What do we <u>really</u> know about food security?[*]

Carlo Cafiero (and Josef Schmidhuber ?).[†]

Incomplete Draft

not to be cited without prior consultation with the author(s)

August 8, 2012

Abstract

Many discussions following the 2007/08 food price crisis have revolved around the magnitude of the negative impacts that it may have had on food security worldwide. Analysts have been asked to provide timely assessments, often based on partial data and information. The variety of opinions and the ranges of reported estimated impacts that have followed have revealed how shaky the informational ground on which they move is.

This paper deals with two issues related to the way in which the state of food insecurity in the world can be assessed from the perspectives of the availability of and the access to food, the dimensions for which the economic lenses conceivably are the most adequate. The two issues are: the quality and coverage of available data and the methods through which the relevant information is filtered from the data to draw inference on food security.

The conclusion we reach is that, for policies to be informed by solid evidence, and to be sure that monitoring and evaluation is based on firm empirical grounds, much remains to be achieved, both in terms of data coverage and quality and regarding methods, standards and tools for assessment. However, we do not have to start from zero. A wealth of data has accumulated in the past that, if properly analyzed, may allow for shading light on the working of food markets and on households' behavior towards food consumption, including the determinants and impacts of price volatility.

Once key data conveying information on those determinants have been identified, a comprehensive food security information system can be devised based on a key set of core indicators. To this aim, a concerted effort must be made in promoting the use of common standards in the collection, validation and dissemination of data, both on agricultural prices, production, trade and uses, and on food consumption patterns.

Keywords:

JEL classification:

---

[*] The views expressed here are the sole responsibility of the author(s) and do not reflect those of the FAO.

[†] FAO Statistics Division. Carlo.cafiero@fao.org (and Josef.schmidhuber@fao.org ?)

"It is well known that there is much starvation and malnutrition in the world. Millions of people never get enough to eat, and much large numbers, not actually hungry, do not obtain the kind of diet necessary for health. Vague knowledge that this situation exists is not enough; facts and figures are needed if the nations are to attempt do to away with famine and malnutrition …"
FAO - The World Food Survey, 1945

1. Introduction. Putting the paper in context

This paper is concerned with measuring food security. Since early 2008, when the FAO Food Price Index reached the 200 mark, its highest level in thirty years, huge amounts of intellectual energy have been spent in trying and assess the causes, the likely impacts, and the possible remedies to what has by now come to be known as the 2007/08 "food crisis," paralleling, in many respects, a similar effort that had been produced following the previous great food crisis of the early 1970s. The tone of the debate within academic and international organizations circles has been at times heated, due to differences in opinions about many aspects, including: the role of financial speculation in conditioning agricultural commodity markets; the impacts of the growing demand for agricultural commodities to be used for biofuel production; the consequences of trade policies and other forms of market interventions, etc.

As a contribution to this overall effort and to possibly resolve some of the outstanding issues, the focus of this conference is on the economics of food price volatility. Attention to prices in relation to food security stems from the almost obvious consideration that prices *must* carry an important signal of relative food scarcity, at least when and where the predominant way of accessing food is through market transactions. Based on the visibility it is given in the press and in much of the academic work concerned with food security assessment, the above cited FAO Food Price Index seems to have been adopted by the international community as a meaningful indicator of relative food scarcity. The problem is that, as more evidence is gathered on actual food availability and food consumption worldwide, there appears to be very limited – if any – relationship between the time evolution of the FAO Food Price Index and the dynamics of what must be considered the fundamentals of price formation and of food security. This is a disturbing finding, which requires careful scrutiny both of the evidence and of the conceptual frameworks that have been used so far to inform the debate.

The thesis we offer for discussion here is that the *type* of data that has been used to search for evidence in support of one argument or the other and the *way* in which it has been used have both played a major role in widening the gap between opinions, rather than in closing it, as it should have been the case.[1]

We think we can offer a contribution by exploring the possibility that different *understanding* and *interpretation* of what the available data and indicators truly are may have been, at least in part, responsible for differences in the assessments. If we are correct in suspecting that the available evidence has been sometimes not fully recognized for what it truly is, and therefore not correctly interpreted as providing the evidence it is believed it does, then we can hope to have offered a valuable contribution to the debate.

To demonstrate that our thesis has value we start by taking stock of some of the data that is more directly related to food security. To keep the task to a manageable size, we limit the presentation to data related to two particular dimensions of the broad concept of food security: *availability* of food and on people's *access* to it. Also, we limit our considerations to the need to inform *aggregate level* indicators, at global, regional, and national levels.[2]

After a brief description of the typical information available on food prices, food supply, food consumption, we will touch on *methods*, by taking as a specific reference the debate that has surrounded the way in which the FAO has, since 1974, monitored hunger through the so called "prevalence of undernourishment" indicator.[3] The debate on the FAO estimates is an interesting one not only for the direct relevance it has for the topic of this conference, but because it raises important questions regarding problems such as the proper definition of a statistical concept that is relevant for the identified political objective, the use of data collected on individuals or households to inform population level indicators, and the inevitable combination of data and theories that are needed to come up with assessments. All

[1] By type of data we mean the combination of several aspects, including the timeliness with which data are collected and made available, the statistical concept associated with the data collected, and the precision with which the typical data point reflects the associated statistical concept. When referring to the way in which data is used, we mostly refer to the relative roles of the data and of the identifying assumptions, on which analytical models are unavoidably based, in the conclusions drawn from applied models.

[2] This is not to be meant to imply that we believe within country differences in the state of food insecurity are not relevant, quite the contrary. We only want to recognize the difference that exists between *population level* and *individual level* measures, a point that has sometime been overlooked in the discussions on food security, as will hopefully emerge in the discussion on the use of survey data.

[3] See in particular: Osmani (1992), Svedberg, (1999 and 2000); Smith, 1999; FAO, 2003; Smith et al. (2006); Naiken, 2007.

these questions arise in many fields of social and economic analysis, including for example on the analysis of poverty incidence.

The remainder of the paper is organized as follows. First, section 2 discusses the definition of food security, to underline one of the major problems related to its monitoring. Lack of clarity on what is meant by the generic expression "food insecurity" may in fact have led users into error when interpreting proposed data and indicators. The section ends highlighting the need for synthesis and to reach agreement on a set of key *operational* concepts that can be used as a basis to inform data collection and analysis.

Next, section 3 deals with data, cataloguing and describing few of the major sources of data on food prices, food supply and food consumption. Merits and drawbacks of the various sources are highlighted to suggest possible ways to improve and/or integrate them.

By making explicit reference to the debate that has surrounded the FAO indicator on undernourishment, section 4 will then touch on the problem of the relevant information signal must be filtered from the "noise" from the noise that is unavoidably contained in the data, in drawing inference on a complex phenomenon when we do not have the means to collect the ideal information. One key problem that is touched upon, is the relative role of models and data respectively defined and collected at the micro and macro level, and the possibility of integrating the two scales of analysis in a coherent way.

A final section closes the papers by proposing a concrete research agenda including a possible division of labor between international organizations, academia, non-governmental organizations and food security practitioners.

2. The importance of careful definitions: the concepts of food security and related indicators

Defining food security in a way that is operationally useful is a daunting task. The prevailing definition describes food security as the condition that "exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[4]

[4] The working concept of food security as adopted by the Committee of World Food Security goes even further, by clarifying that : "The four pillars of food security are availability, access, utilization and stability. The nutritional dimension is integral to the concept of food security and to the work of CFS." See Document CFS

If taken literally, the most important message this definition sends is that food security is a condition that… will never be achieved in practice! Even if the definition is properly recognized as being an aspiration statement, qualifications such as "all people at all the times" or "to meet their dietary preferences" clearly determine the virtual impossibility of a complete monitoring, something that is in striking contrast with declarations made in the same forum a few years earlier according to which "we have a *measurable* and monitorable goal."[5]

The definition is nevertheless useful in that it hints at several potential manifestation of what we may be term food *in*security, which would exist when:

a) People do not have *physical* access to food, simply because food is not physically available where and when is needed;
b) People do not have the *economic* access, means that they lack the means to *acquire* the food even if the food is at their physical reach;
c) People can only afford to procure and eat combinations of foods that do not meet their preferences, are not safe, or are nutritionally unbalanced;
d) Any one of the above conditions holds even occasionally.

Four *dimensions* or *pillars* of food security – commonly referred to as *availability*, *access*, *utilization* and *stability* – have thus been conceptualized (see footnote 4) as a way to provide better guidance to policy aimed at addressing the problem. The complexity that emerges from even the bare attempts at describing food insecurity it has a clear reflection in the difficulties encountered in attempts at measuring it and, which in turn play a role in the debate that discusses the merits of various indicators. It is evident that, no matter how desirable it may be, no single indicator can be imagined that captures each and all the identified dimensions that comprise the problem.

For an empirical measure to be meaningful, in fact, the statistical concept associated with it must be clearly defined, and therefore much narrower than the broad "food security" construct that comes out from the running definition reported above. In the history of food security assessment this has had two major consequences. First, there has been a proliferation

---

2009/2 Rev.2 entitled "Reform of the Committee on World Food Security", available at: ftp://ftp.fao.org/docrep/fao/meeting/018/k7197e.pdf and incorporated in volume I of the Basic Texts of FAO.

[5] FAO (2001) "The World Food Summit Goal and the Millennium Development Goals". Committee on World Food Security, 27th session, Rome, 28 May - 1 June 2001 (emphasis added). Available at: http://www.fao.org/DOCREP/MEETING/003/Y0688E.HTM

of proposals for "food security indicators,"[6] most of which have never come to be applied to such a broad scale to make them truly relevant for the global debate and to guide policies, but have nevertheless contributed to add confusion in the attempts at understanding and monitoring the phenomenon across countries and over time. Second, as data availability has contributed to the selection of only few indicators being applied to a broad scale, these have been exposed to criticisms for not being able to capture all the dimensions that a supposedly ideal indicator should. When superficially read by the vast audience of non-experts, the criticisms have contributed to create an aura of suspicion on the validity of the indicators, thus potentially reducing their relevance and impact.

A lesson that can be drawn from the discussion so far is that the statistical concept being captured by a certain indicator's definition should be fully understood in order to guide on the search for the data that may inform it, and to clarify the dimension on which the proposed indicator is meant to contribute.

Crucial to the aim of evaluating the relative merits of alternative indicators, the *scope* of the analysis and its *depth* should be preliminarily defined. One possible classification framework could be based on the following:

1) Scope (or breadth) of the analysis
   a) Attention given to the *causes* of the food insecurity (limited availability or access) or to the *consequences* (nutritional status, economic and social cost, welfare reduction). This may
   b) The people involved, intending both the number and social organizations characterizing situations ranging from the *individual* food security status within a household, to that of groups of people as *households*, villages, towns, provinces, up to entire *countries* or regions in the world.
   c) The time length over which the food insecurity condition spans, ranging from *acute* situations lasting one or few days up to a few weeks, to *chronic* situations spanning over several months or years.
   d) The *actual* or *potential* nature of the situation distinguishing between historic accounts of past situations from analysis of the prospects toward future conditions.

[6] According to Hoddinott (1999), "there exist approximately 200 definitions and 450 indicators of food security." If anything, the numbers have only increased since.

2) Depth of the analysis
    a) The characterization of the problem, either measured in strict quantitative terms (i.e., food production deficits, energy intake deficits, etc.) or involving qualitative aspects, (e.g. whether it refers to a "diversified" diet, or to the need to acquire food in "socially acceptable" ways, etc.)

Rather than from a careful conceptualization of the scope of the analysis, in reality monitoring effort may have started from consideration of which data were available. Even if this has been the case, it would still prove useful to try and classify existing indicators in one or more of the categories outlined above, especially by understanding on which dimension(s) of food insecurity the data used is actually capable of conveying information.

Failing to do so may have led to the following two consequences: (a) exposing the indicator to unfair criticisms, for not being able to capture something it was never meant to do, and, (b) making serious mistakes in the inference derived simply because the data used does not contain information on the dimension that is intended to be captured.

While the case of the FAO prevalence of undernourishment is a clear example of the first problem (see section 4.1 below), the possibility of making mistakes in drawing inferences is increased by the growing attention that, over time, has been devoted to specific dimensions of food security with the resulting temptation to try and squeeze, from available data and indicators, information that simply is not there.

The remainder of the paper is intended to shed light on the limits inherent in some of the available and widely used data and on the risks of mistaken inference when either implicit or explicit ad hoc assumptions are included in empirical models to fill the data gap.

3. Food security data

3.1. Food Price data

In analyzing the role of food price in relation to food security we should ask: what do we mean by food price? Is there such a thing as the "price of food" or should we rather speak of food *prices*? And, of the many prices we can read about on bulletins, which ones are more relevant for food security consideration? Prices are quoted on different points in time and space, and for a myriad of items. In spite of what seems to be a general perception by the wider community of food security analysts and policy makers, it is not at all clear to what

extent and how they relate to food security. Considerable effort has been devoted to the collection and publication of prices for major traded agricultural commodities, as formed on a number of reference markets, so that we have consistent price series of, say, "export price for no. 1, hard red winter wheat, ordinary protein, delivered at the US Gulf port for prompt or 30 days shipment" or of "5% broken, white rice (WR), milled, indicative price based on weekly surveys of export transactions, government standard, f.o.b. Bangkok"[7] . These are very well defined concepts and the associated measures quite reliable, in the sense that there are immediate and valid records, but how are these particular prices related to the actual price people pay for their food every day?

(To be continued. Touching upon the existing evidence on price transmission, and the alternative sources of *consumer* price indexes as more meaningful indicators of food security, in particular on:

- Food Price Level Indexes compiled within the International Comparison Program at the World Bank,
- Food consumer price indexes collected by ILO and FAO, based on country data from household expenditure surveys.
- Other initiatives at collecting local food prices such as GIEWS price monitoring tool, FEWSNET)

3.2. Food supply data

The two main sources of food availability that are global in scope are FAO's Food Balance Sheets (FBS)[8], and the Production, Supply and Demand (PSD) Online system[9] maintained by the Foreign Agricultural Service of the United States Department of Agriculture (USDA). Both databases provide estimates of yearly production, trade and utilization of agricultural commodities, at the level of single countries and territories. By compiling complete accounts of supply and utilization of food commodities, both systems

[7] These are the definitions of two of the series compiled by the Prospects Group at the World Bank and published monthly in the "Pinksheet" bulletins, one of the most widely used sources of commodity price data.

[8] http://faostat.fao.org/site/368/default.aspx

[9] http://www.fas.usda.gov/psdonline/psdQuery.aspx

provide an assessment of food available for human consumption in the country as a whole, in a specific year.[10]

3.2.1. FAO Food Balance Sheets

According to the description provided in the latest edition of the FAO Food Balance Sheets Handbook[11], FAO's FBS aim at presenting a comprehensive picture of the pattern of a country's food supply during a specified reference period.

Conceptually, the 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 to 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, processed for food use and non-food uses, lost during storage and transportation.

The food supplies potentially available for human consumption at the retail level are thus obtained as a balance. The per capita supply of each food item available for human consumption is finally obtained by dividing the 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 - by applying appropriate food composition factors for all primary and processed products - also in terms of energy, protein and fat content.

The FAO currently compiles balance sheets for about 180 countries throughout the world and on a large number of primary food commodity and food items. Of course, the amount of data needed to complete them is huge, and not all of it is available through official sources. For that reason, both official and unofficial data available in the Statistics Division and other Units concerned in FAO are used. In addition, a large number of missing data points are estimated by FAO on the basis of agricultural and household surveys and other information, as well as on technical expertise available in house.

---

[10] The discussion below is conducted on the FAO's Food Balance Sheets, on which we are more familiar, although many of the reflections would apply also to the USDA commodity balances.

[11] http://www.fao.org/docrep/003/X9892E/X9892E00.HTM

Box. Historical Background of Food Balance Sheets

FAO Food Balance Sheets have a long history that parallels the entire history of the FAO. The first attempts at preparing food balance sheets date back to World War I. Food balance sheets were the major source of data when, in 1936, at the request of the League of Nations Mixed Committee on the Problem of Nutrition and its Sub-Committee on Nutritional Statistics, a systematic international comparison of food consumption data was prepared. During World War II, the interest in food balance sheets increased considerably. The Inter-Allied Committee on Post-war Requirements used them in 1942/43 in their studies of post-war requirements in European countries and an even more detailed technique was developed and employed by a joint committee of experts from Canada, the United States of America and the United Kingdom in the report "Food Consumption Levels in the United States, Canada and the United Kingdom". During these years, food balance sheets were also constructed in Germany for the country itself as well as for the occupied countries. In the work of the International Emergency Food Council, which dealt with problems of food allocation and distribution in the period of worldwide food shortages after the war, food balance sheets played an important role.

At its Fourth Session in Washington in 1948, the FAO Conference recommended that governments be encouraged to develop their own food balance sheets and that FAO assist those governments that find it difficult to do so. It was also proposed that in future food balance sheets be published regularly for as many countries as possible. In 1949, food balance sheets were published for 41 countries covering the period 1934-38 and 1947/48, with a supplement in 1950 giving 1948/49 data for 36 countries. In 1955, food balance sheets giving 1950/51 and 1951/52 data were published for 33 countries, together with revised data for the 1934-38 period. Supplements were issued in 1956 giving 1952/53 data for 30 countries, and in l957 giving 1953/54 and 1954/55 data for 29 countries. For methodological reasons, it was decided in 1957 to discontinue the publication of annual food balance sheets and to publish instead three-year average food balance sheets, the first set of which, for 30 countries, was issued in 1958, covering the period 1954-56; the second for 43 countries in 1963, covering the period 1957-59; the third for 63 countries in 1966, covering the period 1960-62 and the fourth in 1971 for 132 countries, covering the period 1964-66. In 1960, time series covering the periods 1935-39, 1948-50, 1951-53 and 1954-56 were published showing data for 32 countries on production, available supply, feed and manufacture, as well as per caput food supplies available for human consumption in quantity, caloric value and protein and fat content.

In 1977, it was possible to publish provisional 1972-74 average food balance sheets for 162 developed and developing countries. For the first time, tables were included showing for all countries, continents, economic classes and regions and the world, long-term series of per caput food supplies in terms of calories, protein and fat by major food groups for the average period 1961-63 and individual years 1964 to 1974. The following issue included 1975-77 average food balance sheets for 164 countries, together with long-term series of per caput food supplies and tables showing the conversion ratios applied and the various assumptions made in arriving at the published figures. For the first time in this series, the table of per caput food supplies also showed, in addition to calories, protein and fat, the supply by food groups of selected minerals (iron, calcium) and vitamins (retinol, thiamine, riboflavine, niacine, ascorbic acid).

Starting with the 1979-81 issue, three-year average food balance sheets were published in a standardized format; 146 countries were covered. The publication showing standardized food balance sheets for the average 1984-86 included, in addition to the food balance sheets for individual countries, tables showing long-term series of per caput supplies, by major food groups, in terms of product weight, calories, protein and fat. These tables were shown also for the world, developed and developing countries. The tables were based on information for more countries than those included in the publication, and covered almost 100 percent of the population in both developed and developing countries. The 1992-94 issue covered 175 countries and the 1994-96 issue about 180 countries.

Food balance sheets were the main source of data used in the assessment and appraisal of the world food situation which FAO made for the pre-war period in its First World Food Survey (1946), for the early post-war period in the Second World Food Survey (1952), for the late 1950s in its Third World Food Survey (1963), for the early 1970s in its Fourth World Food Survey (1977), for the 1970s and 1980s in the Fifth World Food Survey (1985) and, covering the two decades from 1969-71 to 1990-92, in the Sixth World Food Survey (1996) . Food balance sheets also provided a major source of information for establishing the statistical base of FAO's Indicative World Plan for Agricultural Development, for which purpose 1961-63 average food balance sheets were prepared for all the 64 developing countries included in the study.

Source: FAO (2001) FOOD BALANCE SHEETS. A handbook.
Available on line at: http://www.fao.org/docrep/003/X9892E/X9892E00.htm

Ideally, the basic data required for the preparation of food balance sheets should be obtained from the same source. In principle each country should have a comprehensive agricultural and food statistical system, recording all current information relating to each component of the food balance sheet. Definitions of the data series should correspond to those of the food balance sheet concepts and the information available should be consistent, at least with respect to measurement unit and time reference period. In practice, however, and despite considerable technical assistance efforts made by the FAO and other organizations, an ideal statistical system does not exist, and problems of harmonization of standards and definitions still condition the possibility of full cross country comparison. Even in the few, mainly developed, countries which possess uncommonly sophisticated reporting procedures, the available data do not always meet either the criteria just listed.

In practice, the basic data used come from a variety of sources, with the result that the quality and their coverage vary considerably among countries and commodities. Production and trade data are part of the ongoing national official statistics. They are based either on direct enquiries or records, or are estimated by Government agencies and reported upon request. Where available, information on stock changes comes from marketing authorities and the processing industry, or from farmer stock surveys. Information on industrial uses is obtained from industrial/manufacturing censuses/surveys. Feed and seeding rates are obtained from cost of production surveys or are estimated by the Government agencies concerned. Losses occurring in industrial processing are also obtained from manufacturing surveys.

Since they are obtained from different sources, the basic data may reveal inconsistencies that need to be resolved to compile a coherent balance. Inconsistencies may be due to different definitions of the basic concepts or to different time reference and estimation, or to missing data. Adjustments and imputations are thus necessary in order to maintain a sufficient degree of consistency, completeness and reliability of the resulting food balances.

How reliable are Food Balance Sheets data?

Assessing the reliability of the FBS data is not easy, as there are many considerations to be made, and no generally valid conclusion can be drawn on for all countries and commodities.

Conceptual problems frequently arise with respect to coverage/representativeness of the basic data. Production statistics are mostly confined only to commercialized major food crops. Non-commercial or subsistence production (i.e. home produce and food obtained from

hunting, fishing and gathering by households for their own consumption) are usually not included in official statistics and are very difficult to estimate. This might be an appreciable part of total production in some countries, but not in others.

Manufacturing surveys may cover only a certain size of industrial establishment. Information on commercial stocks may be available from official or marketing authorities, factories, wholesalers and retailers, but inventories of catering establishments, institutions and households may not be available. Information on waste in industrial processing may be available, but waste/losses during storage, transportation or on quantities intentionally discarded for the purpose of price control or epidemic disease control may not be available. In these cases, even though the basic data are reliable, some adjustments are required to adapt the basic data to food balance sheets concepts/coverage.

The incompleteness and inaccuracy of the basic data, even when gathered from official sources, tend to be major problems. Production statistics may not be available for all commodities needed. Even where the statistics are available, they are not always reliable. This may be due to the fact that crop patterns and utilization of some crops in developing countries are sometimes rather complicated, making it difficult to estimate the production. 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). Certain kinds of food may not be covered by food balance sheets because they are not included in national production statistics. For example meat, such as that of game, wild animals and insects may be excluded for this reason. Under conditions such as those prevailing in many developing countries, this meat may form a substantial part of the consumption of animal protein. Also, major food crops may not be grown in pure stands but mix-planted in fields of bewildering complexity, thus eluding the possibility of accurate production assessments by governmental officers.

The reliability of official production data may also be questionable. When they are based on farmers reporting, they may be underestimated, as farmers may equate production with tax collection. On the other hand, reliable information on pre-harvest food grain losses caused by pests and diseases are not usually available, making assessments based on surveys of planted areas rather imprecise, as the estimates of yield are likely to be inaccurate.

Import and export data may be accurate in the majority of countries, but in some countries there may be significant amounts of trade across national boundaries that go

unrecorded. Moreover, import and export transactions may not receive equal attention from the custom's administration as taxes or quantitative controls are generally concentrated more on import items than export. As a consequence, the reliability of export data may also be questionable.

One common problem is that the availability of basic data on the feed, seed and industrial/manufacture use components of food crops are rather limited. 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 feedstuffs fed to livestock may vary from one year to the next. Cost of production surveys and manufacturing surveys, which are the appropriate sources of such data, have not been conducted regularly in most developing countries. Even where surveys are conducted, their coverage is usually limited (e.g. cost of production surveys cover only a few major crops or do not cover livestock commodities, etc.).

Another crucial aspect for the relevance of FBS data for food security analysis is that information on stock changes and losses/waste during storage and transportation are often nearly non-existent or, at best, only fractional in its coverage, e.g. commercial stocks of some commodities may occasionally be available from official sources or marketing authorities. And even if reliable figures on the total amount of storage held by governments and large private enterprises would be available, stocks held by small farmers and households during the reference period will not be covered.

All this considerations can be made for each item on which balances are constructed. In principle, to give a complete account of the food supply, all potentially edible commodities should be taken into account, regardless of whether they are actually eaten or used for non-food purposes. The definition of a complete list of potentially edible commodities however presents virtually insurmountable difficulties - both conceptual and statistical. For practical purposes, therefore, a pragmatic list of commodities has been typically adopted, with the result that reliability of the balances may be very different across items for the same country.

The estimate of the total population is also a part of the set of ongoing official statistics. The per caput figure of each food commodity is obtained by dividing the figure for food available for human consumption by the total population partaking of it during the reference

period, i.e. it should refer to *de facto* population living in the country. However, for many countries, the total population estimates may refer to the *de jure* population, i.e., the official legally resident population only. Thus, non-resident population, such as illegal immigrants, tourists, refugees, foreign diplomatic personnel and their dependents, foreign armed forces, etc., are not included. This omission may constitute a considerable part in some countries. This, therefore, would understate the total partaker population and overestimate the per capita availabilities.

There are also problems related to the time-reference period to be used in preparing food balance sheets. Several twelve-month periods, such as July/June, October/September, April/March, have been proposed and were indeed also applied. However, none of these periods satisfactorily and uniformly covered the production of all agricultural commodities, their trade and domestic utilization. It can be assumed that there is no single twelve-month period which is fully suitable for recording supply and utilization for all products. The decision of taking the calendar year time-reference period (January-December) has been made for accounting purposes, but may have consequences, for example, in the determination of the levels of stock variations.

All these problems raise some concern on the reliability of the detailed information that is provided through a typical food balance sheet, some of which seem not to have been clearly recognized if the data is to be used to inform sophisticated analysis, for example of the nutritional value of the diet.

Uses of the Food Balance Sheets

Probably the main use of the annual food balance sheets, tabulated regularly over a period of years, is to show the trends in the overall national food supply, to reveal changes that may have taken place in the types of food available for consumption, to reveal the extent to which the food supply of the country as a whole is adequate in relation to nutritional requirement and compare these trends across countries. Observed trends are also useful in developing projections of future food supply, in setting targets for agricultural production and trade and for establishing relationships between national food supplies and various other dimensions of food security and development, as well as evaluating national food policies.

Arguably, FAO food balance sheets provide the best assessment of food supply worldwide, which is one dimension of the food problem that still forms a fundamental basis for the policy analysis and decision-making needed to ensure food security. For this reason,

international organizations, governments, planners and researchers have found them as a very important tool in determining whether a nation as a whole is moving towards adequate food supply. The FAO, in particular, has been traditionally using the average per capita caloric availability derived from FBS as an estimate of the mean food consumption for the assessment of undernourishment, a use that has not been exempt from criticisms (see section 4.1 below.) One other useful indicator that can be derived from FBS data is the comparison of the quantities of food available for human consumption with those imported (the food import dependency ratio), indicating the extent to which a country depends upon imports to feed itself. Similarly, the amount of food crops that is used for feeding livestock, in relation to total crop production indicates the degree to which primary food resources are used to produce animal feed which is useful information for analyzing livestock policies or patterns of agriculture.

These are all very important uses, which justifies the maintenance and continued improvement of the Food Balance Sheet System by FAO. It is important however to point also to what FBS data is not, and the information they do not contain. They do not give any indication, for example, of the differences that may exist in the diet consumed by different individuals or population groups, e.g. people of different socio-economic groups, ecological zones or geographical areas within a country. Neither do they provide information on seasonal variations in the total food supply. To obtain a complete picture of the distribution of the national food supply at various times of the year, across regions, and among different groups of the population, different kinds of data would be needed, and the best source is certainly food consumption surveys of the population.

In fact, the two sets of data – those from aggregate supply and those from consumption surveys – are complementary in many respects. There are in fact commodities for which a production estimate could best be based on estimated consumption as obtained from food consumption surveys rather than from official production statistics. On the other hand, there are commodities for which production, trade and utilization statistics could give a better nationwide consumption estimate than the data derived from food consumption surveys. Data obtained through household and food consumption surveys are often the preferred source of food consumption estimates to conduct analyses of covariates of the food consumption, as they provide also information on the people who are purchasing and eating the food, a type of information that is not available from food balance sheets.

Another warning should be raised on the use of FBS to provide information on specific components of the food supply. Even though the list of items covered is long, the information provided at the level of each individual item is likely to be less reliable than the one provided on aggregates such as the total calories, and there are reasons to believe that the latter is much more reliable than other aggregates, such as the supply of micronutrients such as minerals and vitamins. Generally, food balance sheets are constructed for primary crops, livestock and fish commodities up to the first stage of processing in the case of crops and to the second (and sometimes the third) stage of processing in the case of livestock and fish products. The reason for the restriction on the higher stages of processing is the difficulty in obtaining data for all the varied forms of processed products, and even more difficult, in tracing the components of the processed composite products. Reliable quantities of food availability can thus be estimated only at the level of primary commodities (say "wheat" or "bananas") with no possibility of knowing whether, say, wheat is made available to consumers as refined flour or whole grains or if it is enriched or not. While these may make little difference in estimating the average caloric content (to the extent that the proper nutrient conversion factor is use) things become much more problematic in estimating contents of micronutrients such as minerals and vitamins.

3.3. Food Access Data

Even if the aggregate supply of food may be sufficient to cover the total food need of a population, food insecurity may exist because the available food is distributed unequally in the population. FAO assessment of the world food problem, as presented up to the fourth World Food Survey of 1974 has been criticized precisely because the estimate of the likely proportion of people suffering from food inadequacy in the world did not considered the distribution of food access. The situation has changed considerably since, and significant efforts have been made to include considerations related to the inequality of food consumption within population in assessing the actual prevalence of food deprivation. Nationally representative Household Income and Expenditure Surveys (HIES) have been, for a long time, *the only* source of available information to assess other parameters regarding in the distribution of food intake.[12]

[12] For countries for which no household surveys were available, FAO had to devise indirect means to estimate the parameters of the distribution, by referring, for example, to tabulations of the income distribution and to other indicative data on food insecurity, such as child mortality rates. These indirect methods are obviously

As the approach FAO has taken in addressing food insecurity has focused on the *nutritive* value of food rather than on the economic aspects, the proper denominator for food consumption has been taken to be the caloric contribution of the various sources. As most of these surveys are not designed to specifically address food consumption from a nutritional perspective, but rather from an economic point of view, the data they provide on monetary values of food expenditure must be treated in order to infer the required information on the households' level of normal food consumption over the year.[13] There are two major common problems that need to be tackled.

First, the actual quantities of food consumed need to be estimated by converting first the monetary values of expenditures into quantities, and then, in turn quantities are converted into calorie equivalents. Problems arise both in converting expenditures into quantities (as not always the needed unit values are available) and in converting them into calories when either the composition of the food basket to which the expenditure refers is not known (as it is often the case for food consumed at restaurants) or when the description of the food item is too generic to allow for proper nutrient conversion.

Second, to increase reliability of the reported data, which is normally collected through recall questionnaires, the expenditures or the quantities of food are collected with reference to a short period (usually a week or a fortnight) and the issue arises on how representative these values are of the household average level of food consumption over the year. This is especially true when the quantities or expenditures being reported refer to food acquired during the reference period, but not necessarily consumed. Even if the overall mean calorie consumption in the sample may still be a good estimate of the average, because "households in a large population group are equally likely to be drawing down on food stocks as they are to be accumulating them" (Smith *et al.*, 2006, p.), the values calculated for each *individual household* would likely be biased whenever household level storage of food is relevant. This shall have consequences on the estimated distribution of food consumption across households, as the variability *within* households will be confounded with the variability *between*

---

fated to generate more unreliable estimates of the distribution of food intake and are being gradually discontinued, as soon as data form survey is made available.

[13] Sometime the quality of the household level information pertaining to food consumption in household expenditure surveys is so low that they are of no use for food security assessments. In their analysis of Sub-Saharan countries Smith *et al.* (2006) were able to use in the end only 13 out of more than 100 household surveys, having to disregard the others for various problems related with data quality.

households. Second, and perhaps more worrying, if the individual household status of being undernourished is going to be used to conduct disaggregated analysis by subpopulation groups (the possibility of which constitutes one of the major attractiveness of household survey data), the risk exists that the analysis would yield inconsistent results if the difference between acquisition and consumption happens to be correlated to the grouping variable.[14]

For all these reasons, the data on household level food consumption from surveys is used by FAO in an indirect way, to estimate the parameters of the distribution of *habitual* food consumption in the population (essentially by controlling for the intra household variability) and to conduct inference at the population level only.

It is hoped that in the near future more nationally representative household surveys explicitly collecting average quantities of food consumed over the year will be available to improve the precision of the estimates at the population level, and also to allow for analysis of individual households food consumption, in relation to other socio economic characteristics. A minimal set of requirements for such a survey should include features that would allow:

a) To have a complete assessment of the type of food consumed by all household members, including that consumed away from home;
b) To discern actual food consumption of the surveyed household from food acquisition over the surveyed period, recognizing that the latter may include food that is acquired for other uses (storage, food given to guests, etc.);
c) To control for possible seasonal variation in food consumption (ideally by conducting repeated observation on the same household in different points in time)

4. From macro-data to micro-inference and from micro-model to macro-inference

The cursory survey of food price, availability and consumption data conducted in the previous sections has revealed that there is wide heterogeneity in the quality of the available data which often refer to concepts that do not correspond to the ideal ones. This has invariably forced analysts to try and "fill the data gap" with assumptions, and the debate on the evidence has thus been transferred from the data domain to that of the modeling approach.

[14] As an example, consider the case in which most households build up food stocks in the period after the harvest. If that is not being taken into account when defining the sampling plan, it may happen that one area of the country is surveyed in that period, with the result that there will be a bias in the data correlated with the geographic location of the household.

The debate that has accompanied the FAO method for estimating the prevalence of undernourishment is an interesting one, as it touches on many issues related to the problems of conducting analysis at the aggregate level when the fundamental concept is defined at the individual level (that is how to conduct macro-inference with micro-modeling, which calls on the question of proper aggregation) and on the specular one to try and derive micro inference from aggregate level data.

4.1. The debate on the FAO prevalence of undernourishment indicator, or: how to draw population level inference from imprecisely observed individual level data.[15]

Within its broader objective of contributing to the fight against food insecurity, FAO has received a mandate from the international community to monitor progress towards achievement of the objectives set by the World Food Summit and the UN Millennium Development Goal,[16] to which it has responded with production and publication of figures on the prevalence and number of undernourished people in the developing world, at global and regional level for the first time with the 1985 Fifth World Food Survey and since 1999 with the annual "State of Food Insecurity"(SOFI) publication.

The first issue to be resolved has been that of trying to define the concept of "hunger" narrowly enough that it could be meaningfully monitored. The terms "undernourished" and "hunger", as used in describing the two targets, have thus been interpreted as referring to a situation of *continued inability to obtain enough food*, i.e., a quantity of food sufficient to conduct a healthy and active life. While much more specific than a generic expression such as "food insecurity", this definition is still too vague to lead to practical monitoring. First, considering the complexity of the process of human nutrition and the fact that there are both quantity and quality dimensions associated with food, the expression 'enough food' needed to be qualified. From that The FAO method has been traditionally based on dietary energy intake (i.e., calories) as the metric of 'food', and that 'enough' ought to be addressed against normative benchmarks established by nutritionists related to human energy requirements. The

[15] This section draws on Cafiero (forthcoming) "Advances in hunger measurement. Traditional FAO methods and recent innovations". *Global Food Security*. 2012

[16] The 1996 World Food Summit pledged "... to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015" (FAO, 1996) while the MDG Target 1.C is defined as to "halve, between 1990 and 2015, the proportion of people who suffer from hunger." (UN, 2000)

FAO operational definition is thus based on the assumption that a human being is undernourished if the level of his or her dietary energy intake is below the minimum level that nutritionists would deem appropriate for normal life. But even this further narrowing down of the concept was still not sufficient to reach the dimension needed for practical measurement. Though temporary dietary energy shortage may in fact exist, the FAO definition of the indicator has been associated with the level of *habitual* food consumption over one year, that is, a period long enough for the consequences of low food intake to be truly detrimental to health. As such, the operational definition of food insecurity that is embedded in the FAO indicator could be better described as of "*chronic undernourishment"*

Formally, the Prevalence of Undernourishment (*PoU*) is defined as:

$$PU \equiv \int_{x<MDER} f(x)dx \qquad (1)$$

where $f(.)$ represents the distribution of yearly habitual dietary energy consumption across individuals, or, equivalently, the probability distribution of the habitual food intake levels for the population's "representative" individual.

In evaluating the merits of this estimator, one of the most common sources of misinterpretation is the fact that the probability distribution in (1) has tended to be interpreted as the empirical distribution of the actual food consumption in the population, that is, the distribution that could be obtained, for example, through a food consumption census of the population, but such an interpretation is largely misleading.

Under such an interpretation, in fact, it would be very difficult for example to make sense of a unique threshold level to be applied to all individuals, as it is obvious that energy requirements vary among individuals. If reference were to be made to the empirical distribution of food consumption in the population, than the proper measure of the prevalence of undernourishment ought to be:

$$PU_2 = \iint_{(x,r)\in\{x<r\}} f(x,r)drdx \qquad (2)$$

where the possibility of a *joint distribution* of dietary energy consumption (x) and requirements (r) is explicitly recognized.[17] The attractiveness of an approach as in (2) is that

[17] In the past, the FAO approach has been described with reference to a joint distribution, most notably by Svedberg (2000), who claimed that under such an approach, the choice of a single threshold level would

it gives the impression that it may be possible to classify *individuals* in the population as being undernourished or not, based on the comparison between the individual intake x_i and the individual requirement r_i. Estimating the prevalence of undernourishment in the population would then amount to simply head-count those who are classified as undernourished.

The major obstacle to the proper application of a joint distribution framework as in (2) is that *individual dietary energy requirement is practically unobservable.* It is in fact widely recognized that individual dietary energy requirement proper depends not only on observable individual characteristics, such as body mass and level of physical activity, but also on a rather elusive individual degree of efficiency in the metabolism of food.[18] As an important practical consequence of this fact, normative food requirement standards can only be given as *ranges valid for groups of individuals* (usually defined by age, sex, and physical activity) in recognition of the many unobservable factors affecting the individual requirement.[19] When the only information available on an individual is the combination of sex, age and level of physical activity, therefore, only a range of energy requirement levels that are compatible with good health can be given.[20]

Contrary to what seems to have been implied by some critics of the FAO methodology, the difficulty to precisely assess individual energy requirement thresholds (which led to the suggestion of monitoring anthropometrics as an indirect way to assess undernutrition) does not exclude the possibility of conducting a valid inference at the *population* level, based on a probabilistic statement and a proper understanding of the concepts involved. To facilitate such

---

necessarily lead to estimation errors. As pointed out by Naiken (2007) and Cafiero and Gennari (2011), Svedberg criticism is vitiated by a fundamental misrepresentation of the FAO methodology (see also below.)

[18] The actual metabolic efficiency in food processing could be measured through clinical trials at very high costs per single measure, which makes it infeasible for the practical purpose of monitoring undernourishment.

[19] "Estimates of energy requirements are derived from measurements of individuals. Measurements of a collection of individuals of the same gender and similar age, body size and physical activity are grouped together to give the average energy requirement - or recommended level of dietary intake - for a class of people or a population group. These requirements are then used to predict the requirements and recommended levels of energy intake for other individuals with similar characteristics, but on whom measurements have not been made. Although individuals in a given class have been matched for characteristics that may affect requirements, such as gender, age, body size, body composition and lifestyle, *there remain unknown factors that produce variations among individuals*. Consequently, there is a *distribution of requirements within the class or population group."* (FAO/WHO/UNU, 2002, p. 5, emphasis added).

[20] A joint FAO/WHO/UNU group of experts convened with the task to assess human energy requirements have repeatedly make a point that the norm corresponding to the average of the range provided should not be used at the individual level, lacking a more comprehensive assessment of other individual characteristics.

an understanding, the distribution in (1) is best interpreted as the probability distribution of the possible levels of habitual dietary energy consumptions for the population's "representative individual" (that is, the "average" individual in terms of all the observed and unobserved characteristics that may affect energy requirements). The threshold level can thus be interpreted with reference to that 'special' individual, and the question arises on how to set the caloric threshold level to obtain the best estimate of the status of undernourishment, an issue that has raised lots of controversies in the past.[21]

There should be no controversy on the fact that the starting point must be found in the normative standards set by nutritionists, such as those produced by the joint FAO/WHO/UNU group of experts in various occasions.[22] At a superficial consideration, one may be tempted to refer to the average requirement given as "recommended level" of dietary intake for a group of individuals of a certain age and sex as the most suited threshold to determine whether an individual belonging to that group is likely to be undernourished or not. After all, lacking any other information, why not considering any individual as the "average" of the group of same sex and age in terms of caloric requirements?

Unfortunately, such a simplistic reasoning is faulty and would lead to grossly mistaken inference.[23] The reason is that, even if a group of individuals were composed only of well-nourished people, it would be expected that roughly 50% of them have intakes below the average requirement. Using the average requirement as a threshold in any situation where less than half of the population is undernourishment would produce an overestimate (a point effectively made as early as 1960 by P.V. Sukhatme, and subsequently recognized, among others, by Srinivasan (1983)).

---

[21] Osmani (1992) provides an excellent collection of articles contributing to the debate in the 1980's. Most of the discussion at that time was concerned with the roles of intra- and inter-individual variation in energy requirements, with unresolved issues among nutritionists and others on whether or not human beings can effectively adapt their dietary energy requirements to the environment. Notice however that, in view of the interpretation of the model in equation (1) as referring to the representative individual in the population, the question is of no relevance here. Irrespective of whether it is due to individual adaptation to changing conditions, or to differences in the metabolism among different individuals, the relevant concept is that there will be not a single value, but rather a whole range of requirement, associated with the variability in the efficiency of food processing that is compatible with good health and nutrition even for the representative individual in the population.

[22] The latest expert consultation was held in 2001. Results are published in UNU/WHO/FAO (2004)

[23] Several researchers in the past have fallen in such a mistake, including Smith *et al.* (2006),

The obvious corollary of recognizing that there is variability of intakes also among well-nourished, similar people is that the proper threshold should be set at a level below the average, so that the probability of overestimating the prevalence of undernourishment in the group is reduced.[24] By choosing as a threshold the level that corresponds to the *minimum* of the range of dietary energy requirement indicated by nutritionists as compatible with good health and normal physical activity for that group (as FAO does in setting the MDER as the threshold), the probability of overestimating the prevalence of undernourishment in a group is minimized.

Of course, as lucidly pointed out, among others, by Osmani (1999), there is still the possibility that the measure thus obtained is an *under* estimate of the actual prevalence of undernourishment, as there would be individuals who, despite consuming at a level higher than the MDER, are undernourished. In choosing the threshold level, a trade-off thus arises between the risk of overestimation and the risk of underestimation. By choosing a threshold that is higher than the MDER, the probability of underestimation of the prevalence of undernourishment is reduced, but at the cost of increasing that of overestimation.

How to choose the most appropriate threshold depends therefore on the cost that is associated with the two estimation errors, which is likely to be a function of the expected *size* of the estimation errors. It is conceivable that over- or underestimating by a "little" is less costly than doing it by a "lot". In judging what the proper threshold should be, therefore, not only the mere possibility of underestimating or of overestimating should be considered, but also by how much. Seen from a statistical inferential perspective, this is the aspect that has probably been lying underneath the debate that, over the years, has surrounded the FAO estimator.

One aspect that has emerged clearly in the debate is that the extent of possible errors in setting a given threshold crucially depends on the supposed relationship between the (observable) level of intake and the (unobservable) level of requirements. The conclusion Osmani draws from the review of the elements in the debate is that: "a value-neutral way of tackling [the problem of estimating the prevalence of undernourishment] would be to shun the

[24] The use of a single threshold value in estimating the prevalence of undernourishment has been criticized by many others (e.g., Anand and Harris, 1992)on the account that it may never lead to correct identification of all the undernourished in a population. It is worth to remind the reader that the objective of the FAO methodology discussed here is not, and has never been, that of identifying individuals as being undernourished, but only to estimate the likely prevalence in the population.

‘cut-off approach’ altogether and use instead a joint distribution of intake and requirement” (Osmani, 1999, p. 142).

There are two main issues that can be raised with such a conclusion and that, if properly recognized, could contribute to move forward in the debate and in making proper use of the evidence provided by an indicator such as the PoU. The first one is to realize that the existence of a pure “value-neutral” way of tackling any estimation problem as suggested by Osmani is essentially an illusion created by what could be termed an “idealistic” view of statistical inference. As best put by the late Arnold Zellner in his pioneering and valuable contribution to the theory and practice of statistical inference, no estimator can ever be deemed void of value judgment. Whatever estimator can be conceived, the most that can be hoped is that it is proven optimal *under a specific loss function*. The value judgment that is supposedly avoided by claiming the “optimality” of the estimator reemerges, implicitly, in the choice of the loss function.

With reference to the problems related to the use of a single cut-off point in estimating undernourishment, the use of the minimum dietary energy requirement as the threshold level can then be justified if the cost of overestimating undernourishment dominates that of underestimating it, something that is in line with the definition of “undernourishment” as the *extreme* form of food insecurity. This is not to deny the possibility of underestimation, but only to clarify that the possible *extent* of such underestimation has been deemed small by the proponents of the FAO methods, based on the presumption that the probability of undernourishment, conditional on intakes being larger than MDER, should become very small as intakes increase (see FAO, 1996, Appendix 3, Figure 1). If that assumption is true, a threshold at, or very close to, the MDER is the appropriate one, unless one associates a disproportionately higher cost to the risk of underestimating compared with that of overestimating it. Nothing would prevent that, other considerations deemed relevant or other perspectives on the food deprivation problem being considered, a different (higher) threshold may be used, resulting in an estimator that would implicitly give more weight to the cost of underestimating it.

The second problem with the conclusion drawn by Osmani is the idea that use of an approach based on the joint distribution of intake and requirement might have paved the way towards a better estimator. As elaborated by Naiken (2007), and hinted to in Cafiero and Gennari (2011), the possibility of defining a joint probability distribution for dietary energy

intake and requirement is highly problematic, to say the least. It has to confront the very definition of the concept of "adequate nourishment" from a statistical point of view. If we define the condition $x < r$ as "undernourishment" and, by symmetry, $x > r$ as "overnourishment", it is clear that the event $x = r$ should correspond to adequate nourishment. Any continuous joint density function would assign zero probability to such an event, and therefore could not be used as a legitimate representation. One possibility is to define adequate nourishment as an approximation, $x \approx r$ by recognizing that small differences between x and r may exist due to measurement errors and therefore, even though $x = r$ gets assigned zero probability, a joint distribution could be defined that assigns the proper mass to the event "adequate nourishment." However, it should be self-evident that, even if such a distribution could be conceived, it is very unlikely that it may have elliptical iso-density contours and therefore it would be fundamentally different from joint normal or similar distributions.[25]

Ruling out the possibility of using a joint distribution framework the question seems to revolve around the problem of whether or not it is possible at all to conduct meaningful inference based only on the (observed) variability in intakes when this in part reflects (unobservable) variability in requirements. The FAO method provides one such possibility, which is fully consistent with the principles of statistical inferences, even though the "optimality" of the proposed estimation method stands on an unproven – though quite reasonable – assumption on the probability of being undernourished conditional on various levels of observed food intake.

There is however another argument that can be made to demonstrate that inference on undernourishment can properly be drawn on observing only the distribution of food consumption, and that appears to have eluded the attention of researchers so far. The argument is the following: any population for which measuring undernourishment is meaningful should be properly viewed as composed of three different groups: that of the undernourished individuals, that of the adequately nourished, and that made of people with *excess* food consumption. Sampling from such a population, therefore, would correspond to what has been termed in the statistics literature as a problem of conducting inference on a

[25] A double normal distribution, with various degrees of correlations, has been used by Svedberg (2000, ch. 9) in his criticism of the FAO methodology. In light of the discussion being conducted here, the whole argument raised by Svedberg appears virtually irrelevant.

finite *mixture* of distributions (Everitt, 1985), and there is ample literature on how to conduct such inference.[26] An interesting avenue for further research on how to improve the practice of estimating the extent of undernourishment (which would bring the important addition of being able to estimate at once also the extent of *over*-nourishment) resides in the application of statistical procedures developed to deal with mixture distributions on datasets of individuals' or households' food consumption obtained from representative samples of the population. The aim would be that of classifying each observed case in one of the three underlying sub-populations, thus effectively providing an estimate of the relative size of the groups in the overall population.

4.2. Nutritional analysis based on aggregate food supply data: or the impossibility of deducing individual level outcomes from aggregate data

Use of aggregate food supply data to derive information on the quality of the diet has been recently proposed by Reedy, Krebs-Smith and Bosire (2010) in an attempt to assess the "quality of the food environment.[27] The proposal is to apply the Healthy Eating Index,[28] an index of dietary quality developed to assess the conformity of *individual* diets to the recommendations of the US Dietary Guidelines for Americans,[29] to a diet composed by the average availability of foods in the country.

This proposal is questionable to the extent that the objective is to assess the quality of the average American diet. Even a cursory reading of nutritional principles in fact would suggest that the nutritional value of a certain diet depends on the *combination* in which nutrients are ingested.[30] It should be clear, however, that the combination of average quantities of nutrients as derived from the aggregate supply of food in a country would provide information on the quality of the diets actually consumed by the individuals only under the very unlikely assumption that all individuals consume exactly the same diet. As it is obvious that

---

[26] Principles of how to conduct inference from finite mixture distributions are given in detail by Titterington, Smith and Makov (1985), using maximum likelihood principles and the E-M algorithm, and by Diebolt and Robert (1994), using Bayesian procedures based on Markov chain Monte Carlo (MCMC) methods.

[27] Use of aggregate food supply data to derive information on the quality of the diet has been proposed in Reedy, Krebs-Smith, Bosire (2010) "Evaluating the Food Environment: Application of the Healthy Eating Index-2005". *American Journal of Preventive Medicine* (38) 5:465-471.

[28] http://www.cnpp.usda.gov/healthyeatingindex.htm

[29] http://www.cnpp.usda.gov/DietaryGuidelines.htm

[30] "By assessing multiple dietary components simultaneously, […] the HEI-2005 captures the *balance* among different types of food and, therefore, measures the quality rather than the quantity of the diet" (Reed et al. 2010, cit., p.466). Emphasis added.

unbalances in different components of the diet *do not* compensate each other (you cannot compensate a deficit in, say, fibers, by eating more proteins, the very essence of the concept of the value of a balanced diet), any meaningful index of dietary quality is going to be a highly non-linear combination of its components (usually based on minimum or maximum thresholds of individual nutrients). Therefore, the quality of a hypothetical diet made of average nutrient supplies may bear little resemblance of average quality of the diets in the country; a simple manifestation of Jensen's inequality. In simpler terms, the hypothetical diet formed by the averages of the aggregate supply of foods available in the countries is going to be per force more "balanced" that any of the individual diets in the population (unless, as said, all individual diets are identical).

4.3. Gender and nutrition issues in food security assessments based on household level data: or the risk of using assumptions to substitute for missing information

As another example of the methodological problems that can be encountered in food security assessment, consider the recent evolution of the debate on food insecurity, in which attention to gender issues and to nutrition is taking center stage. For both aspects to be properly evaluated, it seems quite obvious that one cannot really do without *individual* level data. Unfortunately, as reported in section 3.3 above, nationally representative food consumption data are still only collected at the household level, under the influence of the economic literature that has tended to consider the household as a single decision making unit.

With reference to food security, it has long been recognized that it is important to ascertain whether there is discrimination in accessing food among members of a household. Assuming that there is none, as it is often implicitly done under the "unitary model" of the household as a guideline for policy prescriptions may lead to serious policy failures.[31] On the other hand, whether or not discrimination within households exists in practice is an empirical question which should be resolved in order to be able to evaluate the potential effectiveness of different types of programs or targeting mechanisms in specific contexts. In turn, the possibility of resolving the issue cannot dispense of the availability of *individual* data, which is still too scarce at the global level and on nationally representative samples. As the same consideration can be made, even more strongly, for discriminations that lead to different

[31]. Haddad, Hoddinott and Alderman (eds.) (1997) *Intrahousehold Resource Allocation in Developing Countries. Models, Methods, and Policy*. The Hohns Hopkins University Press for the International Food Policy Research Institute. Baltimore and London.

quality of the food eaten by different members of the household, we must conclude that the vision of the household as a unitary decision making unit, a die-hard feature of data collection efforts in the development field, still hinders the possibility of properly assessing the gender and nutritional dimensions of food insecurity.

5. Conclusions: what's ahead

This article has presented a review of conceptual and practical issues associated with the use of available data and information for food security monitoring and analysis. The presentation has likely raised more questions that it has answered, and therefore may have been of little comfort to those seeking for solutions to the important question of how to assess the impact of economic shocks on food security.

Two main conclusions can be drawn at this stage. The first is that data availability, in terms of both quality and coverage, is still an important limitation for our collective ability to conduct meaningful and timely analysis of relevant socio-economic phenomena such as food security. If not properly recognized, and if insufficient scrutiny is applied to the understanding of the real information content of published data, mistaken inference can be drawn.

The second one is that, as it is very likely that analysts will never enjoy the luxury of being able to wait for the right data to be collected before being asked to conduct analyses of current events, the role of theory as a guiding principle is of fundamental importance. By making extended reference to the debate on the practice of food insecurity assessment, we hope to have demonstrated how the risk of slipping away from proper inference is always around the corner.

(To be completed)

References

(To be added)