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FAO ESTIMATES OF FOOD DEPRIVATION

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FAO ESTIMATES OF FOOD DEPRIVATION

FAO Statistics Division

Rome, August 2002

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I. INTRODUCTION *

FAO's measure of food deprivation, which is referred to as the prevalence of food deprivation, is based on a comparison of usual food consumption expressed in terms of dietary energy (kcal) with certain energy requirement norm. The part of the population with food consumption below the energy requirement norm is considered underfed.

By focussing on dietary energy intake the measure is attempting to capture those whose food consumption level is insufficient for body weight maintenance and work performance. It follows from this that the FAO measure is focussing on the phenomenon of hunger rather than undernutrition (or malnutrition), which has a broader nutritional connotation.

FAO has been traditionally preparing estimates referring to the prevalence of food deprivation in connection with its World Food Survey reports, the last being The Sixth World Food Survey (FAO, 1996). The principal aim of the estimates in this context has been to provide information on the broad dimension of the hunger problem in the developing world. In fact, although the estimates have been worked out on a country-by-country basis, only the global and regional aggregates have been published. Furthermore, the focus has been on the long-term trends as the World Food Surveys were issued between periods of roughly ten years. However, monitoring needs have changed following recent major international Summits. The World Food Summit in 1996 fixed a hunger reduction target to be reached by 2015. The Millennium Declaration in 2000 integrated hunger and poverty reduction in one single goal, specifically as the first of the Millennium Development Goals.

Hence, for the purpose of monitoring progress towards the target of halving the number of underfed, the need had arisen to prepare and regularly up-date such estimates at the global as well as country level. FAO has been undertaking this task in its annual report on "The State of Food Insecurity in the World" (SOFI), which was first issued in 1999. SOFI 2001, which is the latest report, was issued in October 2001.

In the following sections the basic methodological framework, the data and the procedures used by FAO for deriving the country estimates are described and discussed. The relationship with similar measures used by other organizations is also discussed. Then, the feasibility of disaggregating the estimates by demographic or sub-national breakdowns is discussed.

II. BASIC METHODOLOGICAL FRAMEWORK

In developing the methodology for estimating the prevalence of food deprivation a basic problem concerns the use of the available energy requirement norms. These norms are usually specified as the average for groups of individuals of the same age, sex, body-weight and activity. This means that even after taking into account the most influential factors such as age, sex, body-weight and activity, differences exist in the energy requirement of

* Modified version of the document presented by Mr. L. Naiken (former Chief of the Statistical Analysis Service, FAO Statistics Division) at the *International Scientific Symposium on Measurement and Assessment of Food Deprivation and Under-nutrition*, Rome, June 2002.

individuals. This variation has been attributed mainly to differences in the efficiency of energy utilization between individuals. As it is not feasible to determine the efficiency of energy utilization of each individual, the departure of the specific energy requirement of an individual from the average is not known. In view of this, the estimate of the proportion of individuals having inadequate energy intake has been defined within a probability distribution framework:

$$P(U) = P(x < r_L) = \int_{x<r_L} f(x)\,dx = F_x(r_L) \qquad \text{.....} \quad (1)$$

where $f(x)$ is the marginal frequency distribution of dietary energy intake and rL is a cut-off point reflecting the lower limit of the marginal distribution of energy requirement (and hence also referred to as the *minimum energy requirement*).

In applying the formula, $f(x)$ is taken to reflect the frequency distribution of household per caput dietary energy consumption and consequently the cut-off point, r_L, refers to the household *per caput* minimum energy requirement. By implication the variation in energy requirement to be considered in arriving at the cut-off point reflects the composite effect of the differences in the composition of the households with respect to the age, sex, body-weight, activity and efficiency of energy utilisation of their members. The next two sections discuss the estimation of $f(x)$ and r_L.

III. ESTIMATION OF THE DISTRIBUTION OF DIETARY ENERGY CONSUMPTION

a) Source of data – household surveys

The only sources of basic data pertaining to f(x) are the surveys that collect data on the quantities of food products consumed by individuals in a representative sample of households in the population. Such surveys provide data on household size and the food consumption of the households surveyed thus leading to household level data on *per caput* dietary energy consumption, which can be used to estimate $f(x)$.

A well-known type of survey in this context is the specialised food consumption or dietary survey. The information collected in these surveys normally refers to the quantities of food items actually consumed by the household members, which are converted into nutritive values by applying the appropriate nutritive factors. However, since the main objective of these surveys is to obtain a close approximation of the total amount of food eaten (food intake) by members of the household, the data collection procedures are usually rather complicated (e.g. weighing the food items used for the preparation of each meal). They are therefore costly to implement on a national scale. As a result, only a few countries have attempted to carry out such surveys. Even in these cases the sample size is often so small that their usefulness for distributional analysis is questionable.

On the other hand, the more commonly and regularly undertaken type of survey is that usually called as Household Income/Expenditure Survey (HIES). The HIES, which also includes food consumption data as an integral part of its broader inquiry on household

consumption expenditures, has been conducted in many countries. Frequently, information not only on the monetary expenditures but also the quantities relating to food items purchased or acquired for consumption by households has been collected.[1] In addition, the food items recorded are often sufficiently detailed to enable the conversion of the food quantities into nutritive values and the estimation of the household *per caput* energy consumption. The surveys also provide data on household income/expenditure as well as a number of other socio-economic characteristics, so that they permit an analysis of the inter-relationship between food consumption and certain socio-economic variables. Furthermore, to the extent that these surveys may have been designed to yield sub-national estimates, they may permit mapping the sub-national variations in food consumption. These surveys are in fact the only existing source of data for distribution analysis of both income and food consumption and hence for the estimation of the prevalence of both poverty and food deprivation.

FAO promotes a better and enhanced use of the food consumption data from the existing HIESs. The problem is that the data that are normally processed and tabulated by the respective national statistical organizations refer to the monetary values of the food consumed. In this form the information is not directly usable as input for estimating the frequency distribution of dietary energy consumption. For this purpose there is a need, as indicated above, to convert the quantities of the various items of food expenditure corresponding to each household into their dietary energy (calorie) equivalents and then derive the appropriate tabulations referring to dietary energy consumption distribution. Despite FAO's promotional efforts in this direction, few countries have actually undertaken the related work systematically in connection with their existing HIESs. Consequently, a potential source of data remains largely unexploited. The data and research will benefit the countries' information system for assessing and monitoring the prevalence of food deprivation.

b) Problems in the use of the distribution data from household surveys

Even when survey data pertaining to food consumption are available, considerable problems are encountered in using such data for estimating the distribution of dietary energy consumption. These problems are generally of two kinds: one concerning the precision of the household level data and the other referring to the reliability of the estimated frequency distribution due to sample design.

(i) Precision of the household level data

As a matter of fact the methodology and concepts applied in the surveys are usually not sufficiently precise to provide an accurate estimate of the usual consumption at the household level. In some cases certain contributions to the consumption of the household members are excluded; in others, certain consumption that should be excluded is included. Generally, the HIES has a questionnaire format that refers to food purchased or acquired during the reference period making no distinction according to the consumer so that food given to guests, visitors or tenants and residual household wastages are included. Food transfers to and from household stocks may not be adequately taken into account. Food consumed away from home by the

[1] Especially where home produced food is an important part of food consumption or where data on quantities are a prerequisite to arrive at the expenditure.

household members may be recorded but these usually correspond to prepared food and are expressed in monetary terms, which present difficulties for conversion into nutritive values. Furthermore, irrespective of the questionnaire format, the precision of the information collected depends on the ability of the respondents to recall the quantities of the different food items that have been consumed. For this reason the reference period is chosen to be sufficiently short (one day, one week or two-weeks) to facilitate recall but this increases the risk of not reflecting the usual consumption of the household due to the effect of seasonal variations, etc.

As a result of the above problems, the household *per caput* dietary energy consumption figures derived from the food consumption data collected at the household level are imprecise and, in many cases, found to be unrealistically high or low.

(ii) Sample Design

Many of the problems mentioned above stem from the fact that the sample surveys are designed to provide reliable estimates of the population means or totals rather than the individual household *per caput* values and hence the frequency distribution. This is evident if we take into account the points below.

- Data collection is usually undertaken in rounds by spreading the sample over the survey period of one year. This ensures that the sample means or the means of households corresponding to certain socio-economic groups and/or sub-national categories are free from the effect of seasonal variations and any random errors in the individual household measurement.

- For the purpose of administrative convenience and the aim of minimizing the variance in order to increase the precision of the population mean or total, the sample design is not usually implemented according to the Equal Probability Selection Method (EPSEM). In other words, the different households in the population do not have the same probability for being selected in the sample. As a consequence even if the individual household data reflect usual consumption the resulting sample frequency distribution is not an unbiased estimate of the distribution in the population.

It follows from the above that to the extent that the surveys have not been designed to yield reliable estimates of the usual consumption at the household level and the selection of the households in the sample has not been implemented with equal probability, the resulting sample distribution is subject to significant errors. This problem applies not only to the food consumption data but also to the total income/expenditure data that are used to estimate the prevalence of poverty.

In view of the problems relating to the distribution data from the existing sample surveys, FAO has continued to rely on a theoretical model to represent the distribution of household *per caput* dietary energy consumption. Furthermore, as will be seen later, special care is taken to avoid the effects of the irrelevant factors influencing survey data in estimating the measure of inequality in distribution.

c) *The choice of theoretical distribution*

As the frequency distribution depicted by the tabulated survey data is generally unimodal, only such kinds of theoretical distributions have been considered for application. In connection with the estimates of food deprivation prepared for The Fourth World Food Survey, the Beta distribution has been applied (FAO, 1977). This distribution was chosen because it enabled fixing the lower and upper limits of the range as determined by the physiological lower and upper limits of intake in individuals. However, beginning with The Fifth World Food Survey (FAO, 1987), the Beta distribution was abandoned in favour of the two-parameter lognormal distribution

The idea of fixing the lower and upper limits of the distribution (based on knowledge/assumptions about the physiological limits of intake) is appropriate when dealing with the true intake of individuals, but not when dealing with the kind of household level data emanating from the existing surveys. In most of these surveys the data refer to the food available to or acquired by the household and thus include household wastages, food fed to pets, etc. In this context, the lognormal distribution with its short lower tail and long upper tail is considered to reflect better the fact that wastages, food fed to pets etc. are likely to be confined to the upper tail representing the richer and more affluent households.

d) *The approach used to specify the parameters of the distribution of dietary energy consumption*

As indicated earlier, household survey data that have been processed to yield information on the distribution of dietary energy consumption still cover only a limited number of countries. Even in these cases the time reference of the surveys differs from country to country. On the other hand information on the national *per caput* dietary energy supply (DES) is available for nearly all countries. The *per caput* DES, which are regularly prepared and updated by FAO, are widely used to reflect the levels and trends of the average food consumption in the different countries of the world. In view of this, FAO has used the *per caput* DES to represent the mean, $\bar{x}$, of the distribution for each country in preparing estimates of the prevalence of food deprivation at the national, regional and global levels.

Thus, as the distribution is assumed to be lognormal, the only other information required in order to specify $f(x)$ for each country, is the coefficient of variation CV(x). This parameter reflects the inequality in the distribution and (under the assumption of log normality) can be easily expressed in terms of the well-known Gini coefficient. It is estimated as far as possible on the basis of survey data. Given $\bar{x}$ and $CV(x)$, the two parameters of the lognormal distribution, μ and σ^2, can be determined as follows:

$$\sigma^2 = \log_e (CV^2(x) + 1)$$

and

$$\mu = \log_e \bar{x} - \sigma^2 / 2.$$

The estimation of the mean, $\bar{x}$, and the inequality in distribution parameter, $CV(x)$, is described below.

(i) Estimation of the mean

The mean represented by the *per caput* DES does not refer directly to energy intake but to the energy available for human consumption during the course of the reference period, expressed in kcal per person. It is assumed that the latter is a close approximation of energy consumption, at least for developing countries. The available data are derived from the food balance sheets compiled every year by FAO on the basis of data on the production and trade of food commodities. Using these data and the available information on seed rates, waste coefficients, stock changes and types of utilization (feed, food, other uses) a supply/utilization account is prepared for each commodity in weight terms. The food component, which is usually derived as a balancing item, refers to the total amount of the commodity available for human consumption during the year. The total DES is obtained by aggregating the food component of all commodities after conversion into energy values.

(ii) Estimation of the CV

As indicated earlier the household level data from surveys providing data on dietary energy consumption are not sufficiently precise to yield reliable information on the usual consumption. However, given the HIES sample design, the means for large groups of households classified by the key variable determining household food consumption, i.e. household *per caput* income or its proxy total expenditure, provide reliable estimates of annual average consumption. On the basis of such a classification it is possible to estimate the CV of household *per caput* usual dietary energy consumption due to income. However, household dietary energy consumption is likely to vary also due to factors such as the sex-age composition, body-weight and activity level of the household members i.e. the factors determining dietary energy requirements. The composite effect of these factors can be approximated by the variation of the dietary energy requirements. Thus by only considering these two sources of variation, the CV of the household *per caput* dietary energy consumption distribution is estimated as follows:

$$CV(x) = \sqrt{CV^2(x \mid v) + CV^2(x \mid r)},$$

where $CV(x)$ is the total CV of the household *per caput* dietary energy consumption, $CV(x|v)$ is the component due to household *per caput* income (v) and $CV(x|r)$ is the component due to energy requirement (r).

The variation in household *per caput* dietary energy consumption, due to differences in the energy requirements, will always exist and is not expected to vary significantly between countries and over time. In view of this, $CV(x|r)$ can be considered to be a fixed component of $CV(x)$. It follows from this that the survey data are used to estimate only $CV(x|v)$.

The CV(x|v) is estimated using the averages of household *per caput* dietary energy consumption by household *per caput* income (or total expenditure) classes from **n** households as $CV(x|v) = \sigma(x|v) / \mu(x|v)$, with

$$\sigma(x \mid v) = \sqrt{\left[\sum_{j=1}^{k} f_j (x \mid v)_j^2 - (\sum_{j=1}^{k} f_j (x \mid v)_j)^2 / n\right] / (n-1)}$$

where k is the number of income classes and f_j is the number of sampled households and $(x|v)_j$ the average household *per caput* dietary energy consumption of the jth income class.

The denominator

$$\mu(x \mid v) = \sum_{j=1}^{k} (x \mid v)_j \, f_j \, / n$$

is the estimated overall average household *per caput* dietary energy consumption.

It follows from the above that household survey data are used to estimate the CV of household per caput dietary energy consumption due to income only. Thus the effect of differences in the sex-age composition of the households is not taken into account and consequently the distribution derived by linking this CV to the mean given by the per caput DES refers to a population composed of average individuals in so far as sex-age composition is concerned. In other words, the unit of the distribution is what is sometime referred to as the national per caput unit. For this reason the derived distribution will henceforth be referred to as "distribution of per caput dietary energy consumption".

(iii) Changes in the inequality in distribution over time

Estimates of the prevalence of food deprivation in the developing countries are prepared for the benchmark periods 1968-71, 1979-81, 1990-92 and the most recent period for which estimates of *per caput* DES are available (which currently refer to 1998-2000). This means that $f(x)$ needs to be specified for each of those four periods for a given country and therefore estimates of $\bar{x}$ and $CV(x)$ are required for each of these periods. In this connection, the means for the different periods are taken from the most recently available series of *per caput* DES but the same $CV(x)$ is used. This implies that the inequality in distribution, as measured by $CV(x)$ is assumed to have remained constant over the last three decades. This approach has been dictated by the fact that the available survey data referring to dietary energy consumption, food expenditure and income/expenditure used for estimating $CV(x|v)$ in the different countries spread throughout the three decades and in no single country information close to all the four periods is available. In other words, there is no possibility of taking into account any change in the inequality that may have occurred in the individual countries. However, evidence provided by the available series of Gini coefficients of income/expenditure compiled for a number of developing countries

suggest that there has been little, if any, change in the inequality of income / expenditure (see Appendix).

The Gini coefficient is a measure of inequality in access to certain goods or services (income/expenditure in our case) among the units under consideration (households in our case). It ranges from zero to unity – zero implying an equal distribution among the units and unity implying absolute inequality or concentration in a single unit. Thus, the more the coefficient departs from zero, the more unequal is the distribution.

IV. DEFINITION OF ENERGY REQUIREMENT AND ESTIMATION OF THE CUT-OFF POINT

a) Definition of energy requirement

The human body requires dietary energy intake for its expenditure of energy, which in turn is composed of several components: the basal metabolic rate (BMR), i.e. the energy expended for the functioning of the organism when the individual is in a state of complete rest; the energy needed for digesting food, metabolising food and storing an increased food intake; and the energy required for performing physical activities, both work and non-work. For children, the energy required for growth should be taken into account. Similarly, for women during pregnancy and lactation, the energy required for the deposition of tissue and secretion of milk needs to be considered.

The energy requirement norms or standards, adopted at the international level, are periodically reviewed by expert groups and consultations. The report of the FAO/WHO/UNU Expert Consultation on Energy and Protein Requirements (FAO/WHO/UNU, 1985), has defined energy requirements as follows:

> "The energy requirement of an individual is the level of energy intake from food that will balance energy expenditure when an 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."

b) Specification of energy requirement

Energy requirements are specified by sex and age groups. As per the recommendations of the FAO/WHO/UNU Expert Consultation, the procedure for deriving the sex-age specific energy requirement differs between adults and adolescents on the one hand and children below age 10 on the other.

For adults and adolescents, the specification of energy requirement begins with the BMR. This is derived on the basis of body-weight through the use of a set of sex-age specific regression equations linking the BMR with body-weight. The energy needed for activity is expressed in terms of the BMR so that the energy requirement for a given sex-age group is finally expressed as a multiple of the BMR. The BMR multiple is referred to as the Physical Activity Level (PAL) index. For example, the energy requirement for adult males having light

activity is given as 1.55 BMR, while for females it is 1.56 BMR. The component involved in digesting and metabolising food is difficult to measure in isolation of activity since the very act of eating involves activity. In view of this, it is allowed for in the PAL value.

For children below age 10, the above component approach is not applied and the sex-age specific energy requirements are expressed as fixed amounts of energy per kilogram of body-weight. In addition, for children below age 2 from developing countries, an allowance is made for the energy needed to recover from frequent attacks of infection.

It follows from the above that the key parameters that need to be specified for deriving the energy requirements for adults and adolescents are body-weight and the PAL index and for children below age 10, is only body-weight.

c) *Definition of the minimum energy requirement by sex-age groups*

It may be recalled that the FAO/WHO/UNU Expert Consultation has defined requirement as the level of intake "that will balance energy expenditure when the individual has a body-size and composition and level of physical activity consistent with good health and that will allow for the maintenance of economically necessary and socially desirable activity". This definition implies that energy requirement should be derived on the basis of normatively specified body-weight and physical activity level rather than the actual body-weight and activity level of the individual.

However, the Expert Consultation has recognised that for a given height, there is a range of body-weights that are consistent with good health. Similarly, there is a range of physical activity levels (PAL) that are consistent with performance of economically necessary and socially desirable activity and may therefore be considered to be acceptable. In view of this, the range of variation in requirement for adults and adolescents has been defined in terms of the range of energy expenditure resulting from the application of the different combinations of acceptable weight-for-height and physical activity level. Accordingly, the lower limit of the range of variation of requirement is reflected by the energy expenditure corresponding to the lowest acceptable weight-for-height and the lowest acceptable activity allowance and the upper limit by the energy expenditure corresponding to the highest acceptable weight-for-height and the highest acceptable activity allowance.

Thus, as the cut-off point should be based on the lower limit of the range of variation, the sex-age specific minimum energy requirements for adults and adolescents have been specified on the basis of the lowest acceptable body-weight and the lowest acceptable PAL index. The lowest acceptable body-weight for given height has been estimated on the basis of the fifth percentile of the Body Mass Index [2] (BMI) (WHO, 1995) and the PAL index corresponding to light activity (1.55 for males and 1.56 for females) has been taken to reflect the lowest acceptable activity level.

It follows from the above the sex-age specific minimum energy requirements have not been derived through the μ-2σ formula but by directly considering the energy expenditure corresponding to the lowest acceptable weight-for-height and the lowest acceptable activity level.

[2] The BMI refers to weight (kg) divided by height^2 (m).

As regards children below 10 years of age, the body-weight figures required are fixed at the median of the range of weight-for-height given by the WHO reference data (WHO, 1983) rather than a lower limit as in the case of adolescents and adults. This is due to the lack of recommendations by the FAO/WHO/UNU Expert Consultation concerning the range within which weight-for-height for a given sex-age group may be regarded as satisfactory. The energy requirement was estimated on the basis of the specified weight and the energy requirement per kilogram of body-weight recommendations provided by FAO/WHO/UNU (1985). However, the energy requirements per kilogram of body-weight recommended by the Expert Consultation include a 5% allowance to account for the fact that the energy intakes of the reference groups on which they were based do not reflect the optimum activity levels for children. This extra allowance has been removed for the purpose of deriving the minimum requirement.

d) The overall minimum per caput energy requirement (the cut-off point)

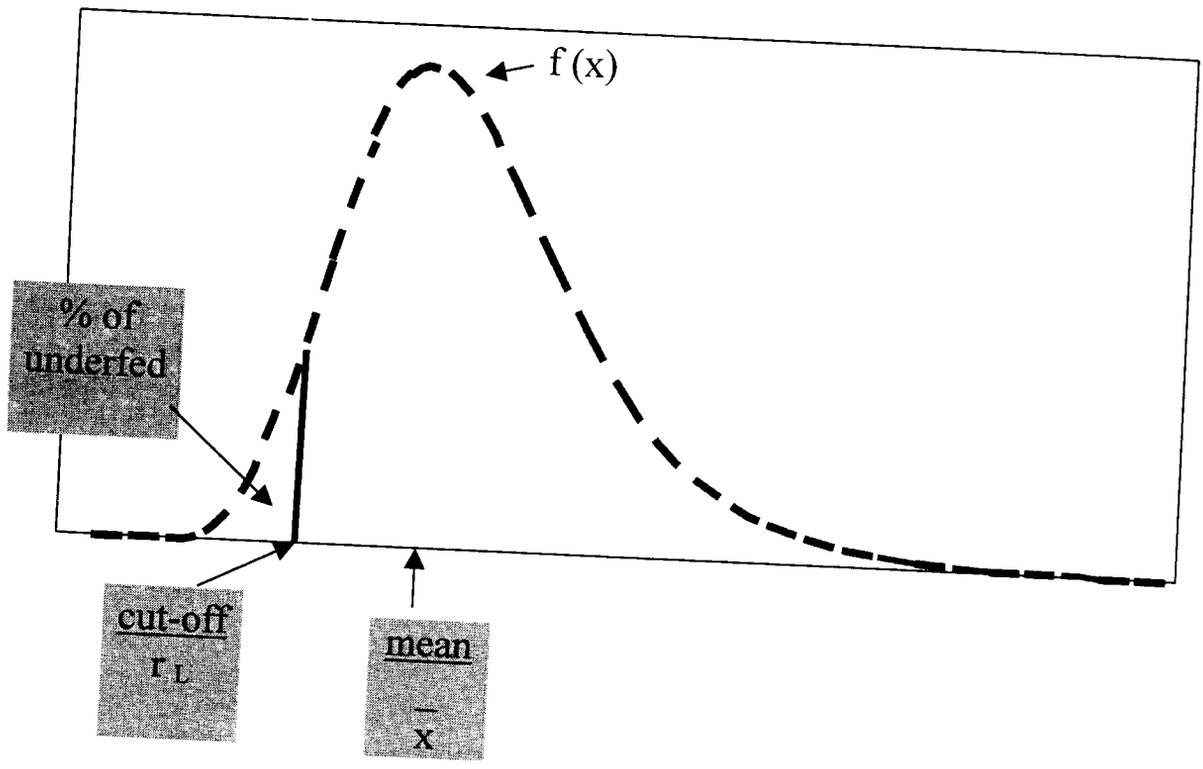
The minimum *per caput* dietary energy requirement, which is used as the cut-off point for estimating the prevalence of food deprivation, is derived by aggregating the estimated sex-age specific minimum dietary energy requirements using the relative proportion of the population in the corresponding sex-age groups as weights. Thus, as the sex-age distribution of the population changes over time, the cut-off point has to be adjusted to reflect this change in demographic structure.

It may be recalled that the frequency distribution of intake, *f(x)*, refers to the average individual or the national *per caput* unit. Hence, the variation in requirement to be taken into account in defining the cut-off point should reflect the composite effect of not only the acceptable differences in body-weight and activity as discussed above under c) but also the differences in the efficiency of energy utilization of the individuals. However, there is likely to be significant covariance between the latter factor on the one hand and the weight and activity factors on the other. As the extent of the covariance is not known it was not felt prudent to unduly reduce the energy requirements further in order to specifically take the effect of the differences in efficiency of energy utilization into account in arriving at the cut-off point.

V. CALCULATION OF THE PREVALENCE OF FOOD DEPRIVATION

Figure 1 below graphically illustrates the framework for the calculation of the prevalence of food deprivation.

Figure 1: Framework for calculation of proportion of population underfed



In the figure the curve *f(x)* depicts the proportion of the population corresponding to different per caput dietary energy consumption levels *(x)* represented by the horizontal line. The cumulative proportion of the population up to the cut off point, r_L, on the horizontal line represents the proportion of the population underfed.

The distribution, *f(x)*, is assumed to be lognormal so that the parameters of the distribution of the logarithm of x (i.e., μ and σ^2) can be derived on the basis of the mean, $\bar{x}$, and the coefficient of variation, *CV(x)*. Section III discussed the derivation of the two latter measures on the basis of the available data while Section IV discussed the derivation of the cut-off point, r_L. Here, only a summarised version limited to the procedure for calculating the prevalence of food deprivation on the basis of $\bar{x}$, *CV(x)* and r_L for an hypothetical country is given.

The values of the three input measures for the calculation of the prevalence of food deprivation are as follows:

$$\bar{x} = 2414 \text{ kcal/caput/day}$$
$$CV(x) = 0.29$$
$$\text{and } r_L = 1885 \text{ kcal/caput/day}$$

The first step following the specification of the above is to derive the two parameters of the lognormal distribution as follows:

$$\sigma = [\log_e(CV^2(x) + 1)]^{0.5}$$
$$= [\log_e(0.29^2 + 1)]^{0.5}$$
$$= 0.2842$$
$$\mu = \log_e \bar{x} - \sigma^2/2$$
$$= \log_e 2414 - 0.2842^2/2$$
$$= 7.7487$$

The next step is to construct the standard normal deviate corresponding to the cut-off point:

$$Z = (\log_e r_L - \mu)/\sigma$$
$$= (7.5417 - 7.7487)/ 0.2842$$
$$= -0.7284$$

Finally, the proportion of the population below the cut-off point is obtained as:

$$\Phi(Z) = \Phi(-0.7284)$$
$$= 0.2332$$

The prevalence of food deprivation is therefore estimated to be 23%. The number of underfed is obtained by multiplying $\Phi(Z)$ by the total population in the country. As the total population is 11 million, the number of underfed is estimated as 2.6 million.

VI. MEANING, SIGNIFICANCE AND ADVANTAGES OF THE RESULTING ESTIMATE OF THE PREVALENCE OF FOOD DEPRIVATION

The data and approximations used to derive the distribution of dietary energy consumption and the cut-off point have implications on the precise meaning and significance of the resulting estimate of the prevalence of food deprivation. These are discussed below.

a) Concept of food consumption

It was noted that the *per caput* DES is used as the mean of the frequency distribution, *f(x)*. This means that the distribution refers to food acquired by (or available to) the households rather than the actual food intake of the individual household members. As a consequence, the resulting estimate refers to food availability rather than food intake.

b) Unit of analysis

The unit of analysis is the household *per caput* average rather than the individual within the household. This means that any inequity that may exist in the intra-household access to food is ignored so that conceptually speaking, the measure of food deprivation refers to the proportion of households in the population whose food availability is below requirement.

c) *Time reference*

The *per caput* DES used as the mean of $f(x)$ corresponds to a three-year rather than annual average in order to even out the effect of errors in the annual food stocks data used in preparing the food balance sheets. Furthermore, for the purpose of deriving the $CV(x|v)$, only household survey data grouped according to income/expenditure classes are used thus removing the effect of seasonal and other short-term variation that the household level data are subject to. As a consequence of these, the estimate refers to the average condition during the given three-year period and the effect of seasonal and other short-term variations in food availability are not considered.

d) *Use of concept of minimum energy requirement as cut-off point*

The cut-off point is derived by aggregating the sex-age specific minimum energy requirements using the proportion of the population in the different sex-age groups as weights. The sex-age specific minimum energy requirements for at least the adults and adolescents are based on the energy expenditure corresponding to the lower limit of the range of acceptable body-weight for given height and the light activity norm. This approach of arriving at the cut-off point might give the impression that food deprivation is operationally defined as the state of having a food consumption level that is below that needed by an average individual for maintaining minimum acceptable body-weight and performing light activity. This is however, strictly speaking, not so. The minimal approach in establishing the cut-off point is a consequence of the consideration that, due to the effect of correlation between energy intake and requirement, the individuals with consumption falling within the range of variation of requirement are likely to be close to, if not exactly, matching their requirements. In other words their risk of food shortfall or excess is low if not exactly zero.
The main strength of the FAO estimates lies in the fact that the distribution of household *per caput* dietary energy consumption is directly linked to the *per caput* DES derived from the food balance sheet. This procedure is useful for the reasons given below.

e) *Advantages of the FAO estimates*

- The FAO *per caput* DES database, which covers practically all countries of the world, is regularly revised and up-dated in connection with FAO's continuous work programme on supply/utilization accounts and food balance sheets. As a result the database represents a readily available source of information for the assessment and monitoring of the prevalence of food deprivation at the global, regional and country levels.

- The linkage of the *per caput* DES with a measure of inequality within a theoretical distribution framework provides a mechanism for assessing the effect of short-term changes in aggregate food availability as well as its components (production, import, etc.) on the distribution of dietary energy consumption and hence the prevalence of food deprivation. In addition, the use of a distribution model – such as the log-normal function – facilitates the assessment of expected changes in the prevalence of food

deprivation as a result of the combined effect food supply increase and inequality reduction, as illustrated in the table below.

Mean Food Consumption (kcal/caput/day)	Percentage of food deprived at different levels of food consumption and inequality (CV = coefficient of variation)			
	CV=0.20	CV=0.24	CV=0.29	CV=0.35
	65	64	63	63
	30	34	38	42
	7	12	17	23
	1	2	6	10

VII. SIMILAR MEASURES BY OTHER ORGANIZATIONS/AUTHORS

The approach of using information pertaining to food availability, income distribution and energy requirement for estimating the global prevalence of food deprivation has been followed by other organizations/authors. Two recent studies can be referred to in this context – one by the US Department of Agriculture in its annual assessment of food security in developing countries (USDA, 2000) and the other by Senaur and Sur (2001).

Both approaches in fact rely on a basic methodological framework that was first applied by Reutlinger and Selowsky (1976). In this section, following a description of this basic methodological framework, the essential differences in the implementation of the two approaches are noted. Then the relationship with the FAO measure is highlighted.

a) Basic methodological framework

The methodology relies on three components:

- a relationship between food consumption and income
- a distribution of income
- a cut-off point for defining food deprivation

The relationship between food consumption and income is represented by the Engel function

$$x = a + b \log_e v$$

where x and v represent food consumption and income respectively and a and b are parameters. The latter are estimated by cross-country regression using the *per caput* food availability derived from food balance sheet as x and the *per caput GDP* as v.

The distribution of income is derived on the basis of World Bank data on income and the cut-off point for food deprivation is based on certain energy requirement level.

The relationship between x and v enables the derivation of the *per caput* food availability corresponding to a given *per caput* income level or vice-versa. Hence, once the cut-off point defining food deprivation is specified, the population in the income groups with *per caput* food availability below this level is taken as the underfed.

b) Differences between the USDA and Senaur/Sur approaches

While the two approaches share the above basic methodological framework certain differences are noted in actual implementation as stated below.

(i) Unit of measurement of food availability

The USDA expresses food availability in terms of grain equivalents whereas the Senaur/Sur study retains the FAO dietary energy supply approach.

(ii) Income distribution

In the USDA approach the population is divided into five income groups using the World Bank data on income quintiles and the Engel function is used to derive the *per caput* food availability corresponding to each income group. The population in the income quintiles with food availability below the specified cut-off point is taken as the underfed.

In the Senaur/Sur approach the World Bank data on income quintiles is used to generate a cumulative density function with the *per caput GDP* as the mean. In view of this density function approach, the Engel function is used to derive the income level corresponding to the food consumption level implied by the specified energy requirement level. The proportion of the population below this income level, read off the generated cumulative density function, is taken as the prevalence of food deprivation.

(iii) The cut-off point for defining food deprivation

The USDA uses the concept of average energy requirement for each country, which averages to about 2100 kcal/person/day for the 67 developing countries covered in their study. Whereas the Senaur/Sur study adopted the FAO regional minimum energy requirements derived in connection with the estimates published in the Agriculture: Towards 2010 report (FAO, 1995) which are on average about 300 kcal/person/day below the level used by USDA.

It may nevertheless be pointed that the differences with respect to the unit of measurement for food availability and the degree of detail in representing income

distribution are not likely to have systematic effects on the results. What is likely to have a systematic effect is the difference with respect to the cut-off point. The lower cut-off point used by Senaur/Sur implies that their estimates are likely to be lower than those of the USDA.

c) *Relationship with FAO approach*

The two approaches described above essentially rely on data relating to the distribution of household income and its effect on the variation in per caput food consumption. The FAO approach also relies on such data but with the aim of deriving the distribution of *per caput* food consumption. As a consequence the FAO approach also takes into account the effect of certain non-income factors on per *caput* food consumption.

It follows from the above that the key distinction between the USDA and Senaur/Sur approaches on the one hand and the FAO approach on the other lies in the fact that the latter also considers the effect of certain non-income factors that determine the inequality in the distribution of food consumption. This suggests a difference in the focus of the two kinds of measures. In the case of the USDA and Senaur/Sur approaches the focus is on the part of the population whose income level is insufficient to ensure a minimum food consumption level as determined by the specified requirement level. In the FAO case the focus is on the part of the population whose actual food consumption level is below the specified minimum energy requirement level.

VIII. FEASIBILITY OF DISAGGREGATING THE ESTIMATES BY SEX-AGE AND SUB-NATIONAL GROUPS

There is of course an interest in obtaining information on the differences that may exist in the prevalence of food deprivation among individuals in different sex-age groups and among those living in different areas within a country. The feasibility of undertaking these within the framework of the FAO methodology is discussed below.

a) *Disaggregation by sex-age groups*

Although the minimum energy requirements are first specified by sex-age groups and then aggregated as a weighted average for all sex-age groups, the consumption data refer to household *per caput* averages that do not permit breakdowns according to the household member sex and age. The available consumption data therefore do not allow for disaggregation of the estimates by sex and age groups.

b) *Disaggregation by sub-national areas*

In so far as the global assessment - which relies on the *per caput* DES from the food balance sheet as the mean of the distribution of consumption - is concerned, it is not possible to disaggregate the national estimate by sub-national areas as the food balance sheet approach is not applicable at the sub-national level. However, it may be feasible to apply the FAO

methodology separately to the different areas and thus derive sub-national estimates of the prevalence of food deprivation if the mean and CV of the distribution of dietary energy consumption by sub-national areas are available from household survey data of specific countries. In this context the national estimate can be obtained as an aggregation over the sub-national areas.

ANNEX 1

AVAILABLE DATA ON CHANGES IN THE INEQUALITY OF INCOME DISTRIBUTION

The available series referring to the Gini coefficient of the distribution of household income/expenditure for a number of developing countries in Asia, Africa and Latin America are given in the table below. Only the countries with data referring to more than one time period are shown in the table. In referring to this table it should be borne in mind that, as the share of food in household expenditure declines with rising income and there is an upper limit to food consumption levels, the inequality in the distribution of the household *per caput* food consumption is much smaller than the inequality in the distribution of household income. In view of this, the focus should be on the changes rather than the actual levels observed.

In interpreting the changes in the Gini coefficient from survey to survey over time, account must be taken of the fact that the coefficients are based on distributions derived from data collected in sample surveys, which are normally designed to provide valid estimates of the means rather than the distribution. Furthermore the means as well as the variances derived through these surveys are subject to sampling errors. As the distribution of income is known to be positively skewed, the sampling error is in fact larger than what would be expected in the case of a normal (symmetric) distribution. The effect of these errors, which are common to all socio-economic surveys based on samples, implies that the estimated variances and hence Gini coefficient is not likely to be stable even if there is no true change in the inequality. Thus, considering these issues associated with the precision of the measures based on sample surveys, the period-to-period change observed cannot be taken to reflect a true change unless it is very large.

The table below shows that the changes over time in the different countries are rather small with no clear indication of either a decreasing or increasing trend wherever the number of observations is sufficient for drawing such conclusions.

Gini coefficient of distribution of household income/expenditure in developing countries, 1970-1993

Region/Country	Year																						
	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93
L. America & The Caribbean																								
Brazil (1)	.58										.58	.55					.55	.56						
Colombia (1)		.52	.53						.55										.51					
Guatemala (2)																		.58		.59				
Jamaica (3)																			.43		.43	.41	.38	.38
Mexico (2)														.51						.55				
Trinidad y Tobago (1)	.51										.42													
Venezuela (1)						.44	.42	.41	.39															
Sub Saharan Africa																								
Côte d'Ivoire (3)															.41	.39	.40	.37						
Gabon (4)					.59		.63																	
Ghana (3)																			.36	.37				
Mauritius (3)																.40					.37			
Nigeria (3)																.37						.41		
Asia																								
Bangladesh (1)			.36				.33	.35		.39		.36			.37									
China (2)										.32		.29	.27	.26	.31	.33	.34	.35	.36	.35	.36	.38		
China, Hong Kong (1)		.41				.41				.37														
India (3)	.30		.32	.29			.32						.31			.32	.32	.31	.30	.30	.33	.32		
Indonesia (3)						.35		.39		.36	.34			.32			.32			.33				
Rep. of Korea (1)										.39					.35			.34						
Malaysia (1)						.53								.48										
Pakistan (5)	.31								.32						.32		.32	.31						
Philippines (1)	.49														.45			.45			.48			
Sri Lanka (1)		.35						.44		.45						.47								
Thailand (1)			.42							.43					.47		.47		.49		.52			

(1) Gini coefficients based on the distribution of households by household gross income
(2) Gini coefficients based on the distribution of persons by household gross income
(3) Gini coefficients based on the distribution of persons by household net expenditure
(4) Gini coefficients based on the distribution of households by household net income
(5) Gini coefficients based on the distribution of households by household net expenditure

Source:
The United Nations University's World Institute for Development Economics Research (UNU/WIDER) – UNDP

World Income Inequality Database (WIID) Version 1.0, 12 September 2000. UNU/WIDER, Helsinki, Finland, 2000.

ANNEX 2

MONITORING FOOD DEPRIVATION IN ESCWA COUNTRIES

ESCWA countries monitored by FAO

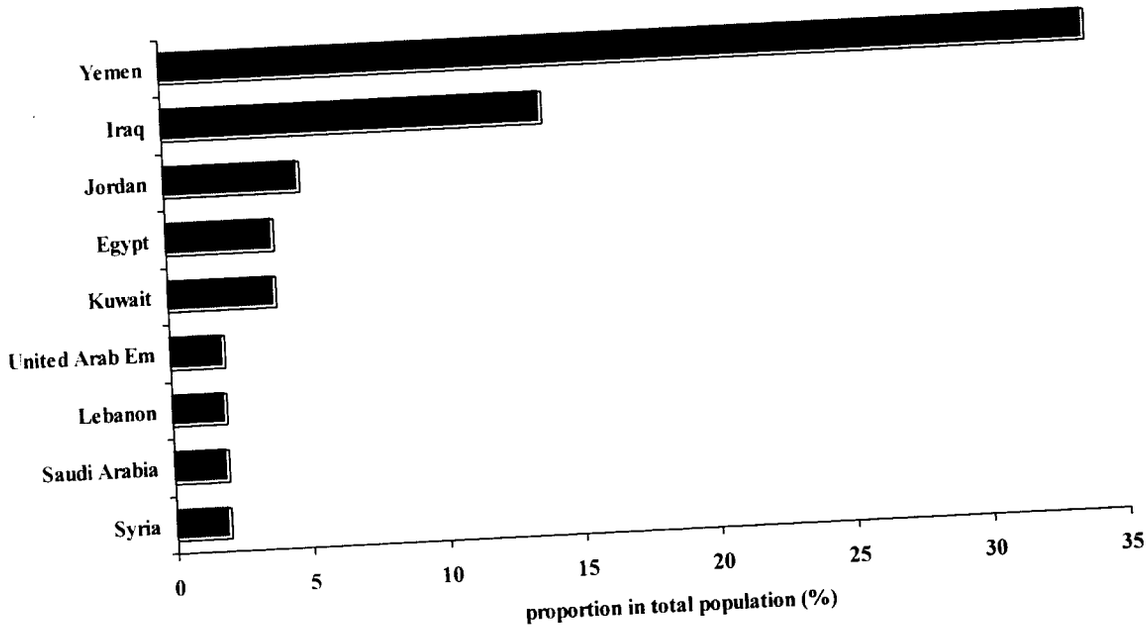
INCLUDED IN FAO ASSESSMENT

- Egypt
- Iraq
- Jordan
- Kuwait
- Lebanon
- Saudi Arabia
- Syria
- United Arab Emirates
- Yemen

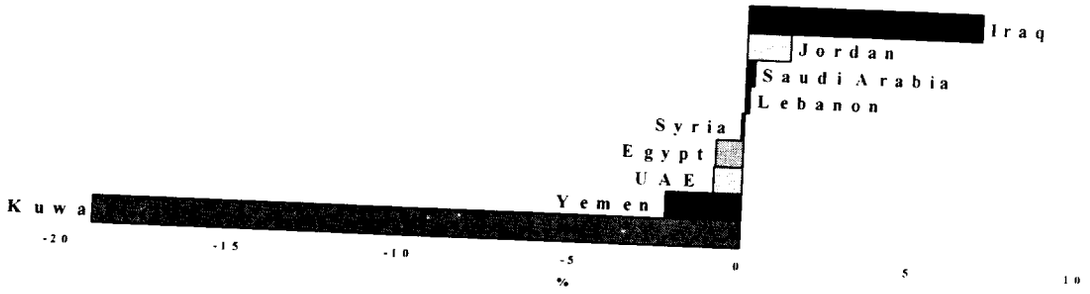
INSUFICCIENT INFORMATION

- Bahrain
- Oman
- Palestine
- Qatar

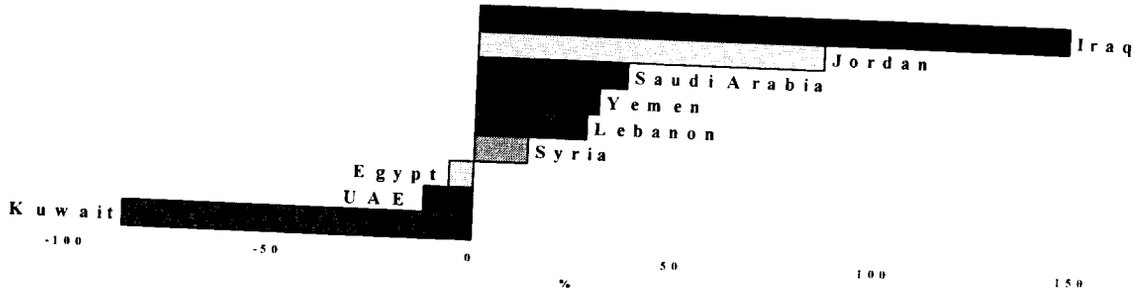
Prevalence of food deprivation 1997-99 (%)



Reductions / increases in the proportion of undernourished, 1990-92 to 1997-99



Relative change in the number of undernourished, 1990-92 to 1997-99



ANNEX 3

CORE INDICATORS FOR ESCWA COUNTRIES

Category of prevalence of food deprivation in total population	FOOD AVAILABILITY AND DIET DIVERSIFICATION		POVERTY	HEALTH		CHILD NUTRITIONAL STATUS
	Dietary energy supply (DES)	Share of non-starchy food in total DES	Proportion of people living on less than 1 US$ per day	Life expectancy at birth	Under-five mortality rate	Proportion of underweight children under five years of age
	1998-2000		1990's (last survey)	2000		1990 to 2000 (last survey)
	kcal/day per person	%	%	years	per ' 000 births	%
Less than 2.5% undernourished						
United Arab Emirates	3180	65	n.a.	75	9	14
2.5 to 4% undernourished						
Egypt	3320	34	3	67	43	12
Kuwait	3130	62	n.a.	77	10	10
Lebanon	3160	62	n.a.	70	32	3
Saudi Arabia	2840	51	n.a.	73	29	14
Syrian Arab Republic	3050	52	n.a.	70	29	13
5 to 19% undernourished						
Iran, Islamic Rep. of	2910	39	n.a.	69	44	11
Jordan	2720	47	*	72	34	5
20 to 34% undernourished						
Iraq	2150	34	n.a.	61	130	16
Yemen	2040	33	16	56	117	46

KEYS:
n.a. not available.
* Proportion less than 2 percent.

SOURCES:
Dietary energy supply (DES) and share of non-starchy food: FAO estimates.
Poverty: World Development Indicators 2002, World Bank.
Life expectancy at birth: World Development Indicators online database, World Bank, July 2002.
Under five mortality and child nutritional status: UNICEF online database, September 2001.

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