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New framework for the Food Balance Sheet (FBS) and Supply Utilization Accounts (SUA)

New framework to compile FAO's Food Balance Sheets[1]

R. Mahjoubi and A. Prakash

Abstract
Food Balance Sheets (FBS) are one of the most important statistical products of FAO being used in host of contexts, from food security analysis, to analysing dietary trends to policy-making. One of the most visible uses of FBS is in providing the foundations for monitoring the number of undernourished. As such, FBS are instrumental in the delivery of FAO's core mandate as well as for the monitoring of MDG goal 1.

With food security taking centre stage in the development agenda, a profound need has emerged for more timely and more accurate data for decision-making. This paper outlines the changes in methods and in structure that are being made to ensure that FBS remain relevant to user needs.

[1] This paper is the result of the work of Team A, CapEx (Capital Expenditure/working system project) project and consultants that have been hired by FAO to review the statistical framework to generate FBS. The authors have just put together the most important ideas and conclusions. All the papers that have been used are cited as references.

Introduction

The preparation of Supply Utilization Accounts (SUA) and their aggregated form – the Food Balance Sheets (FBS), maintained by ESS, has a particularly a very long history, extending as far back as the period 1934-38. Over this time, they have undergone methodological change, but since 1984, when FBS were published in "standardized" format, methods and architectural foundations have been left largely unaltered, despite periodic scrutiny.

Considering the importance of the FBS system, particularly in the pivotal role in the estimation of undernourishment, it is understandably a very sensitive issue and explains why the last update of the methodology was undertaken almost three decades ago. While several attempts to update the FBS system have been unsuccessful, it is clear that many of the assumptions, parameters and variables have become obsolete and are in need of revision. Most importantly, the lack of observed data, particularly for processed products, makes it currently necessary to impute many of the components, making the system computation-heavy and error-prone. These issues raise a number of questions, including: How is the FBS system currently structured and how are the FBSs compiled? What are the strengths and weaknesses of the current system? How can we improve the system? Can we make the process of compiling FBS more efficient? Can we simplify the system without losing accuracy?

To answer these questions this paper is structured in four sections: (i) description of the current framework to compile FBS, showing the strengths and weaknesses of the current system; (ii) the proposed new framework (iii) the role of international classification schemes in making FBS more efficient to prepare and more meaningful in interpretation; and (iv) the issue of aggregation.

1. The current framework

Conceptually, the food balance sheets produced by FAO are designed to allow the calculation of food available for human consumption and selected nutrient equivalents on a per capita basis, as well as other uses, at the annual frequency. The result is the depiction of food supply and utilization patterns that can be summed geographically or, for perspective, compared to other countries over time.

Currently, the food balance sheet shows for each food item -- i.e. for each primary commodity and for a number of processed commodities potentially available for human consumption -- the sources of its supply and its utilization. Thus it employs a SUA framework to arrive at apparent consumption (of food) of the population of the country defined in the following manner:

Food Available For Human Consumption = (production + imports + opening stocks) minus (exports + re-exports + usage input for processed food + seed + feed + non-food usage + wastage + closing stocks)

Per capita (per person) food supply is then obtained by dividing the food supply (net) by the population. Data on per capita food supplies are expressed in terms of quantity and also in terms of the energy content of food (k/cal) and protein and fat.

The statistics in the food balance sheets contain both official and unofficial data. Production and trade data drives the current system, and will continue to drive any new system. Consequently, data collection efforts, especially in the production domain that rely on questionnaire response, remain key. The information that FBS supplies ultimately can only be as good as the core underlying data, and concerted action is required to improve data inflows. Current fill-rates in the trade domain are relatively high but are very low in the production domain only 60 percent of countries respond to questionnaires and there is no guarantee that questionnaires are fully completed. Also it has to be mentioned that the lack of a commonly adopted international classification scheme in the realm of agricultural production, limited capacity and resources at the national level in measuring productive activities as well as insufficient investment in statistical systems pose formidable hurdles in data collection

Different other reliable sources are then used to get as much data as possible before recurring to imputation of missing data.

Apart from trade and production for which the data are mostly collected through questionnaires the other elements of the FBS balance are usually estimated and official data are available only for very few developed countries. In the rest of this section we will describe the current methodologies and parameters used to estimate the utilization part of the balance.

Seed: Amounts used for seed are calculated, by multiplying area sown in the following year by the seeding rate. When sown area is unknown, harvested area is used. If neither sown nor harvested area of the following year is known, the current year is used.

Feed: represents the quantity of the commodity available for feeding to livestock and poultry during the year. Less than 15 percent of the countries respond to FAO's feed questionnaire and most of them are developed countries. For the rest of the world feed is calculated based on fixed rates which multiply the total supply (Production + import + decrease in stocks) of a specific commodity in that country.

Waste: is the amount of the commodity lost through wastage during the year at all stages between farms and the household level in handling, storage and transport, but not including waste in the edible and inedible part of the commodity which occurs after the commodity has entered the household. The quantities lost during processing are also not included under this element because they are implicitly considered in applying the underlying extraction rate[2].

Stock changes

Limited statistical information exists on opening or closing stocks for many commodities in many countries, making stocks estimation complicated and imprecise. As a result, stock changes are often calculated to smooth supply and utilization –in practice, they are used as a balancing factor and they may, in part, be calculated residually by first estimating food available for consumption. As the item is partially and residually derived it then reflects not only stock changes but also other statistical errors in the food balance equation.

Food Processing

The food processing item, also known as food manufacturing, is the amount of a commodity processed for food purposes and for which separate entries are provided in the food balance sheets either in the same commodity tree or in another food commodity. This helps to maintain the concept of accounting for all foods (once and only once) and maintains the links in the various levels of the balance sheets.

Other utilization

Other utilization is a miscellaneous category to account for all other uses not identified elsewhere (e.g. the use of maize to produce ethanol). This category also includes consumption by those who are not accounted in the country's population (e. g., tourists).

Food

Food is the total supply of all agricultural and derived products available for human consumption. Food available can be reported in terms of primary product equivalent such as wheat and milk or in the form that the products may actually be consumed, such as bread and cheese. This number is typically the residual of the balance sheet. However, because of the uncertainty surrounding many other elements of the balance and because of weak methods and outdated parameters, food is not the only residual element. Therefore simultaneous equations subject to several constraints are required to be resolved to estimate several elements at the same time. This leads to results that cannot be replicated and therefore difficult to revise, and, to resolve inconsistencies.

2 Extraction rate is the ratio of production to input of the processed commodity in the case of reported production. Otherwise, it refers to the conversion factor applied to the input data to estimate production data; the average national rate at which these commodities are converted from the original form into the form in which they are subsequently pursued in the system.

The current framework to compile FBS has several strengths that will be maintained and reinforced, but weaknesses prevail. As a summary

Strengths

- By country
- Multitude of commodities
- Long time series
- Only source of food balance sheets for numerous countries
- Balance sheets that display key variables and supporting data
- Provides for the calculation of at least three nutrient variables (calories, protein and fat)
- An analytical tool for examining basic data (production and trade) at the country level
- Publicly available
- Staff are experienced and knowledgeable about their own work areas

Weaknesses

- Enormous dependence on imputed data, especially on processed products
- Methods of aggregation are unnecessarily complicated, involving an array of coefficients that are outdated.
- Feed estimates are usually a fixed rate and are not linked to the livestock sector.
- Waste is also estimated as a fixed rate but not revised regularly
- Trade and FBS imbalances are not checked and dealt with in a systematic way. However, this consistency check and correction can be a plus to the system and a sound method to help detect cases of misreporting. Also balanced world trade is very important for trade analysis

2. Towards a new framework

In July 2010, a workshop was held at FAO to discuss the current framework to generate FBS. The papers provided scant ground for changing current FBS methodology. On the other hand, the CFS Roundtable of September 2011 provided a series of recommendations on the requirements and performance of an ideal FBS system. These recommendations, while hard to argue with, did not provide details on the changes needed in the context of the current system.

What is clear from all the guidance provided in shaping a new FBS system is that there is little scope to circumvent the core data requirements of the current FBS. However, by advocating the collection of more commodity data, e.g., in order to complete accounts for processed commodities, there is a clear failure to make connection with the reality of data availability in most developing countries and even in developed countries. Burdening countries with extra data reporting requirements, when capacities for data collection are already low, negates the plausibility of meeting data collection requirements for processed foodstuffs and commodity inventories. If and when such capacities improve, then FBS methodology could be reworked.

Presently, there is enormous scope to enhance the fill rates in the primary FBS datasets, especially production. This scope is illustrated by the large number of missing data points in the agricultural domain that require imputation.

An important fact that is too easily forgotten in the drive towards an improved FBS methodology is that in the current framework, full accounts for processed commodities are superfluous to needs. The only entry point for processed commodities is in dealing with their trade. Processed food trade forms an important driver of total food trade, and measures to reconstitute inflows and outflows of processed commodities into primary equivalence are all that may be required. But this is no easy task given the rising complexity of the product mix entering trade. The parameters that govern standardization (convert derived products to their primary equivalent using extraction rates) need to be reviewed to ensure that they continue to accurately reflect the composition of primary equivalence of processed trade. The direct standardization of trade before generating the SUAs could be the best solution. This will reduce significantly the time spent by ESS staff balancing the commodities to the profit of data collection, checking and validation.

Taking stock of the new realities of the food system is crucial for FBS precision, especially the growth in livestock sectors, and the demands on agriculture by industry and the bio-based economy, such as feedstocks for bioenergy and the evolution of waste along commodity value chains up to the household level. Ascribing shares to the different forms of utilization as is done now should be maintained, but they must be better "anchored" according to reality. Specifically,

- produce a methodologically sound **stock** estimates
- better integration of **feed** demand with livestock sectors,
- ensuring **seeding** rates accurately reflect area cultivated
- ensuring post harvest **losses** along the value chain are realistically accounted for, as well as waste
- understanding better the derived demands by **industry** on agriculture

Consequently, research, including surveys and ground-truthing, needs to be put into use to determine how the components of utilization have evolved over time and how they are likely to evolve in the future and adjust the methodology and the parameters in the light of that. As a first step, the extent of the inconsistency in utilization elements have been identified as well as research avenues for improved estimates. More than that, new methodologies to estimate several elements of the FBS have been developed and tested:

Seed. Among the different categories of utilization, seed use is one of the few categories which can be modeled *a priori* according to a deterministic rule, animal feed is possibly another. Seeding rates, and ultimately the demand for seed, can be modeled as a function of target plant density, establishment percentage, and seed weight. Multiplied by area planted, seed use can then be derived.
However, with the rise in high-precision commercial farming, many farmers are choosing to use certified seed, purchased from specialized seed farmers. This trend requires the need to capture commercial seed production quantities.

Feed. A simplified model through which coefficients for calculating livestock feed based on animal numbers was developed. The model used livestock data from FAOSTAT, and intensification rates and feed ratios were based on literature reviews and expert opinion. The model results for feed were compared with feed data in FBS. It was found that there are gaps between the two. Several model simulations were undertaken in order to reduce this gap. The analysis raises questions about the feed utilization, and the need for wholesale scrutiny, at least for some key producing countries: Brazil, Argentina, Mexico, Korea Republic, China, India, Indonesia, Iran, Pakistan, Philippines, Turkey, and the Russian Federation.
As the next step in methodological development, it is planned to modify some of the parameters and get access to data for these parameters. The idea is to use a demand-driven approach to livestock feed calculation as opposed to the supply-driven approach (production and imports) followed so far. In the new approach, herd structure, rate of intensification, and metabolisable energy and protein requirements will form the building blocks of livestock feed data. Given the increased data requirements resulting from this approach, collaboration with private sector, and academic and research institutes will play an important role.

Waste. waste data have been reviewed for some 140 developing countries. It can be seen that the coefficients developed to calculate waste in FAOSTAT (waste is calculated as a percentage of total supply) have been constant for many years. Moreover, the review shows inconsistencies in the waste parameters among countries, and commodities within countries.
Precursory research was also undertaken on developing a new methodology on waste with the aid of an accounting framework, parameterized from expert assessments and/or published. Here, food waste could be potentially estimated by taking into account the different stages of the commodity supply chain. Estimates showed higher level of waste in general, and for root crops and fruits and vegetables in particular, when compared to FBS data. If the model estimates are used, there would be reduction in the estimated level of per capita food consumption in the FBS at the country level. However, if these

new parameters are used in conjunction with the new feed parameters it is foreseen that there would be limited changes in per capita food consumption at the country level.

A way forward would be to design a sound methodology that would develop plausible and updateable parameters to estimate food waste along the various stages of the supply chain. In the absence of a formal econometric model, these parameters would need to be researched, supported by in-depth studies undertaken in key countries to ascertain the level and composition of food waste for key food security-relevant commodities, including table waste. When researchable lines of enquiry have been exhausted, commodity-specific estimates might be based on existing data on the country's quality of infrastructure, adequacy of storage and length of paved roads to assess food losses, and the level of urbanization and possibly income to gage waste. This exercise would take stock of the inherent perishability and fragility of the commodity in question.

Stocks/ Stock Changes. Reporting stock levels would not only add meaning to the FBS from a user's point of view, but would also avoid discrepancies in cases where stock variations over time are able to implicitly result in either negative holdings or implausible levels. Furthermore, the level of stocks forms an important indicator for monitoring food security (self-provisioning capacity) and for price developments, as stock levels are an important determinant of price variability.

Countries that do not report need to be reminded of the importance of these data in making world food market and also food security assessments. Estimates are being made and will continue to be made by analysts in FAO, International Grain Council (IGC), USDA and so on. These estimates usually have to make at least rough calculations for an initial year, probably when consumption is at a low and it can be fairly assumed that stocks too had been run down to a minimum level. Alternatively, spikes in domestic prices coinciding with prior periods of low production or availabilities might also be indicative of a "stock-out". From this point, annual series of net changes in stocks (production + imports-exports-consumption) can be added and subtracted to arrive at stock level estimates for all later years. Care must be taken so that the sum of cumulative net changes in stocks does not become negative at any point. It is helpful, of course, if other sporadic stock estimates, partial or full, are available for particular years in order to refine the series.

The Agricultural Marketing Information System (AMIS) of the G20, whose Secretariat is based at FAO is also charged with getting more timely and accurate information on market situations, including stock levels, from key member exporting and importing countries. Ideally, this information would be inserted into FBS.

Based on the above, a strategy combining improved data collection and model-based estimates when data are absent is being devised.

Other utilization. Agriculture is playing an increasingly important role in the industrial economy, providing feedstocks for the production of liquid fuels, chemicals and advanced materials, such as composites for industry. The emergence of green industries provides expanded opportunities for the rural sector. Biological science has the ability to make both incremental efficiency improvements and to bring about wide change in a host of farming sectors. This includes enzymes, fermentation and organisms for processes and products in the energy, chemical, pharmaceutical, food, textile, and pulp and paper industries. Much of this potential is already being realized, especially when considering the rapid growth of the bio-fuel sector. Currently, ethanol is being produced from easily fermentable agricultural feedstocks such as sugar cane, sugar beet, cereal grains and cassava. Bio-diesel is produced from vegetable oil (typically rapeseed, soybean and palm oil) using a process of chemical modification.

It is difficult to conceive how a generalized model framework might provide reliable estimates of industrial usage. Income and the level of industrialization might be important drivers, and also a country's comparative advantage in cultivating and processing the crop. Therefore, a strategy on data collection needs to be devised. This is supported by the fact that data on certain industrial activities involving food crops are already subject to collection. For example, the Aglink-Cosimo framework of OECD/FAO provides data on bio-energy production by feedstock. The USDA provides some data on starch production as do several international trade associations.

Food. Food will remain the residual of the equation according to the new framework. With a radical change regarding the method that is used to derive it. Currently and as described earlier there is no reproducible method to estimate the food available for human consumption. One simple reason is that the current equation is composed of several elements that are estimated simultaneously as residuals (Food, Other uses, Stocks, Feed etc.) without a clear methodology. There may be degree of certain freedom to decide on which element to allocate which quantity. This is based on expertise, is usually very sound when information is available. However this remains impossible to replicate and usually institutional memory disappears when the expert leaves the position.
With the new methodology, food will constitute a residual balancing the FBS, using Bayesian techniques applied all countries and all commodities without exception.
The Baysian Highest Posterior Density (HPD) will be applied following in the following five steps:

1- Trend estimations based on historical data;
2- Generation of a complete time series;
3- Assignment of priori weights, in the form of probabilities, to each element based on data quality;
4- Generation of posterior probabilities (zero to infeasible and constant positive probability to feasible);
5- Generation of the FBS combining the weighted time series and the posterior probabilities.

If it is not possible to reconcile all the elements to obtain a plausible quantity of food available for human consumption, data at all levels will have to be re-verified and reconfirmed at source. At the FBS level, there will not be any allowance to impute data. However, after validation, if there is still a persistence of abnormally high levels of potential food availabilities, a statistical discrepancy element might be added to rebalance the equation. Food will be then estimated based on prior knowledge and checked and validated by experts at FAO and at the country level.

Collaboration
Given the corporate importance of FBS, dialogue and collaboration should be initiated with other divisions and programmes. Not only will such co-operation likely improve FBS estimates, but it will also foster the much needed sustainability and stakeholdership, and will provide synergies for those participating to share. The following ongoing initiatives can contribute to improve FBS:

- A data collection strategy needs to be devised, making use of FAO extensive outreach in the field, viz the Statistics Division’s regional statisticians
- AMIS to improve stock data, sources and methodology
- AGS and NRL programmes on posh harvest losses (PHL) and waste. ESS must seek active collaboration with NRL and AGS on their respective initiatives
- PHL are a priority research topic in the African Action Plan to implement the Global Strategy for the Improvement of Agriculture and Rural Statistics
- The EC-FAO programme on the Global Hunger governance has a substantial statistical component that on the one hand includes the FBS improvements and the development of a tool to compile FBS’s at country level. Both project teams have a strong interest in cooperating and exchanging results and experience. On the other hand, it includes the improvement of household survey analysis and the development of a suite of food security indicators. The programme can contribute with guidelines on how to reconcile FBS and household surveys with one another.

Also, a major issue pertains to the fact that no initiative exists to systematically update parameters and technical conversion factors. Most parameters are not data in the traditional sense. They can be expected to vary relatively slowly and to belong to the arena of expert knowledge. Several options ought to be considered to build a permanent system to collect such information:

- Create an international experts network
- Organize workshops at regular intervals
- Use regional statutory meetings (AFCAS, APCAS, IICA) to solicit up-dates and build capacity
- Information from other databases

In this context, FAO should ideally become a hub fed by information from countries, partners, international experts and projects.

3. Commodity Classification[3]

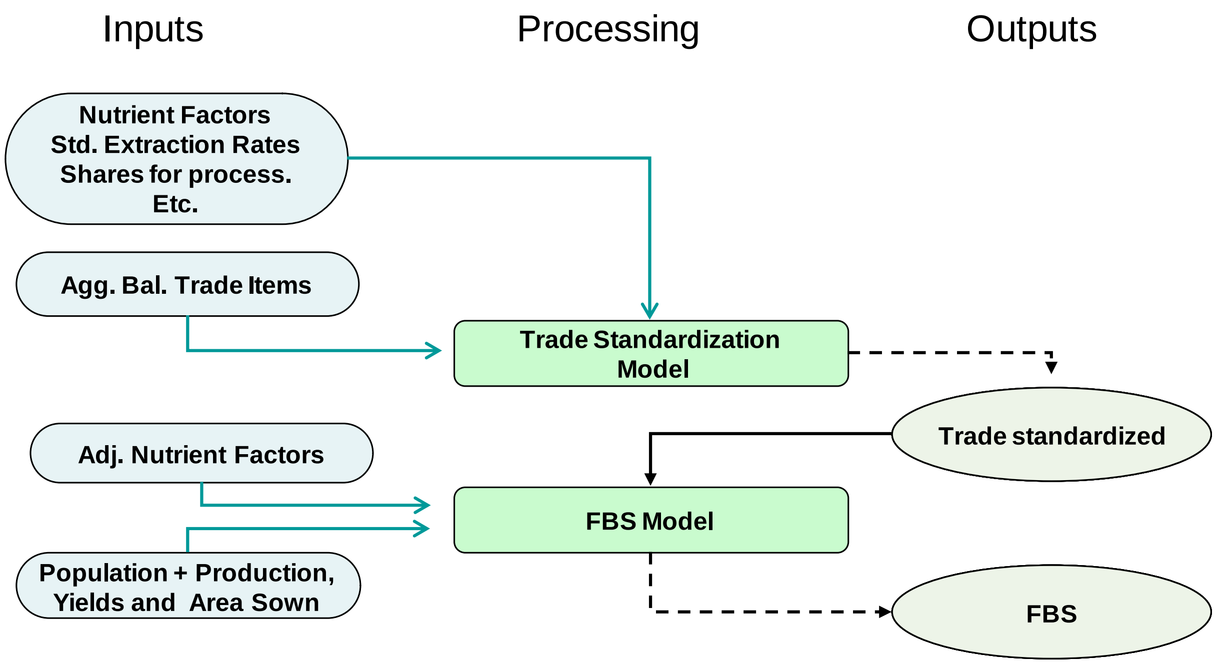
In cooperation with other FAO Departments such as the Natural Resources, the Forestry, and the Fisheries and Aquaculture, since 2005 FAO Statistics Division has continued collaboration with the United Nations Statistics Division (UNSD) and the World Customs Organization (WCO) in the review of the Central Product Classification (CPC), the Harmonized System (HS), and land classifications to be used in the revised System of Environmental and Economic Accounts (SEEA).
The purpose of FAO contribution is to make major international schemes suitable for agriculture and food statistics, thus facilitating the harmonization and comparison of agriculture statistics across different countries and statistical domains.
Currently the FAOSTAT commodity list is used to provide a framework for collecting and analysing data on production and trade of crops and livestock and, ultimately, to compile the Supply and Utilization Accounts and Food Balance Sheets (SUA/FBS) for the estimation of undernourishment. Its structure reflects the item “commodity tree”, which means that the primary crop and its derived products are traceable all along the value chain of agricultural production.
Due to the specialized nature of FAO and as the CPC is as a general purpose scheme, detail on agriculture is still not sufficient in CPC. Therefore, when implementing CPC, FAO will use an expanded structure to further disaggregate agriculture data available. This structure will overcome the lack of information on the primary product of origin in the CPC at five digits, by adding detail at the lower level (6^{th} or 7^{th} digit).
Replacing the FAOSTAT commodity list with the CPC expanded will have direct impact on the way the current system is functioning and suggests several adjustments to the current methodology. First of all this will reduce the burden on countries when reporting to FAO as they do not have any longer to deal with several classifications. This will reduce the gap between data coming from different national and international organization, so this will increase the data harmonization. And also this will help us reduce the bias related to data conversion from HS when used for FBS and other indicators compiled by FAOSTAT. HS classes constitute the building blocks for CPC which make the matching between the two classification well established. Therefore the error is reduced when converting trade data from HS to CPC compared to converting data from HS to FAOSTAT commodity list.

4. Aggregation/Standardization vs Pre-Standardization

The Supply and Utilization Accounts (SUA) provide a framework to estimate food supply. They track food availability from national agricultural production to international trade in derived food products. Typically, the number of commodity balances that are maintained at the SUA level exceeds 800, and is hence resource-intensive. But taking stock of data availability, especially for derived products and for elements other than trade, we find that data collection in most countries is non-existent or at best very limited. As a result, more than 80 percent of the elements for derived products at the SUA level is imputed. For most of the time only trade data are available. From these 800 commodity balances that are maintained only 100 aggregated commodities are published as FBS. In other words, the FBS is roughly an aggregated SUA for food products. In parallel we receive through FAOSTAT agricultural production questionnaires, a wealth of data on primary commodities, which go a long way in constituting the FBS.

[3] This section it is extracted from the paper “ACTIVITIES ON INTERNATIONAL CLASSIFICATIONS FOR AGRICULTURAL STATISTICS” presented at the twenty second session of AFCAS held in Addis Ababa, Ethiopia from 30 November - 3 December 2011

By complementing information on traded commodities, both primary and derived, we can create FBSs without need of SUA. This means we need only to maintain 100 balances per year per country compared to 800. So instead of converting all of the balance elements of derived products back to primary equivalent, we can now just convert the trade component to primary equivalent and maintain balances at the FBS level. In contrast with the current Standardization aggregation methodology we call this “Pre-Standardization” (i.e. standardization of trade only). The process to compile FBS can be schematized as follows:



In essence, **Pre-standardization** amounts to bringing traded quantities of derived products directly to the accounts of their parent products; expressed in the equivalents of these parent products. Then there is no need for maintaining separate accounts for these derived products which leads to **a reduced number of accounts to be considered in the preparation of the FBSs**. Reducing the number of commodity balances at a processed level will by consequence reduce the number of imputed data which may help reduce inconsistencies leading to imbalances. Also, more time to check each commodity balance will also help reduce the errors that may occur when preparing the FBS data on the working system platform.

Timeliness

Owing to human resource constraints, the current system allows the compilation of FBSs with a minimum of a three year lag. With the importance of food security on the global agenda, this gap must be reduced, and can be reduced by automating the collection and processing of data, freeing up resources for better research regarding data gaps.

Conclusion

The information conveyed by Food Balance Sheets is both unique and important for food security policies and decision-making at a variety of levels. For instance, countries are able to assess the impact of changes in productivity or in area harvested of key staples on food consumption. Also trade dependency and self-sufficiency with regard to food can be calculated. Assessing the food security of countries in difficult periods such as conflict, human-induced or natural disasters, when surveys and censuses are impossible to administer, can be done with FBS. Donors may need to quantify the impact of their development assistance on food security in beneficiary countries. Indeed, donor interventions are increasingly evidence-based. FBS provide the key data for measuring the number of undernourished, and ultimately assist in delivering the mandate of the Organization.

Given their importance, this paper has set out a number of innovations to improve the accuracy, relevancy and timeliness of FBS. One area of intervention required that is not fully explored in this paper concerns the capacities of countries to provide the basic data needs of FBS. However, FAO is investing in ways to equip countries with better skills in this regard. CountryStat is a good example as well as the Global Strategy for Improving Agricultural and Rural Statistics.

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