The FAO indicator of the prevalence of undernourishment

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Incomplete draft, February 11, 2011 - DO NOT QUOTE

> *"[...] This index is unsatisfactory in a number of ways. Food availability is a rather poor predictor of failure to grow, mortality and economic productivity (Svedberg, 2000). The index is not distribution-sensitive and an increase in food deficiency of the most deprived sector of the population would leave the index unchanged.*
> *Food availability data are averaged over a 3 year period and the effects of seasonal crises and droughts go unnoticed. There are also issues regarding the caloric cut-off point adopted by the FAO. The FAO follows estimates of minimum energy requirements calculated by the WHO for different age and gender groups. Estimated requirements are based on multiples of the basal metabolic rate in order to account for occupational and social activities (WHO, 1985). Country specific cut-off points are obtained by the FAO by aggregating sex age-specific minimum energy requirements using the proportion of the population in the different sex–age groups as weights (Neiken,2003).*
> *Svedberg (2002) and Dasgupta (1993) critically discuss the FAO cut-off points and maintain that their use results in a large underestimation of undernutrition in the world.*
> *The index can be calculated for all countries because data on food availability are readily available, though they are not fully reliable (Svedberg, 2000). The index is not robust as is very sensitive to the parameter values used for its calculation: energy cut-off points, food availability, and the distribution of calories across households (Beaton, 1983; Neiken, 2003; Svedberg, 2000). The index provides data on the scale of hunger in the world and a measure for assessing countries progress in achieving the MDG goal of halving hunger by 2015. Because the information generated by the index does not have value at the country level, the index cannot be used in causal models or for targeting purposes."* Masset (2010, p. S104)

Introduction

The quote above is from a recent "review of hunger indices and methods to monitor country commitment to fighting hunger" (Masset, 2010). It synthesizes a view that is becoming increasingly popular among analysts and academic researcher, namely that the FAO estimate of the prevalence of undernourishment is of little value today, and that perhaps the definition of such an index of chronic hunger should be deeply modified or even its production discontinued.

[1] Advice and comments in answering specific question on the methodology by dr. Loganaden Naiken are gratefully acknowledged. Also we wish to thank all members of ESS Team 3 for their precious collaboration. Neither dr. Naiken nor any of the other colleagues in ESS are responsible for any error or omission, which should be only blamed on us.

We strongly believe that such a conclusion is unwarranted, and that, instead, the work of the FAO (and of the Statistics division in particular) in this field is still extremely useful and, if anything, should be strengthened.

As it can be inferred from the quote above, criticisms of the FAO index have revolved around the three aspects of (a) the appropriateness of the operational definition of hunger, (b) the soundness of the methodological approach on which the estimate is obtained, and (c) the reliability of the elementary data which are used to construct the estimate. In this note we confront the three types of criticisms in turn, to render justice of the real strengths and weaknesses of the methods used by FAO to better inform the international community and to constructively participate into a discussion of how to increase our ability to fight hunger.

1. What do we do, and why

One aspect of the debate on hunger indicators has revolved around the question of how nourishment should be defined; whether it can be simply referred to the amount of food intake, or it should be rather referred to the consequences of the combination of food intake with other relevant aspects of human biological life, such as health and sanitation.

Also, food intake may have a dimension of "quantity" as well as of "quality", and there is an issue of whether the two are closely correlated or not.

The FAO methodology accepts the view that:

- Nourishment as a socially/demographically relevant phenomenon refers to food intake,
- Food intake can be measured through the amount of dietary energy, on the account that the correlation between dietary energy and quality of the diet is expected to be close to one.

As a result, we **estimate the prevalence of undernourishment, defined as the proportion of the population in the Country with a level of Dietary Energy Consumption (DEC) lower than the Dietary Energy Requirements (DER**). This indicator is used (widely?) to monitor evolution of hunger over time (at the World, Regional and, since 1999, National level, through publication of the State of Food Insecurity). In particular the indicator is used to monitor achievement of the Millennium Development Target (indicator 1.9).

1.1. What the FAO hunger index is and what it is not

As other proposed indicators of hunger based on anthropometric measures, the FAO estimated prevalence of undernourishment is **an indicator of *chronic hunger***. It is intended to capture the evolution of fundamental elements that drive the long term nutrition condition in a Country.

Reliance on an underlying distribution of the yearly average per capita food consumption in the country means that short term phenomena, such as seasonal crises, are not covered and are not intended to be.

Most importantly, given the current pervasive debate on food price volatility, the impact of short term food price crises is not captured, unless it is such that it determines long term changes of food intake habits in the population. This view is

consistent with considering that many mechanisms exist (food item substitution, savings, debt, etc.) for households to cope with temporary food price crises and yet maintain energy consumption at levels that do not compromise long term nutrition

Analogously, year to year variation in food availability due to weather conditions is assumed to be dealt with primarily trough food storage. The possibility of coping with periods of food shortage through use of accumulated stocks is known since biblical time to be an effective mechanism for preventing famines. Other than for perishable products such as fruits and vegetables, year to year variation of supply does not imply similar variation in food caloric intake.

Indeed, it would be very surprising if a series of the indicator of undernourishment, other things being equal, would closely follow the series of total food production or the series of an aggregate food price index.

All this is not to be intended that short term phenomena related to either food availability or food prices are not important: quite the contrary, we consider them very important, as they could imply other types of costs, with potentially very serious impacts on the overall quality of life. The point here is that such type of costs may not be captured by sizeable changes in the amount of food intake, though they may be very large in economic terms especially for the poor, precisely because food is such an important need that households would give up other consumptions (including health services and education) before giving up food.

This discussion points to the fact that perhaps **chronic hunger is not the only interesting phenomenon that needs to be monitored**. Other phenomena, including the evolution of food production, the prevailing diet composition, the ratio of food expenditure to that of other basic needs expenditures such as for health services or education, may be equally important to monitor the state of human development and the role that agricultural and food policy play in it. FAO already does much in this sense, though perhaps even more could and should be done.

The FAO indicator of chronic hunger has an undeniable merit: that of having raised and kept high the attention towards the problem. It is true that it does not immediately suggest measures on how to address the problem, but that should not be seen as a drawback of this indicator, but rather as the evidence that not enough is being done to monitor the broader problem of malnutrition.

Lack of other indicators has probably had the effect that the numbers FAO provides have been misinterpreted. The debate seems sometimes to point to problems with the way the indicator is produced, when perhaps the problem reside on its *inadequacy* with respect to specific analytic objectives. To avoid confusions, each indicator has to have as a narrow definition as possible, and the exact meaning of the indictor should be comprehended before it can be used in models aiming to answer specific questions. The puzzles surrounding the nature of the relationship existing between material poverty and undernourishment, just to make one example, cannot be fully resolved by changing the way given indicators are estimated, while might have been partly fuelled by possible misinterpretations of them. The bottom line is that once an indicator is produced, its precise meaning must be well understood, and it must be used in a consistent way within proper analytic models, before claims on its inefficacy or inadequateness can be supported.

As for the role that FAO in general, and the Statistics division in particular, may play in informing the debate on development, we recognize that more analytic work is needed to understand things like the causes of undernourishment and its effect on various dimensions of human wellbeing and social progress. This is different from purely statistical work, though there are many statistical and inferential questions related to the use of the information FAO provides on which we, as producers of the indicators, can and should contribute effectively. If and when the inadequacy of existing indicators is clearly identified, producers and users of such indicators should jointly agree on other possible indicators, carefully assess the feasibility of obtaining reliable measures, and then promote their production and use on a wide scale.

Before deciding on which other statistics are to be produced, however, we must recognize that the commitments already made absorb almost all of the available resources. If it is decided that other things are important, a trade-off might emerge with things currently done, if the amount of resources available is not increased and better methods for a more effective use of the available resources are developed.

1.2. Is it the right thing to do?

The two major objections to the operational definition of (under)nourishment as adopted by FAO relate to the two points highlighted above.

First, food intake may not be enough to capture the various aspects related to the problem of hunger. The individual ability to process food, the quality of the food, and the combined effect of other factors such as health and sanitation conditions may be such that focusing on food intake may be misleading in informing policies intended to promote the objective of a better universal quality of life.

Second, the amount of dietary energy may be not the best way to measure food intake, in that it may miss the "quality" dimension of food. A "balanced" diet, also in terms of micronutrients, may be more important than an "abundant" diet in achieving acceptable nutrition levels.

Both criticisms have value, pointing to the usefulness of anthropometric based indicators, though it is our opinion that, in the end, they do not undermine the validity of the definition adopted by FAO. Rather, they highlight the need to have more indicators, each using different operational definitions of "hunger" to be used in combination to inform food and health policies.

Trying to evaluate the quality or usefulness of one indicator by comparing it with another one can be subtly misleading and actually counterproductive, unless the two indicators are intended to measure precisely the same thing. Differences between the number of people not eating enough food, and the number of people showing below norm BMI's could actually be informative, and reveal specific problems related, for example, not to the availability or access to food, but to health and sanitary conditions. Confusion arises when the same term is used to indicate two conceptually different objects.

1.3. What else we already do?

FAO already provides a wealth of other information that, together with the estimated number of undernourished, can be used in analytic models trying to assess causes and consequences of undernourishment.

A partial list includes:

- The integrated online database **FAOSTAT** with the globally most comprehensive series of production, trade and utilization data
- The system for agro-climatic forecasting **AGROCLIM**
- The global spatial database of agricultural land-use statistics **AgroMAPS**
- The Emergency Prevention System for trans-boundary Animal and Plant Diseases, **EMPRES**
- The **Desert Locust Watch**
- A Global Information and Early Warning System, **GIEWS**. GIEWS is informed by/based on:
    - Crop and Food Supply Assessment Missions, CFSAMs (in cooperation with WFP)
    - Satellite imagery and related spatial databases
    - Food supply monitoring system based on current supply-utilization accounts
    - A global food price monitoring system
    - A national food price data and analysis tool
    - A country policy monitoring tool
    - Local and regional rainfall estimates
    - Assessments of cereal import requirements of LIFDCs

  GIEWS results are made available through the **Geonetwork** portal including:
    - The Food Outlook publication
    - The FAO Food Price Index and related indicators (Food import bill of developing countries)
    - Food price monitoring and alerts for vulnerable local markets
    - GIEWS country briefs
    - CFSAM reports and special alerts
    - The Food crops and shortages publication
    - The Africa reports and the Sahel reports
    - Interactive maps with changes in the vegetation index, etc.

In addition to the short-term monitoring efforts of GIEWS, analytical studies on food security are published in:

- The State of Food Insecurity publication, SOFI
- The State of Agricultural Commodity Market Publikation, SOCO
- The State of Food and Agriculture publication (SOFA)
- Food Security Maps, Country Nutrition Profiles, Food Security Analysis Papers, National Food Security Bulletins, and Integrated Food Security Phase (IPC) classification based maps and reports.

Also, the following publication is expected to be launched in 2011:

- The State of Natural Resources/Land and Water (SONAR/SOLAW) publication, inter alia with analyses on natural resource scarcity and food security, Climate Change and Food Security, etc.

Finally, there is a set of things that are on our "wish list":

- A system of global field crop surveys to monitor the state of key food crops during the growing system.
- An integrated food reserves/stocks monitoring system.
- A global price volatility forecasting system and a stock based price alert system.

Scope for improvements:

- More efficient and timely publication of information.
- Better co-ordination of information flows within FAO.
- Better co-ordination of information flows with national partners, NGOS, CSOs.
- Close co-operation with OCHA for short-term aid assessments and strategic planning of aid flows and aid infrastructure

2. How do we do it

2.1. General considerations

Evaluation of the value of any estimation procedure rests on two fundamental principles: reliability of the estimates it produces, and practical feasibility. The two are interrelated, in the sense that an estimator can be shown to be highly reliable (i.e., the confidence intervals for the estimated parameters are very narrow) under "ideal" conditions, but those ideal conditions cannot be created in any real world estimation exercise.[2] The problem then should be framed in terms of the attempt at devising the best estimator among those which are feasible (in the sense of being applicable given the available data or those that can reasonably be expected to be collected at acceptable cost and in time for making the estimates useful).

The methodology that FAO has developed to estimate the prevalence of undernourishment tries to respond to these needs. Criticisms have been raised both to the efficiency and to the feasibility of the current estimator, though it would be unfair to address one property independently from the other. To correctly frame both the merits and the drawbacks of the FAO methodology, a few considerations are at hand, distinct between the theoretical aspects of the methodology in general and the practical aspects of its implementation.

2.2. Theoretical considerations

Ideally, to estimate the number of undernourished according to the above operational definition, one would conduct a census to measure each individual's level

[2] One example of this is the asymptotic efficiency of the Maximum Likelihood estimator, a general result of very limited practical relevance in many situations in which estimation must be conducted on small samples

of Dietary Energy Consumption (DEC), x_i, and Dietary Energy Requirement (DER), r_i, and count the number of people for whom $x_i < r_i$.

A census would, of course, be impractical for continued monitoring of hunger, thus a representative survey of individuals in the population should be conducted instead, and the problem becomes properly that of an *estimate* rather than a measure. The reliability of the estimate would depend:

(a) on the possibility of precisely measuring both x_i and r_i

(b) on the representativeness of the sample

Both points call into serious question the practical feasibility of even an approach based on surveys, especially if it is to be repeated frequently, ideally every year.

As an alternative, one may postulate a joint distribution for the individual DEC and the individual DER in the Country, $f(x,r)$, and define the required prevalence of undernourishment as:

$$PU = \iint_{x<r} f(x,r)drdx. \quad (1)$$

This approach has been proposed as early as 1961 by P.V. Sukhatme, then Chief Statistician at the FAO Statistics division, who also recognized that estimation of the joint density $f(x, r)$ would require specific assumptions to be made on the marginal distributions $f_x(x)$ and $f_r(r)$ and on the structure of correlation existing between the two variables, x and r. (Sukhatme, 1961).

Given that, as noted above, obtaining observations on the joint distribution of x and r in a population is infeasible, and that only information on the marginal distributions can be readily available, the definition in (1) has been expressed in terms of only the marginal distribution of DEC, $f_x(x)$, as follows:

$$PU \equiv \int_{x<L_r} f_x(x)dx \quad (2)$$

where L_r is an appropriately chosen threshold value.

A debate has arisen over the years both on the theoretical validity of the shift from (1) to (2), and on the proper implementation of this concept. The history of the debate is presented in Naiken (2007), where it is pointed out that much of the controversy arose from a misinterpreted definition of undernourishment in terms of the comparison between x and r. Such a definition raises questions on what the meaning of "adequate nourishment" should be. If we define the condition ($x < r$) as "undernourishment" and, by symmetry, ($x > r$) as "overnourishment", it is immediately clear that the event ($x = r$) should indicate adequate nourishment, and obvious considerations suggest that any credible joint density cannot assign probability zero to such event. Therefore, a very special structure of the joint density of x and r is needed to capture the possibility that a sizeable share of the population is neither undernourished, nor over nourished, in a probabilistic sense.

Figure 1 below sketches a hypothetical representation of such a joint distribution of DER and DEC in a population.[3]

[3] The graph is built with simulated data, taking account of possible noise in the observation of the two variables, especially around the minimum (MDER) and maximum (XDER), and a strong correlation between the two variables in the range between the two extremes.

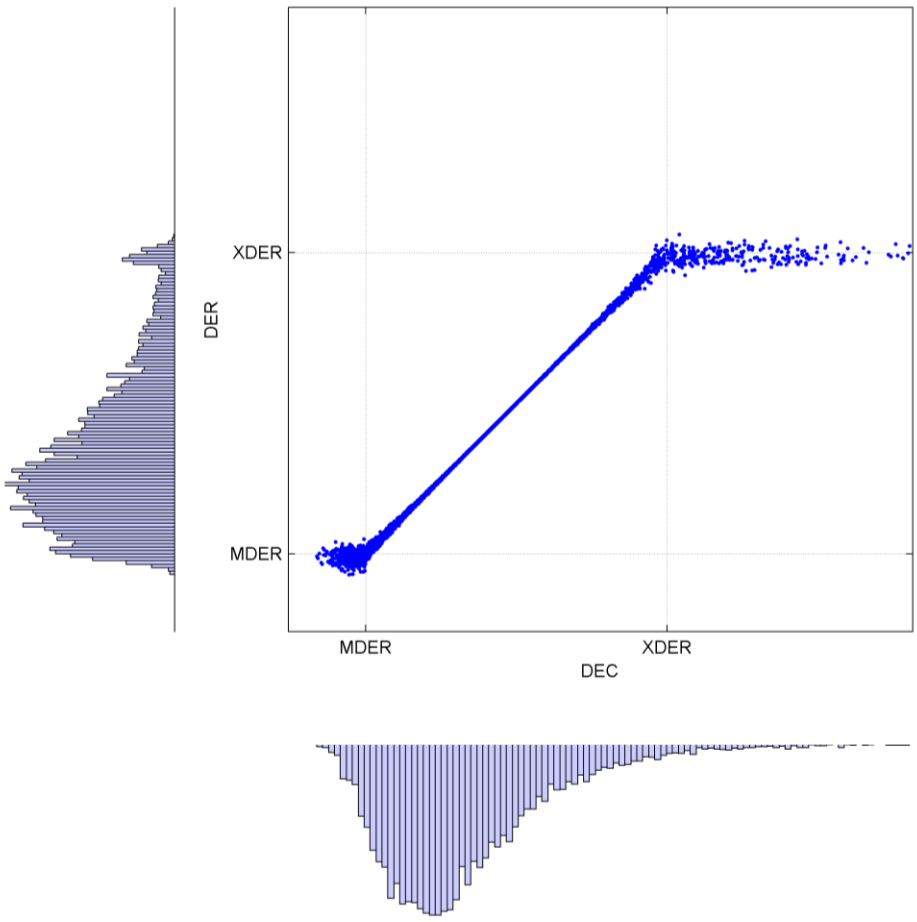

Figure 1 - A representation of the bivariate distribution concept

The criticisms by Svedberg (2002), which have received wide attention by the international community (including many within FAO itself) fail to recognize that the FAO methodology implicitly assumes that the latent joint density of x and r is a mixed one, in which the event ($x = r$) is assigned finite positive probability. Svedberg presents his arguments as if the implicit joint density used by FAO could be a joint Normal distribution, (see Svedberg, 2002, Fig.1 p. 7 and the discussion therein) something that has never been assumed by FAO, neither implicitly or explicitly.

The origin of the deep misunderstanding about the propriety of the FAO methodology is revealed by the description of what, in Svedberg's understanding, the variable r is. Svedberg talks of the "distribution of *minimum* per capita calorie requirement (MPCCR) across households in all populations" (Svedberg 2002, p.7, emphasis added) whereas the FAO methodology is defined in terms of the distribution of the *average* individual's requirement in the population, used to estimate its minimum (MDER). The distribution of the minimum and the minimum of a distribution are, obviously, two very different objects.

Naiken's (2007) counter of Svedberg's argument, leading to a complete rebuttal of the assumption of a joint density (as originally proposed by Sukhatme), which may have been very unpalatable to many. We propose here that it is the existence of a *continuous* joint density of DEC and DER which is at odds with the fact

that there are people in a population (hopefully many) who are neither undernourished nor over nourished.

From whatever angle one may choose to look at the question, the fact remains that observations on individual DER are virtually impossible to obtain. The graph above should help in forming an intuition of why, if the hypothesis of strong correlation between DER and DEC holds true for the majority of people with DEC within the limits of what can be considered adequate nourishment, inference on the prevalence of undernourishment can be properly conducted under the estimated marginal distribution of DEC only, as it is done by FAO.

2.3. Practical implementation

Implementation of the methodology broadly described in the previous section requires:

a. Choice of a probabilistic model for the marginal distribution of intra-household average per capita calorie intake in the population,
b. Estimation of the parameters of such distribution, and
c. Estimation of the cut-off point, L_r.

In the next section, we shall briefly discuss the above points in turn, highlighting the crucial issues to be considered in making an operational choice and next describe how the FAO Statistics division has proceeded for practical purposes.

The procedures followed by FAO with respect to each of the three aspects have been criticized to a variable extent and in various moments in time, though no agreement has been reached even among the critics on a feasible, fully coherent, alternative procedure.

2.3.1. Choice of the probabilistic model.

Choice of a probabilistic model to represent the distribution of DEC in the population should be guided by two criteria: parsimony in the number of parameters to be estimated and adherence to the true distribution of the variable in the population.

Evaluation of the latter must confront the fact that there exist no census data of DEC in a population that can be used as a benchmark. The data in nationally representative Household Income Expenditure Surveys (HIES) which include direct record of food available for consumption could be used, in principle, to this aim, but care must be taken to purge them from the effect of unwanted variability, especially the one due to the presence of outliers (values of recorded per capita DEC close to zero or reaching absurd values of tens of thousands kilocalories per day), and to the effect of intra-year variation due to the fact that HIES rounds are based on short recollection periods.

This last point is important: HIES never record the average per household food consumption over the year. Usually, the observation is limited to the amount of food consumed over a very short period of time (a day or a week) in order to reduce problems associated with recollection. While evenly spreading the various survey rounds over the year can help improving the estimate of the mean consumption, it induces additional variance in the data to the extent that food consumption varies systematically across seasons.

Also, HIES have often been found incomplete or imprecise in recording food consumed away from home, in which case not only the variance, but also the mean of the sample distribution of DEC may depart from the one which is sought.

Given the lack of an adequate benchmark, choice of the model distribution must be informed by the careful consideration of its flexibility, relative to the number of parameters needed for its full characterization. Several families of distribution can be considered, such as the Log Normal, the Beta, the Gamma, and the Pareto distribution, among others.

2.3.2. Estimate of the average per capita DEC in the population

This is one of the thorniest issues in the current debate surrounding the various methodologies available to estimate undernourishment, and rightfully so.

First, it must be said upfront that the possibility of directly observing DEC is deemed very difficult in practice, both at the individual and at the aggregate level, and therefore Dietary Energy Supply (DES) is commonly used as a proxy for DEC.

Dietary Energy Supply, in turn, is usually obtained from data on food available for consumption, either at household level, or as a national aggregate, by converting the quantities of each food item into the corresponding dietary energy content. The needed conversion factors may be very difficult to obtain, especially for food items that are very specific to particular regions of the World or even to provinces of countries within those regions.

Before discussing possible sources of data on food availability, it must be pointed out that use food availability as a proxy for food consumption is valid to the extent that availability is netted of decay and wastage, and that all other phenomena that are expected to make consumption different from availability are duly taken into account. In particular, food consumption over time is expected to be less variable than food availability whenever food can be stored at low cost. The major difference between yearly available food and yearly consumption of food, in fact, may well be related to the carrying over of food from one year to the next, and to the consumption of some of the food carried in from previous periods. In a given year the difference may be very large, even at the household level, due to in-household management of food storage, the detail of which may escape not carefully conducted household surveys.[4]

This is a reason why, if an indicator is defined in terms of food consumption, when elementary data on food availability is used, care must be taken to avoid mistakenly considering food that is available - but stored - as food consumed. One solution is to consider averages of more than one year, rather than yearly figures, thus netting out yearly stock variations, but this comes at the cost of compromising the possibility of on-time monitoring of current aggregate consumption levels. To the extent that the data on food availability can be appropriately corrected for stock variations, annual figures could (and should) be used.

[4] See, for example, Park 1998 who reports on rice stocks amounting to more than 60% of annual production and over half of annual rice consumption among China rice farmers. [Park 1998, cited in Park 2006, p. 1096]

Having clarified the point of the potential difference between availability and actual consumption of food, the next question is on which are the possible sources of information on food availability. Two possible sources are: individual household level surveys data and aggregate Commodity Balance Sheets.[5,6]

When reliable nationally representative household survey data are available, it seems that these should be the first choice to form an estimate of the average per capita dietary energy availability. However, household survey data are not exempt from problems that may affect the reliability of the estimate. In addition to the already mentioned problem of how to take into account household level storage, issues related to how to consider food wasted, given to guests, received as a gift or as wage, and possible food aids arise. Also, whether or not food consumed away from home is recorded or not, may cause systematic distortions.

Checking the surveys' elementary data to ensure that these problems would not systematically affect the estimate of food available for consumption is a delicate process. It makes the "cleaning" of elementary data from household surveys a particularly burdensome one, with consequences on extending the time needed from the moment in which elementary survey data are made available to the moment in which they can be used to produce the estimate of mean food consumption per capita.

Fortunately, when survey data are collected through stratified samples and expansion factor are available to project the estimates of conditional means to the entire population, the precision of such parameters can be greatly improved. The practice of aggregating individual household data in groups (say, by income class), and then considering the means within such groups, goes a long way in the direction of reducing the impact due to the presence of outliers, and allows more reliable estimates also from survey data of less than ideal quality.[7]

The alternative option of estimating per capita food available for consumption from national level food balance sheets is also problematic. It has indeed been repeatedly questioned on the account that mean food availability measures thus obtained could be plagued by errors due to:

a. Errors in the basic data on production, trade and stock variation used to form the commodity budgets, and

b. Various approximations and assumptions made to balance production, trade, stock changes and various type of uses.

While it is true that these problems may affect each of the items in a food balance sheet in significant ways, the impact on the total dietary energy supply in the country may be reduced by aggregation, given some errors in opposite direction would cancel out.

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[5] See Annex I for a detailed discussion on the comparison of methodologies and results from analysis of food balance sheets and household consumption surveys.

[6] Examples are FAO Food Balance Sheets (http://faostat.fao.org/site/354/default.aspx), USDA World Agricultural Supply and Demand Estimates (http://www.usda.gov/oce/commodity/wasde/)

[7] Some of these practices to reduce the bias in the estimates of population means from stratified samples have consequences on the way in which population variance can be estimated from the same data, as we shall see below.

This is not to deny that any effort should be made to improve on the reliability of the data on each individual component of a food balance sheet and the soundness of the procedures adopted to balance the equations, especially because FBS are a resource whose utility goes far beyond that of providing an estimate of average per capita available food, and FAO is committed to maintaining and increasing that value as far as its own Food Balance Sheets are concerned.

The bottom line of this discussion is that both surveys and FBS could and should be used to estimate food available for consumption. Once the sources of possible systematic differences are identified, methods should be devised to correct for them, and the estimates reconciled.[8]

2.3.3. Estimate of the variability of the distribution of per capita DEC in the population

While for the mean per capita available supply of food in the population there exist at least two potential sources of data, the only practically available data on which to base an estimate of the variability of the distribution of food consumption in the population come from surveys.

In principle, a *direct* estimate of the variability in the distribution of DEC could be obtained through a measure of the empirical dispersion of individual household consumption in a survey. There are, however, several reasons why this may be problematic. Individual household data on per capita food consumption from surveys, in fact, are very likely to be more dispersed than the actual per capita yearly average of food consumption in the population, due to the presence of "spurious" variability (introduced both systematically through features of survey design and accidentally, due to non-sampling errors) related to:

a. The fact that survey rounds of data collections are usually spread over the year. This is done to avoid introducing biases in the estimation of mean consumption, when consumption of food is known to be varying over the seasons. Concentrating all surveys in a sub-period of the year would thus bias the estimate of the required year average. Unfortunately, spreading data collection over the seasons means that seasonal *variability* in consumption (which should not be considered in estimating the variability of the average year consumption in the population) is still present.
b. Missing data and outliers. In fact, non-sampling errors, associated with errors in recall, under or over reporting, non-completeness of data collection forms, especially with reference to food consumed away from home, interview effects, etc.

All these factors might induce a systematic positive bias in the estimate of the *variability* parameter of the distribution that unfortunately can hardly be reduced, once survey data have been collected, through the methods available for controlling the bias in the estimation of standard errors of estimates of the mean, and that have become standard features of commercial statistical packages.[9] Cleaning the data to try and identify outliers and missing values can help reduce the potential bias, though specific assumptions about the criteria on which to classify outliers, or

[8] A discussion of how to use food consumption data from household surveys in the construction of Food balance Sheet is included in an unpublished working paper by Naiken (1999).
[9] Thus the suggestion by Smith et al. 2006 (footnote 15, p. 20) is irrelevant for the problem at hand.

how to impute missing values will call for specific assumptions which may introduce a certain degree of subjectivity in the analysis that should not go unnoticed.

In addition, when the distribution in the population is skewed, non EPSEM sampling design, such as for example two stage sampling very common in household income expenditure surveys, may lead to a systemic bias in the estimate of variability indicators.

All these considerations raise reservations on the possibility of obtaining a reliable estimate of DEC variability through the observed empirical variance of individual household data in a survey. The procedure of aggregating individual household level data into groups, as discussed above with reference to the estimate of the mean, can be used but caution need to be devoted to the fact that averaging within groups of household will eliminate not only the "unwanted" variability of DEC, but will also eliminate some of the variability that is expected to be, so to say, "physiological" in a population, due to the fact that even those who are adequately nourished will vary in their level of food consumption.[10] How to control for such a problem can be debated but the merits of any solution should be weighted against those of any alternatives by considering all other implications discussed above. The solution adopted by FAO will be presented and its merits and potential drawbacks discussed in the next section.

The question remains of how the distribution of DEC can be estimated when *no data on individual DEC* is available. This is indeed a thorny question, and the proper answer should have been that it is impossible to do it at a reasonable level of reliability, and that any estimate of undernourishment when no data on individual DEC is available is likely to be affected by large uncontrolled errors. [11] Again, the FAO operational solutions devised by FAO are discussed in the next section. In any case, the hope is that, in reasonable time, the relevance of this issue will be greatly reduced thanks to widespread availability of household surveys reporting DEC data on all countries.

2.3.4. Estimation of the cut-off level L_r

As discussed above, the proper cut-off point needed to evaluate, in a probabilistic sense, the prevalence of undernourishment in the population is the Minimum Dietary Energy Requirement (MDER), which should be properly interpreted as the minimum of the distribution of DER in the population.[12]

As individual DER cannot be observed, and therefore there are no bases for direct estimate of its distribution, indirect estimation procedures are needed. Such procedures may be based on available information from nutrition experts, as obtained through nutrition surveys and clinical trials, and on knowledge of the demographic structure of the population.

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[10] With reference to Figure 1, this will be the variability manifested by the vast majority of those having a level of DEC within the ranges of MDER and XDER.

[11] One if not the fundamental reason why individual country estimates of the prevalence of undernourishment were not published by FAO until 1999, was acknowledgment of the unreliability of country figures due to the lack of proper estimate of CV_x.

[12] In a given population, in a certain moment in time, and conditional to the level of physical activity that is deemed acceptable, this is a single value. Contrast this with figure 1 in Svedberg (2002, p7) where a *distribution* of the minimum energy requirement in the population is depicted.

2.4. Do we do it well enough?

Before entering into the details of the actual implementation, it must be recalled that an indicator is always an *estimate*, and not a direct measure, and this is the case also for the FAO hunger indicator. Evaluations of its quality should take into consideration, as mentioned before, both the *precision* of the estimate and the *feasibility* of alternatives.

There is no question that, were detailed representative surveys available, these could be used to directly estimate the parameters of the distribution of DEC. Given the paucity of surveys available when the methodology was initiated, FAO had to devise other methods to be used for an *indirect* estimate of the parameter, methods which have been subject sometime to harsh criticism, and whose resulting estimates have been received with wide skepticism, though in our opinion no fully valid alternative has been proposed so far.

More precise estimates should, could and will be produced when the various sets of elementary data will be available of better quality at reasonable cost and in a timely fashion. Nevertheless, we still believe that the methodology that FAO has devised and the practical implementation procedures it adopts constitute a good compromise, considering the quality of the available data.

2.4.1. How do we choose the probability model for $f_x(x)$

Currently, the marginal distribution of DEC in the population, $f_x(x)$, is assumed by FAO to be Log-Normal, with country specific parameters. Choice of the Log-Normal is admittedly *ad-hoc*, being guided by pragmatic considerations linked to the flexibility of the log normal model and the parsimony in the number of parameters (the mean, $\bar{X}$, and the coefficient of variation, $CV_x(x)$) needed for its characterization.

When the method was first proposed, three theoretical distributions were tested, the Normal, the Log Normal and the Beta. The Log Normal was chosen based on the much better fit of the data from the few household surveys available at that time (See the discussion in FAO 1987, p. 63). Since then new survey evidence has become available. Preliminary tests we have conducted so far, on a number of recent HIES surveys (and after controlling for the effect of the presence of outliers) have consistently failed to reject the assumption of Log Normality.

We are currently undergoing a thorough revision of all available HIES data, in order to update the parameter estimates for all countries for which new surveys have been made available, and one outcome of this revision will also the provision of data for an extended battery of tests of the Log Normality assumption. Indeed, there will be no theoretical or practical reason to maintain that assumption if we should discover that it is at odds with the evidence.

2.4.2. How do we estimate mean per capita food availability

The mean food consumption in the population can be estimated from household level data on food available for consumption obtained through surveys. When surveys are stratified and expansion factors are available, these can be used to project the sample mean to the population, at national level and at sub national levels, either by geographic areas or by socio-economic population groups.

Unfortunately, though the situation is rapidly improving, surveys are still not available for every Country and every year. Therefore, the second best alternative for FAO has been to use the per capita availability of food for consumption, as recorded in the FAO FBS, and convert them in dietary energy thus obtaining a measure of per capita DES to be used as estimate of the mean of the DEC distribution. The parameters needed to convert quantities of particular food items into corresponding DES are obtained by the FAO Statistics division from available sources, updated when new information is available and checked for consistency.

The major advantage of using an estimate of the mean food supply from aggregate data is that they are already compiled by FAO every year.[13] Whereas it is true that there are many aspects that raise concern on the reliability of the FBS, the resulting estimate of the mean dietary energy consumption may be more precise than each individual component, due to the fact that errors in various elementary components may cancel out with aggregation.

Until the situation on the country coverage of recent surveys providing food consumption data improves, we might need to continue taking the second best option of using Food Balance Sheets, and this entails a serious continuing effort at improving the reliability of the way the food balance sheet estimate of the mean is conducted.

It is not the case to go into details of the actual procedures followed by FAO at this moment,[14] but some of the points raised in section 2.3.2. above still need to be carefully reconsidered.

2.4.3. How do we estimate the CV of the distribution of per capita food availability

The second parameter needed to fully characterize the marginal distribution of DEC, $f_x(x)$, is the coefficient of variation, CV_x, and it has always been clear to us that its precise estimation presented significant challenges.

As mentioned before, surveys are essentially the only available source of data on the distribution of DEC, though their variability may be affected by several problems. When data on individual food consumption from surveys is available, the estimation of the CV of DEC is conducted by FAO in two steps, with the overall objective of reducing the incidence of those problems.

First, individual household data are grouped in income classes, and only an average of the per capita food consumption in each class is considered in calculating the coefficient of variation of DEC *across income classes*.

By averaging within an income class however, most variation in the level of the DEC due to factors that are not strongly correlated with income are clearly netted out. The resulting measure of CV should thus properly be interpreted as an estimate of the component of the total variability of DEC in the population due to income, which we term $CV_{x/v}(x)$.

While the role of income in explaining DEC and its variability within a population is at the heart of all theories of poverty and economic development, and as

[13] See FAO (2001) for an extended presentation of the FAO methodology used to prepare FBS.
[14] A discussion is included in Sibrian et al. (2007).

such, it is hopefully well understood by development economists and policy analysts, there are certainly other factors inducing variability in DEC. These are factors that are to be considered physiological in a population, and that should therefore be tolerated and not removed in the context of attempting to reduce the inequality in distribution and eliminate the prevalence of undernourishment (or over nourishment) over time.

If it is true that people tend to consume according to their respective DERs, and as long as there is an inter-individual variation in DER, there will be variation in DEC due to this factor. For this reason, a component reflecting the variability of DEC induced by the factors determining variability of DER, $CV_{x|r}(x) = CV(r)$, is considered, and the needed coefficient of variation is estimated as:

$$CV(x) = \sqrt{\left[CV_{x|v}(x)\right]^2 + \left[CV_{x|r}(x)\right]^2} \qquad (3)$$

For practical reasons and for lack of adequate data on which to base a precise country level estimation of this second component, $CV_{x|r}(x)$ has been assumed equal to 0.20 for many countries. How the value of 0.2 has been obtained is described in Appendix B of Naiken (2003, pp. 34-35).

Though this may have looked as an ad-hoc adjustment, it has been lack of adequate data that has informed its choice.

More problematic has been to devise procedures to be followed when no data on individual household food consumption are available. To this aim, since the first proposals, country had been classified in different groups, depending on the type of available data, but it has been always clear that the estimation procedures would become more shaky as we moved down the list, and the results should have been accompanied by more than a simple note a caution (see footnote 11 on page 13). We have attempted to continuously improve on the specific procedures, with the set of current ones as described in Annex II. [15] As we are committed to continued improvement of the overall reliability of the estimate, any comment in this respect will be highly welcome.

2.4.4. How do we estimate the cutoff MDER level

To estimate the MDER FAO has devised an indirect procedure based on recommendations on what the acceptable ranges of DER would be in groups of individuals of the same sex and age, and on the observed sex-age composition of the countries.[16]

In practice, a minimum dietary energy requirement for each sex-age class of individual is estimated, based on recommendations by experts on what is the energy requirement (based on the Basic Metabolic Rate) for the lowest acceptable body weight for that sex-age combination, and adjusted for a minimal Physical Ac-

[15] Annex II, by Nathalie Troubat, contains a description of the procedures currently adopted by FAO to estimate CV of DEC for data available from alternative sources.
[16] FAO (2008, section 3.2 and Appendix) contains a detailed description of the current method for estimating the MDER cutoff point.

tivity Level (PAL) compatible with a healthy life. [17] Estimated minimum DERs of each sex-age class are then aggregated at the country level using the proportion of the population in the corresponding sex-age groups as weights.

While no large variation is expected to exist between the metabolic rate of people in different countries within the same sex-age group, (though differences across latitude could be important), the sex-age composition of the population changes over time, and so does the estimated cut-off point L_r.

2.5. Have we communicated it well?

As the number of criticisms that have been raised on the value of the FAO hunger indicator demonstrates (especially in consideration that some of those criticisms have been affected by important misunderstanding on what was actually being done) FAO is certainly guilty of insufficient and/or inefficient communication.

One element that might have contributed to reduce the extent of the misunderstanding is the lack of communication of the degree of confidence we put on each of the published number. Raising attention on the uncertainty surrounding some of the point estimates might have helped users of the indicator to better frame questions regarding the appropriateness of the indicator.

Until 1996, figures were published only at an aggregate level. Aggregating to the level of regional figures was believed to reduce the overall impact of individual country figures imprecision, so that the aggregate, three year average was deemed acceptably precise to monitor global hunger. Following publication of the Sixth World Food Survey, however, a decision was made to publish also the figures related to individual countries every year, even when no reliable data on which to base precise estimates was available. The decision obviously required us to try and make all possible efforts to improve on the estimates for individual countries, by collecting all available information on household surveys and process them in order to obtain the needed estimates. The speed at which that revision has been conducted has been affected by the amount of resources available to that task, and has been certainly insufficient so far.

Publication of individual country figures which could not be considered having an acceptable level of precision has, in retrospect, probably been a mistake, even though those were the best possible estimates we possessed. Some apparent inconsistencies in some of the published estimates might have raised the suspect that there could be fundamental problems in the method being applied, rather than being just a feature of the limited amount of information on which those estimates were produced.

We are hoping to contribute to clear the ground from such unfounded suspects and practical skepticism. That there may be problems with some aspects of the methodology is undeniable, as it should be equally undeniable that FAO has always been open to criticisms and willing to discussing them. Some of the past accusations on not having been transparent enough (for example, those advanced by

[17] This operational assumption reflects the underlying theoretical assumption of the existence of a physiological variability of energy requirements within a population, due to the different requirements of individuals with different body weight structure and different physical activity levels, which are compatible with adequate nutrition.

Svedberg, 1999) have been rapidly addressed. Responding to the criticisms has always been considered as an opportunity to make the entire methodology even more transparent, and this paper follows in that tradition.

We are undergoing a thorough strengthening of our communication efforts. In the process of assistance to individual countries in processing household survey data, dedicated software has been developed and it is distributed to those who request it. It is being continuously updated by the FAO ESS Statistics division and includes extended documentation.[18] The recently upgraded website, just launched on February 14th 2011, is a sign in this direction.

It is only once the ground will finally be cleared of the suspicion of errors in the overall methodology that we, as a community, can focus on the real question of how to improve the reliability of existing estimates, and on how to broaden the set of indicators that can be produced with the available data, and within the same broad methodological framework. The following two sections briefly elaborate on some of these points.

3. Moving forward

3.1. What is being done to improve the current indicator

As it should be evident from the previous discussion, the limited reliability of the estimator of prevalence of undernourishment as published by FAO for some countries and some years can be traced to the quality of the available elementary data and to the difficulties that must be overcome in processing incomplete and sometime erroneous information. Such difficulties may have imposed too heavy of a burden in the past on the FAO Statistics division, which was at the same time putting its best resources in trying to resist to largely unjustified methodological challenges, while being under the continued pressure to increase the time and geographic scope of the estimates it produced, especially because of the perceived importance of the indicator.

There are several avenues we have already taken to reduce the existing problems. Let us focus here only on the two most burning issues.

3.1.1. Revision of existing estimates of CV's

One of the most often cited criticisms of the FAO estimates of undernourishment at country level was that they did not appear to change has much as it was perceived to be the case, following periods of reported economic growth of several countries.

While some of the puzzles may have been arisen from a partial confusion between hopes and evidences, they nevertheless drove attention to the reasons for limited variability of the measure over the years.

[18] See the documentation on the FSSM software available on line at: http://www.fao.org/fileadmin/templates/ess/documents/food_security_statistics/household_survey_programme/FSSModule2.pdf

That the distribution of the coefficient of variation of DEC was not promptly updated when new evidence had been produced through surveys has definitely been a mistake, no matter how justified by the limitation in resources available to process the new surveys. Also, the publication of conflicting figures for individual countries in the SOFI and in the specific country reports is difficult to justify on any defensible ground.

We have already mentioned the program of processing a large set of household survey data that have been produced over the years and made available by several institutions, including FAO. This activity intends to ensure that elementary data are processed in a consistent way as regarding: conversion of food items into calories, identification and treatment of outliers, identification and treatment of missing values. This is a daunting task for the resources available within the ESS division, and therefore we are seeking for ad hoc external assistance. We recongize that extra effort is needed now, to bring the activity of survey data processing to pace with their production, but we expect that, in the future the demands from such activity may be more diluted over time. By mid-year, we expect a significant number of surveys to be processed and the corresponding values of $CV_{x/v}$ updated.

3.1.2. Devising proper methods for interpolation and extrapolation

Many parameters used in the procedure are by their nature, time varying. Given that, as pointed out by many critics, the FAO hunger indicator is rather sensitive to the value of key parameters, it is essential that such parameters be updated as soon as new information is available.

Estimation of one of the key parameters in the model, namely the CV of DEC is based on data from household surveys which have not been available on a continued basis for all countries in all years. Admittedly, this is one of the limits in the current FAO published estimates of the number of undernourished at the individual country level. For many countries, lacking new household level information, the CV of DEC has been kept constant over the years, with the effect that some of the possible changes in the prevalence of undernourishment associated with this particular aspect of the phenomenon have been overlooked.

We are rapidly correcting this problem. Recently, FAO has undertaken an intensive program of collection and processing of data from a large number of available household income expenditure surveys, and the soon the updated estimates of the CV of DEC will be available for many countries. This will imply that some of the figures published in the past will be revised. While the change that this will imply on the global level of undernourishment is expected to be small, for some of the individual countries we may find sizeable differences.

Additionally, as the surveys are never going to be available for every country every year, we are studying methods to better interpolate the estimates of undernourishment in the years between those when surveys and other fundamental data are made available.

The general approach we wish to take is that of interpolating the values of the variables associated with relevant dynamic phenomena[19] and to revise the estimate of the various parameters needed to produce our final indicator based on the interpolated values.

Research is being conducted in exploring the relationship existing between the CV of DEC (in its component due to income) and per capita income, possibly controlling for income distribution. The hope is that, in this way, we will have a quick method to properly update the series of estimates for the year between surveys and to project it for the year when no survey is made available yet.

3.2. Which other indicators may be rapidly produced, given the available data

As noted in the first section, an indicator of chronic hunger as the prevalence of undernourished in a population is by no means sufficient to provide a comprehensive picture of the many dimensions related to lack of adequate nutrition, both in terms of the causes and of the consequences.

In the following we put up for debate the proposal for three additional indicators, which could be easily produced given the available information, and which would be fully consistent with the theoretical underpinnings of the current methodology. While this list does not exhaust the set of needed additional indicators, it is certainly a starting point for a constructive debate.

3.2.1. An indicator of the prevalence of continued over nourishment

As the methodology already provides for estimation of the distribution of DEC and (albeit indirectly) of the distribution of DER in the population, it would be natural to also measure the proportion of the population which is over nourished. To do so, the area below the marginal distribution of DEC and above a threshold equals to the estimated maximum of the distribution of the average individual's requirement (XDER), can be easily calculated.

3.2.2. A measure of the prevalence of people under food stress, or an alternative definition of hunger

The cut-off point to evaluate chronic hunger is defined by taking as reference the minimum acceptable physical activity level compatible with a healthy life. If one is interested to evaluate the potential impact of undernourishment of the potential for economic progress, a higher PAL should be considered, compatible with an economically active life. Definition of another cut-off point, say MDER* > MDER, would allow estimation of the prevalence of "*economically significant*" hunger.

3.2.3. A measure of the depth of food deficit

The average of the individual's dietary energy requirement, ADER, is a proper *normative* reference for adequate nutrition in the population. While it would be mistaken to take the value ADER as the cutoff point to determine the prevalence of undernourishment (as some of the critics have suggested), its value could be used

[19] Very important among the relevant phenomena that should be taken into account are: food availability, income growth (with the accompanying change in income distribution) and population growth (with possible change in demographic composition).

to calculate the ***depth of the food deficit*** (FD), that is the amount of dietary energy that would be needed to ensure that, if properly distributed, hunger would be eliminated. Such an index could be calculated as:

$$FD \equiv \int_0^{L_r} (ADER - x) f_x(x) dx \qquad (3)$$

4. Conclusions

This note has discussed the theoretical bases and the various operational assumptions adopted by FAO in producing its index of the prevalence of undernourishment.

Taking stock of the many criticisms that have been made to the FAO index over the many years in which it has been published, we have reconfirmed the soundness of the overall methodological approach and explained the rationale behind the many assumptions that are needed to produce, on a continued basis, a reliable estimate of the likely percentage of people suffering from chronic hunger, given the current capacity of researchers, governments and international institutions to collect elementary data on the field.

We have also pointed to several issues that we ourselves, as some of the authoritative commentators, deem critical, and on which there is certainly room for improvement, both in the treatment of the elementary data to reduce the effect of various measurement errors, and in the theoretical assumptions made to make up for the missing information.

On all these points, the FAO as a whole and the Statistics division in particular, have engaged into a deep scrutiny of each of the many procedures that are required to compile the estimate, and are committed to keep the broad community of users of the FAO hunger timely informed of all the results that this activity will yield.

If and when changes will be identified that may lead to the improvement of our estimate, we will offer them for discussion, hoping that our work will continue to be considered as important as we think it is, and to attract the level of qualified attention that it has so far, even if sometime it may come under the form of underserved harsh criticism.

We hope that this period of increased attention on the fundamental issues at stake will be fruitful in setting a more productive environment, in which all institutions and individual researchers work together to the common objective of increasing our strength in fighting hunger.

Rome, February 14 2011

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ANNEXES

ANNEX I

Food Balance Sheets and the Food Consumption Survey: A Comparison of Methodologies and Results[♣]

1. INTRODUCTION

The most common and widely used data sets in the field of food consumption statistics are obtained through food balance sheets. They provide estimates of quantities available for human consumption in a country during a specified period. Information on food consumption or availability is also available from surveys of household consumption or expenditure.

Due to differences in the concepts and definitions used and to measurement errors, the data from these two sources are not expected to be directly comparable. It is the purpose of this paper to review the differing conceptual and practical approaches of these two sources of data on food and to consider when and how they may be used to complement each other.

2. FOOD BALANCE SHEETS

Food balance sheets present a comprehensive picture of the pattern of a country's food supply during a specified reference period. A food balance sheet shows for each food item - i.e., each primary commodity and a number of processed commodities potentially available for human consumption - the sources of supply and its utilization. The total quantity of foodstuffs produced in a country added to the total quantity imported and adjusted for any change in stocks that may have occurred since the beginning of the reference period, gives the supply available during that period. On the utilization side, a distinction is made between the quantities exported, fed to livestock, used for seed, put to manufacture for food use and non-food uses, lost during storage and transportation, and available as food for human consumption at the retail level. The per caput supply of each such food item available for human consumption is then obtained by dividing its respective quantity by the related data on the population actually partaking of it. Data on per caput food supplies are expressed in terms of quantity and also in terms of caloric value, protein and fat content.

It is important to note that the quantities of food available for human consumption, as estimated in the food balance sheets, relate simply to the quantities reaching the consumer in private households, as well as in the non-household sector, i.e., catering establishments, boarding schools, hospitals, prisons, armed forces' bases and other communities. The amount of food actually consumed may be lower than the

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[♣] This text is available on line at: http://www.fao.org/economic/ess/methodology/methodology-systems/food-balance-sheets-and-the-food-consumption-survey-a-comparison-of-methodologies-and-results/en/

quantity shown in the food balance sheet. The difference reflects waste occurring between the retail level and the kitchen and losses of edible food and nutrients in the household, e.g., during storage, in preparation and cooking (which affect vitamins and minerals to a greater extent than calories, protein and fat), as plate-waste, or as quantities fed to domestic animals and pets, or that thrown away.

The accuracy of food balance sheets, which are in essence derived statistics, is of course dependent on the reliability of the underlying statistics of supply and utilization of food and of population.

Among the practical issues that often must be addressed in constructing food balance sheets, a conceptual problem frequently arises with respect to the coverage/representativeness of the basic data. Production statistics are mostly confined to commercialized major food crops. Non-commercial or subsistence-level productions usually are not included.

The incompleteness and inaccuracy of the basic data are the major problem encountered in developing countries. Production statistics may not be available for all commodities needed. And even where the statistics are available, they are not always complete or reliable. An appreciable part of total production is non-commercial or subsistence production, i.e., foodstuffs grown or gathered wild by households for their own consumption. The estimation of production of some crops is further complicated because they are continuously harvested at regular or irregular intervals over a long period of time, e.g., cassava, and certain fruits and vegetables. Moreover, for certain crops, the produce is not completely harvested; a portion is held back as a reserve from which to draw if the need arises or even left to rot, e.g., cassava and plantains. Moreover, certain kinds of food may not be covered by food balance sheets because they are not included in national production statistics. Meats, such as those of game, wild animals and insects, may be excluded for this reason. Under conditions such as those prevailing in many developing countries, these meats may form a substantial part of the low consumption level of animal protein. Also, major food crops may not be grown in pure stands but mix-planted in fields of bewildering complexity. In such instances, per caput food consumption data derived from household surveys, multiplied by population numbers, can sometimes help to provide the required production estimates.

Import and export data may be reasonably accurate in the majority of countries, but in some countries significant amounts of trade across national boundaries go unrecorded. Moreover, import and export transactions may not receive equal attention from the custom's administration because taxes and/or quantitative controls are generally concentrated more on imports than exports. As a consequence, the reliability of export data may also be questionable.

Seeding rates for crops are fairly well established in most countries, but when the quantities fed to animals have to be estimated, many aspects must be considered. Feeding practices vary from country to country according to the quantity and quality of pastures, the degree to which rearing is intensive, the prices of feedstuffs, etc.

In addition, the quality of grain and other feeding stuffs fed to livestock may vary from one year to year to the next.

Often in constructing the food balance sheets, a number of adjustments on the basic data as well as imputations/estimations of the missing data have to be carried out. Once estimates of the other components have been made, the estimate of food available for human consumption is usually derived as a residual according to the following equation:

Food available for human consumption =
Total food supply - Feed - Seed - Industrial uses - Waste.

Since the estimate of food available for human consumption is derived as a residual, its reliability would depend on the availability and accuracy of the other components on which it is based. In the case where the majority of the basic data are available and reliable, and the adjustments are based on second judgments, the estimate of the food available for human consumption is likely to be reliable.

It stands to reason that where the basic data are incomplete and unreliable, an estimate of food available for human consumption is unlikely to be accurate. Furthermore, since it is derived as a residual, the error is unquantifiable and its direction is also unknown. In view of the frequent use of the estimate of food available for human consumption in various food and nutritional studies, it would be desirable if a more reliable and justifiable estimate of this component could be made available. At a minimum, this means the quantity of food available for human consumption would have to be estimated independently based on other existing statistical sources of information. One such source would be a household survey which collects quantities of food items consumed or acquired. Consideration of the survey data as the basic statistics pertaining to the food availability element does not, of course, necessarily imply using them directly as the estimates of food availability. They should rather be used as inputs or starting points in a process of adjustments that will have to take into account conceptual differences, judgments regarding data quality and also the consistency in relation to the inputs or estimates for the other elements of the food balance sheet. The use of the survey data in this manner should help to reduce the reliance on the residual or balancing approach in arriving at the food availability estimates, while also allowing more flexibility in handling the other elements for which the basic statistics are poor.

3. HOUSEHOLD SURVEYS

The main objective of household food consumption or dietary surveys is to collect data on the quantities of food items consumed by a representative sample of households selected from the population. They provide detailed data on food consumed in the household as well as away from home, i.e., any food and beverages, meals and snacks eaten outside the home by members of the household. The information on household food consumption are obtained by weighing and measuring food items to be used before the preparation of each meal (in some surveys, food wasted on the plate also is weighed). Information on food consumed away

from home are obtained by interviewing each member of the household. The food consumption data obtained from this type of survey represent an estimate of the quantities actually eaten. The enumerations normally are carried out for a period of two, five and seven consecutive days. This type of survey calls for very careful supervision by the interviewer and close cooperation of the respondents. In general, these surveys are rather complicated and costly to undertake and, therefore, are not always carried out frequently, or even at regular intervals.

On the other hand, the household income/expenditure survey or budget survey, which collects data on food items as an integral part of its broader enquiry on household consumer expenditure and income, is being undertaken on a more-or-less regular basis in many, if not most, countries. These surveys attempt to measure household consumption through the expenditure approach, i.e., the monetary value of the food (as well as other goods) acquired by households. In the past, many of these surveys were confined to household expenditures. Moreover, in developing countries they often covered urban areas only. However, over the years, the trend has been toward nation-wide surveys and to cover self-produced food, food acquired through barter, gifts, payment-in-kind etc., - all of which are important factors in rural areas. Furthermore, the practice of systematically recording both expenditure and quantity has become commonplace.

Information on food, whether purchased or otherwise acquired, is normally collected by interviewing household respondents (recall method) or by record-keeping. Since quantities of food that are wasted or lost at the household level, including food fed to pets, food consumed by visitors, etc., are not normally accounted for, the household data obtained tend to reflect consumption levels similar to those obtained from the food balance sheet (food availability) for the nation as a whole. However, it is only the expenditure data that are normally processed and tabulated.

Data on household expenditure from household expenditure surveys are collected primarily for the construction of cost-of-living indices. Hence, from the consumption perspective, the focus is on household acquisition of both food and non-food items (i.e., obtained either from purchases, home produce, hunting, fishing, gathering, or in lieu of cash income earnings). The food expenditure data, which are collected either by interview or book-keeping methods, therefore, normally refer to food items acquired by the household. The food consumption data obtained from the household expenditure surveys generally reflect the food acquired by, or available to, the household during the reference period. Wastage or losses in the household, such as food fed to pets, leftovers, food thrown away, etc., are not normally accounted for.

The reference period used in collecting the data of food from each sample household is usually one week, one month, or more. Field enumeration is usually carried out for a period of twelve months (i.e., sample households are spread over a period of twelve months). Therefore, overall average estimates of food consumption results refer to average food consumption during the course of a year.

As far as the concept and reference period of the food acquired/available are concerned, the ones adopted by the household expenditure surveys are similar to that of the food balance sheet. A distinction arises in that food balance sheets take account of food available to collective households and institutions, such as military camps, boarding schools, hostels, hotels, nursing homes, homes for elderly people, hospitals, prisons, religious houses, etc., whereas household surveys normally do not.

Thus, in the absence of such information, national estimates of total quantity of the food consumed/acquired from household surveys would be expected to understate the level of total food available for human consumption. This error could be minimized by instead using the estimates of the average per caput quantity either consumed or acquired. This should be calculated by dividing the estimates of the total quantity either consumed or acquired of the commodity in question by the total number of persons in the households. An estimate of total food available for human consumption is then obtained by multiplying the average per caput figures with the estimate of total population.

Information on food eaten outside the household is usually collected in household expenditure surveys. However, the information collected refers to monetary values only. As such, the quantity data exclude the quantities of food eaten away from home. This omission has little effect on the national estimate of average per caput consumption figures for countries where eating outside the household is not a common practice. However, for countries where a significant proportion of food is eaten outside the home, consumption would be underestimated accordingly.

4. COMPLEMENTARY ROLE OF HOUSEHOLD SURVEY AND FOOD BALANCE SHEET DATA IN THE ASSESSMENT OF THE FOOD SITUATION

Although data for a given country from both the food balance sheet and the household survey refer to food availability, the overall per caput estimate obtained from the household survey is not expected to be the same as that from the food balance sheet. The principle reason is that while the food balance sheet refers to the total amount of food available for human consumption in the country, the household survey is confined to the part flowing to the household sector. The difference will therefore depend on the share of consumption in the non-household sector (restaurants, street food, public houses, hospitals, army barracks, etc.). The difference may be smaller in cases where the household survey has attempted to take account of food eaten away from home.

For the purpose of assessing the food availability or consumption levels of the population as a whole, it appears that the food balance sheet is a more appropriate source than those of the household survey. Furthermore, since the food balance sheet is based on frequently updated food and agricultural statistics, the estimate has the added advantage of being available on a more or less current basis.

This does not mean the overall per caput averages from the household survey are not useful. They may well serve to improve the food balance sheet estimates in

some respects. This is particularly true regarding the consumption of minor food crops as well as self-produced food (own consumption). Furthermore, broad consistency checks can be made by comparing the consumption patterns (contribution of various food groups to the total) from the two data sets. The principal asset of the household survey is the generation of household-level data that enables an assessment to be made of the variation in food availability among households. Since this variation is not likely to change significantly in the short term, the related data need not be available as frequently as the food balance sheet data.

5. CONCLUSION

Although both household surveys and food balance sheets provide data on food supply/consumption, discrepancies should be expected between the data obtained from these two sources. In fact, discrepancies are also to be expected between data from different types of household surveys, namely, the income/expenditure/budget survey and the specialized food consumption survey.

Differences in the concepts, definitions and in the methodology used in food balance sheets and in household surveys are the main reasons for the discrepancies. Food balance sheets provide data on food supplies, while data on food consumption obtained through household surveys can be classified into two types. The first type, obtained mostly from income/expenditure/budget surveys, is the quantity of food available to or acquired by the household; the second type is an estimate of the quantities of food intakes, which is ideal from the nutritional point of view.

Although the survey data refer to averages during the course of a year, the reference year (survey period) used may not correspond to the calendar year which is normally adopted in the food balance sheets. This is not a serious issue since the level of food consumption in the country normally does not change significantly during such a short period.

Food balance sheets measure the total quantity of food flowing into both the household and non-household sectors, without taking into account losses of edible food and nutrients in these sectors. The household surveys normally do not cover food consumption in the non-household sector. Among such surveys only the specialized food consumption surveys take into account losses and wastage at the household level. Therefore, food data derived from food balance sheets should exceed that from household surveys.

Measurement deficiencies also contribute to discrepancies between food balance sheets and household surveys. The reliability of the data from food balance sheets depends on the available range and accuracy of basic statistics, such as production, trade, utilization and population data on which food balance sheets are based. The reliability of data from the household surveys depends on the magnitude of sampling and non-sampling errors.

To summarize, both data sources have their own separate purposes and uses. For assessing food availability/consumption they should be used in a complementary

manner. Food balance sheets provide data on the national average of food supplies which are suitable for estimating the overall shortages or surpluses in the food supply of a country. They provide no indication of the food consumption levels of people living in different geographic areas of the country, or in different occupations, or at different income levels. Such supplementary information can only be obtained from household surveys that provide details on the distribution of food consumption among different population groups.

As far as the food consumption levels of the consumers is concerned, food consumption data obtained through household surveys provide a better estimation of the actual level of food consumption, provided that food eaten away from home is included. In the absence of data from household surveys, food balance sheet data provide a good proxy for food consumption levels of the population as a whole.

It is evident that the concept of food consumption data adopted in the household surveys is not perfectly compatible with that of the food balance sheets. To some extent, however, the two sets of data are complementary. For certain commodities a production estimate could best be derived from food consumption surveys. On the other hand, there are commodities for which production, trade and utilization statistics could give a better nation-wide consumption estimate than the data derived from food consumption surveys. Thus, survey data could be considered as a basic statistic pertaining to the food availability element of the food balance sheet.

Using the survey data in the construction of food balance sheets has several advantages. The immediate advantage is that the estimate of food available for human consumption is an independent estimate; consequently its reliability can be, to a certain extent, independently assessed. Moreover, while the residual approach employed in the food balance sheets may still be necessary in some cases, the use of survey data to arrive at an estimate of food availability means that any utilization element could be treated as a residual depending on the situation.

For instance, typically the basic data on stocks and waste are rather limited. The food consumption figure from household surveys could be used as an indicator in arriving at plausible estimates of these two elements. For example, where the results of a household survey indicate the consumption of a particular commodity has increased, and the production and trade data do not suggest such a rise, this might be an indication of a large withdrawal from stocks. Moreover, because most food is perishable and household food waste is relatively small, the estimates of per caput food available for human consumption from food balance sheets have usually been used as an approximate level of food actually consumed. This may work reasonably well in developing countries, but in developed countries, this approach can overstate the level of consumption because the amount of food spoilage and waste in catering establishments is rather high. Household survey data may prove useful in such instances for adjusting the waste component in the food balance sheet.

In cases of minor food crops, such as fruits and vegetables, for which production statistics in many developing countries are rather limited or unavailable, the con-

sumption figures from household surveys may be used to arrive at production estimates, particularly in light of the perishable nature of these foods.

Moreover, because household surveys usually include all food items, estimates of average per caput calorie consumption can be derived and this may in turn be used as an independent check on the estimate of per caput food availability from the food balance sheet. In principal, the difference between the two figures should be minimal and their trends should be similar.

ANNEXES

ANNEX II