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Can FAO's measure of chronic undernourishment be strengthened?

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In its *Sixth World Food Survey* released at the 1996 World Food Summit, the Food and Agriculture Organization of the United Nations (FAO) reported that 841 million people in developing countries are chronically undernourished. This number and its country and regional-level disaggregations have proved tremendously useful to countless development aid agencies and researchers. In the context of a recent wave of new nationally-representative household food consumption and expenditure surveys, this paper examines the estimation methodology underlying the food insecurity measure, which relies on national aggregate measures of food availability and distribution. The paper finds that the measure largely reflects national food availabilities and does not adequately capture people's ability to gain access to food – the ultimate key to food security. The implications for the indicator's use by policy makers in geographical targeting and tracking changes in food insecurity over time are drawn out. The paper concludes by arguing that the time has come to review the potential for employing the new household survey data, along with new methods, to strengthen the empirical foundations of FAO's measure. © 1999 Elsevier Science Ltd. All rights reserved.

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Introduction

As the world reinvigorates its efforts towards alleviating food insecurity in developing countries following the 1996 World Food Summit, the availability of an accurate national-level indicator of food insecurity that is comparable across countries has become more imperative than ever. Just as monitoring food insecurity within countries is fundamental for generating adequate information for program planning and policy making for individual countries (Babu and Quinn, 1994), monitoring food insecurity at national, regional and global levels is essential for such planning and policy making across countries. It is needed for three main purposes: (1) identifying where food insecurity exists and is most severe; (2) tracking changes in food insecurity over time; and (3) understanding its causes so that the most effective interventions can be chosen to alleviate it. The accuracy of the numbers used for these purposes is central to the identification and successful implementation of policies to improve food security.

Currently, the most widely-employed national-level indicator of the prevalence of food

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insecurity is a measure of 'chronic undernourishment' developed by the Food and Agriculture Organization of the United Nations (FAO). The measure gives the number and proportion of people in each country who consume insufficient dietary energy to meet their requirements. Along with the Plan of Action for the World Food Summit, the FAO released its *Sixth World Food Survey (SWFS)* in which it employed the chronic undernourishment measure to estimate that 841 million people in developing countries were food insecure in the 1990/1992 period, down from 918 in 1969/71 (FAO, 1996a). The 186 countries adopting the Plan of Action agreed to a goal of halving the 1990/92 baseline number by the year 2015 (FAO, 1996c).

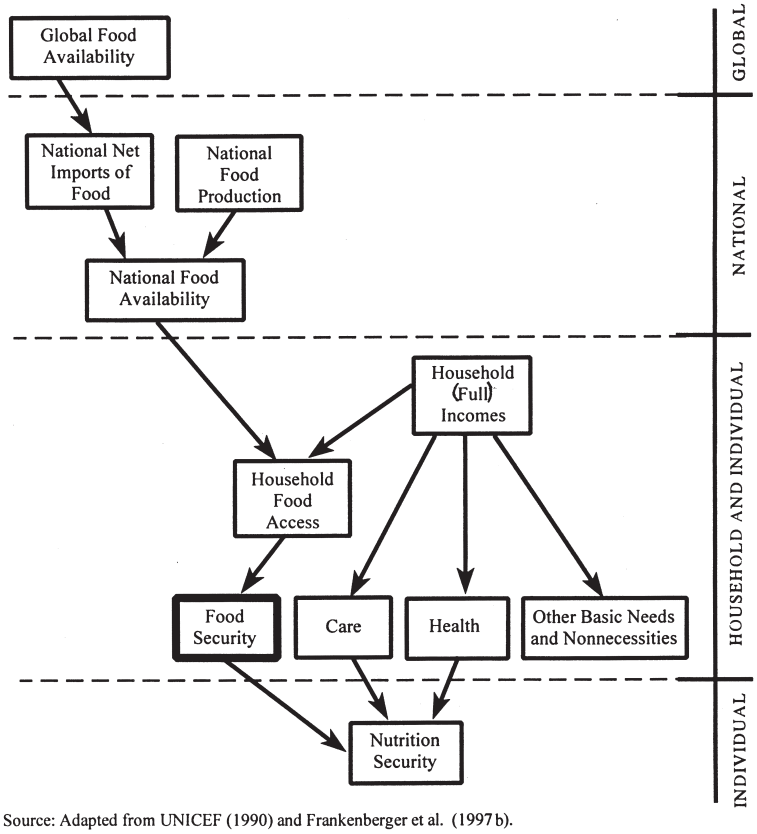
In addition to serving as the baseline for the World Food Summit goal, the FAO measure has been employed by a wide variety of institutions for several purposes. It has been utilized for educational, advocacy, and awareness raising for issues of food insecurity and hunger, being cited frequently in widely-disseminated publications (e.g., Bread for the World, 1997; Pinstrup-Andersen *et al*., 1997; FAO, 1996b; Mason, 1995). It has also been used for projecting future food insecurity (Alexandratos, 1995) and for food security policy analysis at country and regional levels (e.g., FAO, 1996a, e; ACC/SCN, 1993; Wiebe, 1998). The heightened focus on the indicator due to its high visibility during and following the Summit instigated a debate over its use as a food security indicator for cross-country allocation of international development resources (e.g., Ferris-Morris and Smith, 1997). These examples show, firstly, the large influence the FAO measure has on policy makers' understanding of where food insecurity exists and how it has changed over time. Secondly, they show the strong demand for and many uses of a national-level indicator of food insecurity.

The aim of this paper is threefold: to lay out and critically examine the current FAO methodology, to investigate the accuracy of the resulting estimates of chronic undernourishment, and to consider how the empirical foundations of the estimates can be strengthened. Achieving this goal requires a clear understanding of the meanings of the terms 'food availability', 'food security' and 'nutrition security', and the main determinants of each. In the next section, a conceptual framework linking these concepts is presented. The section includes a brief historical overview of shifts in the research and development communities' understanding of the causes of food insecurity. Following, the FAO methodology is presented. The accuracy of the chronic undernourishment estimates is explored in the context of a discussion of their use by policy makers for geographical targeting and tracking changes in food insecurity over time. The concluding section discusses how, given the increased availability of household food consumption and expenditures data from national surveys, the chronic undernourishment measure can be strengthened.

Food security, food availability, and access to food: concepts and measures

Food security is defined as 'access by all people at all times to enough food for an active, healthy life' (World Bank, 1986). Ultimately, an individual person is food secure when his or her consumption of food is sufficient, secure (not vulnerable to consumption shortfalls), and sustainable (Maxwell, 1996a). A simplified conceptual framework for food security is given in Fig. 1.

Global food availability stands at the most macro level of the food security 'equation'. Enough food produced in the world, and enough food available in countries (through food production and imports) to feed all of their populations, are necessary conditions for achieving food security. At the time of the world's first global summits on food security, the World Food Conference of 1974, the world was in a 'food crisis' marked by food shortages and



Source: Adapted from UNICEF (1990) and Frankenberger et al. (1997b).

Figure 1 Conceptual framework for food security: From global food availability to people's nutrition security

rising grain prices. The conference focused on global and national food availability as the most immediate food security problems (FAO, 1996d). Since this time, global food supplies have increased substantially, keeping pace with increases in population: global daily kilocalories available for human consumption per-capita rose from 2440 to 2720 between 1970 and 1990 (FAO, 1996a). Over this twenty-year period, food availability at the national level improved for 62 out of 99 developing countries (FAO, 1996a). While in 1970, 32 developing countries were in dietary energy deficit, i.e., had dietary energy supplies that did not meet the aggregate energy needs of their populations, by 1990 the number had fallen to 26.

As seen in Fig. 1, while national food availability is a necessary condition for achieving food security, it is not sufficient. In addition, people must have enough income to be able to have access to the available food while at the same time meeting their other basic needs (Frankenberger, 1996).[1] This income factor is the main determinant of how aggregate food supplies are distributed among countries' populations. Access to food may be gained through

[1]In particular, they must have sufficient 'full incomes' which, in addition to cash income, includes the value of goods produced (such as food) and services provided (such as child care) in households that do not enter the market, as well as in kind transfers of goods and services.

(1) production or gathering of food by the household for its own members' consumption, (2) purchase of food on the market with cash income, and/or (3) receipts of in-kind transfers of food (Smith *et al*., 1998). At a broad level, who eats available food is determined by a range of factors, including economic opportunity, political power, discrimination based on race, ethnicity, gender and age, violence, and environmental factors (Cohen, 1998). The importance of these factors varies across countries.

Between the World Food Conference and the World Food Summit, it became clear that food insecurity can remain a problem even in countries where food availability is not. A broad consensus has been reached that the cause of most peoples' food insecurity today is inadequate access to food by households, and by some people within them, due to poverty (Sen, 1981; Maxwell, 1996b; Serageldin, 1995; Alexandratos, 1995; von Braun *et al*., 1992; Haddad *et al*., 1997). The problem of food access was a focal point at the Summit, whose Plan of Action contained the commitment:

> We will implement policies aimed at eradicating poverty and inequality and improving physical and economic access by all, at all times, to sufficient, nutritionally adequate and safe food and its effective utilization (FAO, 1996c:13).

Food inaccessibility is one reason why 167 million developing-country children under five are currently malnourished (WHO, 1997) despite a global food surplus. In the early 1990s, an estimated 78% of these children lived in countries with the highest prevalences of poverty and dietary energy *surpluses* – enough food at a national level available for everyone to meet their dietary energy needs for an active, healthy life (Smith *et al*., 1998).

Given the above, it is essential that any national measure of the prevalence of food insecurity accurately reflects peoples' access to food. Evaluating the FAO measure of chronic undernourishment from this standpoint is not straightforward as no widely-available benchmark measure with which to compare it currently exists. This paper relies on country-level data on the prevalence of child malnutrition as its main reference. The specific measure employed is the percent of countries' under-five populations that are underweight.

Child malnutrition is an indicator of *nutrition* insecurity. A person is considered nutrition secure 'when she or he has a nutritionally adequate diet and the food consumed is biologically utilized such that adequate performance is maintained in growth, resisting or recovering from disease, pregnancy, lactation and physical work' (Frankenberger *et al*., 1997a, p. 1). Nutrition insecurity is determined by the quality of care for mothers and children in households and the quality of households' health environments as well as food security (Fig. 1). Thus measures of nutrition insecurity and food insecurity can only be compared when accompanied by information about these two factors (Maxwell and Frankenberger, 1992). The health environment indicator utilized for this purpose in this paper is an index of the percent of countries' populations with access to health care, sanitation and safe water. The indicator of the quality of care in households is country rankings on the basis of three variables believed to have a strong positive influence on care: women's education, women's status, and breast feeding duration (Engle *et al*., 1997).

Table 1 defines child malnutrition, the health and care indicators, and several other measures employed in this paper.

The 841 million chronically undernourished: How was it calculated?

The FAO chronic undernourishment measure endeavors to capture the proportion and number of people in each developing country 'whose food access is deemed to be inadequate' (FAO,

Table 1 Measures employed and their definitions

Measure	Definition	Source
Child Malnutrition (%)	Percent of children under five whose weight falls below –2 standard deviations from the median NCHS/WHO reference values for their age (data from many countries are estimated using regression techniques–see Appendix Table 6 for a fuller explanation).	ACC/SCN (1993), Table 2.1; FAO (1996a) Appendix 2, Table 8; WHO (1997).
Health Environment Quality (%)	An index combining the percentage of countries' populations with access to health care, sanitation and safe water. Each measure is given equal weight.	UNDP (1993), Table 12.
Quality of Care for Mothers and Children (Index from 1 to 99)	An index ranking countries on the basis of their gross female primary school enrollments, a ratio of female to male life expectancy at birth (a proxy for women's status), and the percent of mothers breast feeding at six months.	UNESCO (1997), Table 3.2, World Bank (1997b), and UNDP (1996) Table 11.
National Food Availability (kilo calories)	Daily per-capita dietary energy available for human consumption.	FAO (1996a), Appendix 2, Table 1 and FAO (1997).
Adult Undernourishment (%)	Percent of adults with Body Mass Index less than or equal to 18.49 (the cut-off below which a person is considered to be at high risk of chronic nutritional deficiency).	FAO (1996a), Table 25.
Food Energy Deficiency (%)	Percent of adults consuming less than 80% of their dietary energy requirement.	Broca and Oram (1991).
Prevalence of Poverty (%)	Percent of people with income less than one dollar per day (with income measured using purchasing power parity-adjusted 1985 U.S. dollars)	World Bank (1997a) and Ravallion and Chen (1996).

1996a, p. 33) using information on national food availabilities and on the distribution of food among households within countries. The measure is thus intended to reflect the role of both aggregate food supplies and household incomes in determining food insecurity. In the *SWFS*, estimates are given for the years 1969/71, 1979/81 and 1990/92 for 99 developing countries. The three statistics on which they are based are the following.

- *Daily per-capita dietary energy supply (DES)*: the energy (in kilo calories) available for human consumption per day from the food supply divided by the population.

DES is a measure of national food availability. It is calculated from FAO food balance sheets for each country using food production and trade data. Taking into account use of food for seed, wastage of food, stock changes, and food utilized for animal consumption, the total amount of each food commodity available for human consumption each year is calculated. Per-capita DES is then derived by adding up the calorie values of the commodities and dividing this number by the total population. For the 1990/92 period, the estimated developing country per-capita DESs range from 1590 (for Somalia) to 3510 (for Turkey) (See Appendix B Table 6, column 4).

- *Coefficient of variation (CV) in dietary energy intakes*: an estimate of the variability in dietary energy intake across a country's population.

The CV is a summary measure of the degree of inequality in the distribution of dietary energy intakes within a country. It is equal to the standard deviation (SD) of dietary energy intakes divided by its mean. For 18 out of the 99 countries, the CVs are estimated based on analysis of nationally representative household food consumption or expenditure surveys. The rest of the countries' CVs are predicted either from measures of income distribution or as the mean CV estimated for other countries in the same region. An appropriate range for the CVs is assumed to be 0.2 (relatively equal distribution) to 0.35 (relatively unequal). Any country whose estimated CV falls outside of this interval is assigned the closest endpoint. The CVs are also assumed not to change over the twenty-year period for which undernourishment estimates are undertaken.

- *Minimum daily per-capita dietary energy requirement (DER)*: a cut-off point below which the average person in the country would not be meeting his or her minimum daily dietary energy requirements.

The DER for each country is calculated in two steps. In the first, the minimum energy needs of age and sex-differentiated demographic groups are determined. These needs are based on body weights and activity levels consistent with the energy intake needed to maintain body weight and to support light activity. The second is to aggregate the energy requirements to arrive at the 'typical person's' energy requirement through a population-weighted average of the age-sex groups' requirements. The smallest regional average DER employed in the *SWFS* is 1790 kilo calories (kcals) per-capita per day (for South Asia); the highest is 1880 (for East and Southeast Asia).

How are these statistics combined to arrive at estimates of the prevalence of chronic undernourishment for each country? The method is illustrated in Fig. 2. The key assumptions are that (1) the actual distribution of dietary energy intakes within all countries follows a log-Normal probability distribution; and (2) the mean of this distribution equals countries' per-capita DESs. Given these assumptions, a DER cut-off and a CV of dietary energy intake, the probability that the 'average' person in the country will fall below the cut-off is calculated using the mathematical formula given in Appendix A and a table of standard normal probabilities. This probability is then used as the percentage of chronically undernourished. The number of undernourished in each country is calculated using the total population size.

Columns (1) and (2) of Appendix B, Table 6, report the resulting estimates for each developing country for the 1990/92 period. South Korea had the lowest estimated prevalence

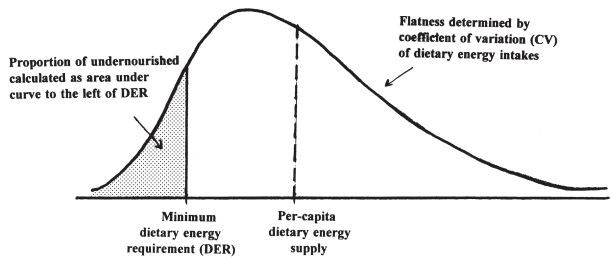


Figure 2 Log-normal distribution of dietary energy intakes employed for estimating country-level chronic undernourishment prevalences

Table 2 FAO estimates of the prevalence and numbers of chronically undernourished by developing-country region (1969/71–1990/92, percent)

Region	1969/71		1979/81		1990/92	
	N (millions)	Percent	N (millions)	Percent	N (millions)	Percent
Sub-Saharan Africa	103	38	148	41	215	43
South Asia	38	33	303	34	255	22
East and Southeast Asia	476	41	379	27	269	16
Latin America and the Caribbean	53	19	48	14	64	15
Near East/North Africa	48	27	27	12	37	12
Total	918	35	906	28	841	20%

Source: FAO, 1996a, Table 14.

of chronic undernourishment (1%) while Afghanistan had the highest (73%). Estimates by region for the three periods covered are given in Table 2.

What is the chronic undernourishment measure really measuring?

The FAO measure has been criticized both with respect to the accuracy of the data employed and its appropriateness as an indicator of food insecurity.[2] This section goes beyond these concerns to ask: do the methodology and assumptions underlying the measure represent a valid procedure for accurately estimating how many people in a country consume insufficient dietary energy and how this number changes over time?

Of the two parameters of the log-Normal distribution used to identify the prevalence of chronic undernourishment, it is the CV that distinguishes the FAO measure from a simple measure of national food availability. However, in effect, the CVs themselves make little difference in comparison to the DES to the calculated prevalences of undernourishment. In an effort to avert concerns over measurement errors plaguing the CV estimates, the *SWFS* makes this clear in the form of a sensitivity analysis based on 16 'hypothetical' country cases.

The results are reproduced in Table 3. The rows of the table give the percent undernourished

Table 3 Percent undernourished at different levels of per-capita dietary energy supply (DES) and coefficient of variation of dietary energy intakes (CV)

CV	0.2	0.24	0.29	0.35
Per capita DES				
1700	65	64	63	63
2040	30	34	38	42
2450	7	12	17	23
2940	1	2	6	10

Source: FAO (1996a) Table 13. The minimum dietary energy requirement (DER) is assumed to be 1800 kcals per-capita per day.

[2]The accuracy of data on per-capita DES is addressed in Svedberg, 1990; FAO, 1983; Gibson, 1990; that of the minimum dietary energy requirements employed is discussed in Svedberg, 1990; Waterlow, 1989. These concerns are also addressed at length in FAO, 1996a. The inappropriateness of a calorie-based indicator as a measure of food insecurity has been emphasized on the grounds that it disregards: (a) protein and micronutrient consumption, (b) intra and inter-seasonal fluctuations in food availability and access, and (c) those whose calorie intake is sufficient but not secure (von Braun *et al*., 1992).

at four different CVs, starting at the minimum allowable of 0.2 and increasing by 20% increments till reaching 0.35. The columns of the table give the percent undernourished at four different levels of per-capita DES, starting from 1700 and then increasing by 20% at each increment. Moving from a CV of 0.2 to 0.35, the percent undernourished varies relatively little for all levels of per-capita DES. It is practically insensitive to changes in the CV at the lowest DES level. At the highest, it varies by only 10 percentage points. In contrast, moving down the rows from a per-capita DES of 1700 to 2940, the estimated percent undernourished increases dramatically for all CV levels, the smallest interval (at a CV of 0.35) being 53 percentage points. Overall, the sensitivity of the undernourishment measure to the DES is always greater than it is to the CV, even when the effect of the CV is at its maximum (2500 kcals). In the *SWFS* the conclusion is reached that 'Given a cut-off point, therefore, the most important determining factor in the general level of food inadequacy is the per caput DES' (FAO, 1996a, p. 43), where 'general level of food inadequacy' refers to the additional dietary energy a country needs to bring the people currently undernourished up to their requirements.

Accordingly, a strong statistical association exists between the prevalences of chronic undernourishment and the per-capita DESs used to estimate them, as can be seen graphically for 1990/92 levels in Fig. 3. In fact, an almost perfect and highly significant correlation exists between these two variables, their Pearson correlation coefficient being 0.91 ($p < 0.001$).

Clearly, variation across countries in the estimates of chronic undernourishment is being driven primarily by their food availabilities. Is this phenomenon a reflection of reality or of the statistical technique employed? The high sensitivity of the FAO measure to countries' DESs and low sensitivity to their CVs could be because, as claimed above, the distribution of dietary energy (representing the degree of inequality in food consumption) is in fact a minor factor in undernourishment compared to the importance of overall food availability. While this

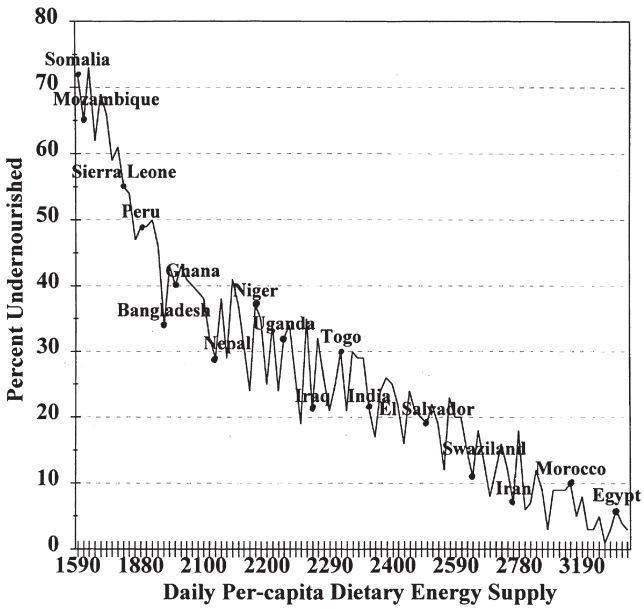


Figure 3 Comparison of FAO chronic undernourishment prevalence estimates with per capita dietary energy supply (1990/92)

presumption defies conventional wisdom, the relative importance of the two factors has yet to be examined empirically due to lack of appropriate data (Smith and Haddad, 1998).

A more likely source lies in the estimation method itself. From this standpoint, one possibility is that the CVs employed are assumed to fall within a range that is smaller than their actual range, thus inappropriately diminishing their influence on the estimations (Maxwell, 1997). The rationale for the 0.2–0.35 range (from FAO, 1975) is as follows. The range for developing countries is assumed to be the same as a 'hypothetical population composed of adequately fed individuals' (FAO, 1996a, p. 139). The SD of dietary energy intakes is therefore assumed to follow that of the intake *requirement* distribution of such a hypothetical population, giving an SD of 660 kcals. Upper and lower limits to the CV range are calculated by dividing this number by the approximate highest (1900) and lowest (3400) developing-country per-capita DESs (see FAO, 1996a Appendix 3, p. 139, footnote 5), leading thus to the approximate maximum and minimum CVs.

However, the true variability of dietary intakes found in developing countries (which contains many people falling below their energy requirements) is likely to be much higher than that of a population of adequately fed individuals. To justify the assumed range, CVs are calculated from five International Food Policy Research Institute household food consumption surveys (for Bangladesh, Kenya, Pakistan, the Philippines and Zambia) (FAO, 1996a, Appendix 3, Table 4). All of the CVs are shown to indeed fall into the range. However, the surveys analyzed are all sub-national, from predominantly rural, homogeneous, and relatively small samples. Countries' *national* CVs are likely to be significantly higher. Therefore, rather than verifying the assumed range, the analysis indicates that the actual range of the CV of dietary energy intakes in developing countries is most likely wider.

With respect to changes over time, since countries' CVs are assumed to be temporally constant, all estimated changes in chronic undernourishment necessarily reflect changes in DES only. Recent studies of changes in income distribution over the last thirty years indicate that, in the real world, distributional measures do vary over time (Deininger and Squire, 1996). The assumption of a constant CV is also likely unfounded.

The most fundamental problem, however, lies in the use of an 'analytical'[3] (or theoretical) probability distribution framework as a predictive tool. This framework relies heavily on the mean of the distribution as a *predictor* of the risk of undernourishment. Writes Naiken, 1998:36,

> . . . in any frequency distribution of the kind dealt with here, the proportion below a cutoff point . . . is likely to be, to a large extent, determined by the distance between the mean and cutoff point. In other words, the greater is the mean in relation to the cutoff point, the smaller is the proportion below the cutoff point. It is for this reason that the CV, which reflects the dispersion around the mean, has a relatively minor effect.

Thus the method inherently gives greater weight to the distribution's mean – in this case assumed to be per-capita DES – than its CV.

As discussed above (Fig. 1), food insecurity is an individual or household-level phenomenon. The average amount of food available to each person in a population, even corrected crudely for the possible effects of low income on its distribution, is not a good predictor of food

[3]By 'analytical' is meant that the distribution can be modeled using a mathematical formula. As such it is smooth (as in Figure 2) and follows a regular shape across the population. In the case of the log-Normal distribution, this regularity is particularly strong because (unlike alternative 'flexible functional forms') the mathematical function relies on only two estimable parameters (See Appendix A).

insecurity among the population. Other factors are at play as well, and the more important they are in influencing undernourishment, the higher the prediction error is likely to be. Since the relative importance of food availability differs across countries (Smith and Haddad, 1998), cross-country comparisons are even more of a problem. In effect, the use of per-capita dietary energy supplies for the mean of an analytical distribution of dietary energy intakes amounts to a *methodological bias in favor of food availability* in estimates of the prevalence of chronic undernourishment.

Implications: The potential for policy error

What is the consequence of this bias in the FAO estimates for their effectiveness as a policy tool? This section explores this question for two of their uses: identifying where food insecurity exists and how it changes over time.

Geographical targeting

To reduce food insecurity globally at the fastest pace, interventions must be targeted on countries and regions with the highest prevalences (and/or numbers) of food insecure people. Policy makers who use the FAO estimates for targeting purposes will tend to emphasize areas with the greatest food availability problems rather than the greatest food insecurity problems *per se*. The consequence is that reductions in food insecurity will take place at a slower pace than would be possible with more accurate information about its geographic distribution. A sense of the degree of error in current estimates can be gained by comparing differences in the FAO estimates across countries and regions with differences in the areas' food security situations as described by alternate data.

Table 4 compares two countries, India and Ghana. India's relatively high DES of 2330 kcals corresponds to a relatively low estimated chronic undernourishment prevalence of 21%. Yet in the early 1990s its prevalences of child malnutrition (53%) and adult undernutrition (49%) were among the highest in the world. Despite its 'embarrassment of food' in recent years (Punjab, 1995), India has a serious food insecurity problem, thought to be explained by its high poverty (Suryanarayana, 1997). Over half (53%) of all people in India are estimated to have real incomes of less than one dollar per day, leaving them without the resources to be able to purchase a nutritionally adequate diet year round.

Ghana's per-capita DES of 2090 kilo calories corresponds to a prevalence of chronic undernourishment almost double that of India's, at 40%. Yet by other measures, Ghana's food insecurity problem, while grave, is not nearly as severe as India's: Ghana's child malnutrition

Table 4 Comparison of food and nutrition insecurity indicators for India and Ghana

	India	Ghana
% Chronic undernourishment (FAO method)	21%	40%
Daily per-capita dietary energy supply (kcals)	2330	2090
% Children under five malnourished	53%	27%
Health index	44%	54%
Care index	7	59
% Adults undernourished (BMI $\leq$ 18.49)	49%	20%
Poverty rate (PPP-adjusted dollars)	53%	31%

Sources: The first three indicators are from Appendix B Table 6, columns (2), (3), and (4). See Table 1 for definitions and sources of the others.

rate is 50% lower than India's. The poorer state of India's health environment and quality of care for children are probably partially responsible for its higher malnutrition rate than Ghana's. However, other measures show that food insecurity is also at the root of the differences. Ghana's adult undernutrition rate is less than half of India's; its poverty rate (31%) is also far lower.

The above pattern holds for regional comparisons as well. Fig. 4 shows chronic undernourishment and child malnutrition prevalences by developing-country region for 1990/92. The estimate for Sub-Saharan Africa (43%) is almost double that of South Asia (22%). These regions have about the same poverty prevalences, at 39% and 43%, respectively (Ravallion and Chen, 1996), which means that low incomes are likely to be a major factor in both regions' food insecurity. Yet almost half of Sub-Saharan African countries have food availability problems (18 out of 40 had dietary energy deficits in the 1990–92 period) while most South Asian countries do not (only Bangladesh had a dietary energy deficit). The methodological bias in favor of food availability in the chronic undernourishment estimates leads to an understatement of the South Asian prevalence and overstatement of the relative differences in food insecurity between the two regions. The differences may be exaggerated due to systematic underestimations of food availability in Sub-Saharan Africa as well (Svedberg, 1990).

Fig. 4 also shows that South Asia's prevalence of child malnutrition (53%) is almost double that of Sub-Saharan Africa (30%). In the *SWFS*, this reversal of the regional prevalences in comparison to the chronic undernourishment measure is explained by South Asia's high population density and monsoon climate, which make the spread of disease easier than in Sub-Saharan Africa (FAO, 1996a). Ramalingaswami *et al*. (1996), by contrast, propose that South Asia's extremely high malnutrition rates compared to Sub-Saharan Africa are due to its relatively poor disease environment and inadequate child care practices *in addition* to the critical food insecurity problems both regions share. Note that the regions are roughly on a par in terms of the quality of their health environments: 46% for South Asia and 42% for Sub-Saharan

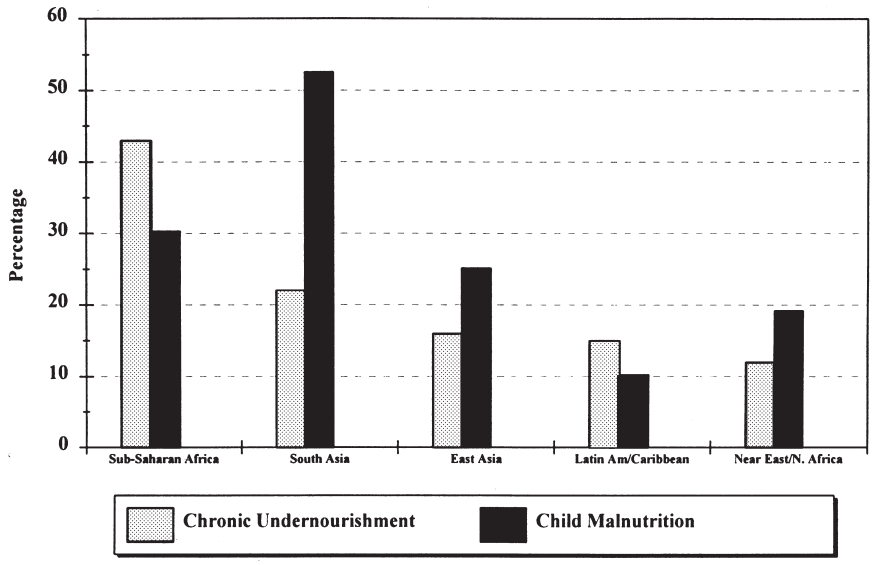


Figure 4 Estimated prevalences of chronic undernourishment and child malnutrition by region (1990/92)

Africa. The regional care ranks are 8 and 37, respectively, implying that South Asia's much higher child malnutrition rate has its roots partially in the poor quality of care for South Asian women and children, as suggested by Ramalingaswami *et al*. (1996).

Broca and Oram (1991)'s 'Study on the Location of the Poor' provides an independent estimate of the regional differences in undernourishment. The authors utilize household survey data on food consumption and expenditure to estimate the prevalences of 'food energy deficiency' in several developing-country regions (see Table 1). While most of the data are from rural areas and are not taken from nationally-representative surveys, the regional differences are nevertheless informative. The deficiency prevalence in Sub-Saharan Africa (38%) is found to be almost equal to that of the Asia region as a whole (35%). Since South Asia has a much higher poverty rate than does East Asia (South Asia's is 43%, while East Asia's is 26% (Ravallion and Chen, 1996)), South Asia's deficiency prevalence is likely much higher than even the overall Asia average.

The Broca and Oram results thus suggest – as do the other indicators (poverty and child malnutrition) – that South Asia's undernourishment prevalence may be on a par with or higher than that of Sub-Saharan Africa rather than 49% lower. If this is the case, then the magnitude of error in the FAO estimates is quite large. While they would imply that policy makers should put much greater emphasis on Sub-Saharan Africa than on South Asia, alternative measures suggest more equal regional emphases.

Tracking changes in food insecurity over time

Information on how food insecurity changes over time is just as crucial to the success of food security interventions as its geographical location. Such information can be used to trace progress towards national, regional and global food security goals. It can be used to make decisions about whether to change approaches or strengthen existing efforts if the desired progress is not being made and to reallocate scarce resources elsewhere if the goal is achieved. However, policy makers who use the FAO estimates of chronic undernourishment for tracking progress in achieving food security will tend to track changes in food availability over time rather than food insecurity *per se*. The efficiency with which food insecurity is reduced developing-world-wide will thus be compromised.

FAO reports a reduction in the prevalence of chronic undernourishment over the 1969/71 to 1990/92 period, from 35% to 20% (see Table 2). Due to the assumption of a constant CV of dietary energy intakes over time, all of this estimated reduction is based on the 12% increase in DES that took place over this period. To gauge the possible magnitude of error in the reported reductions, Fig. 5 simulates the correspondence between increasing DES, on the one hand, and changes in chronic undernourishment and child malnutrition prevalences on the other, using cross-country data. The developing countries are divided into six groups based on their food availability positions in 1990/92, ranging from 'high deficit' to 'high surplus'. Moving across the groups, the estimated prevalence of undernourishment shows a distinct and continual downward trend as food availability improves.

The same close inverse relationship between national food availability and estimated prevalences of child malnutrition is not apparent. The probability that a child will suffer from malnutrition is about the same in countries with low dietary energy surpluses as it is in those with high deficits. Similarly, countries with medium dietary energy deficits show a tendency to have about the same child malnutrition rates as do those with medium surpluses. Differences in the group child malnutrition prevalences may be partially driven by variations in the quality of

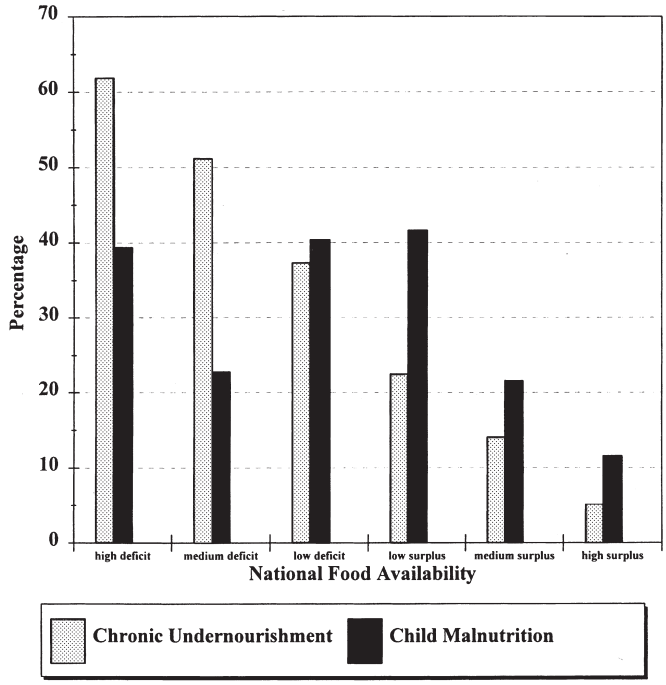


Figure 5 Estimated prevalences of chronic undernourishment and child malnutrition by dietary energy balance country groupings (1990/92)

caring practices.[4] However, the fact that the malnutrition prevalences show no correlation with the groups' undernourishment estimates suggests the possibility of substantial error in the latter. The magnitude of the error appears to be especially high for the high-to-medium deficit and low surplus food availability groups.

Mauritania is an example of a country in which there has been a weak link over time between child malnutrition and national food availabilities. Even though its per-capita DES increased from 2160 kcals to 2557 from 1981 to 1991 – improving national food availability by almost 20% – the prevalence of child malnutrition increased from 31% to 48% over this same period (FAO, 1996a, Table 22 and Appendix 2, Table 1). Table 5 lists several additional countries for which child malnutrition has worsened at the same time as national food availability has improved in the last two decades. For these countries food security improvements have probably been minimal, yet the chronic undernourishment measure would suggest otherwise.

Rather than decreasing continuously with increases in food availability, the prevalence of food insecurity in some countries may show a more bumpy evolution corresponding to shifts in a variety of national and sub-national factors. The above examples illustrate the dangers of relying on a national food availability-based measure of food insecurity for tracking changes in food insecurity, including making policy judgments about the success or failure of efforts to improve food security.

[4]The care rankings of the groups (24, 50, 42, 22, 45, and 58, respectively) are generally negatively correlated with their malnutrition prevalences. The health environment quality measure, however, shows no correlation. It improves continuously over the groups (30, 47, 49, 50, 79, and 85 percent, respectively).

Table 5 Countries in which children's malnutrition has worsened at the same time as national food availability has improved

Country	Period	Percent increase in per-capita dietary energy supply (%)	Percent increase in the prevalence of child malnutrition (%)
Mauritania	1981–91	18.4	53.6
Nigeria	1990–93	14.0	10.8
Ghana	1987–93	10.0	0.74
Algeria	1987–95	8.4	40.7
Mexico (rural)	1974–89	8.3	9.2
Malaysia	1986–93	7.8	36.3
Philippines	1987–92	5.5	1.5
Lesotho	1976–94	4.3	23.7
Bolivia	1989–93	4.0	12.9
Myanmar	1983–95	3.8	12.9
Bangladesh	1982–85	3.7	4.3
Egypt	1990–94	3.5	61.5
Mali	1987–95	2.3	30.7
Jamaica	1989–93	2.2	41.7
Sri Lanka	1987–93	2.0	1.1
Honduras	1991–93	1.5	1.7
Uganda	1988–95	0.7	10.9

Sources: For Mauritania and Malaysia, the child malnutrition data are from FAO (1996a) Table 22; the rest of the countries' child malnutrition data are from WHO (1997). The per-capita dietary energy supply data are from the FAO (1997).

Conclusion: how can the chronic undernourishment measure be strengthened?

In recognition of the need for food security indicators that are comparable across countries, the World Food Summit Plan of Action states that 'To improve sub-regional, regional and international cooperation and to mobilize, and optimize use of, available resources to support national efforts for the earliest possible achievement of sustainable world food security,' governments and international institutions will 'encourage relevant agencies within the UN system to initiate . . . consultations on the further elaboration and definition of a food insecurity and vulnerability information and mapping system . . .' (FAO, 1996c, p. 39). For such a system to contribute most effectively to improvements in food security, it is imperative that, in addition to measures of its main determinants (national food availability and household incomes) and its consequence (malnutrition), an accurate national-level measure of food insecurity be included.

Due to past data limitations, the chronic undernourishment measure employed in the *Sixth World Food Survey* is based on national aggregate measures of food availability and distribution rather than directly on household survey data. The methodological assumptions entailed in translating these measures into estimates of undernourishment compromise the accuracy of the estimates. This paper has shown that variations in the estimates across countries and over time largely reflect national food availability – an important, but poor predictor of food insecurity on its own. The paper illustrates the resulting potential for misguided policy decisions.

The chronic undernourishment measure has been extremely valuable in focusing the world's attention on the issue of food insecurity in developing countries. It has helped to establish that there are indeed large numbers of food insecure people in the world. It has also been useful for focusing governments' and other international development actors' attentions on a numerical goal and generating the political will to attain it as part of the World Food Summit agenda. However, the measure has its limits. These limits become harder to ignore with the increasing

numbers of nationally-representative household food consumption and expenditures surveys that have become available in the past few years (see FAO, 1986, 1988, 1993a, b).

In order to be a useful component of a global food insecurity and vulnerability information mapping system (known as 'FIVIMS'), two steps can be taken to strengthen the measure. First, chronic undernourishment prevalences can be estimated directly from currently-existing high quality household survey data. Second, the new data, along with a plethora of national-level data sets containing socio-economic and demographic data for developing countries can be used, employing appropriate extrapolation techniques, to generate regional and global estimates. The assumption of an analytic probability distribution with a pre-determined shape common to all countries can be dropped. A wide variety of factors affecting food insecurity, in addition to dietary energy supplies, can be taken into account.

As the lead actor within the United Nations system for the development of national and international FIVIMS, it will require FAO's leadership for such a change in methodology to take place. Simply gathering the data together in a central location and processing it is no easy task. FAO has already taken the first steps in this direction by assisting several countries in processing data from their national surveys (e.g., China, Mexico, Peru, Bangladesh and Pakistan). As writes Naiken (1998: 40):

> . . . for the required data processing and tabulation work to become a regular feature of the respective national statistical organizations' programme and for the resulting information to be readily accessible, a concerted effort is needed on the part of the national as well as international organizations interested or involved in the use or analysis of food consumption statistics. This effort should include the preparation of appropriate technical guidelines and the provision of technical assistance to build up national capacity.

Effort should also be made to regularize the collection of household food consumption or expenditures data in every developing country, as is done for most developed countries. In this way, changes in food insecurity over time, including progress toward the World Food Summit goal, can be tracked. While the collection and processing of such data are costly, investment in them is critical for developing an accurate information base from which to make informed decisions for improving food security.

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References

Maxwell, S. (1997) Personal Communication.

ACC/SCN (1993) *Second Report on the World Nutrition Situation. Volume II*. United Nations Administrative Committee on Coordination–Sub-Committee on Nutrition, Geneva.

Alexandratos, N. (ed.) (1995) *World Agriculture: Towards 2010*. Food and Agricultural Association of the United Nations and John Wiley and Sons, New York.

Babu, S. C. and Quinn, V. J. (1994) Food security and nutrition monitoring in Africa. *Food Policy* **19**, 211–217.

von Braun, J., Bouis, H., Kumar, S. and Pandya-Lorch, R. (1992) *Improving Food Security of the Poor: Concept, Policy, and Programs*. International Food Policy Research Institute, Washington, DC.

Bread for the World (1997) *Hunger in a Global Economy. Hunger 1998*. Bread for the World Institute, Washington, DC.

Broca, S. and Oram, P. (1991) Study on the location of the poor. Mimeo. International Food Policy Research Institute, Washington, DC.

Cohen, M. (1998), World hunger in a global economy. In *Hunger in a Global Economy. Hunger 1998*, Chapter 1. Bread for the World Institute, Washington, DC.

Deininger, K. and Squire, L. (1996) A new data set measuring income inequality. *The World Bank Economic Review* **10**, 565–591.

Engle, P. L., Menon, P. and Haddad, L. (1997) *Care and Nutrition: Concepts and Measurement*. International Food Policy Research Institute, Washington, DC.

FAO (1997) FAOSTAT Database found on FAO's home page.

FAO (1996a) *The Sixth World Food Survey*. Food and Agriculture Organization of the United Nations, Rome.

FAO (1996b) Mapping Undernutrition: An Ongoing Process. (Poster). Food and Agriculture Organization of the United Nations, Rome.

FAO (1996c) Rome Declaration on World Food Security and World Food Summit Plan of Action. Food and Agriculture Organization of the United Nations, Rome.

FAO (1996d) Food, Agriculture and Food Security: Developments Since the World Food Conference and Prospects. *World Food Summit Technical Background Documents 1–5*. Technical Background Document No. 1. Food and Agriculture Organization of the United Nations, Rome.

FAO (1996e) Success Stories in Food Security. *World Food Summit Technical Background Documents 1–5*. Technical Background Document No. 2. Food and Agriculture Organization of the United Nations, Rome.

FAO (1993a) *Compendium of Food Consumption Statistics from Household Surveys in Developing Countries. Volume 1: Asia*. Food and Agriculture Organization of the United Nations, Rome.

FAO (1993b) *Compendium of Food Consumption Statistics from Household Surveys in Developing Countries. Volume 2: Africa, Latin America and Oceania.* Food and Agriculture Organization of the United Nations, Rome.

FAO (1988) *Review of Food Consumption Surveys – 1988.* FAO Food and Nutrition Paper No. 44. Food and Agriculture Organization of the United Nations, Rome.

FAO (1986) *Review of Food Consumption Surveys – 1985.* FAO Food and Nutrition Paper No. 35. Food and Agriculture Organization of the United Nations, Rome.

FAO (1983) A Comparative Study of Food Consumption Data from Food Balance Sheets and Household Surveys. Statistics Division. Food and Agriculture Organization of the United Nations, Rome.

FAO (1975) *Population, Food Supply and Agricultural Development*. Food and Agriculture Organization of the United Nations, Rome.

Ferris-Morris, M. and Smith, L. C. (1997) Forum on USAID Food Security Policy: Final Report. International Science and Technology Institute, Arlington, VA.

Frankenberger, T., Oshaug A. and Smith L. C. (1997a) A Definition of Nutrition Security. CARE Mimeo.

Frankenberger, T. R., Frankel, L., Ross, S., Burke, M., Cardenas, C., Clark, D., Goddard, A., Henry, K., Middleberg, M., O'Brien, D., Perez, C., Robinson, R. and Zielinski, J. (1997b) Household livelihood security: A unifying conceptual framework for CARE programs. In *Proceedings of the USAID Workshop on Performance Measurement for Food Security*. December 11–12, 1995, Arlington, VA. USAID, Washington, DC.

Frankenberger, T. (1996) Measuring household livelihood security: An approach for reducing absolute poverty. *Food Forum* **34** (November–December 1996). Food Aid Management, Washington, DC.

Gibson, R. S. (1990) *Principles of Nutritional Assessment*. Oxford University Press, New York.

Gillespie, S., Mason, J. and Martorell, R. (1996) *How Nutrition Improves*. ACC/SCN State-of-the-Art Series Nutrition Policy Discussion Paper No. 15. United Nations Administrative Committee on Coordination–Sub-Committee on Nutrition, Geneva.

Haddad, L., Hoddinott, J. and Alderman, H. (1997) *Intrahousehold Resource Allocation in Developing Countries: Models, Methods, and Policy*. The Johns Hopkins University Press, Baltimore.

Mason, J. (1995) Within a decade no child will go to bed hungry? The Lord Boyd Orr Memorial Lecture, Aberdeen, July 13, 1995.

Maxwell, D. G. (1996a) Measuring food insecurity: The frequency and severity of 'Coping Strategies'. *Food Policy* **21**, 291–303.

Maxwell, S. (1996b) Food security: A post-modern perspective. *Food Policy* **21**, 155–170.

Maxwell, S. and Frankenberger, T.R. (1992) *Household Food Security: Concepts, Indicators and Measurements*. UNICEF and IFAD, New York and Rome.

Naiken, L. (1998) 'Response'. In Smith, L. C. *Can FAO's Measure of Chronic Undernourishment Be Strengthened?*, L. C. Smith. Food Consumption and Nutrition Division Discussion Paper No. 44. International Food Policy Research Institute, Washington, DC.

Pinstrup-Andersen, P., Pandya-Lorch, R. and Rosegrant, M. (1997) *The World Food Security Situation: Recent Developments, Emerging Issues and Long-Term Prospects.* International Food Policy Research Institute, Washington, DC.

Punjab, D. T. (1995) Problems of plenty. *Time* 31 August 1995.

Ramalingaswami, V., Jonsson, U. and Rohde, J. (1996) The Asian enigma. In *Progress of Nations*. UNICEF, New York.

Ravallion, M. and Chen, S. (1996) What can new survey data tell us about recent changes in distribution and poverty? *The World Bank Economic Review* **11**, 357–382.

Sen, A. (1981) *Poverty and Famines: An Essay on Entitlement and Deprivation*. Clarendon Press, Oxford.

Serageldin, I. (1995) *Nurturing Development: Aid and Cooperation in Today's Changing World*. The World Bank, Washington DC.

Smith, L. C. and Haddad, L. J. (1998) Overcoming child malnutrition in developing countries: Past performance, future possibilities. Mimeo. International Food Policy Research Institute, Washington, DC.

Smith, L. C., El Obeid, A., Jensen, H. H. and Johnson, S. R. (1998) The geography and causes of food insecurity in developing countries. In *Food Security: New Solutions for the 21st Century*, eds S. R. Johnson, Amani El Obeid, H. H. Jensen and L. C. Smith, Chapter 5. Iowa State University Press, Ames.

Suryanarayana, M. H. (1997) Food security in India: Measures, norms and issues. *Development and Change* **28**, 771–789.

Svedberg, P. (1990) Undernutrition in Sub-Saharan Africa: A critical assessment of the evidence. In *The Political Economy of Hunger*. *Volume 3: Endemic Hunger*, eds J. DrPze and Amartya Sen, Chapter 5. Clarendon Press, Oxford.

UNDP (1996) *Human Development Report*. Oxford University Press, New York.

UNDP (1993) *Human Development Report*. Oxford University Press, New York.

UNESCO (1997) *Statistical Yearbook*. United Nations Educational, Scientific and Cultural Organization and Berman Press, Paris and Lanham, MD.

UNICEF (1990) Strategy for Improved Nutrition of Children and Women in Developing Countries. UNICEF Policy Review Paper. United Nations Children's Fund, New York.

Waterlow, J. C. (1989) Observations on the FAO's methodology for estimating the incidence of undernutrition. *Food and Nutrition Bulletin* **11**, 8–13.

WHO (1997) *WHO Global Database on Child Growth and Malnutrition*. Programme of Nutrition. Doc WHO/NUT/97.4. World Health Organization, Geneva.

Wiebe, K. (1998) Resources, sustainability, and food security. In *Food Security Assessment*, eds Shahla Shapouri and S. Rosen. International Agriculture and Trade Report No. GFA-9, pp. 36-42, November 1997. United States Department of Agriculture, Economic Research Service, Washington, DC.

World Bank (1997a) *World Development Indicators 1997*. The World Bank, Washington, DC.

World Bank (1997b) *World Development Indicators 1997* on CD-Rom. The World Bank, Washington, DC.

World Bank (1986) *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*. The World Bank, Washington, DC.

Appendix A

FAO methodology for calculating the prevalence of chronic undernourishment

Dietary energy intake in each country is assumed to follow a log-Normal distribution. This distribution is positively skewed with underlying parameters mean and standard deviation. The area beneath the energy intake distribution curve to the left of the minimum per-capita dietary energy requirement (denoted y^*), gives the percent undernourished.

Mathematically, the calculation is as follows: Let μ^* be a country's per-capita dietary energy supply and CV^* be the country's coefficient of variation in dietary energy intakes. Then the standard deviation (σ) and mean (μ) of the log-Normal distribution are calculated as follows:

$$\sigma = \sqrt{\ln(CV^{*2} + 1)}$$

$$\mu = \ln(\mu^*) - \frac{\sigma^2}{2}.$$

These numbers are used to compute a *z*-score

$$z = \frac{\ln(y^*) - \mu}{\sigma},$$

which can then be looked up in a table of standard normal probabilities to find the estimated percent undernourished.

Source: FAO (1996a), Appendix 3.

Appendix B

Table 6 Food security data for developing countries

Country	Chronic undernourishment (predicted using log-Normal distribution) (1990/1992)		Percent children underweight (partially predicted) (1988–92)	Per-capita dietary energy supply (1990/92)	National dietary energy balance (1990/92)
	Percent	Number (millions)		(kcals)	(kcals)
Sub-Saharan Africa					
Angola	54	5.1	35.3	1840	(–260)
Benin	20	1	23.5	2520	420
Botswana	29	0.4	26.8	2320	220
Burkina Faso	41	3.8	27.1	2140	40
Burundi	50	2.9	29.1	1950	(–150)
Cameroon	43	5.1	13.6†	2040	(–60)
Central African Republic	62	1.9	31.9	1720	(–380)
Chad		61	3.5	30.6	1810
Congo	34	0.8	27.5	2210	110
Côte d'Ivoire	22	2.7	12.3	2460	360
Ethiopia	65	31.2	39.8	1620	(–480)
Gabon	24	0.3	15.1	2490	390
Gambia	29	0.3	17.1	2320	220
Ghana	40	6.2	26.7	2090	(–10)
Guinea	25	1.5	24	2400	300
Kenya	46	11.3	17.4	1970	(–130)
Lesotho	35	0.6	17.5	2260	160
Liberia	59	1.6	20.1	1780	(–320)
Madagascar	31	3.8	38.1	2160	60
Malawi	49	4.8	23.5	1910	(–190)
Mali	34	3.3	21.6	2230	130
Mauritania	20	0.4	15.7	2610	510
Mauritius	18	0.2	17	2780	680
Mozambique	66	9.6	46.8	1740	(–360)
Namibia	35	0.5	26.2†	2190	90
Niger	37	2.9	44	2190	90
Nigeria	38	42.9	35.4	2100	0
Rwanda	47	3.4	31.7	1860	(–240)
Senegal	30	2.3	19.6	2310	210
Sierra Leone	55	2.4	25.9	1820	(–280)
Somalia	72	6.4	38.8	1590	(–510)
South Africa	*	*	*	2810	710
Sudan	37	9.7	33.7	2150	50
Swaziland	13	0.1	8.8	2680	580
Tanzania	38	10.3	25.2†	2110	190
Togo	30	1.1	18.4	2290	120
Uganda	32	5.8	23.3†	2220	10
Zaire	39	14.9	33.2	2090	(–10)
Zambia	43	3.6	25.1†	2020	(–80)
Zimbabwe	41	4.2	14.1	2080	(–20)

—Continued

Table 6 ***Continued***

Country	Chronic undernourishment (predicted using log-Normal distribution) (1990/1992)		Percent children underweight (partially predicted) (1988–92)	Per-capita dietary energy supply (1990/92)	National dietary energy balance (1990/92)
	Percent	Number (millions)		(kcals)	(kcals)
Near East and North Africa					
Afghanistan	73	12.9	40.3	1660	(–490)
Algeria	9	2.4	9.2	2900	750
Egypt	6	3.2	10.4†	3340	1190
Iran	7	4.2	39	2760	610
Iraq	21	4	11.9	2270	120
Jordan	3	0.1	12.7	2900	750
Kuwait	16	0.3	5	2460	310
Lebanon	5	0.1	8.9	3260	1110
Libya	3	0.2	4	3290	1140
Morocco	10	2.6	12	3000	850
Saudi Arabia	12	1.9	12.6	2730	580
Tunisia	3	0.2	8.9	3260	1110
Turkey	3	1.8	10.5	3510	1360
United arab Emirates	4	0.1	7	3370	1220
Yemen	24	3	30†	2160	10
Latin America and the Caribbean					
Argentina	9	2.9	1.2	2950	750
Bolivia	40	2.9	11.4†	2030	(–170)
Brazil	6	9.7	7.1†	2790	590
Chile	22	2.9	2	2540	340
Columbia	18	5.9	10.1†	2630	430
Costa Rica	12	0.4	8.1	2870	670
Cuba	9	1	8.4	3000	800
Dominican Republic	32	2.4	10.4†	2270	70
El Salvador	19	1	19.4	2530	330
Guatemala	26	2.4	25	2280	80
Guyana	24	0.2	18	2350	150
Haiti	69	4.6	24.4	1740	(–460)
Honduras	21	1.1	19.8	2310	110
Jamaica	23	0.6	7.2†	2580	380
Mexico	8	7.2	13.9	3190	990
Nicaragua	25	1	18.7	2290	90
Panama	19	0.5	11	2240	40
Paraguay	15	0.6	3.7†	2620	420
Peru	49	10.7	10.8†	1880	(–320)
Suriname	21	0.1	*	2510	310
Trinidad	11	0.1	9	2630	430
Uruguay	8	0.3	7	2680	480
Venezuela	20	4	5.9	2590	390

—Continued

Table 6 ***Continued***

Country	Chronic undernourishment (predicted using log-Normal distribution) (1990/1992)		Percent children underweight (partially predicted) (1988–92)	Per-capita dietary energy supply (1990/92)	National dietary energy balance (1990/92)
	Percent	Number (millions)		(kcals)	(kcals)
South Asia					
Bangladesh	34	39.4	66.5†	1990	(–120)
India	21	184.5	53†	2330	220
Nepal	29	5.9	50.5	2140	30
Pakistan	17	20.5	40.4†	2340	230
Sri Lanka	26	4.6	42	2230	120
East and Southeast Asia					
Cambodia	29	2.5	37.7	2100	(–120)
China	16	188.9	21	2710	490
Hong Kong	5	0.3	*	3150	930
Indonesia	12	22.1	38	2700	480
Korea-DPR	9	2	*	2930	710
Korea-Republic	1	0.3	*	3270	1050
Laos	24	1.1	34	2210	(–10)
Malaysia	7	1.3	17.6	2830	610
Mongolia	32	0.7	12.3†	2100	(–120)
Myanmar	12	5.2	32.4†	2580	360
Philippies	21	13.1	33.5†	2290	70
Thailand	26	14.4	13†	2380	160
Vietnam	25	17.2	41.9†	2200	(–20)

The symbol * means data are not available.
The symbol † is explained in Note 3.
1. *Percent Undernourishment.* Source: FAO (1996b).
2. *Numbers of Undernourished.* Source: FAO (1996b).
3. *Percent Children Underweight.* A child is considered underweight when his or her weight falls below – 2 standard deviations of the expected weight of healthy children of her or his age using National Center for Health Statistics/World Health Organization norms. The underweight rates with superscript † are from nationally-representative surveys that took place over the period 1989 to 1992. The source for these data is ACC/SCN (1993) Table 2.1, with the following exceptions: the Namibia and Mongolia rates are for 1992 from FAO (1996a) Appendix 2, Table 8; the rate for India is for 1992/93 and reported in Gillespie *et al*. (1996). For the remaining 74 countries, data close to the 1990–92 period were not available at the time of the analysis. For these countries, ACC/SCN predicted 1990 underweight rates are employed. These are estimated using data from nationally representative surveys that took place from 1975–1991 using two multivariate regression models: (1) a global model estimated with data from 100 surveys in 66 countries; and (2) a Sub-Saharan Africa model using data from 20 surveys in 20 countries. The independent variables employed in the global model were per-capita dietary energy supply, female secondary education, percent government social support, child population under five, and regional dummies. For the Sub-Saharan Africa model, the independent variables employed were per-capita dietary energy supply, female secondary education, percent calories from root crops, percent calories from animal sources, and population size. The global and Sub-Saharan African models had (adjusted) R^2s of 0.9 and 0.82, respectively. The predicted values are given in ACC/SCN (1993) Table 2.6. Since this analysis was undertaken, the WHO Global Database on Child Malnutrition (WHO, 1997) was released. This database now contains the highest-quality, most up-to-date data on national child malnutrition prevalences estimated directly from survey data.
4. *Per-capita Dietary Energy Supply (Daily).* Data given are averages of the daily per-capita dietary energy supplies (DES) for human consumption for 1990, 1991 and 1992. Source: FAO (1996a) Appendix 2, Table 1.
5. *National Dietary Energy Balance (Daily).* Calculated as per-capita DES (using the data in Table A1, column 4) minus average per-capita dietary energy requirements. Regional requirements given in FAO (1996a) Table 16 are used as proxies for national requirements. These are Sub-Saharan Africa (2100), Near East and North Africa (2150), East and Southeast Asia (2220), South Asia (2110), and Latin America and the Caribbean (2200).