Part 3

Using food consumption data from surveys to improve national food balance sheets

7 Peru: using food consumption and food balance sheet data to assess the food situation

Seevalingum Ramasawmy[30]

ABSTRACT

There are notable differences between the estimates of DEC per person per day obtained from food data collected in NHSs and that collected from FBSs. These differences stem from the fact that estimates in FBSs refer to food available for human consumption in the country, which includes private and public consumption. Estimates in NHSs are confined to private consumption. Public food consumption includes, for example, the share of consumption from food consumed at home, as well as in restaurants, public houses, hospitals, army barracks, hotels and from street vendors. If the purpose was to assess the availability of food, then FBSs are more appropriate sources of data than NHSs, since they are available on a yearly basis. However, NHSs, which also collect food data at a family level, provide reliable data on food consumed. This data is useful for carrying out consistency checks on the construction of the supply and utilization accounts used to prepare FBSs. NHSs can also help to improve the estimates of some elements of the FBSs, particularly in relation to own-production food. Other consistency checks are total nutrients, energy, protein, carbohydrates and fats. While useful, comparisons of food data from the FBSs and NHSs should be performed with caution given the different concepts and definitions used in each case. This paper illustrates the usefulness of NHS data on food consumption collected in Peru's 2003/04 Encuesta Nacional de Hogares, the FBS prepared by FAO based on Peru production and trade data and other complementary information on food available for human consumption for 2003/04.

Keywords: food balance sheets, household surveys, food consumption, nutrients

BACKGROUND

Peru has three different climatic zones, which affect its agricultural production. These are the arid coastal regions, the Andes and the tropical lands. Agriculture is intensive in the fertile river valleys of the coastal regions where citrus and vegetable cultivation predominate. Subsistence farming predominates in the cultivated arable land of the Andes, while rice, cereals, cocoa and coffee are produced in the rainforest regions and are mainly grown as export products. Peru's coastal waters provide abundant fish for export and domestic consumption. The country also produces a large variety of agricultural products, which are also meant for both domestic consumption and export. These are asparagus, coffee, cocoa, sugarcane, rice, potatoes, corn, plantains, grapes, oranges, pineapples, guavas, bananas, apples, lemons, pears, coca, tomatoes, mango, barley, palm oil, onion, wheat, dry beans, poultry, beef, dairy products, fish and guinea pigs. Given the variety and size of the produce for domestic use, the processing sector for food and beverages is very dynamic in Peru.

The FBS measures total food supply for domestic use and is a measure at the most aggregate level of the food distribution system. It includes food available for both the

---

[30] Statistician, Statistics Division, FAO, Rome; Seevalingum.ramasawmy@fao.org

household and non-household sectors. The NHS measures total food consumed or acquired at the household level. The FBSs compile information on all food available for human consumption as a residual of supply minus non-food use during a period of one year. The data quantities used are food produced and imports, from which are subtracted food exports, feed to animals, seed and other non-food uses, such as bio-fuel. The net amount of food available for human consumption was usually expressed on a per person per day basis. This amount was obtained by dividing the net food quantity by the country's population size and the number of days of the reference year. This per person per day amount of food was also expressed in dietary energy and macronutrients values. The food quantity of each food item was converted into macronutrient values using the Peru food composition table (PFCT). It was then aggregated to give the nutrient consumption of dietary energy, protein and fat at the food item level.

The Dirección General de Información Agraria of the Ministry of Agriculture of Peru is the institution responsible for preparing the annual FBS, namely hoja de balance de alimentos (HOBALI). The latest publication of the HOBALI gives the annual FBSs for the ten-year period 1998–2007. The revised series of the yearly FBS includes data on 20 food commodity groups and follows FAO methodological recommendations. This data facilitates regional and international comparisons.

The Instituto Nacional de Estadística e Informática (INEI) of Peru conducted the 2003/04 National Household Expenditure Survey (ENAHO). Food data was one main component of the information on total household consumption expenditure collected in the ENAHO, the main objective of which was to update the basket of goods and services for the compilation of the consumer price index (CPI). Two sets of questionnaires were used to collect household expenditure data, including that on food, over a reference period of seven days. Households used a diary to record all daily acquisitions, and an individual questionnaire was used to collect information on other expenditures, including food bought and consumed outside the home. All food acquisitions from all sources such as purchases, own-production and food received as gifts or aid were recorded in the diary on a daily basis for the seven-day reference period. Food quantity and monetary values were collected, which resulted in a list of 201 food items including food consumed outside the home. The food data collected in most ENAHO is based on the acquisition concept which includes: food purchases for the home, food consumed outside of the home, own-production (subsistence) food and other food receipts (gifts, donations and income in kind).

RESULTS AND ANALYSIS

A food security analysis of the food data collected in the ENAHO 2003/04 was undertaken using the FAO statistical procedures of the FSSM. The food quantity data of each food item at household level was converted into dietary energy and macronutrients using the PFCT with aggregation made at both food commodity and household levels. The analysis produced a large number of food security indicators at national and sub-national levels. These indicators relate to three main components of food security, namely, food availability, food access and food utilization. Some derived indicators of food availability and food utilization from the ENAHO 2003/04 are compared with their corresponding estimates as compiled in the FBS 2003/04 to evaluate any over- or underestimation useful for improving Peru's FBS. It should be noted that based on the different food coverage of the FBS and ENAHO, it is expected that estimates of FBSs could be higher than those of ENAHO. FBSs refer to food available on the market, which also includes food stocks, and does not account for any food wastage and losses such as those due to handling, transportation and storage. On the other hand, the food consumption data obtained from ENAHO is likely to include food consumption obtained from the household's own-production.

FIGURE 7.1
**Distribution of DEC by population groups (2003/04) (Peru)**
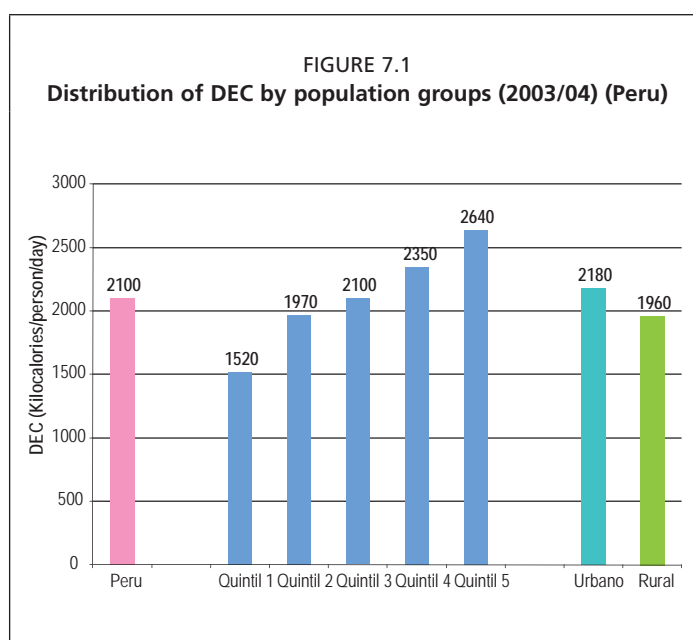
The average daily DEC in Peru in 2003/04 was 2 100 kcal/person (Figure 7.1). A higher DEC was observed in urban areas as compared to rural areas. Furthermore, it was noted that DEC increased as income increased.

It was observed that the variation of DEC among the different income levels differed by more than 1 100 kcal between the lowest and highest income groups. Households acquired food mainly from purchases, which supplied about 72 percent of the total DEC. Households' own-production food supplied about 21 percent of food, while food consumed away from home contributed about 7 percent.

The dietary energy supply (DES) of Peru, as compiled from the FBS for 2003/04, was 2 255 kcal/person/day, which was about 7 percent higher than the DEC value derived from the 2003/04 ENAHO. The marginal gap of about 145 kcal was an underestimation of the public food consumption, which did not consider wastage or loss in the food chain from supply to household. It also did not include food from subsistence farming.

The two micronutrients, proteins and fats, were compared (Figure 7.2). Protein availability in the FBS was almost at the same level as that of consumption in ENAHO. This result could indicate some underestimation of some protein food items, such as fish, in the FBS. It is well known that Peru is an international leader in fishing and that it produces nearly 10 percent of the world's fish catch. With regard to fats, the value of consumption was about 16 percent higher than that the FBS fats availability.

FIGURE 7.2
**Comparison of proteins and fats values (g/person/day)
from ENAHO and FBS (2003/04) (Peru)**
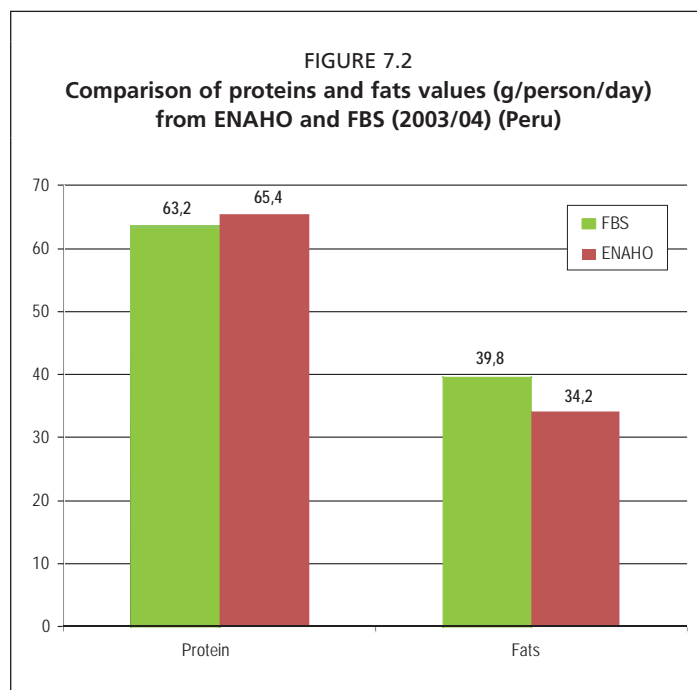
The protein availability in the FBS was 65.4 g/person/day, which was about 3 percent higher than the value of 63.2 g/person/day obtained from the ENAHO 2003/4. The fats consumption in ENAHO was 39.8 2 g/person/day as compared to 34.2 2 g/person/day in the 2003/4 FBS.

A COMPARATIVE ANALYSIS

A comparative analysis of food commodity groups may give some indication of any underestimation or overestimation of the FBS and ENAHO estimates. The main food commodities of the ENAHO, which contribute to the average DEC of 2 100 kcal/ person/day were cereals, sugar, roots and tubers, prepared meals, oils and fats, pulses, meat and milk. These products made up about 90 percent of total DEC. These same food commodity groups made up about 85 percent of total DES.

Figure 7.3 illustrates the comparison between the share of total dietary energy by main food commodity groups for the FBS and ENAHO estimates. Estimates from FBS for food commodity groups of cereals, roots and tubers, fruit, alcoholic beverages, nuts and spices were found to be marginally higher than the ENAHO estimates. These marginal food gaps could be due to differences in the categorization of ENAHO food items. Food items in ENAHO are usually those foods that are ready to be consumed, while food items in FBSs relate to raw food crops. In FBSs, too, all processed and ready to be consumed foods are converted to their original raw food crops, e.g. wheat flour is converted to wheat.

On the other hand, ENAHO estimates for food commodity groups such as vegetable oils and fats, meat and pulses were marginally higher than those of the FBS. For these cases, there is a need to double check the average consumption in terms of food quantity per person per day for a better evaluation of individual consumption. In addition, there could be some under-reporting of industrialized food for public consumption in the FBS.

FIGURE 7.3
Comparison of main food commodity share (%) of total dietary energy (ENAHO and FBS 2003/04) (Peru)

FIGURE 7.4
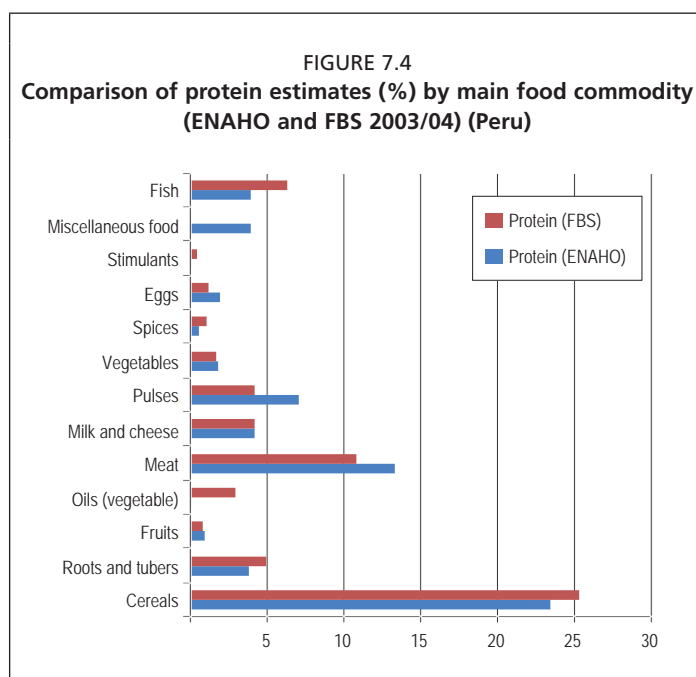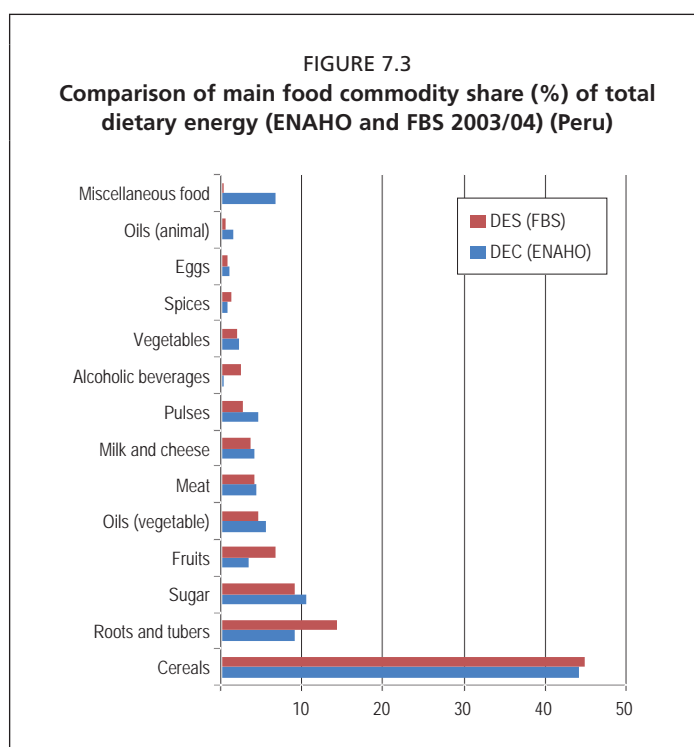**Comparison of protein estimates (%) by main food commodity (ENAHO and FBS 2003/04) (Peru)**

Figure 7.4 shows a comparison of protein by food commodity groups for ENAHO and FBS. ENAHO values were higher than the FBS values for the commodity groups of meat, pulses, vegetables, eggs, fruit and other miscellaneous foods. The high values of protein in ENAHO were related to some food items such as fish and miscellaneous food, which were not significantly captured in the FBS. Again, this result highlights the need for further in-depth analysis of production and trade data for the compilation of the FBS.

FIGURE 7.5
**Comparison of fat estimates (%) by main food commodity
(ENAHO and FBS 2003/04) (Peru)**
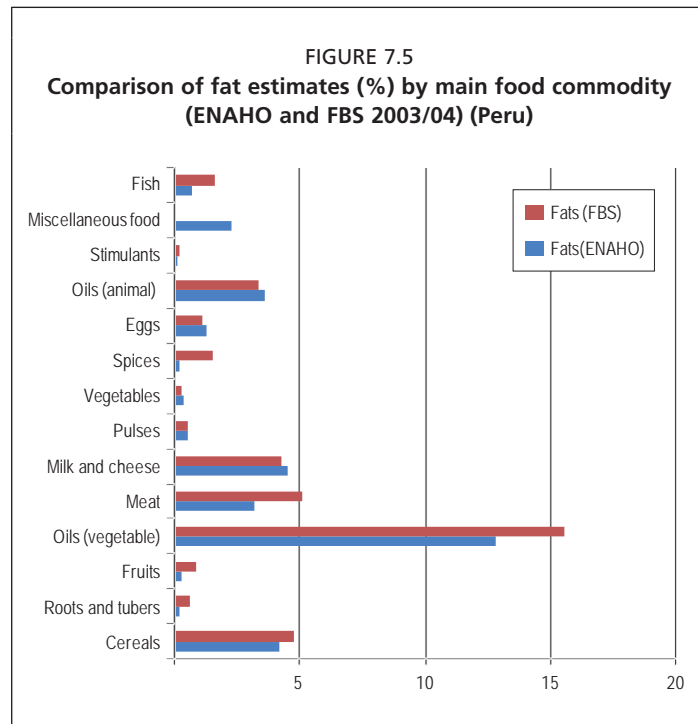
Similarly, Figure 7.5 shows a comparison of fats by food commodity group for the ENAHO and FBS. Again, some discrepancies between the two values can be seen and a much closer analysis needs to done to investigate those differences.

An analysis of the Peruvian diet in terms of macronutrients was made using the ENAHO data. According to the WHO/FAO recommendations, a balanced diet should consist of 10 to 15 percent protein, 15 to 30 percent fat and 55 to 75 percent carbohydrates. The FBS also provided protein and fat availability values, and the values of carbohydrates were calculated as a residual from the total dietary energy available. Figure 7.6 highlights the comparison of ENAHO and FBS values with the WHO/FAO recommended limits.

The macronutrient availability from FBS data shows a low availability of protein food and a high availability of carbohydrates as compared to corresponding values in the ENAHO. Therefore, there was a lack of protein food products in the FBS and an overestimation of carbohydrate food items, particularly cereals.

FIGURE 7.6
Percentage comparison of macronutrient consumption (ENAHO) and availability (FBS) with WHO/FAO recommendations (Peru)
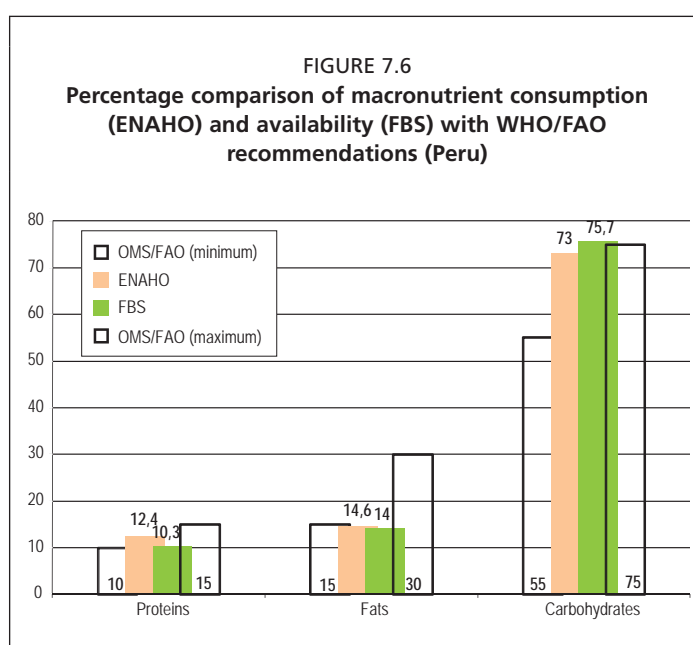
CONCLUSIONS

The main purpose of the FBS is to estimate the overall food supply meant for human consumption in the country, on a yearly basis. Annual FBSs over a period of years show trends in the overall national food supply and reveal changes that may have occurred in the type of food consumed. For example, such changes may include differences in the composition of the diet and the impact of agricultural and food policies in terms of food production, trade and use. Data sources come from the statistical system of Peru within the institutions of the Ministry of Agriculture and Trade and Statistics. Data analysis is constrained by the fact that basic data is collected from different sources, which are often inconsistent, incomplete and unreliable. ENAHO food data is collected from families during a short-term period and relates to consumed food in contrast with the raw food crops of the FBS. ENAHO reveals the composition of the diet and, if available for regular periods, supplies the trend analysis of the food commodity items. These are useful indicators for analysing the food supply patterns from the FBS.

ENAHO data cannot be directly used as inputs in FBSs to compensate for the weaknesses of the data in FBSs. However, the ENAHO may complement the data from FBSs after thorough analysis of both data at aggregated food commodity group and item level, particularly for the few major food contributors. In addition, trend values are useful to correlate the different patterns and to provide better estimates of the components of food production including own-consumption, for which estimates are usually missing. Given the assumption that both food data sources are comprehensive, it should be noted that values from FBSs should always be substantially higher than ENAHO values as the former includes public food availability.

Food data from the two food sources are very useful for the assessment and monitoring of the food situation at national and sub-national levels. In addition, these sources provide a wide range of information on the consumption patterns of the population, food gaps in terms of production and deficiency of micronutrients for more focused food policies and programmes.

REFERENCES

FAO. 1983. *A comparative study of food consumption data from food balance sheets and household surveys.* Statistics Division. FAO Economic and Social Development Paper No 34. Rome.

FAO. 2001. *Food balance sheets: a handbook*. Rome (available at http://www.fao.org/DOCREP/003/X9892E/X9892E00.htm).

FAO. 2006. Step 1 – processing user manual, step 2 – analysis user manual and step 3 – reports user manual. In *Food Security Statistics Module*. Rome.

FAO. 2008. *FAO methodology for the measurement of food deprivation*. FAO Statistics Division. Rome (available at http://www.fao.org/corp/statistics/en/).

INEI (Peru). 2004. *Evaluación de la inseguridad alimentaria y nutricional en Perú con resultados de la encuesta nacional de hogares 2003/04*. Lima, Peru.

Naiken, L. 2002. *FAO Methodology for estimating the prevalence of undernourishment*. Keynote paper presented at the International Scientific Symposium on Measurement of Food privation and Under-nutrition, 26-28 June 2002, Rome.

Sibrián, R. 2006. Indicators for monitoring hunger at global and sub-national levels. In *First World Congress of Public Health Nutrition Congress Proceedings*. Barcelona, Spain.

Sibrián, R., Ramasawmy, S. & Mernies, J. 2007. *Measuring hunger at sub-national levels from household surveys using the FAO approach: Manual*. FAO Statistics Division Working Paper Series No. ESS/ESSA/005e. Rome (available at http://www.fao.org/es/ess/faostat/foodsecurity/Papers_en.htm).

WHO. 2003. *Report of a joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases.* WHO Technical Report Series 916, Geneva (available at http://www.fao.org/WAIRDOCS/WHO/AC911E/AC911E00.HTM).

8 Tanzania: improving the compilation of food balance sheets to better monitor food security

Onasimbo Ntikha[31], Seevalingum Ramasawmy[32] and Gladys Moreno Garcia[33]

ABSTRACT

Tanzania's national FBS is one of the tools used to monitor food security in the country. It involves compiling and forecasting demand-supply possibilities within the food system, based on depletion and replenishment processes of the national food basket. It is prepared and managed by the National Early Warning System of the Ministry of Agriculture, Food Security and Cooperatives. The tool is potentially useful for a myriad of important activities, such as: implementing food trade policies by determining domestic food balance; recording current stock levels; forecasting stocks at the end of the consumption year and deciding on levels of national food reserves; or providing guidance on both food aid requirements, not least for Tanzanian's food export strategy. Despite its usefulness, the FBS faces various challenges. For example, the undercoverage of food commodities and of food requirement parameters registered in the FBS has a national focus. The FBS does not take into account differences that exist at sub-national level based on agro-ecological and livelihood potential. The objective of this paper is to address the problems that arise from using food consumption data from the Tanzania household budget survey (THBS), in order to improve the compilation of Tanzania's FBS and the monitoring of the food situation at both national and sub-national levels. In conclusion, the paper will reveal what new opportunities are brought about by the variability in consumption patterns, crop suitability and livelihoods across Tanzania. Furthermore, the paper will draw on the expandability and relevance of food composition (e.g. inclusion of livestock, fish and wildlife components as they become appropriate) for the national food basket, in general.

Keywords: Food balance sheets, consumption data, national household survey

BACKGROUND

FBSs are compiled every month by the Ministry of Agriculture, Food Security and Cooperatives, with country-level data on the production and trade of food commodities. Using this data and the available information on seed rates, waste coefficients, stock changes and types of use (e.g. feed, food and processing), a supply/utilization account is prepared for each commodity in weight terms. The food component of the commodity account, which is usually derived as a balancing item, refers to the total amount of the commodity available for human consumption during the year. The non-food component adds to the food component to account for gross commodity requirement towards total food availability. However, food availability

is only estimated at the national level and it is not possible to have sub-national level estimates for the assessment of food security.

The objective of this paper is to address this particular challenge through the use of food consumption data from THBSs to improve the compilation of Tanzania's FBS for the monitoring of the food situation at both national and sub-national levels.

FBSs are widely used to analyse the overall food supply situation and to estimate import requirements of a country or a region. In essence, the analysis simply compares the food requirement with its availability to obtain an estimate of the food deficit, sufficiency or surplus status.

AVAILABILITY AND ACCESSIBILITY

The principal strength of FBSs is that they offer an objective methodology for assessing overall food security based on quantifiable facts rather than qualitative judgement. FBSs also enable comparisons and aggregations of such elements to be made across countries and regions.

However, because of their aggregate nature (they are normally prepared for national level), FBSs only provide an assessment of the adequacy of overall food supplies. They can indicate the extent of any food shortfall and the amount of food that needs to be imported, but they cannot quantify how many people are affected, or where food shortages are most severe within the country.

For this reason, FBSs cannot properly identify all situations of food security or insecurity. In this respect, two facets of food security or insecurity are often distinguished: availability and accessibility. Availability is concerned with ensuring the adequacy of overall food supply. Accessibility is concerned with ensuring that each member of the population is able to obtain enough food. As Table 8.1 illustrates, using these two facets it is possible to distinguish three types of food security situation: Type A, Type B and Type C.

TABLE 8.1
Types of food security in relation to accessibility and availability (Tanzania)

		Availability	
		No	Yes
Accessibility	No	A	B
	Yes		C

In situation Type A, available food supplies are insufficient to meet the needs of the population; consequently, not everyone is able to obtain enough food. With neither the availability nor accessibility conditions satisfied, there is food insecurity. Type A is the typical situation faced by a low-income food-deficient country.

Type B occurs when available supplies are sufficient, yet not everyone is able to obtain enough food. In this case, even though the availability condition is satisfied, there is still food insecurity. Type B situations are typical of many low-income, but not necessarily food-deficient, countries.

Only in type C, where there is both an adequate availability of and accessibility to food are people able to obtain enough food. Type C situations offer true food security in the country.

The important message for assessment of data from FBSs is that while an unhealthy balance sheet indicates food insecurity (Type A situation), a healthy balance sheet does not necessarily imply food security.

It is important to recognize these limitations of the food balance sheet in order to use the tool in a responsible and useful way. Like any tool, unless handled and

understood properly, information can be distorted. This distortion has damaging consequences when determining food security policies.

TIME FRAMES OF NATIONAL FOOD BALANCE SHEETS

In principle, the FBSs have two distinct phases: active and historical.

An active FBS (Figure 8.1 below), deals with the forthcoming or current marketing year. For this reason, most of the elements that make up an active FBS are subject to change and will be revised on a regular basis. In Tanzania, this revision was done on a monthly basis.

FIGURE 8.1
Active and historical national food balance sheet (Tanzania)

National Food Balance Sheet

Food Balance Item	Maize	Sorghum & millets	Rice	Wheat	Total cereals	Pulses	Cassava	Banana	Potatoes	Non-cereals	Total Food
Domestic Availability											
A.1 Opening Stocks*											
Public Stocks (NFRA)											
Private Stocks											
Farm/Household retention											
A.2 Gross Harvest											
B. Gross Domestic Requirements											
C. Desired NFRA Carryover Stocks (fill up to 180,000 tonnes)											
D. National Food Balance											
E. Commodity Cross Substitution											
F. Domestic Shortfall [-]/Surplus											
G. Imports											
G.1.1 Commercial											
G.1.2 Food Aid											
H. Export											
I. Forecasted Closing Stocks											
K. Current Stocks											

An active FBS is primarily a forecasting tool. Its main function is to determine whether there is enough food to cover various requirements. For this purpose, interest is focused on such indicators as the size of the projected surplus/deficit and the scale of any import gap. In an active type of FBS, the food supply/demand equation does not necessarily balance, as in the case when projected availability is not sufficient to meet projected requirements.

FIGURE 8.2
Food balance item sheet (Tanzania)

Food Balance Item	Maize
Total Supply	
Opening Stocks*	
Gross Harvest	
Imports	
Total Utilization	
Domestic Utilization	
Export*	
Closing Stocks	

An historical FBS deals with a past marketing year. Data within an historical FBS is not subject to regular revision and remains substantially unchanged over time. The primary purpose of an historical FBS is to explain how available food supplies were consumed between different uses. As such, the supply and demand sides of an historical FBS will always balance. In an historical FBS, there are no such concepts as shortfall, surplus or import gaps.

It should be apparent by now that an active FBS, eventually and inevitably, will become an historical FBS. This transformation happens at the close of the current marketing year. At this point in time, a reconciliation of the data contained in the active FBS should take place to ensure that availability and utilization balance.

Although the primary focus of this paper is with the active phase of the FBS, the process of transforming an active FBS into an historical one is also dealt with. Up to now, this end of year reconciliation has not been undertaken in Tanzania. As a consequence, the balance sheets from past years cannot be used to predict trends in future active balances.

The Tanzania food balance sheet

As discussed above, the main focus of this paper is on the active phase of the FBS. In order to facilitate explanation and understanding, it is necessary for the paper to adopt a standard FBS structure as shown in Figure 8.3.

FIGURE 8.3
The standard food balance sheet (Tanzania)

Food Balance Item
Domestic Availability
Opening Stocks*
–Monitored
–Unmonitored
A.2 Gross Harvest
Domestic Requirements*
Food Use
Feed Use
Other Uses/Losses
Desired Monitored Stock
Domestic Shortfall [-]/Surplus
Net Imports
Imports
–Commercial*
–Food Aid*
Export*
Import Gap
Closing Stocks
Current Stocks*

This structure conforms to the style already adopted by national early warning systems in many South African Development Community (SADC) countries.

Before carrying out a balance sheet assessment of the food supply situation, it is necessary to define a number of parameters that determine the layout and content of the FBS. These include: time frame, commodity coverage, base commodity, population estimates, units of measure and use of trend projection method.

TIME FRAME

The standard time frame for a FBS is a year. However, there are a number of possible choices for an annual time frame: the calendar year, the government fiscal year, the crop year or the marketing year.

Within the SADC region, the time frame convention is to adopt the marketing year, which is defined as the period from one main crop harvest up to, but not including, the next. However, whatever time frame is adopted, it is essential that all data entering the FBS must conform to the predefined period of analysis.

Thus, for example, if the adopted time frame is the marketing year, which runs from June to May of the following year (12 months), then data on imports, exports, consumption and stocks must conform to this time period. The one exception to this rule is production data, which is normally reported according to the cropping year. Production from any given cropping year enters the FBS of the following marketing year (the year during which it would be marketed and consumed). For example, the maize harvest from 2009/10 cropping year would be entered as the production variable in the annual FBS for the 2010/11 marketing year. The distinction between the cropping year and the marketing year is extremely important and care should be taken to ensure that years are properly labelled in order to avoid any confusion or misunderstanding.

It is likely that different types of data, which are used in the construction of a FBS, are collected and recorded according to different time frames. For example, trade data may be recorded by the Ministry of Trade, Industries and Marketing on the basis of the fiscal year because duties and taxes are involved, while commercial millers may record their statistics (stocks, purchases and sales) according to their own financial year.

It is important to recognize the different time frames used by each source of information. Failure to do so is one of the main sources of error in any FBS. For

example, if a commercial miller is asked for the current year's opening stock level they may provide the stock position at the beginning of the company's financial year and not the stock position needed at the beginning of the marketing year.

Commodity coverage

Ideally, it is desirable to include all food commodities in the FBS. However, in practice, this option is almost impossible to attain due to the diversity of diets and to difficulties involved in data collection, especially for minor commodities. At regional levels within the SADC, commodity coverage is currently restricted to main cereals, i.e. maize, wheat, sorghum/millets and rice. At national levels, important non-cereal commodities, particularly cassava, are also included. The more commodities that are included in the balance sheet assessment, the more accurate and meaningful will be the analysis. As a general rule, FBSs should try to include all the major food commodity contributors of the diet; or those commodities capturing about 90 percent of calorific intake. Tanzania's FBSs include nine staple food items, namely, maize, sorghum, millets, rice, wheat, pulses, cassava, banana and potatoes.

Base commodity equivalence

When dealing with food commodities there is a need to convert data into standard definitions in order to facilitate comparison and aggregation. This conversion presents a twofold problem.

Firstly, certain data, notably that for stocks and trade, can be collected in different forms of the same commodity. For example, wheat imports may be delivered in the form of grain and flour. These two forms of wheat need to be aggregated to give an estimate of total wheat imports. Different forms of a single commodity have different food content. For example, a kilogram of wheat flour provides more calories than a kilogram of wheat grain. Therefore, it would not be correct to add them together without first converting all forms of the commodity into a common standard, such as its original form or raw product. In the case of flour, all flour products are converted to wheat.

The established convention, which has been adopted by the national Early Warning System (EWS) is to measure commodities in terms of whole grain or un-milled amounts. Such conversions are carried out using milling extraction rates. This rate is defined as the percentage of whole grain remaining after the milling process. For example, wheat has an extraction rate of between 72 and 80 percent, meaning that 100 kg of wheat grain after milling will be converted to between 72 and 80 kg of wheat flour.

Rice is an exception to this general rule, as it is usually expressed in milled amounts rather than as paddy. As rice is an important commodity, care is taken to ensure that gross harvest amounts are expressed in rice terms rather than paddy. It should be possible to obtain country-specific milling extraction rates (reflecting, for example, the predominance of commercial small-scale or household milling practices). However, if this information is not available locally, the standard extraction rates provided in Table 8.2 are used.

TABLE 8.2
Milling extraction rates (Tanzania)

Derived commodity	Extraction Rate (%)
Maize meal	80-95
Wheat flour	72-80
Sorghum flour	80-95
Millt flour	80-95
Paddy	65-35
Cassava flour	25-33

Secondly, in addition to providing assessments for individual commodities (e.g. maize, wheat and rice), most FBSs also make some sort of aggregate, cross-commodity assessment, such as total cereals. Because different commodities contain different amounts of energy, it is not strictly correct to add commodities together on a simple tonnage weight basis. Instead, it is more accurate to convert each commodity into equivalent amounts of a predefined base commodity using established food equivalent values (FEV). This base commodity (the common denominator) is normally the dominant commodity (e.g. maize, in most SADC countries) in the FBS.

However, the practice of using a base commodity when aggregating across commodities is not commonly used. For example, neither FAO Global Information and Early Warning System on Food and Agriculture (GIEWS), nor SADC regional EWSs have adopted this approach because they include food items other than cereals. Tanzania is an exception in this respect.

Nevertheless, if it is decided that this refinement to the FBS should be carried out, the exercise is relatively straightforward using the food energy values, after accounting for water loss and waste skin.

TABLE 8.3
Conversion to base commodity (Tanzania)

Crop	Tonnes	fev	Maize fev	Maize T		Exact coversion factors	Approx coversion factors adopted in Tz considering skin peals
Maize	100	3570	3570	100	1	1.00	0.98-1.03 or approx 1
Wheat	100	3320	3570	93	1	1.08	0.98-1.03 or approx 1
Rice	100	3630	3570	102	1	0.98	0.98-1.03 or approx 1
Sorghum	100	3450	3570	97	1	1.03	0.98-1.03 or approx 1
Millets	100	3410	3570	96	1	1.05	0.98-1.03 or approx 1
Cassava flour	100	3550	3570	99	1	1.01	0.98-1.03 or approx 1
Cassava, fresh	100	1490	3570	42	2	2.40	2.33-2.95 or approx 3
Sweet potatoes, fresh	100	1210	3570	34	3	2.95	2.33-2.95 or approx 3
Banana, Cooking	100	1530	3570	43	2	2.33	2.33-2.95 or approx 3

Conversions (Table 8.3) occur by multiplying the tonnage of the commodity to be converted (e.g. wheat) by its own FEV, and then dividing by the FEV of the base commodity (e.g. maize). Note that adding raw food to 900 tonnes of a food item is not appropriate; rather, the conversion procedure results in the appropriate sum of 705 tonnes of maize equivalent.
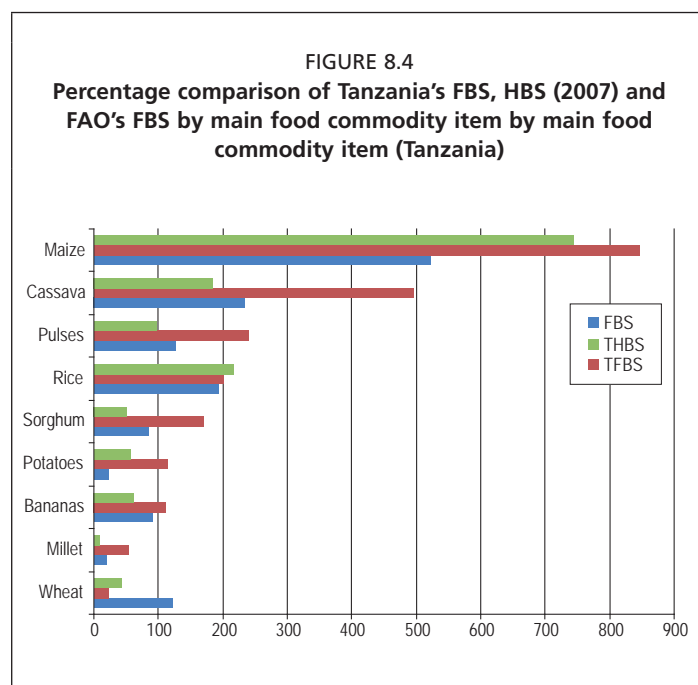
An example of the FBS constructed using this approach is shown in Table 8.4. Food availability is measured in kcal/person/day.

TABLE 8.4
National food balance sheet (Tanzania)

An analysis of adequacy of calories (Kcals based on aggregate food production)							
Commodity	Production (Tonnes)	Inputs	Ext Rate	Food (tonnes)	Kg/Year/ person	G/day/ person	Kcals/100g	Kcals/day/ person
Cereals								
Maize	3 373,391	3 373,391	0,96	3 238,456	85	234	362	847
Sorghum	700,815	700,815	0,95	665,775	18	48	353	170
Millets	221,421	221,421	0,95	210,350	6	15	355	54
Rice	783,775	783,775	1	783,775	21	57	354	201
WTheat	110,200	110,200	0,85	93,670	2	7	346	23
Subtotal	**5 189,602**	**5 189,602**		**4 992,025**	**132**	**361**		**1 295**
Pulses	1 017,642	1 017,642	1	1 017,642	27	74	326	240
Cassava	2 005,912	2 005,912	1	2 005,912	53	145	342	496
Bananas	1 140,001	1 140,001	1	1 140,001	30	82	135	111
Potatoes	1 375,113	1 375,113	1	1 375,113	36	99	114	113
Subtotal	**5 538,667**	**5 538,667**		**5 538,667**	**146**	**400**		**960**
Grandtotal	**10 728,269**	**10 728,269**		**10 530,691**	**278**	**761**		**2 255**

Noting that calorific requirement range between 1900 and 2 100 kcals per person per day the amount of food produced satisfies local needs by between 119 and 107 kcals considering maximum and minimum requirements respectively.

Tanzania's FBS food availability results concerning dietary energy are compared with the FAO FBS and food consumption data derived from the food security analysis of the 2007 THBS in Figure 8.4.

FIGURE 8.4
Percentage comparison of Tanzania's FBS, HBS (2007) and FAO's FBS by main food commodity item by main food commodity item (Tanzania)

The Tanzania FBS figure for food dietary energy availability (using just nine food items) was 2 255 kca/person/day. This figure was greater than the FAO estimate of 2 025 kcal/person/day (using items from 19 food commodity groups). Dietary energy for maize, sorghum, millet, pulses, cassava and potatoes was high when compared to the two other sources of the FBS and THBS. However, the FBS excludes animal products, oils and fats, fruit and vegetables, milk and cheese, and sugar, which are

all included in the FBS. Another critical limitation of the FBS was that the food trade, which was an important component in a country's food availability, was not taken into consideration. With the inclusion of these missing commodities, dietary availability could be estimated at over 2 800 kcal/person/day. Using this value, the prevalence of food inadequacy would be less than 10 percent in Tanzania.

Tanzania's food and agricultural raw material imports amounted to US$ 325 million in 2003 and included cereals (especially wheat and rice), vegetable oil and sugar. These items accounted for 85 percent of Tanzania's food imports in 2003. Other food items such as beverages, canned fish and meat, and dairy products are also imported. Nearly 70 percent of Tanzania's food imports come from developing countries, with the leading suppliers being Malaysia (for vegetable oil), Pakistan (for wheat), Thailand (for rice) and South Africa (for sugar). Imports from higher-income countries come primarily from Australia (cereals) and the EU (beverages). Tanzania's food exports are mostly agro-food such as cashew nuts, cotton, fish, fruit, vegetables and honey. Their destinations are either industrialized or neighbouring countries.

The results regarding food consumption from the 2007 THBS are in line with those derived from the 2000/01 THBS.[34] The 2007 THBS offers a good indication of the levels and magnitude of food consumption. The survey also provides a good representation of the patterns and trends of the food commodities in the diet of Tanzanians both at national and sub-national levels.

There were gross errors in estimating the food DES in the FBS when compared to the FAO and THBS data. These discrepancies could be due to the methodological approach of the cereal FBS, which was constructed without taking into consideration all the food sources (trade) and uses, including non-food uses.

CONCLUSIONS

In order to ensure that the information in the FBS is reliable, special care should be taken when preparing data accuracy, particularly with respect to time frames, levels of aggregation, base commodity considerations and commodity coverage. FBS is compiled every month by the Ministry of Agriculture, Food Security and Cooperatives. With country-level data on the production of food commodities, FBS can be considered to be a good attempt at assessing the food availability in Tanzania. The comparison of the FBS results with that of food consumption of the THBS showed several shortcomings in terms of incompleteness of food items and non-inclusion of non-food uses. However, there is a need to improve the FBS. These surveys need to be built up using a harmonized methodological approach for the monitoring of the MDG hunger indicator 1.9, and for comparison both at country and regional levels. In addition, complementing the FBS data with the consumption data of the THBS, will provide useful agricultural and food data to monitor the food security components of food availability, food access and food use.

In conclusion, this paper appeals for further examination of the possible new opportunities that could arise if variability in consumption, crop suitability and livelihood patterns across Tanzania were considered in the process of constructing the FBS. There is room for expanding information on food composition by including livestock, marine and wildlife components as they become appropriate for the national food basket, in general. The use of food consumption data from THBS could initiate enhanced FBS to monitor the food security situation from the perspective of expanding the national food basket. The end result could be a more food secure Tanzania.

---

[34] See Trend in Food Insecurity Assessment, 2010.

REFERENCES

FAO, 1983. *A comparative study of food consumption data from food balance sheets and household surveys*. FAO Statistics Division, Economic and Social Development Paper No 34. Rome.

FAO. 2001. *Food balance sheets: a handbook*. Rome (available at http://www.fao.org/DOCREP/003/X9892E/X9892E00.htm).

FAO. 2006. Step 1 – processing user manual, step 2 – analysis user manual and step 3 – reports user manual. In *Food Security Statistics Module*. Rome.

FAO. 2008. *FAO methodology for the measurement of food deprivation*. FAO Statistics Division. Rome (available at http://www.fao.org/corp/statistics/en/).

Naiken, L. 2002. *FAO methodology for estimating the prevalence of undernourishment*. Keynote paper presented at the International Scientific Symposium on Measurement of Food privation and Under-nutrition, 26-28 June 2002, Rome.

SADC. 2006. *Study report on the expanded food balance sheets for the SADC region*. Gaborone, Botswana, Agricultural Information Management System (AIMS) of SADC-FANR.

Sibrián, R., 2006. Indicators for monitoring hunger at global and sub-national levels. In *World Congress of Public Health Nutrition Congress Proceedings*. Barcelona, Spain.

Sibrián, R., Ramasawmy, S. & Mernies, J. 2007. *Measuring hunger at sub-national levels from household surveys using the FAO approach: Manual*. FAO Statistics Division Working Paper Series No. ESS/ESSA/005e. Rome (available at http://www.fao.org/es/ess/faostat/foodsecurity/Papers_en.htm).

WHO. 2003. *Report of a joint WHO/FAO expert consultation on diet, nutrition and the prevention of chronic diseases*. WHO Technical Report Series 916. Geneva (available at http://www.fao.org/WAIRDOCS/WHO/AC911E/AC911E00.HTM).

Part 4
Micronutrient trend analysis of food consumption data with links to food policies

9 Bolivia: a micronutrient analysis of food consumption data

Ana Moltedo[35] and Ricardo Sibrian[36]

ABSTRACT

The National Institute of Statistics of Bolivia, Instituto Nacional de Estadística (INE), conducted the 2003/04 NHS, encuesta contínua de hogares (ECH), as part of its Programme of Surveys of Living Conditions, Mejoramiento de las Encuestas y Medición sobre Condiciones de Vida (MECOVI). A sample size of 9 770 households was selected to be surveyed in two phases. The first phase was from November 2003 to March 2004 (4 610 households); and the second phase was from May 2004 to November 2004 (5 160 households). Data on food consumption and income collected in the NHS 2003/04 was processed using the FAO FSSM. In this case, the FSSM derived food security statistics for a number of vitamins, minerals and amino acids that are found in food acquired by Bolivian families for their own consumption. Food quantities were converted to micronutrients and amino acids using the Bolivian and the United States Department of Agriculture (USDA) food composition tables. This paper reports on the identification of food-insecure population groupings in Bolivia in terms of calcium, iron and some vitamins as well as the protein quality of an acquired diet. It then analyses their implications.

Keywords: household survey, micronutrient, amino acid, food security, Bolivia, MECOVI

BACKGROUND

At the Millennium Summit in 2000, a large gathering of world leaders committed their nations to a series of targets to be achieved by 2015, known as the MDG. One of the three targets of Goal 1 is to reduce the proportion of people who suffer from hunger by 50 percent by the year 2015. Two indicators are used to monitor progress for this target: one is MDG indicator 1.8 (prevalence of underweight children under 5 years of age; or stunting), and the other is MDG indicator 1.9 (proportion of a population below the minimum level of DEC; or proportion of undernourishment). MDG indicator 1.9 refers to energy consumed, but it does not consider other nutritional dietary components acquired by the population.

Vitamin and mineral deficiencies known as hidden hunger are generally characterized by an inadequate intake of energy-yielding macronutrients (protein, fat and carbohydrate) and micronutrients. These deficiencies have consequences to human health including the production of frequent infections or diseases. Therefore, an analysis of the nutritional status of vitamins, minerals and EAA available for human consumption would be helpful to identify population groups prone to nutrient deficiencies. These deficiencies may pose a particular threat to human health and development in children and pregnant women. Depending on the micronutrient deficiency, different effects can be found in the population, including anaemia, cretinism, blindness, stunting, wasting, retarded intellectual development in young children or a compromise of the immune system. EAA are needed for many

---
[35] Consultant, FAO Statistics Division, Rome; amoltedo@yahoo.com
[36] Former Senior Statistician, FAO Statistics Division, Rome; Ricardo@Sibrian.net

important roles in human metabolism and cannot be synthesized by the body itself, but must be obtained through the diet.

Most commonly, malnutrition affects rural families without access to drinkable water and sanitation, and whose women members have low levels of education. In 2003, the proportion of Bolivian children suffering from chronic malnutrition was higher in rural areas than in urban areas (37 percent and 18.5 percent, respectively). Malnutrition was reported to be higher among children whose mothers were without education than among those whose mothers had received a higher education (44 percent and 9 percent, respectively). The 2003 Bolivia National Demographic Health Survey revealed that more than one-half of Bolivian children suffered from iron deficiency (51 percent, with any grade of anaemia). Iron deficiency was found in 89 percent of children between the ages of 10 and 11 months. At least one in ten (11 percent) of young children in Bolivia also suffer from vitamin A deficiency, which compromises immune systems and leaves them prone to disease.

OBJECTIVE, METHODS AND DATA

Since May 1999, the INE has conducted various household surveys within the framework of the MECOVI program. One of the most complete of such surveys was the nationwide ECH of 2003/04, conducted over a period of 12 months to include seasonal variation. The sample size was 9 770 households. These were selected based on variables from the MECOVI-2002 household survey, which included: income, total expenditure, unemployment rate and incidence of poverty. Data processing was done on the basis of the FAO FSSM.

The survey collected quantities acquired by the households for 401 different food items. Most nutrient values were obtained from the Bolivian food composition table and were used to convert food quantities into micronutrient and amino acids content. However, nutrient values of iron were obtained from the USDA food composition table. It must be noted that the results presented in this paper do not take into consideration food eaten away from home or food eaten in public institutions like hospitals and jails.

Estimations of micronutrients are expressed in terms of availability with respect to estimated average requirement (EAR) or recommended intake values. The EAR is the average daily nutrient intake level that meets the needs of 50 percent of 'healthy' individuals in a particular age and gender group. The recommended nutrient intake (RNI) corresponds to two SDs of EAR above EAR levels, which meets the nutrient requirements of almost all apparently healthy individuals in an age- and sex-specific population group (FAO/WHO/UNU, 2004). Because of considerable daily variations in micronutrient intake, the average intake is estimated over a period of time.

For the purpose of this study, the micronutrient EAR and RNI values of population groups were estimated according to their sex-age population structures. The ECH sampled population yielded these structures so that EAR and RNI per person are weighted estimates given by sex and age groups. These EAR and RNI resulted from an FAO/WHO expert consultation on vitamin and mineral requirements in human nutrition.

Protein quality is assessed in terms of digestibility and biological value. Digestibility is a measure of dietary intake made available to the organism after digestion and absorption. The biological value is a measure of how well the absorbed amino acid profile matches that of the requirement (WHO, 2007). The amino acid score (AAS) determines the effectiveness with which absorbed dietary nitrogen can meet the EAA requirement at the safe level of protein intake. It is formulated as follows:

$$\text{AAS ratio} = \frac{\text{milligram of EAA in the diet per gram of protein consumed}}{\text{milligram of EAA requirement per gram of mean protein required}}$$

The protein digestibility corrected amino acid score (PDCAAS), which is one of the indicators used for evaluating protein quality, is defined as:

$$\text{PDCAAS ratio} = \text{AAS* protein digestibility}$$

* Protein quality is determined by the limiting EAA yielding the minimum PDCAAS value.

In 2002, a FAO/WHO/UNU expert consultation group formulated amino acids requirement patterns for infants, preschool children (1–2 years), children (3–10 years) and adults in terms of milligram of amino acid required per gram of protein required. However, in this study the amino acid pattern per gram of protein required by these population groups (excluding infants) is estimated using: 1) the population weighted average amino acid required and 2) the population weighted average protein required.

The experts' group recommended assessing protein quality indicator PDCASS using the preschool children pattern. The FSSM estimates PDCAAS values using infants, preschool children (1-2 years), children (3-10 years) and adult patterns. It also estimates these values on population-based patterns weighted by their sex-age structure of sampled household population groups.

The values of PDCAAS estimates are based on food available for human consumption and should not be considered as intake values. This analysis assumes that all food items reported by the household members in the NHS were acquired for consumption. Therefore, the estimated values of PDCAAS overestimate actual protein quality intake.

BOLIVIAN DIET: PROTEIN, VITAMINS AND MINERALS

The micronutrients analysed are minerals (calcium and iron) and vitamins A (REA), B1 (thiamine), B2 (riboflavin), B6 and B12 (cobalamine) and C (ascorbic acid). The EAA used to assess the protein quality are isoleucine, leucine, lysine, threonine, tryptophan, valine, histidine, methionine-cystine and phenylalanine-tyrosine.

Calcium

At the national level, most consumed food items identified in the survey were potato and bread (pan de batalla), which constituted the main sources of calcium, followed by cheese and milk. The presence of calcium in food consumed was very low with a daily average per person of 353 mg. This level was well below the recommended daily calcium intake of 762 mg/person (Figure 9.1). Even household members of highest income quintile were not able to reach the recommended calcium levels. Among the departments, the calcium availability as percentage of recommended intake was lowest in Potosi (less than 40 percent) and highest in Tarija (less than 60 percent).

FIGURE 9.1
**Recommended intake and availability of calcium
(mg/person/day) for consumption (Bolivia)**
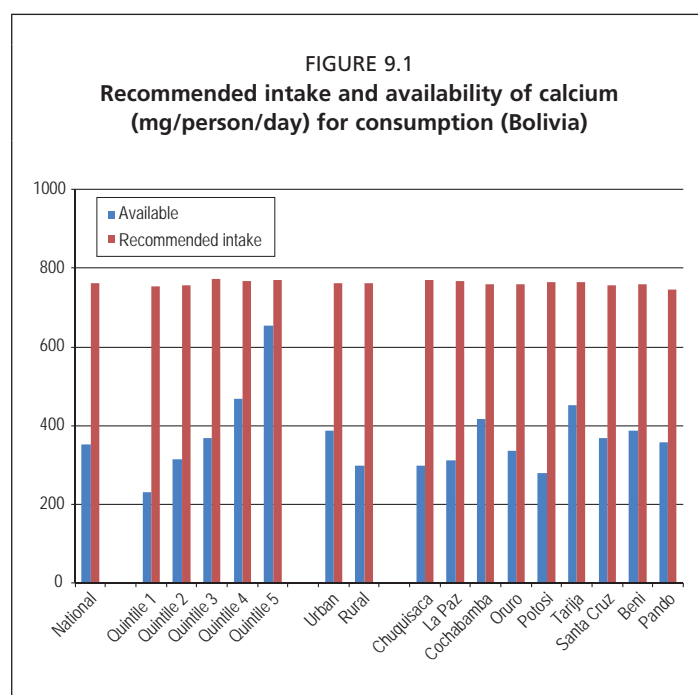
Iron

Iron is found in food in two forms, heme and non-heme. Heme-iron is better absorbed than non-heme iron. Sources of heme-iron are beef, pork, poultry and fish.

FIGURE 9.2
**Total non-heme iron and the proportion of non-heme iron
from meat and fish (Bolivia)**
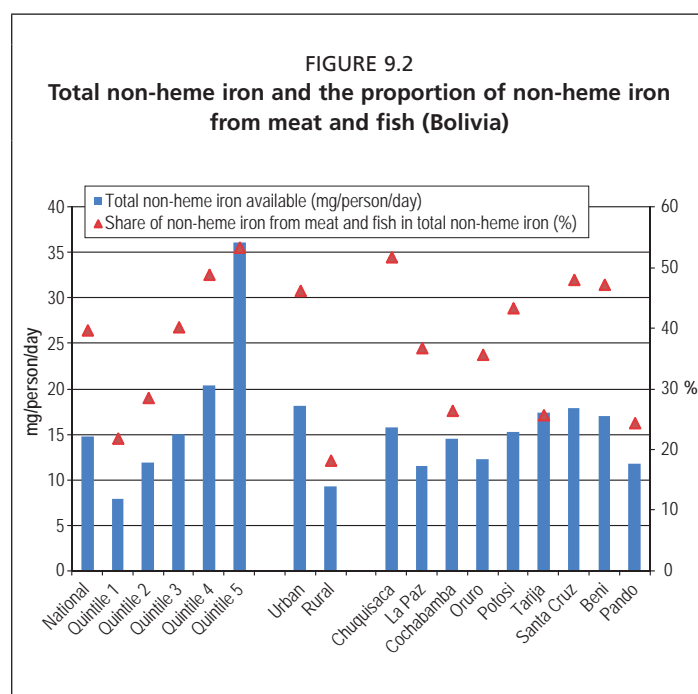
The departments of Beni and Pando had the highest consumption of protein of animal origin and also had a daily availability per person of heme-iron, which was higher than 1.0 mg. The heme-iron available was higher in households of higher income as they could afford to buy more expensive food items (Figure 9.2).

The absorption of non-heme iron is affected by the presence of inhibitors and promoters. Two of the inhibitors are phytates and polyphenols. Phytates are phosphorus compounds found primarily in cereal grains, legumes and nuts. Due to

the low consumption of these food items in Bolivia, the content of phytates in the diet was moderate. Some sources of polyphenols are berries, tea, beer, wine, olive oil, chocolate/cocoa, coffee, walnuts and peanuts. The amount of polyphenols in Bolivia's diet was low as the daily availability of polyphenol per person was less than 100 mg.

The presence of meat and fish in the Bolivian diet promotes non-heme iron absorption. Non-heme iron absorption was found in higher-income families who ate more meat and fish. It was more apparent in urban than in rural areas since there was a higher availability of quantities of meat and fish in urban areas. The department of Pando showed the lowest share of non-heme iron absorption from meat and fish in total non-heme iron (24 percent).

Ascorbic acid, widely available in Bolivia, also promotes non-heme iron absorption. Beni was the only department with less than 50 mg ascorbic acid available for daily consumption per person, while Cochabamba had more than 100 mg.

Vitamin A

The national daily availability of vitamin A per person was 438 g which is above the requirement, but below recommended intakes (Fugure 9.3). Vitamin A availability was higher for urban than for rural families and this result was linked to a higher consumption of carrots and liver in offal in urban environments. However, the availability of Vitamin A in urban families was lower than the recommended intake (92 percent).

FIGURE 9.3
**Recommended and required intake, and availability of vitamin A (g/person/day) for consumption (Bolivia)**
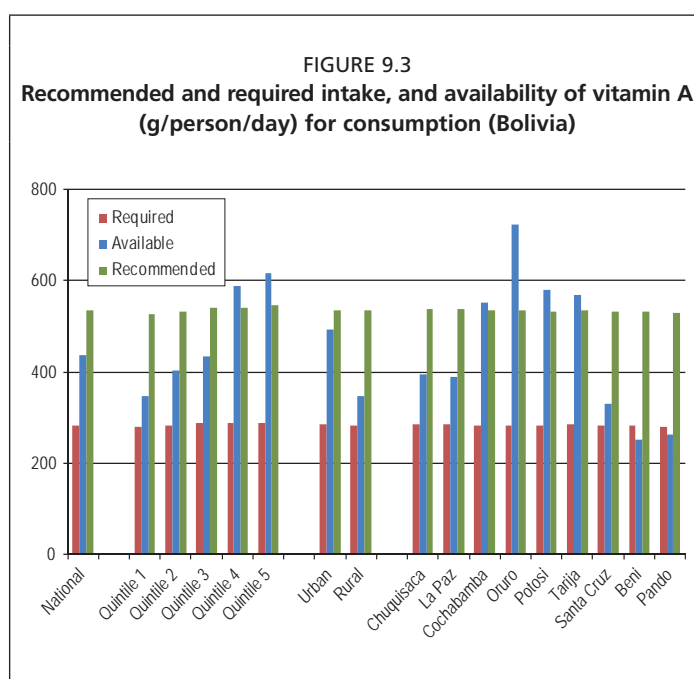
In five out of nine departments, vitamin A availability did not reach recommended intake levels. Beni and Pando showed levels below the requirements due to a low intake of foods containing vitamin A, such as carrots or yellow sweet potatoes. In contrast, vitamin A availability in Oruro was 35 percent higher than the recommended intake due to the daily consumption of carrots of 74 g/person.

Vitamins B1 and B2

With a thiamine availability of 59 percent of the recommended daily intake, Bolivia showed thiamine deficiency spreading over the country as all population groups showed vitamin B1 levels that were below recommended intake. Some natural sources

of thiamine are beef, poultry, whole grain cereals, nuts and legumes. The main sources of thiamine in the ECH were potatoes, followed by fresh milk. Consumption of whole grain cereals, nuts and legumes was very low at the national level.
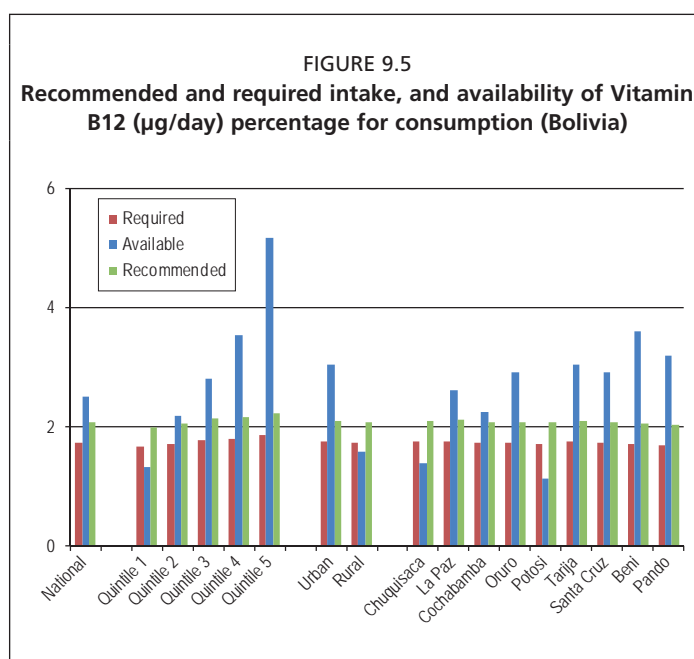
Riboflavin availability was lower than the recommended intake for all population groups except for families in the two highest income quintiles, and those in the department of Cochabamba (Figure 9.4). At the national level, the ratio of riboflavin availability to the recommended intake was 80 percent. This ratio was lower in rural than in urban households, at 71 percent and 85 percent, respectively. Potosi, Chuquisaca and La Paz showed low availability of vitamin B2 among departments with a ratio equal to or below 65 percent.

FIGURE 9.4
Ratio of availability of thiamine and riboflavin to recommended intake (%) (Bolivia)
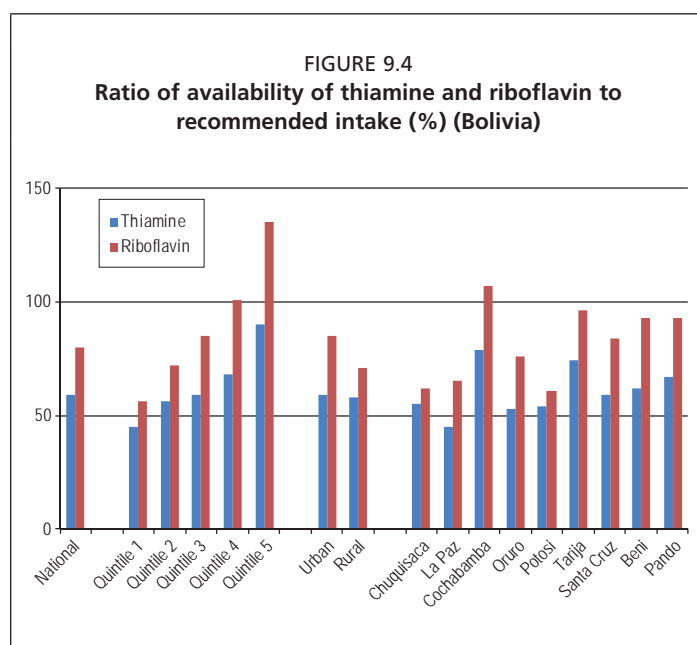
Vitamins B6 and B12

Pyridoxine is one of the compounds that can be called vitamin B_6, along with pyridoxal and pyridoxamine. As vitamin B6 is found in a wide variety of foods including beans, meat, poultry, fish, and some fruits and vegetables, vitamin B6 availability was almost equal to or higher than the recommended intakes for all population groups. Even if La Paz and Potosi, along with the first income quintile, had low pyridoxine availability, they all showed levels above the recommended intake (Figure 9.5).

At the national level, cobalamine availability was higher than the recommended intake. However, household members in the lowest income quintile showed low access to vitamin B12 and were unable to reach the recommended intake level.

FIGURE 9.5
Recommended and required intake, and availability of Vitamin B12 (µg/day) percentage for consumption (Bolivia)

Although rural areas had a high consumption of animal-origin protein from meats, generally population groups were deficient in vitamin B12 as its availability was much lower than the recommended intake. This deficit was due to the high consumption of charque (a mix of fried dried beef with stewed corn, hard-boiled eggs and cheese). Charque is high in protein but contains only moderate values of cobalamine. Liver and beef were the main sources of vitamin B12 at department level. However, Potosi and Chuquisaca both had a low consumption of these two food items, with the result that their vitamin B12 availability was below the recommended levels, at 66 percent and 80 percent, respectively.

Vitamin C

The availability of ascorbic acid was above the recommended intake at the national level. This value applied to all income levels and all departments (Figure 9.6). Daily availability per person at 77 mg was double the recommended intake.
Among Bolivia's departments, Cochabamba had the highest level of ascorbic acid available for consumption, attained mainly from potatoes, tomatoes and oranges.
Beni had the lowest level of ascorbic acide intake at 40 mg/person/day, which was just slightly above the recommended intake.

FIGURE 9.6
**Ratio of available to recommended intake (%) of vitamin C (Bolivia)**
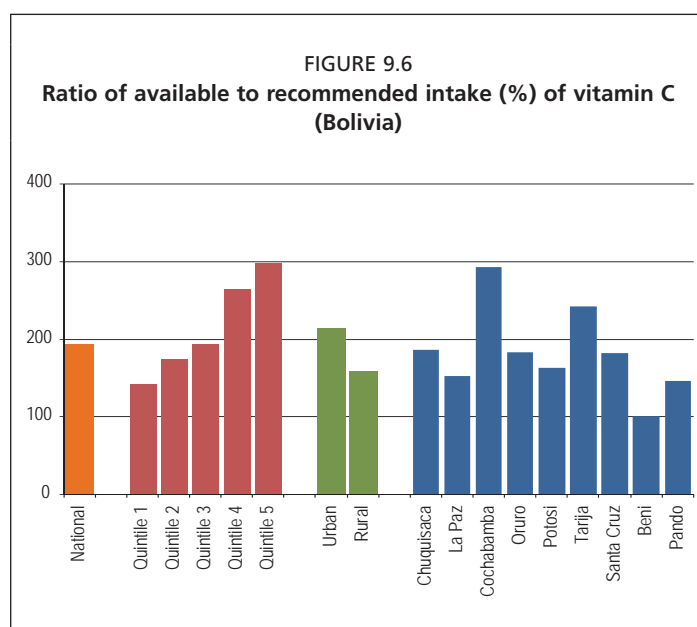
Even though the consumption of potatoes in rural areas was 25 percent higher than in urban areas, the availability of vitamin C in urban areas was higher. Rural areas consumed lower amounts of such food products as tomatoes and oranges than did urban areas.

Protein quality

Based on patterns in preschool children, protein quality in both urban and rural areas of Bolivia was limited by the EAA lysine (Figure 9.7). The main sources of lysine at the national level were beef, chicken and the bread called pan de batalla, which was the second most consumed food item.

Residents of Potosi and Chuquisaca showed a low intake of meat-derived protein, which is in line with lysine as the limiting amino acid. Lysine was the limiting amino acid not only for the three population groups suggested by experts, but for analysis of the whole population as a group.

Consumption of animal-origin protein by the two lowest quintiles was lower than the national level, and showed lysine as limiting EAA in both preschool-children and population-based patterns.

FIGURE 9.7
PDCAAS of Lysine (%) (Bolivia)
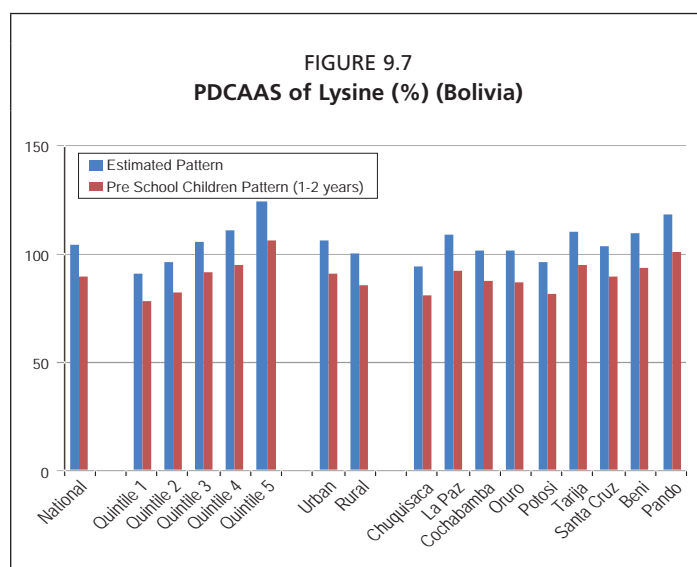
CONCLUSIONS

Unfortunately, the scarce availability of calcium was consistent throughout Bolivia with Potosi being the most affected department. This result was due to low daily consumption of calcium through a very low intake of fluid milk, contributing 38 mg of calcium per person. To bridge the national gap in calcium intake, it is estimated that an increase in fluid milk consumption to one cup or 250 ml daily per person would increase calcium availability by around 500 mg.

The lowest levels of vitamin A availability were found in the departments of Santa Cruz, Beni and Pando. An increase in the consumption of carrots and spinach by household members would correct the problem since this would increase the availability of vitamin A precursors.

An insufficient availability of thiamine and riboflavin was widespread throughout the country. A daily consumption of a cup (250 ml) of fresh, non-processed fluid milk would help increase their availability. Thiamine fortification of popular food items such as flour for the bread, pan de batalla, and riboflavin fortification of cereals may increase their availability.

Even though vitamin B12 availability was higher than the recommended intake at the national level, policies should focus on the departments of Potosi and Chuquisaca as well as on rural areas where the availability of cobalamine was very low.

Access to vitamins B6 and C were equal to or above the recommended levels of intake. However, promoting sources of vitamin C would further enhance non-heme iron absorption.

Protein quality was determined by limiting EAA lysine all over the country. The population of Bolivia consumed low amounts of lysine sources such as legumes (beans, peas and lentils). An increased consumption of legumes would not only improve the quality of protein, but also the levels of calcium and thiamine intake.

The National Food Fortification Program (NFFP) supported the government's targeting Zero Malnutrition, which was initiated in 2006 within the framework of the Zero Malnutrition Programme. Policies for a reduction in micronutrient deficiencies would require an assessment of the effects on micro-nutritional status related to the fortification of: all wheat flour with iron, folic acid and other B complex vitamins; all vegetable oil with vitamin A; and all milk products with iron, zinc, vitamin A and other micronutrients.

The micronutrient analysis based on data collected in 2003/04 may serve as a baseline. The more recent HBS may provide inputs to evaluate effects of the fortification programme, using nutrient conversion factors of fortified food items.

REFERENCES

Bolivia. 2004. *Encuesta contínua de hogares-MECOVI de Bolivia 2003/04*. La Paz, Bolivia Instituto Nacional de Estadística.

FAO. 1991. *Protein quality evaluation in human diets. Report of a joint FAO/WHO expert consultation*. FAO Food and Nutrition Paper no. 51. Rome.

FAO, WHO & UNU. 2004. *Human energy requirements. Report of a joint FAO/WHO/UNU expert consultation*. 17-24 October 2001, Rome.

FOCAL. 2010. *Bolivian maternal and child health policies: successes and failures*. Ottawa (available at http://focal.ca/en/publications/policy-papers-briefs/403-policy-papers-a-briefs-2010).

FORTAF. 2008. *Properties of vitamins* (available at http://www.fortaf.org/files/Properties_of_Vitamins.pdf).

GAIN. 2007. *Bolivia launches national food fortification program to reduce vitamin and mineral deficiency*. Online feature story, 24 September. Geneva (available at http://www.gainhealth.org/press-releases/bolivia-launches-national-food-fortification-program-reduce-vitamin-and-mineral-defic).

MI & UNICEF. 2004. *Vitamin and mineral deficiency: a global damage assessment report*. New York and Ottawa (available at http://www.micronutrient.org/CMFiles/PubLib/Report-67-VMD-A-Global-Damage-Assessment-Report1KSB-3242008-9634.pdf).

MSD (Bolivia). 2005. *Factores de corrección y equivalencias de pesos y medidas.* La Paz, 2004.

Murillo Sasamoto, D. & Mazzi Gonzales de Prada, **E.** 2006. Desnutrición en Bolivia. *Revista Boliviana de Pediatría*, 45(1): 69-76.

NHD, SDE & WHO. 2000.*Turning the tide of malnutrition: responding to the challenge of the 21st century*. Geneva (available at http://www.who.int/mip2001/files/2232/NHDbrochure.pdf).

UN. 2010. The official United Nations site for the MDG indicators (available at http://unstats.un.org/unsd/mdg/Data.aspx).

UNICEF. 2004. *The hidden hunger of the vitamin and mineral deficient child*. Online feature story, 24 March (available at http://www.unicef.org/nutrition/index_hidden_hunger.html).

USDA. 2009. *Composition of foods: raw, processed, prepared*. National Nutrient Database for Standard Reference, Release 22 (available at http://www.nal.usda.gov/fnic/foodcomp/search/index.html).

WHO. 2007. *Protein and amino acid requirements in human nutrition. Report of a Joint WHO/FAO/UNU Expert Consultation* (available at http://www.who.int/nutrition/publications/nutrientrequirements/en/index.html).

WHO. 2008. *Global burden of disease*. *2004 Summary Tables*. Geneva, Switzerland.

WHO & FAO. 1998. *Vitamin and mineral requirements in human nutrition. Second edition. Report of a joint FAO/WHO expert consultation on human vitamin and mineral requirements 21–30 September 1998, Bangkok, Thailand* (available at http://whqlibdoc.who.int/publications/2004/9241546123.pdf).

10 Tanzania: a micronutrient trend analysis of food consumption data

Mlemba Abassy[37], Ricardo Sibrian[38] and Ana Moltedo[39]

ABSTRACT

The National Bureau of Statistics of the United Republic of Tanzania conducted two HBSs in the last decade. The first survey covered the period from May 2000 to May 2001, and the second from January to December 2007. Both surveys collected food data in quantity and monetary values which were necessary for a trend food security analysis. This trend analysis is useful to evaluate the impact of food policies at national and sub-national levels. Overall, a marginal increase of 30 kcal/person/day was observed over the period 2001–2007. Whereas the food insecurity of nine regions improved, ten regions showed deterioration of food security due to a decrease in food consumption. The quality of the diet has improved in most regions particularly because there was a shift from high carbohydrate foods to high protein or fat food. The levels of availability of some micronutrients such as vitamins A, B1, B2 and B6 were above the recommended levels. This paper presents the trends in food security analysis over the two survey periods in addition to an assessment of micronutrients from data on food quantities collected in both HBSs.

Keywords: household budget survey, micronutrient, amino acid, food security, protein quality

BACKGROUND

Poverty and food deprivation are two important aspects of national food insecurity assessment and trend analysis. However, further assessment of micronutrients such as vitamins, minerals and EAA available for human consumption are needed. Such assessment is necessary to identify not only likely nutritional deficiencies, but also policy implications for agricultural and food industry production and trade, as well as other economic and social sectors.

Food commodities are available for human consumption as a result of policies, in particular, those involving agricultural production, agro-industries, trade, and food distribution systems to the national population. The nutritional assessment of food accessed by households provides inputs for the health and productive sectors on what are the main food commodities to promote. The aim is to provide the best possible nutrition for human development, not only for children, adolescents, pregnant women and the elderly, but also for the economically-active population.

The deficiencies of vitamins and minerals, also called hidden hunger, are detectable by clinical and biochemical examinations. Malnourished people cannot feel this hidden hunger. However, if people have inadequate intakes of vitamin and minerals, including low protein quality, what they do experience is very low energy. They are also vulnerable to frequent infections and/or disease. These conditions result

---

[37] Senior Statistician, Social Division, National Bureau of Statistics, Dar es Salaam, Tanzania; abassy@nbs.go.tz

[38] Former Senior Statistician, FAO, Rome; Ricardo@Sibrian.net

[39] Consultant, Statistical Division, FAO, Rome; amoltedo@yahoo.com

in underweight-for-attained-height (i.e. wasting) in children and adolescents. This measure is a clear indicator of severe and chronic forms of undernourishment and insufficient attained-height-for-age (i.e. stunting).

Micronutrients are needed in small amounts to enable the body to produce the required enzymes, hormones and other substances that are essential for physical growth and mental development. Different effects could be found due to a low intake and absorption of specific micronutrients. These effects include anaemia due to iron deficiency, cretinism due to iodine deficiency, blindness due to vitamin A deficiency, reduced mental development in young children or a compromise of the immune system in economically-active population groups.

Amino acids derived from proteins have many functions in the human metabolism and as such, play a critical role in building cells, protecting the body from viruses or bacteria, repairing damaged tissue, providing nitrogen and carrying oxygen throughout the body. EAA cannot be synthesized within the human body and are extracted from protein in the food people eat.

In 2004, almost one in ten African children suffered from wasting or stunting as a result of protein-energy malnutrition. This malnutrition included iron-deficiency anaemia (26 percent), iodine disorders (15 percent) and Vitamin A deficiency (less than 1 percent). In Tanzania, the health of children and women is compromised by poor nutrition, gender inequality and female illiteracy levels. Over two-thirds of the deaths of children under the age of 5 years can be attributed to diseases aggravated by malnutrition, such as pneumonia, diarrhoea and measles, among others. The most recent data estimates show that 45 percent of women of childbearing age suffer from anaemia, while nearly two-thirds of children under the age of 5 years suffer from anaemia while 37 percent are vitamin A deficient. The Preliminary Report for Tanzania DHS conducted in 2009/10 revealed that Tanzanian children have high rates of underweight (61 percent) and stunting (42 percent). The under-5 and infant mortality rates were estimated at 81 percent and 51 percent, respectively.

The national alliance for food fortification is currently coordinating the development of a national fortification programme with WHO. Together, they are promoting the development of a national micronutrient survey that will serve as a baseline for the programme, as well as a comprehensive programmatic response to micronutrient deficiencies.

OBJECTIVE, METHODS AND DATA

The HBS conducted in mainland Tanzania, collected data on food acquired by households, which allowed for the estimation of vitamins, minerals and amino acids available for household member consumption. The Tanzania food composition table (TFCT) provided nutrient factors for each food item. The FAO FSSM was used to process the HBS data and derive food security statistics, including micronutrients and protein quality at the national level and by population groups. The results presented in this paper do not consider food eaten away from home in public institutions such as hospitals, military barracks, hotels, or jails, or that consumed from street vendors.

There is a lack of information on the distribution of intakes or consumption of the different micronutrients in the population, for using parametric approaches. Therefore, the assessment of the nutritional status uses estimates of the daily micronutrients available for human consumption (MNAC) from HBS food data. Two reference cut-off estimates for each micronutrient are used. The first is the EAR, and the second is the RNI. All three estimates (MNAC, EAE and RNI) are weighted by the sex and age population structure of the studied population group.

The EAR is the average daily nutrient intake level that meets the needs of 50 percent of the apparently healthy individuals in a particular age and sex population group. The RNI is the daily intake (2 SDs above the EAR) that meets the nutrient

requirements of almost all apparently healthy individuals in a specific age and sex population group. In this study, the EARs and NRIs were derived based on reference values published in the second edition (2004) of a joint FAO/WHO expert consultation report on human vitamin and mineral requirements.

The assessment of the level of availability of a particular micronutrient for consumption is insufficient if MNAC is less than EAR. It is acceptable if it is equal to or greater than EAR, and less than RNI. It is advisable to be equal to or greater than RNI. The daily micronutrient intake or consumption varies considerably (WHO/ FAO, 2004); however, MNAC estimates from HBS data refer to a weighted average for groups of households over a period that is usually one calendar year.

The assessment of protein quality is performed using the indicator of PDCAAS. This indicator was first proposed in 1991 and subsequently reviewed in 2002 by a joint FAO/WHO expert consultation. The PDCAAS is based on the protein digestibility and the AAS. The AAS relates EAA available for consumption to the respective pattern requirements. The EAA available in food for human consumption is expressed on an available digestible protein basis, while the EAA requirements are expressed on a mean protein requirement basis. Both are weighted by sex and age population structures. The limiting amino acid is identified as the lowest PDCAAS among all PDCAAS values.

The FAO/WHO experts provided patterns of EAA required per gram of protein required for four population groups: infants, preschool children (1–2 years), children and adolescents (3–18 years) and adults (over 18 years). Furthermore, they recommended the preschool children pattern for assessing protein quality in estimating PDCAAS. However, this paper reports on a protein quality assessment that used the pattern of EAA required per gram of protein required, weighted by the sex and age population structure of the studied population groups.

The PDCAAS value can overestimate protein quality since the assessment takes all food items available as a whole, which is not what happens in reality. Food items available may be consumed in a less efficient combination to provide EAA than the optimal combination of all food items, as occurs in estimating PDCAAS values.

The MNAC estimates in this study are indicative of micronutrient consumption, and are derived from the evaluation of consumption by individuals living in the household, assuming equal food consumption among its members.

MICRONUTRIENT AVAILABILITY AND PROTEIN QUALITY IN ACQUIRED FOOD
This section analyses the availability for consumption of vitamins A (retinol), B1 (thiamine), B2 (riboflavin), B6, B12 (cobalamine) and C (ascorbic acid), and minerals, calcium and iron. It also analyses the protein quality based on isoleucine, leucine, lysine, threonine, tryptophan, valine, histidine, methionine-cystine and phenylalanine-tyrosine.
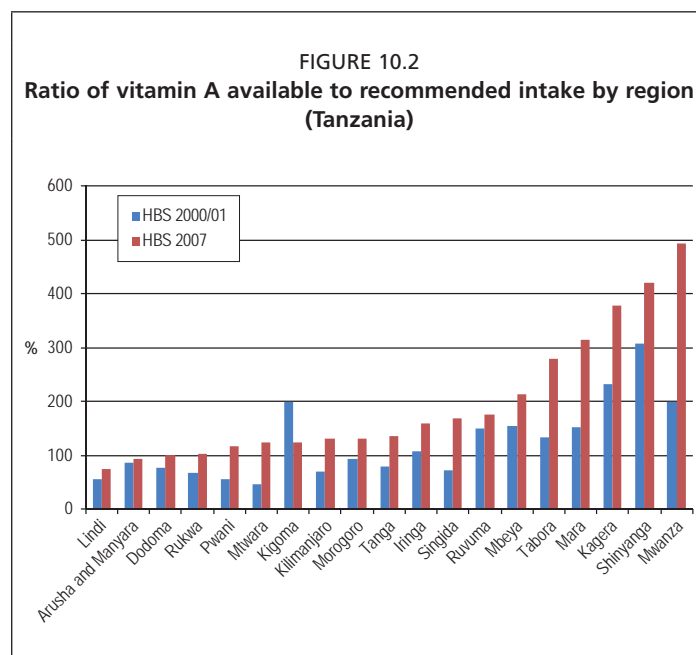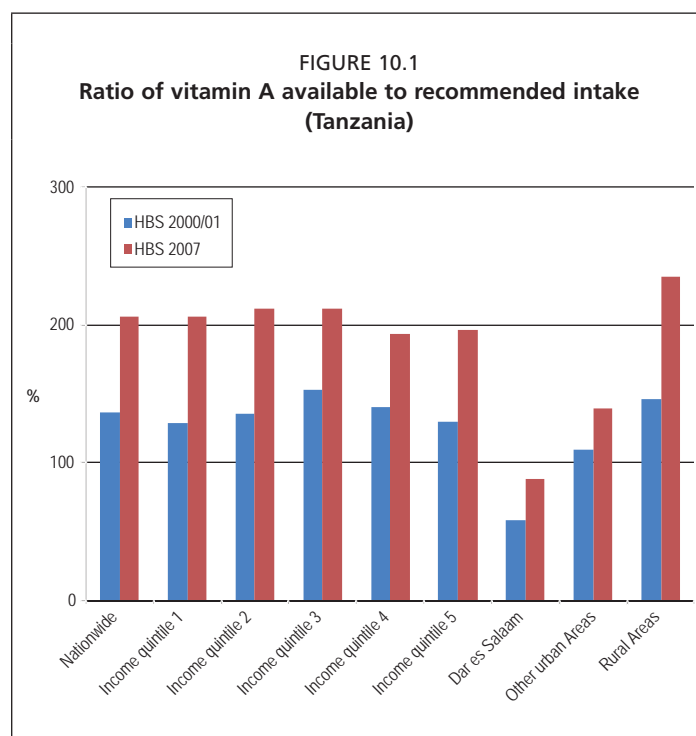
Vitamin A
The main sources of vitamin A were sweet potatoes, plantains, leafy foods (such as spinach or vegetable sponge leaves), tomatoes, pumpkins and cow milk. Vitamin A availability, expressed in RAE/person/day, increased in mainland Tanzania from 717 mcg to 1 088 mcg, in 2000/01 and 2007, respectively. These values are higher than the RNI of 527 mcg/person/day.

From 2000/01 to 2007, all areas increased in RAE availability (Figures 10.1 and 10.2). However, in Dar es Salaam the level of vitamin A was insufficient in 2007, as the RAE available for consumption was below the estimated RNI. No significant differences were observed in RAE availability between different income levels.

The access to vitamin A increased among the regions in Tanzania from 2000/01 to 2007. In both surveys, sweet potatoes were the main source of RAE in Shinyanga, Kagera and Mwanza regions, with more than 1 000 mcg RAE. From 2000/01 to 2007, all regions showed an increase in RAE availability, except Kigoma where it decreased

by 38 percent. This result was partially due to a decrease in sweet potato consumption by 60 percent. Even though vitamin A availability increased in the regions of Lindi, Arusha and Manyara, in 2007 it was still below the RNI values.

FIGURE 10.1
Ratio of vitamin A available to recommended intake (Tanzania)

FIGURE 10.2
Ratio of vitamin A available to recommended intake by region (Tanzania)
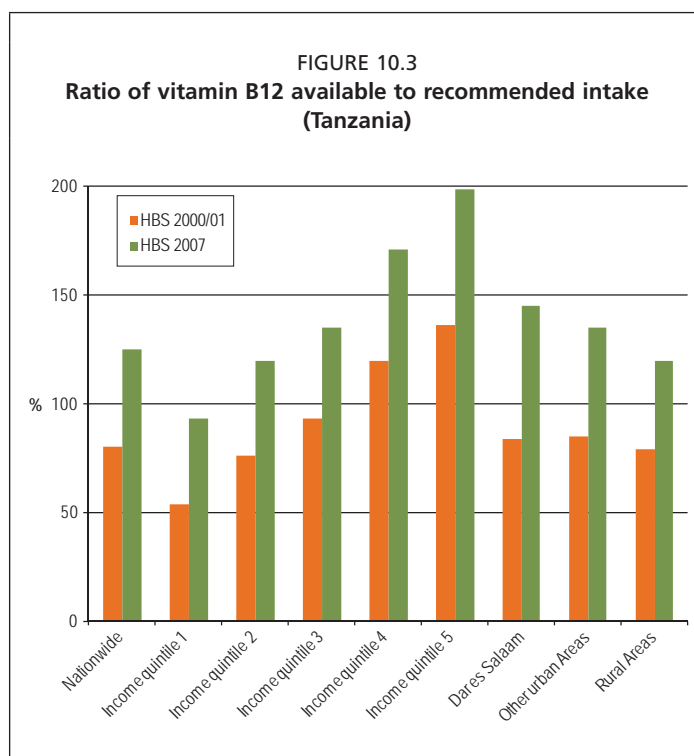
Vitamins B1, B2, B6 and B12

Thiamine, riboflavin and vitamin B6 availability levels were above their respective RNI values for all population groupings in both survey periods. With a national daily average availability of thiamine per person of 2.13 mg and 2.45 mg, in 2000/01 and 2007, respectively, thiamine levels were above the RNI of 0.98 mg. Maize of all kinds and green beans were the main sources of thiamine. Even though in Mainland Tanzania maize consumption decreased, the thiamine contributed by green beans,
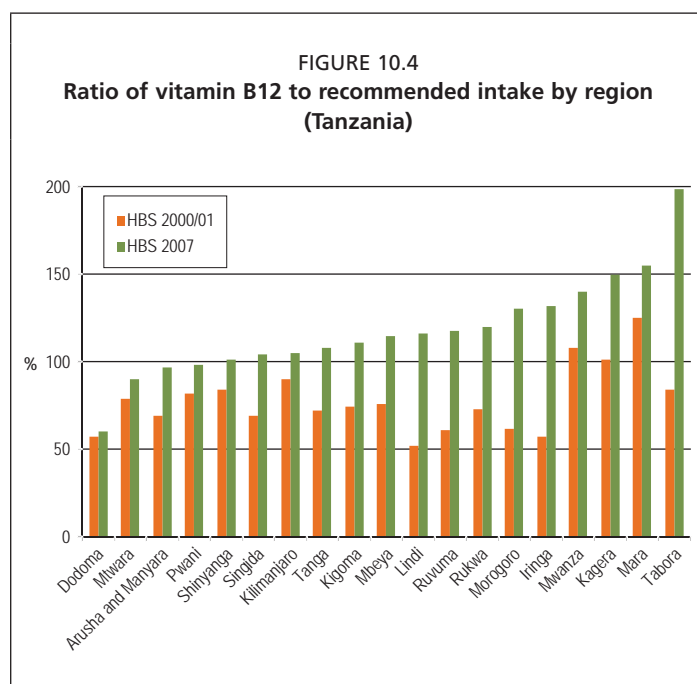
increased by more than 60 percent. The lowest thiamine consumption levels were found in Dar es Salaam and in the regions of Pwani and Kilimanjaro. On the other hand, Tabora region showed an increment of 189 percent, partially due to an increase in the daily consumption of green beans per person from 0.17 g to 23.7 g.

The availability of daily riboflavin per person increased from 1.75 mg to 3.87 mg in 2000/01 and 2007, respectively. These values were well above the estimated recommended intake of 1.01 mg/person/day. These levels can be accounted for by the high consumption of leafy vegetables and maize by the population, especially in the results from 2007. Every region increased its availability of riboflavin. In particular, the region of Iringa doubled its leafy vegetable consumption.

In Mainland Tanzania, the daily availability of vitamin B6 per person remained at the same level from 2000/01 to 2007, at 2.3 mg and 2.4 mg, respectively. These results were above the RNI of 1.1 mg/person/day. Maize, cassava and rice were the major food sources of vitamin B6. Lindi and Tabora region had the greatest drop from 2.7 mg/person/day to 2.3 mg/person/day of vitamin B6 available, but these levels were still above RNI. These reductions were partially due to a fall in maize and rice consumption.

Food from animal origin (fish, meat, milk and eggs) is the main provider of cobalamine. In the case of Mainland Tanzania, salted dried sardines, dried fish, cattle meat and cow milk are the main food sources of vitamin B12. The availability of cobalamine was higher than the RNI level for the two highest national income quintiles as well as for Kagera, Mwanza and Mara regions in 2000/01 (Figures 10.3 and 10.4). From 2000/01 to 2007 a substantial increase of cobalamine availability occurred in all the population groupings. However, this increase was not enough to achieve the RNI estimates for Dodoma and Mtwara region, and for the first income quintile in Mainland Tanzania. At the national level, daily cobalamine availability per person increased from 1.63 mcg in 2000/01 to 2.53 mcg in 2007, which was above the RNI estimate of 2.03 mcg. The availability of cobalamine was lower in households with lower incomes, which is partially explained by the fact that households with higher incomes can afford more expensive food of animal origin.

FIGURE 10.3
Ratio of vitamin B12 available to recommended intake (Tanzania)

FIGURE 10.4
Ratio of vitamin B12 to recommended intake by region (Tanzania)
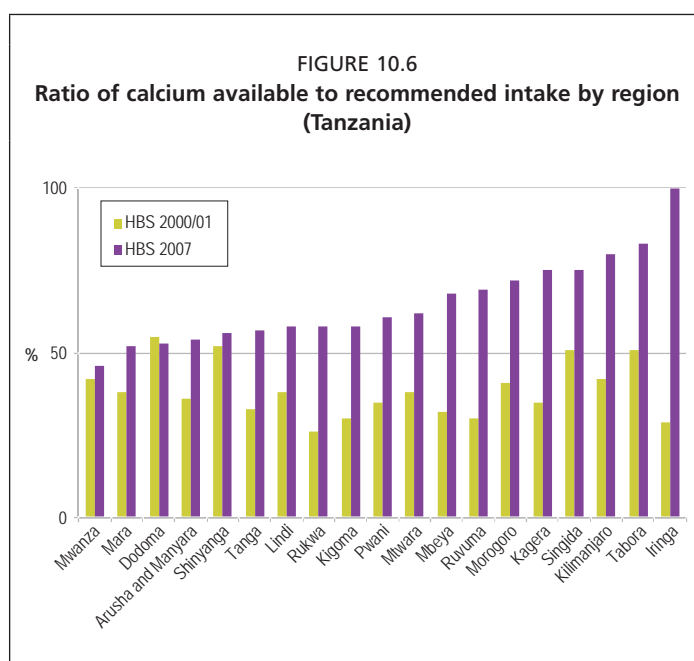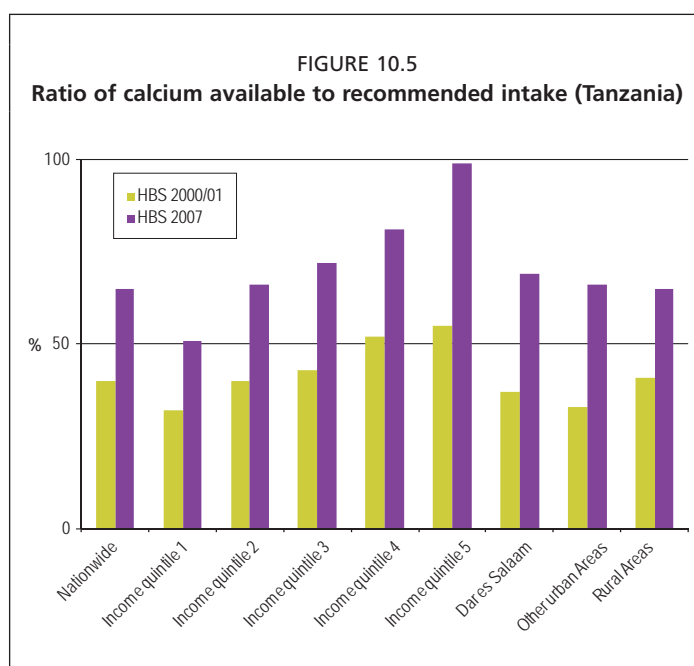
Vitamin C

The national average daily availability of ascorbic acid per person was 92 mg in 2000/01 and 127 mg in 2007. Both levels were higher than the RNI estimates of 40 mg/person/day. Vitamin C availability was higher in higher-income households. Those in the highest income quintile had 30 percent more access to vitamin C than those in the lowest income quintile.

Singida was the only region with vitamin C availability (34 mg/person/day) below the RNI estimate in 2000/01. By 2007, it had increased to 81 mg/person/day, exceeding the RNI of 40 mg/person/day. This increase was partially due to an increase in cabbage and sweet potato consumption. On the other hand, Lindi was the only region with a decrease (36 percent) in vitamin C availability due partially to a decrease of availability of cassava flour, which fell from 52 g/person/day to 21 g/person/day. However, this level was still above the RNI estimate. In Dar es Salaam vitamin C availability increased from 51 mg/person/day in 2000/01 to 104 mg/person/day in 2007. In rural areas, vitamin C availability rose from 100 mg/person/day in 2000/01 to 133 mg/person/day in 2007.

Calcium

Low calcium availability (below RNI) was widespread in Mainland Tanzania (Figures 10.5 and 10.6). Although almost all population groups experienced an increase in calcium availability, but this increase was not enough to reach the recommended nutrient intake level. The exception to this trend occurred in the fifth quintile and Iringa region where availability was practically the same as the RNI (750 mg/person/day and 747 mg/person/day, respectively). Dodoma was the only region to experience a decrease in calcium availability from 407 mg/person/day to 388 mg/person/day.

FIGURE 10.5
Ratio of calcium available to recommended intake (Tanzania)

FIGURE 10.6
Ratio of calcium available to recommended intake by region (Tanzania)

Iron

The daily availability of iron, coming from animal origin, increased from 2000/01 to 2007 in all population groupings (Figure 10.7). The 2007 estimates showed that the regions of Dodoma and Mtwara had the lowest levels (less than 0.5 mg/person/day), while Kilimanjaro, Iringa and Mbeya had the highest (above 1 mg/person/day). The remaining regions ranged from 0.5 mg/person/day to 1.0 mg/person/day. Consequently, the availability of heme iron also increased during this period.

On the other hand, the non-heme iron availability decreased from 2000/01 to 2007 for all population groups, except in six regions.

FIGURE 10.7
Heme iron available (Tanzania)

FIGURE 10.8
Non-heme iron available (Tanzania)
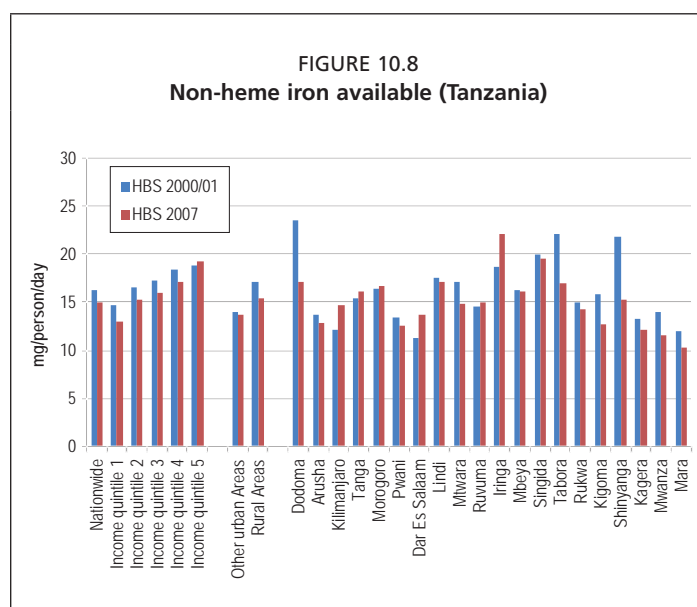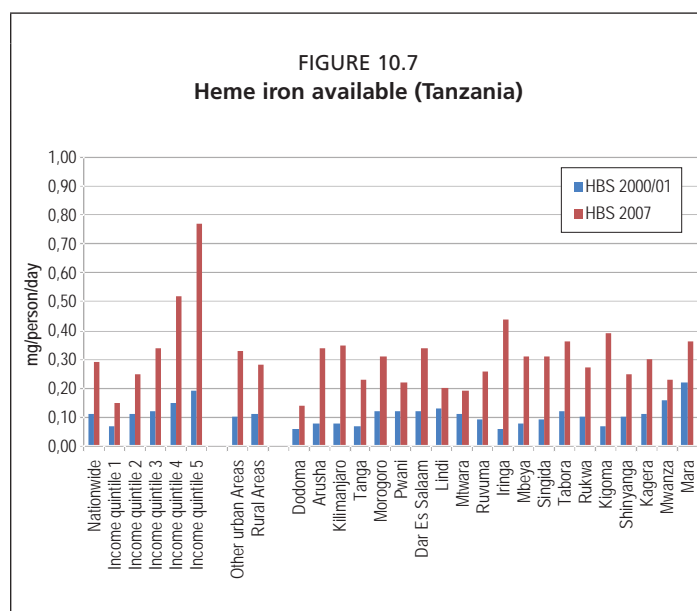
The levels of absorption of non-heme iron available in food consumed are promoted or inhibited by various factors. In this paper, we analyse the promoters: meat, fish and vitamin C, and the inhibitors: phytates and polyphenols.

Meat and fish increase the absorption of non-heme iron. Their consumption increased from 2000/01 to 2007, except in Dodoma, Shinyanga and Rukwa region, where populations consumed less than 43 g/person/day in 2007 (Figure 10.8). Mtwara showed a slight increase in meat and fish consumption, but it was still less than 40 g/person/day.

The availability of vitamin C increased from 2000/01 to 2007 except in the region of Lindi; however, the region of Arusha kept the same low level. That level does not help to promote non-heme iron absorption.

Phytates availability decreased from 2000/01 to 2007 in Mainland Tanzania and by income level, but increased in Dar-Es-Salaam. At the regional level, phytates availability decreased in Dodoma, Iringa, Tabora, Kigoma and Shinyanga, among others. It increased in Lindi and Singida, among others.

In addition, polyphenol availability decreased from 2000/01 to 2007 in mainland Tanzania, in rural areas and by income level, except in the highest income quintile. At the regional level, it decreased significantly in Dodoma, Singida, Shinyanga and Mara. However, in 2007, a high polyphenol availability was still observed in Dodoma, Singida and Tabora.

In summary, the availability of some micronutrients in the diet is shown in three categories: low, middle and high levels (Table 10.1). Low nutrient availability means the level is lower than the corresponding population-based average estimated requirement. High nutrient availability means the level is higher than the corresponding population-based average nutrient recommended intake.

TABLE 10.1
Micronutrient availability (Tanzania)

| Population groupings	Vitamin A		Vitamin B1		Vitamin B2		Vitamin B6		Vitamin B12		Vitamin C		Calcium	
	HBS1	HBS2	HBS1	HBS2	HBS1	HBS2	HBS1	HBS2	HBS1	HBS2	HBS1	HBS2	HBS1	HBS2
Tanzania	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Income quintile1	1	1	1	1	1	1	1	1	3	2	1	1	3	3
Income quintile 2	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Income quintile 3	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Income quintile 4	1	1	1	1	1	1	1	1	2	1	1	1	3	3
Income quintile 5	1	1	1	1	1	1	1	1	2	1	1	1	3	1
Dar es Salaam	2	2	1	1	1	1	1	1	3	1	1	1	3	3
Other urban areas	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Rural areas	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Dodoma	2	1	1	1	1	1	1	1	3	3	1	1	3	3
Arusha and Manyara	2	2	1	1	1	1	1	1	3	2	1	1	3	3
Kilimanjaro	2	1	1	1	1	1	1	1	3	1	1	1	3	3
Tanga	2	1	1	1	1	1	1	1	3	1	1	1	3	3
Morogoro	2	1	1	1	1	1	1	1	3	1	1	1	3	3
Pwani	2	1	1	1	1	1	1	1	3	2	1	1	3	3
Lindi	2	2	1	1	1	1	1	1	3	1	1	1	3	3
Mtwara	3	1	1	1	1	1	1	1	3	2	1	1	3	3
Ruvuma	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Iringa	1	1	1	1	1	1	1	1	3	1	1	1	3	1
Mbeya	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Singida	2	1	1	1	1	1	1	1	3	1	1	1	3	3
Tabora	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Rukwa	2	1	1	1	1	1	1	1	3	1	1	1	3	3
Kigoma	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Shinyanga	1	1	1	1	1	1	1	1	3	1	1	1	3	3
Kagera	1	1	1	1	1	1	1	1	2	1	1	1	3	3
Mwanza	1	1	1	1	1	1	1	1	2	1	1	1	3	3
Mara	1	1	1	1	1	1	1	1	2	1	1	1	3	3

Category 1: High availability
Category 2: Medium availability
Category 3: Low availability

| HBS 2000/01 | HBS1 |
| HBS 2007 | HBS2 |

Protein Quality

The quality of protein in mainland Tanzania's diet improved from 2000/01 to 2007. Food sources of essential limiting amino acid lysine (e.g. fish; dried and fresh) were consumed in higher quantities in 2007 than in 2000/01 (Figures 10.9 and 10.10). Lysine showed the lowest PDCAAS value using the normative preschool children pattern suggested by the experts, as well as the population-based pattern, which was weighted by the sex and age population structure. In general, the lysine PDCAAS value, using the preschool children normative pattern, yielded lower values than the population-based pattern.

Lysine PDCAAS values increased for each income group in 2007 compared to 2000/01. However, using the preschool children and population-based patterns, protein was still limited in lysine amino acid in households in the lowest income quintile.

In 2000/01, using the preschool children pattern, urban and rural areas showed lysine was the limiting amino acid, but in 2007, the lysine increase was not enough to bridge the nutritional gap in Dar-Es-Salaam and rural areas.

FIGURE 10.9
Lysine PDCAAS using the preschool pattern (Tanzania)

FIGURE 10.10
Lysine PDCAAS using the population-based pattern (Tanzania)
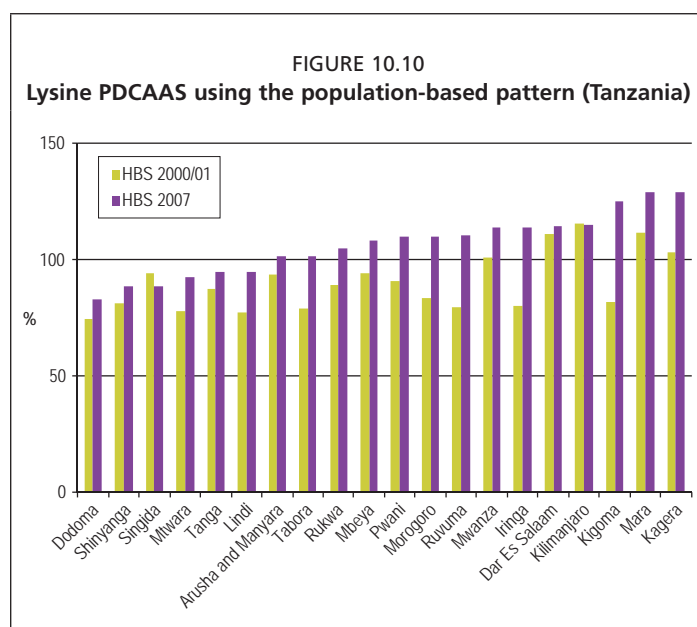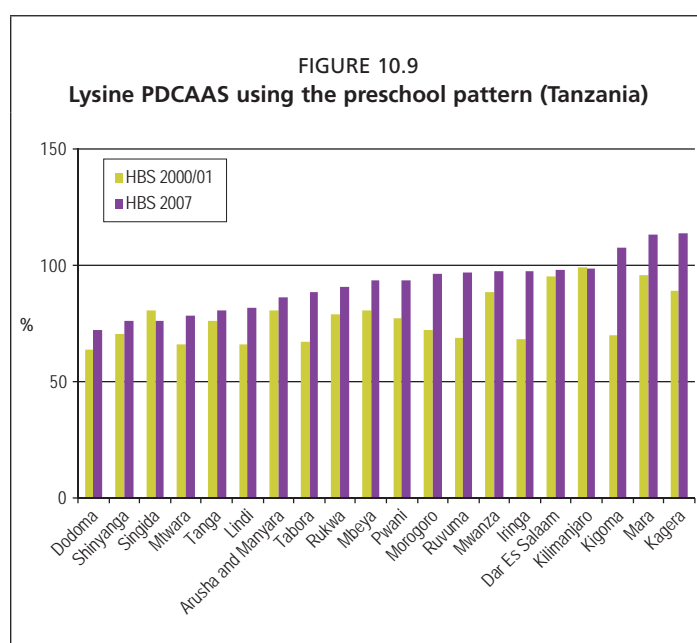
CONCLUSIONS

From 2001 to 2007, Tanzania saw an increase in the consumption of vegetables, oil and fish with the consequent improvement in terms of micronutrients and protein quality consumption by its population. The widespread deficiencies in cobalamine observed in 2001 had improved by 2007 due to an increase of seven percentage points of protein consumption coming from food of animal origin. The exceptions were the regions of Dodoma and Mtwara that registered as deficient in vitamin B12.

In 2007, the population of Mainland Tanzania had better access to calcium than in 2001, but it was still not enough to reach the recommended calcium intake. All regions, with the exception of Iringa, were deficit in calcium.

Despite an overall increase in vitamin A available in the country, Dar es Salaam, Lindi, Arusha and Manyara regions all recorded a deficit in 2007.

The quality of protein improved from 2001 to 2007 and was determined by the level of EAA lysine, with respect to the preschool children normative pattern, in most of the regions.

In general, the promoters and inhibitors of non-heme iron absorption increased and decreased, respectively which would have had a positive effect on iron absorption in the population.

In addressing the issue of malnutrition for the future, an increase in access to proteins from meat and milk would help to increase the vitamin B12 level of intake and, in turn, would assist to lower the deficiency of calcium in people.

Policies should also focus on improving the availability of calcium through fortification of milk and maize flour. The cost can be as little as a few cents per person per year. Vitamin A availability could be increased by carrying out education programs to promote the consumption of foods containing a high content of vitamin A precursors like vegetable juices, sweet potatoes and carrots. These education programmes could also promote the consumption of citric fruits, such as lemons, which are important sources of ascorbic acid. These can be added to prepared food before intake and would further enhance non-heme iron absorption.

Regional policies should concentrate on promoting an increase in lysine food source consumption, such as fish, meat and dry legumes (pulses) with a special focus on Dodoma, Singida and Shinyanga regions. In 2007, these regions had the lowest PDCAAS values for lysine of all the regions. Other possible solutions to tackle hidden hunger would be to take measures to control diseases like malaria, measles, diarrhoea and parasitic infections. Without these diseases, the body would more readily be able to absorb and retain essential vitamins and minerals. Furthermore, food aid programs like school feeding and micronutrient supplements in the form of tablets or syrups would also go a long way to combat malnutrition in Tanzania.

REFERENCES

FAO. 1991. *Protein quality evaluation in human diets. Report of a joint FAO/WHO expert consultation.* FAO Food and Nutrition Paper no. 51. Rome (available at www. fao.org).

Tanzania. 2001. *The Tanzania household budget survey 2000/01*. Dar es Salaam, Tanzania National Bureau of Statistics (available at http://www.tanzania.go.tz/hbs/ Key_Findings_HBS_Eng.pdf).

Tanzania. 2007. *The Tanzania household budget survey 2007*. Dar es Salaam, Tanzania National Bureau of Statistics (available at http://www. healthmetricsandevaluation.org/record/tanzania-household-budget-survey-2007).

Tanzania. 2010. *Tanzania demographic and health survey 2010 preliminary report*. Dar es Salaam, Tanzania National Bureau of Statistics.

UNICEF. 2004. *The hidden hunger of the vitamin and mineral deficient child.* Online feature story, 24 March (available at http://www.unicef.org/nutrition/index_ hidden_hunger.html).

UNICEF & MI. 2004. *Vitamin and mineral deficiency reports* (available at http:// www.micronutrient.org/english/View.asp?x=614).

WHO. *African Region: Tanzania*. Online background information (available at http://www.who.int/countries/tza/background/en/index.html).

WHO. 2005. *Health action in crisis: Tanzania*. Online country profile (available at http://www.who.int/hac/crises/tza/en/).

WHO. 2008. *Global burden of disease 2004 update.* Geneva (available at http:// www.who.int/healthinfo/global_burden_disease/GBD_report_2004update_full.pdf).

WHO. 2009. *Tanzania newsletter*. WHO Country Office in Tanzania No. 007.

WHO & FAO. 1998. *Vitamin and mineral requirements in human nutrition. Second edition. Report of a joint FAO/WHO expert consultation on human vitamin and mineral requirements 21–30 September 1998, Bangkok, Thailand* (available at http://whqlibdoc.who.int/publications/2004/9241546123.pdf).

WHO & NHD. 2000. *Turning the tide of malnutrition: responding to the challenge of the 21st century*. Geneva (available at http://www.who.int/mip2001/files/2232/ NHDbrochure.pdf).

Glossary

AVERAGE DIETARY ENERGY REQUIREMENT (ADER)
The average dietary energy requirement refers to the amount of energy considered adequate to meet the energy needs for normative average acceptable weight for attained height while performing moderate physical activity in good health.

BALANCED DIET
The food consumption pattern is balanced when the contribution of energy-yielding nutrients to total energy is within acceptable ranges as follows: proteins from 10 to 15 percent; fats from 15 to 30 percent; and carbohydrates from 55 to 75 percent.

COEFFICIENT OF VARITAION (CV) IN DIETARY ENERGY INTAKE
The coefficient of variation (CV) in dietary energy intake is an estimate of the viability in dietary energy intake across a country's population. The CV is a measure of the *distribution* of dietary energy intake within a country. It is a summary measure of inequality in the distribution of total energy available, equal to the standard deviation of each country's dietary intakes divided by its mean. For 18 out of the 99 countries, the estimated CVs are based on nationally representative household food consumption or expenditures surveys. The rest of the countries' CVs are projected from measures of income (or total expenditure) distribution or set equal to the regional mean CV estimated for the other countries.

DIETARY ENERGY UNIT COST
The dietary energy unit cost is the monetary value of 1 000 kcal of edible food.

DIETARY ENERGY DEFICIT (DEPTH OF HUNGER)
The dietary energy deficit, or depth of hunger, is the difference between the average daily dietary energy intake of an undernourished population and the national average minimum energy requirement.

DIETARY ENERGY INTAKE (DEI)
Dietary energy intake is the energy content of food consumed.

DIETARY ENERGY REQUIREMENT
The dietary energy requirement is the amount of dietary energy required by an individual to maintain body functions, health and normal activity.

DIETARY ENERGY SUPPLY (DES)
Dietary energy supply is the food available for human consumption, expressed in kcal/person/day. At a national level, it is calculated as the food remaining for human use after deduction of all non-food consumption (exports, animal feed, industrial use, seed and wastage). This food energy supply is for both private and public consumption.

ENGEL RATIO
Engle Ratio of Food Share is the share of food expenses to total income of the household.

FOOD BALANCE SHEETS (FBS)
Food balance sheets are derived for each commodity using data on food production and imports. They record opening-year food stocks after deduction of food export, and end-year food stocks as well as all non-food consumption (animal feed, industrial use, seed, wastage and other non-food use). These estimates refer to both private and public food consumption.

FOOD CONSUMPTION DISTRIBUTION
Food consumption distribution refers to the variation of consumption within a population. It reflects both the disparities due to socio-economic factors and differences due to biological factors, such as sex, age, body weight and physical activity levels.

FOOD INADEQUACY OR FOOD DIETARY ENERGY DEPRIVATION
Food inadequacy or food dietary energy deprivation refers to the condition of people whose food dietary consumption is continuously below what the body needs. FAO's measure of food deprivation is based on the distribution of food consumption expressed in terms of dietary energy.

FOOD EXPENDITURE SHARE
The food expenditure share or food expenditure ratio corresponds to the share of food consumption expenditure in monetary terms in relation to total consumption expenditure; also known as Engel ratio.

FOOD INSECURITY
Food insecurity is a situation when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. It may be caused by the unavailability of food, insufficient purchasing power or inappropriate distribution. Food insecurity may be chronic, seasonal or transitory.

FOOD SECURITY
Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

GINI COEFFICIENT
The Gini coefficient is the ratio of the area between the equality line and the Lorenz curve to the area below the equality line. The Gini coefficient ranges from zero (perfect equality) to one (perfect inequality). The Gini coefficient may refer to the overall inequality, for example when depicting income (percent) and income receiving units (percent). However, when it depicts DEC (percent) and income receiving units (percent), it refers to the inequality of energy consumption due to income.

HOUSEHOLD CONSUMPTION EXPENDITURE
Total household consumption expenditure as defined in the UN guidelines is the sum of all monetary value or expenditure on: goods and services intended for consumption; goods produced and consumed from own-production or own-business stocks, including the imputed rent of owner-occupied housing; and goods and services received in kind.

HOUSEHOLD FOOD CONSUMPTION EXPENDITURE

Household food consumption expenditure refers to food consumed by household members during a specified period, at home and outside the home in places such as restaurants, bars, the workplace or school. It includes food from all sources, either purchased or from a garden or farm. Deductions should be made to allow for wastage and losses occurring from acquisition to cooking, as well as plate and kitchen wastage.

HOUSEHOLD NON-CONSUMPTION EXPENDITURE

Household non-consumption expenditure refers to income taxes, other direct taxes, pension and social security contributions, remittances, gifts and similar transfers made by the household in monetary terms or in kind, including food such as that which is given away, raw or ready-to-eat.

HOUSEHOLD EXPENDITURE

Household expenditure is household consumption plus non-consumption expenditure.

HOUSEHOLD INCOME

Household income is the sum of all receipts, in money or in kind, which are received regularly and in a recurring pattern, including food.

INCOME ELASTICITY OF FOOD DEMAND

The income elasticity of food demand (quantity, monetary or nutrient terms) measures the responsiveness of the quantity demanded of a good (quantity, monetary or nutrient terms) to a unit change of income.

INCOME INEQUALITY

Income inequality refers to disparities in the distribution of income.

INEQUALITY IN FOOD CONSUMPTION DUE TO INCOME

The inequality in food consumption due to income refers to the variation of the food consumption level within a population due to disparities in the income distribution.

INEQUALITY MEASURE OF ACCESS TO FOOD – COEFFICIENT OF VARIATION (CV)

The coefficient of variation of dietary energy consumption (CVx), as defined by FAO, comprises two main components; one reflecting the inequality of food consumption associated with socio-economic levels (CV(x/v)) and the other associated with biological (CV(x/r) factors (sex, age, body weight and physical activity) as follows:

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

KILOCALORIE (KCL)

A kilocalorie is unit of measurement of energy. One kilocalorie equals 1 000 calories. In the International System of Units (ISU), the universal unit of energy is the joule (j): 1 kilocalorie (kcal) = 4.184 kilojoules (kj).

MACRONUTRIENTS

Macronutrients are the proteins, carbohydrates and fats that are required by the body in large amounts and are available to be used for energy. They are measured in grams (g).

MICRONUTRIENTS
Micronutrients are the vitamins, minerals and certain other substances that are required by the body in small amounts. They are measured in milligrams (mg) or micrograms (mcg).

MINIMUM DIETARY ENERGY REQUIREMENT (MDER)
The minimum dietary energy requirement in a specified age/sex category, is the amount of dietary energy per person that is considered adequate to meet the energy needs for light activity and good health. It is expressed as kilocalories per person per day (kcal/person/day).

NUTRITIONAL STATUS
Nutritional status is the physiological state of an individual that results from the relationship between nutrient intake and requirements, and from the body's ability to digest, absorb and use these nutrients.
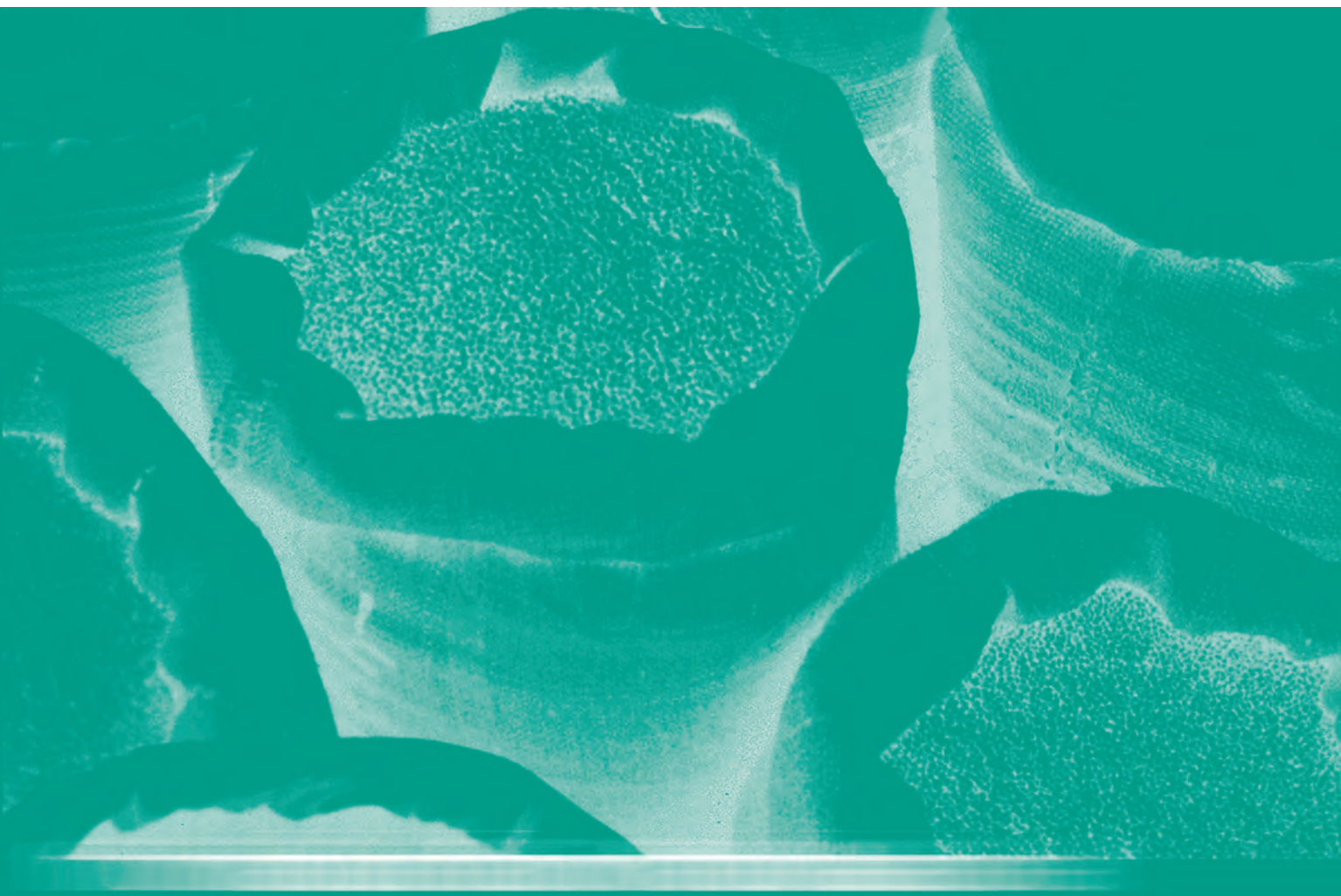
OVERNOURISHMENT
Overnourishment is food intake that is in excess of dietary energy requirements continuously.

UNDERNOURISHMENT
Undernourishment is food intake that is insufficient to meet dietary energy requirements continuously.

UNDER-NUTRITION
Under-nutrition is the result of undernourishment, poor absorption and/or poor biological use of nutrients consumed.