was used in the earlier methodology as the theoretical distribution, the methodology for the fifth survey used the log-normal distribution which, tested on a wider set of data, yielded a better fit.

The interhousehold variation in dietary-energy intakes was previously deduced entirely from the variation in income, excluding variations resulting from non-income factors and thus underestimating the true variance. In the fifth survey it was found possible for a number of countries to estimate the total variation directly from detailed household-level data on dietary-energy intakes. Where such direct estimation was not possible, the income-induced variation was adjusted upward to account for the impact of non-income factors, on the basis of the household survey data for the former countries.

The income-induced segment of the variation was estimated in both methodologies by relating incomes and dietary-energy intakes through a semi-log Engel's function. It was then calculated with the help of an estimated income-elasticity of dietary-energy consumption, derived from the Engel's function, and the income variance. In the fifth survey, an effort was made to generate more reliable estimates of these elasticities both by enlarging the database and by improving the methodology. More direct use than was previously possible was made of country-specific distributional data.

In both methodologies, the variation in dietary-energy intakes for some countries had to be estimated arbitrarily on the basis of the regional average, for lack of detailed country-specific information. With the availability of more distributional data, however, it was found possible in the fifth survey to reduce the number of countries dealt with in this manner.

Glossary

anaemia, nutritional

A condition in which the haemoglobin concentration, the haematocrit or the number of red blood cells in the blood of an individual is lower than normal as a result of a deficiency of one or more essential nutrients, regardless of the cause of such deficiency. In defining a departure from normality, it must be borne in mind that normal haemoglobin levels vary with age, sex, weight, physiological status and altitude. Anaemia is considered to be a late manifestation of nutrition deficiency, and even mild anaemia is not the earliest sign of such a deficiency.

availability, biological

The extent to which a nutrient is in a form that can be absorbed from the digestive tract. Nutrients shown by chemical tests to be present in some foods may not be available, or may be only partly so, because they cannot be liberated by digestive enzymes and hence are not absorbed.

balance sheet, food

See *food balance sheet.*

basal metabolic rate (BMR)

The rate of energy expenditure of an individual while in a fasting state (having ingested no food for 15 hours) and lying at complete rest in a warm environment.

biological availability

See *availability, biological.*

BMR

See *basal metabolic rate.*

consumption, food

See *supplies, food.*

country, developing

"There is no clear-cut agreement on what constitutes underdevelopment. ... Despite the wide differences among developing countries, they share a number of characteristics. In most underdeveloped countries, primary (agricultural or extractive) production accounts for a very large proportion of national income and, not infrequently, a disproportionate share is taken by one or two products. The level and range of secondary industrial activities tend to be very low and marked by poor technological development. Most of these countries have large quantities of surplus labour, considerable unemployment or underemployment, and fairly high rates of population growth. Another common feature is inadequate infrastructures — poor road and transportation networks, lack of sufficient irrigation, etc. Equally important are the underdevelopment of human resources in terms of skills and education and the weakness of economic and financial institutions. ..." (*Encyclopaedia Britannica*, 15th ed., 7:255,2a).

Although a number of countries have made great strides in development since the United Nations classification was established in the 1940s, the list itself has remained practically unchanged (except for the addition of newly independent countries) since that time. As a result, certain countries — particularly in Asia and Latin America — continue to be classified as developing countries despite the fact that their economies no longer qualify them for that classification.

country, least developed

A developing country whose per caput gross domestic product (GDP) is the equivalent of US$100 or less, in which the share of manufacturing in the GDP is 10 percent or less, and in which the literacy rate is 20 percent or less. (Official United Nations Classification.)

country, low-income

A developing country or territory in which the per caput gross national product (GNP) in 1983 was the equivalent of US$400 or less.

country, low-income food-deficit

A food-deficit developing country or territory in which the per caput GNP in 1983 was the equivalent of US$790 or less. (Income level used by the World Bank to determine eligibility for International Development Association (IDA) assistance.)

country, middle- to high-income

A developing country or territory in which the per caput GNP in 1983 was the equivalent of more than US$400.

developing country

See *country, developing.*

diet

The total solid and liquid foods consumed by an individual or by a population group, either on an average basis or during a specified period.

energy requirement

See *requirement, energy.*

food balance sheet

A table presenting an overall picture of the pattern of a country's food supply, showing the types and quantities of food produced, imported, exported, and used as food and for other purposes, and the per caput supplies available for human consumption in terms of energy and nutrients.

food consumption

See *supplies, food.*

food habits

See *habits, food.*

food preference

See *preference, food.*

food, staple

A food which is regularly consumed in a country or community and from which a substantial proportion (for the purposes of this book, the highest share) of the total dietary energy is obtained, especially by the poorer sector of the population and in times of food shortage.

food supplies

See *supplies, food.*

food supply, national

See *supply, national food.*

food, weaning

A food contributing to the nutritional needs of infants during the weaning period. The term is sometimes wrongly applied to specific protein-rich mixtures or preparations given as supplementary feeding to infants and children, in particular, preparations manufactured from protein sources not normally used in human feeding (e.g. protein concentrates). In many circumstances, the cheapest, most appropriate and most accessible weaning food may be a mixture of local foods, the use of which can be taught to mothers by demonstration.

habits, food

The ways in which an individual or group selects foods and consumes them in response to physiological, psychological, cultural and social influences.

LDC

See *country, least developed.*

least developed country

See *country, least developed.*

low-income country

See *country, low-income.*

low-income food-deficit country

See *country, low-income food-deficit.*

malnutrition

A pathological state, general or specific, resulting from a relative or absolute deficiency or an excess in the diet of one or more essential nutrients. It may be clinically manifest or detectable only by biochemical and physiological tests. Five different forms of malnutrition have been distinguished: starvation, undernutrition, specific deficiency, imbalance and overnutrition; some writers do not consider overnutrition and its resulting obesity under the heading of malnutrition.

Weight and height data for individual children in different age categories below the age of five, compared with a reference growth-pattern (such as those established by WHO, based on measurements of well-nourished, healthy children), are used to indicate the extent of malnutrition in a population. The most commonly used indicators are the numbers and proportion of children whose weight-for-age or weight-for-height are more than twice the standard deviation below the median value for the reference, and the proportion of birth below a given standard weight.

malnutrition, protein-energy (PEM)

A range of pathological conditions arising from coincident lack, in varying proportions, of protein and energy, occurring most frequently in infants and young children, and commonly associated with infections. An earlier expression, "protein-calorie malnutrition (or deficiency)", is still in use.

marasmus, nutritional

A severe form of protein-energy malnutrition, occurring mainly in infants and characterized by muscle wasting, loss of subcutaneous fat, and growth retardation, with very light body weight (usually below 60 percent of normal standards). Other factors, such as infection, may play a part in causation.

metabolic rate, basal

See *basal metabolic rate.*

middle- to high-income country

See *country, middle- to high-income.*

nutrient

Any of the organic and inorganic compounds and elements contained in foods and utilized in the normal metabolism of the body. Nutrients are generally classified as carbohydrates, fats, proteins, vitamins, minerals, and other metabolizable organic compounds (organic acids, alcohols, etc.). Proteins, carbohydrates and fats are sometimes termed the principal "energy-yielding nutrients". "Essential nutrients" are those organic and inorganic compounds and elements which the body requires but does not synthesize in sufficient amounts, e.g. water.

nutrition

— the processes whereby living organisms utilize food for maintenance of life, growth, the normal functioning of organs and tissues, and the production of energy;
— the science and study of the reactions of the body to intake of food, to variations in the diet, and to other factors of pathological or systemic significance. "Human nutrition", the scientific discipline that deals with nutrition in man, is concerned in particular with nutritional requirements, food composition, food consumption, food habits, the nutritive value of foods and diets, the relationship between diet and health, and research.

nutrition survey

See *status, survey of nutritional.*

nutritional requirements

See *requirements, nutritional.*

nutritional status

See *status, nutritional.*

obesity

Excessive accumulation of body fat; one of a variety of causes of *overweight.* In practice, obesity has been defined in terms of percentage of body composition represented by fat, or by related indicators such as skin-fold thicknesses at specified body sites.

overnutrition

A pathological state resulting from an excessive intake of food, and hence of dietary energy, over a period of time, and eventually causing obesity. The term is sometimes used, erroneously, as a synonym for "overeating" or for "obesity".

overweight

Weight in excess of the normal range for a given sex, age and height in a specified healthy population. It can result from a variety of causes, of which *obesity* is the most important.

PEM

See *malnutrition, protein-energy.*

preference, food

The attitude toward a given type of food, usually as compared with other foods, on the basis of favourable physiological reaction, sociological norms, or pleasant sensations. It can be studied, in a given society or social group, through examination of non-verbal behaviour or through opinion surveys.

protein-energy malnutrition

See *malnutrition, protein-energy.*

requirement, energy

That level of energy intake of an individual which will balance energy expenditure when the individual has a body size and composition and level of physical activity consistent with long-term good health, and which will allow for the maintenance of economically necessary and socially desirable physical activity. Some individuals will need more, and some less, than the average energy requirement, but in a group, surpluses and deficits cancel each other out, and the average represents the requirement of the group.

requirements, nutritional

The amounts of energy and nutrients, usually based on averages and expressed on a daily basis, which cover the needs of groups of healthy individuals with respect to growth and the normal functioning of the body.

seasonality

Fluctuations in food production, and therefore food availability, due to the regular cycle of the seasons.

staple food

See *food, staple.*

state of nutrition

See *status, nutritional.*

status, nutritional

The condition of the body resulting from the intake, absorption and utilization of food and from factors that are of pathological significance.

status, survey of nutritional

The investigation of population groups to determine their nutritional status. The objectives of a given survey may be the assessment of nutritional status in general, or the obtention of information on the prevalence and seriousness of a specific deficiency in a specific area or in a specific sector of the population. Survey methods may be clinical, anthropometric, biochemical, physiological, etc. The term "nutrition survey" is sometimes used as a synonym, but it can also be applied to surveys in which studies of food consumption and nutritional status are carried out simultaneously in the same population group.

supplies, food

The foods available to a population group from any source, local or imported. The term "food consumption" or "food intake" is sometimes erroneously used as a synonym. The data obtained by food consumption surveys show the actual food consumption of the groups surveyed, whereas the data presented in national food balance sheets relate to supplies of foods, calories, etc. and not to consumption, although of course average per caput supply figures provide an indication of consumption. There is often a considerable difference, however, between national average supplies and observed consumption, particularly with respect to calories (energy).

supply, national food

The amounts of food, whether or not moving in trade channels, at the disposal of the consumers of a given country during a given period (usually a year).

survey, nutrition

See *status, survey of nutritional.*

survey of nutritional status

See *status, survey of nutritional.*

undernutrition

A pathological state arising from an inadequate intake of amounts of food, and hence of energy, over a considerable period of time, with reduced body-weight as its principal manifestation (see *malnutrition*).

vulnerability

The extent to which an individual or population group is prone to develop nutritional disorders. Depending on place, time and conditions, vulnerable groups may include children during the period of growth, pregnant and nursing women, individuals engaged in heavy manual labour, the aged, displaced persons, the very poor, etc.

weaning food

See *food, weaning.*

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