# 2.1. Measurement and collection of FBS source data

FBS constitute an integrated dataset. They combine and reconcile data from a variety of sources. This bears advantages and challenges. A main advantage consists in the broadness of the scope of information provided. FBS provide a full picture of the agricultural economy of the country spanning over different domains comprising agricultural production, international trade, household consumption, nutrition, and over the various subsectors of agriculture, namely crops production, livestock production and fishery. By aligning the data from different sources, FBS ensure data coherence across domains. As each single set of source data is confronted with evidence from other source, FBS can help identifying problems in the compilation of the source data and thereby contribute to enhancing accuracy. The coherence achieved within the FBS of course comes at the cost of potential incoherence between the FBS and their source data. Explaining the reasons for these incoherencies is important for maintaining credibility and may sometimes constitute a challenge. Another challenge consists in reconciling the different variables of the balances in the proper way. If adjustments were carried out mainly in variables measured with high accuracy, while leaving the ones with large measurement error unchanged, such type of reconciliation would most likely reduce the quality of the data rather than increasing it. Therefore, for making appropriate use of the potentials for enhancement of data quality by means of balancing the FBS, application of statistically sound methods is of paramount importance.[[1]](#footnote-1)

FBS require a considerable amount of source data. Ideally these are collected timely from reliable sources, based on precise measurement and grounded concepts and definitions compliant with international standards. FBS compilers should use estimations only as a second-best option, when data cells cannot be filled with collected data. The national statistical systems all around the world have disparate capacities in collecting and measuring the required source data, usually reflecting the different strengths of the national agricultural statistical systems. A global assessment of agricultural data, carried out by FAO and the World Bank, concludes that many developing countries do not dispose of the capacities to collect and disseminate the most basic agricultural data required to monitor national trends or to inform the international development discussion, and that the quantity and quality of agricultural statistics worldwide has even decreased over time (World Bank 2011). As regards the source data required for FBS compilation, providing primary data on losses, stock changes and food appears to be particularly difficult for the national statistical systems in all parts of the world (see Table 1). The FAO Statistics Division has been able to collect from government agencies less than 1% of the required data for these variables. For other variables on the uses side of FBS, such as feed and seed, the availability of official data is slightly higher. Obtaining official data is much less difficult for agricultural production, imports and exports, as systems for compilation of these variables are usually in place, among other purposes for the production of the national accounts. From that follows that the side of domestic supply in FBS can generally be compiled with source data of higher quality than the side of domestic utilization. The availability of source data from official sources is particularly low in Asia and Oceania and in Africa.

Table 1. Proportion of data for FBS compilation collected from official sources, 2011-2013, in %

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Production | Imports | Stock  changes | Exports | Feed | Seed | Losses | Food |
| Developed countries | 54.8 | 77.4 | 0.4 | 72.5 | 5.5 | 15.5 | 1.6 | 0.4 |
| Africa | 27.1 | 41.8 | 0.3 | 35.1 | 2.3 | 3.2 | 0.2 | 0.0 |
| Latin America & Caribbean | 40.5 | 45.6 | 3.4 | 44.2 | 2.6 | 4.7 | 1.2 | 0.3 |
| Asia & Oceania | 37.8 | 54.7 | 0.0 | 48.2 | 1.1 | 1.3 | 0.1 | 0.0 |
| *World* | *39.0* | *54.9* | *0.8* | *51.5* | *3.3* | *5.9* | *0.8* | *0.1* |

Coverage: all data cells for primary agricultural products, excluding fishery, with valid non-zero values. Source: FAOSTAT internal working system, extracted on 14 August 2015.

According to the report above, a lack of integration within national agricultural systems, reflected in poor coordination between the different agencies providing data, is one of the main reasons for the decline in coverage and quality of agricultural data in developing countries – apart from limited capacities and financial resources. This is a crucial obstacle particularly for the compilation of FBS which relies on gathering and reconciliation of data from various subdomains of agricultural statistics and thus on involvement of a number of different organizations. Establishing efficient working arrangements with the different actors to be involved in FBS compilation is therefore of paramount importance for FBS compilation.

The first step for setting up an FBS compilation system should consist in an in-depth review of exploitable data sources. Preference should be given to existing records kept by government agencies or private-sector organizations, before planning new processes for collection of primary data. Based on that review, the main data providers should be identified. The collaboration with them should be institutionalized in some way, for example on the basis of memoranda of understanding, to ensure clear understanding of the details of the data needs and the limits of the data supply. Provisions should be made to enable efficient transfer of data. Ideally, the data will be transferred electronically on the basis of standard templates.

It is recommendable to set up a working group as a governing body of the FBS compilation process, in which the main data providers, from both the public and the private sector, are represented. The working group should coordinate the entire process of FBS production. In the design phase, it will serve as a forum to discuss the commodity coverage, the concepts and methods to be applied, and the development of the infrastructure of the data exchange. During the production phase, the working group may jointly validate the source data provided by its members and review the compiled FBS before dissemination. The working group should also pursue the standardization of data formats and concepts and suggest new ways for filling data gaps.

In the following, the most common, in some cases recommended, sources of data and methods for their measurement and collection are reviewed, separately for the main variables included in the FBS.

## Production

a) Data collection

Collecting data on agricultural production from all farms operating in the country is costly. Agricultural censuses, if in place, usually conducted only each ten years, may collect data on production of selected stable crops and livestock products of the country, as well as on main production factors, particularly harvested area and animal numbers. These data may be taken into account in the compilation of the variable “production” in FBS, but they are by far not sufficient to satisfy the data requirements.

In some countries, administrative records on agricultural production may be available, for example because local government officials need to track the number of slaughtering in their district (Pica-Ciamarra *et al.* 2014, p. 35f). These administrative data may constitute a valuable source for the compilation of the production figures. Furthermore, production of certain types of products, such as meat or milk, is often concentrated on a small number of large production units. In other cases, all farmers sell their production to a handful of agro-industrial companies, as it is the case for cash-crops. These are instances in which the total amount of production can be derived from the sales or purchase records of companies. Those records may be obtained either from the involved companies directly or, indirectly, with the support of industry-wide branch organizations which keep records of the purchases and sales of their constituent members.

To satisfy the remaining data needs on agricultural production, many countries have set up annual agricultural surveys based on samples of agricultural holdings, rural households or area segments, or on combination of those. Some countries carry out dedicated livestock surveys to collect data exclusively from livestock holders and thereby reduce sampling error (Pica-Ciamarra *et al.* 2014). When the sampling units are agricultural holdings and rural households, the sampling frames consist in listings of farm operators and households, while in the case of sampling of area segments the sampling frame is a map. To save resources, many countries apply a two-stage sampling design, mostly with cluster-sampling, where the administrative areas or geographic territories are usually used as primary sampling units. To enhance the accuracy of the estimators, different sampling frames may be combined to carry out multiple-frame sampling (Vogel 2015).

In developing countries, where a large proportion of agricultural production is carried out by smallholdings, good experience has been made with integrating dedicated modules on agricultural production into existing household surveys. One example is represented by the Integrated Surveys on Agriculture (LSMS-ISA) which has been created by integrating a questionnaire on agricultural production into the questionnaire and sampling design of the Living Standard Measurement Survey (LSMS). In the scope of the Global Strategy, FAO is currently developing a more general approach for developing a multipurpose survey, based on combined samples of agricultural holdings in the household (small-holdings) and non-household (larger farms and cooperatives) sector. This so-called Agricultural and Rural Integrated Surveys (AGRIS) is aimed to be implemented in priority countries targeted by the Global Strategy for developing their national agricultural systems. Its themes will cover the whole range of topics addressed by the Global Strategy, thereby comprising also production of the main crops of livestock products (FAO Statistics Division 2015a).

Once a sample has been drawn, by any of the methods above, production needs to be measured for every sampled unit. For this, a variety of methods exist. These are reviewed below, first for production of crops, then for production of livestock products.[[2]](#footnote-2)

*b) Measurement of primary crops production*

Production of primary crops can be measured either by following a direct approach, which relies on counting the harvest obtained during the reference period, or an indirect approach, which relies on the assessment of harvested area and average yield and subsequent multiplication of the two.

For *direct measurement* of crops production the whole-plot harvest method, according to which the harvest of the whole plot is observed and the result recorded by the enumerator, is considered to be the most accurate, although time-consuming, method. To save time, the enumerator may count the number of units, such as sacks, baskets or bundles, harvested by the farmer, and multiply that number by the average weight of one unit, assessed on the basis of a sample of units drawn by the enumerator. When harvest takes place at several times of the year, enumerators may visit farmers regularly, ideally each day, to record the amount of any crop harvested since the previous visit. Alternatively, the amount of the harvest can be inquired from the farmers, ideally in combination with certain checks by the numerator, *e.g.* by inspecting the storage facilities, to prevent false reporting. To reduce recall error, particularly in cases of extended harvest periods, a common method consists in the use of so-called crop cards on which farmers record the results of each single harvest. As under the direct approach only one variable is measured, this approach can in general be expected to lead to smaller measurement error of the estimate of production than the indirect one which involves measurement of two variables, namely area harvested and yield. Thereby, the direct approach appears particularly suited for the purpose of FBS compilation. However, direct measurement of crops production, unless based on farmers’ self-assessment or on the purchase records of large companies, is often time consuming.

*Indirect measurement* of crops production requires, in the first step, measurement of the harvested area. This measurement can be conducted on the basis of maps, by identifying segments with physical boundaries, cells of a grid or individual sample points, and determining the crop for which these area units are cultivated shortly before the harvest on the basis of local visual inspection. Alternatively, the area under different types of crops can also be identified by means of remote sensing, particularly by establishing the proportion of pixels, included in a segment of a satellite image, which have been assigned to different crop types on the basis of their color, and extrapolating that proportion by the known area of the entire segment. A more traditional method consists in visiting the sampled pieces of land and assess their size, for example by fitting the area to an equivalent set of rectangles, triangles or other type of polygons, then measuring the side lengths of these polygons, applying standard geometric formulas to each polygon, and summing the results up. Another method, suggested by FAO (1982) relies on the measurement of the perimeter, which is divided by a number between 4 and 5, depending on the closeness of the area to a square or instead to a complex polygon, and then squared. Based on field experience, fairly accurate results can be obtained with global positioning systems (GPS). Equipped with a GPS device, the enumerator walks along the whole perimeter of the field and the GPS automatically calculates the surrounded area, based on the coordinates of points included in the walk. The assessment of the area harvested of individual crops is complicated when more than one crop are grown, simultaneously on the same field. In that case, imputations are required to assign a certain amount of area to each individual crop. An overview of the different methods is provided by Fermont and Benson (2011, pp. 29-34)

In the second step, indirect measurement of crops production requires an assessment of the average yield. The most common method for that assessment, recommended by FAO (1982) as standard, consists in the crop-cut method. Under this method, a small sub-plot is randomly located within each field prior to the harvest. Instead of harvesting the entire field, only the sub-plot is harvested, by the enumerator or by the farmer themselves, and the yield of that harvest measured. Selecting more than one sub-plot per field for crop-cutting will enhance the accuracy of the yield estimator and enable estimating its within-field variance. Alternatively, the yield can be predicted already before the harvest takes place, either by the farmer themselves, accompanied by the enumerator, or by experts such as extension staff or field technicians. The expected crop yield can be determined by means of an eye-assessment or by empirical formulae taking account of particular measurable characteristics or morphological attributes of the growing crop, such as the number of open cotton balls over a certain row length, grains per head, plant height or ear length. A technically more advanced, and not yet fully technically developed, method consists in the analysis of spectral data obtained from the spectral reflection of different bands in satellite images.

*c) Measurement of livestock production*

Measurement of data on livestock production, such as production of meat, milk or eggs, does not require any measurement of area. As in the case of crops production, physical assessment is generally considered to be more reliable than self-reporting by farmers. Physical assessments are usually carried out by an enumerator, an extension officer or market agent who observes and records the number of slaughtered animals and measures their average carcass weight, or the amount of milk, eggs or wool produced. Carcass weights may also be predicted before the slaughter, based on eye-assessment by experts of the animals’ characteristics, particularly their live weight and fat content, probably complemented by technical devices such as scanners. Self-reporting by farmers, which requires in general less resources, represents the more common method particularly in developing countries. Self-reporting can be conducted in the scope of face-to-face or interviews or interviews on the phone, based on set questionnaires. Alternatively, respondents can fill paper questionnaires and return them by mail, or fill web-forms, to submit their responses.

Certain difficulties arise in the collection of data on livestock production from surveys which require particular attention in the survey design. Firstly, the owner of the livestock is often not the same as the owner of the ground on which the livestock is grazing and who has been selected as respondent in the survey. The livestock owner may in fact not have any land holding at all. In these cases, the respondent is usually not capable to provide the requested information on the livestock found on their farm. Secondly, in production systems where livestock are moved from one place to the other to find fresh pastures for grazing (nomadic pastoralism), particular data collection methods, such as aerial flyover surveys and electronic tagging of animals, combined with remote collection of production data, are required to guarantee appropriate coverage of these animals and to avoid double-counting. Finally, holdings with intensified animal farming, while including a large number of animals and producing high output, usually cover small space. Therefore, these holdings’ probability to be included in area-frame based surveys is exceptionally small (Vogel 2015, p. 35).

## Imports and Exports

National legislation usually obliges importers and exporters of goods to provide information about their cross-border transactions to the customs office in the form of tax declarations. The tax declarations include, among other information, a description of the product, the applicable commodity code, based on the Harmonized System Classification,[[3]](#footnote-3) the weight of the traded good, the country of origin (for imports) or destination (for exports), and the date of the transaction. As principally all transactions of cross-border merchandize trade should be collected by the customs offices on the basis of tax declarations, and this data collection therefore ensures a large coverage as well as low additional reporting burden and low collection costs, UNSD recommends that customs records be treated as the “most prevalent source” of data on international trade and that “statisticians take advantage” of that source (UNSD 2004, p. 11).

Nevertheless, customs records are usually not free of errors. Errors emerge, for example as a result of, intentional or unintentional, mistakes in the customs declaration, which have been made by the traders and have not been spotted during the occasional checks that should be carried out by customs officers. Typical reporting mistakes concern the classification of the goods, as traders may find it difficult to assign them with the correct code. A considerable amount of goods is not declared by the traders at all for instance with the purpose to avoid customs duties or trade restrictions (shadow trade). Sometimes, certain goods are excluded from the customs records for confidentiality reasons. This is often the case for military equipment. Errors may also slip in during the processing of the tax declarations by the tax administration or other institutions involved (Eurostat 2009, Annex I).

To clean the customs records from errors they should be carefully edited by the customs office to correct obvious false reporting. Furthermore, it is recommendable to enhance the quality of the trade data by merging the customs records with data from other sources. These may comprise:

* the records of financial flows accompanying transactions between residents and non-residents kept by the central bank and collected from the financial institutions in charge of the settlement of these transactions in the framework of the International Transactions Reporting System (ITRS);
* the foreign shipping manifests prepared for ships, aircrafts and vehicles crossing the border, which list details on their cargo;
* records of port administrations which are sometimes prepared on the basis of the shipping manifests;
* records of the parcel post and letter post which need to be kept in the majority of countries, as stipulated by the acts of the Universal Postal Union;
* aircraft and ship registers, particularly to record exports and imports of ships and aircrafts, which do not always imply border-crossing of the traded objects; reports of commodity boards; records compiled for the collection of value added tax; and enterprise surveys (2004, chapter 4).

In some countries, such as the Democratic Republic of the Congo, records on cross-border trade in agricultural products are compiled by the national veterinary service which is represented on the main customs points to verify compliance of animal- and plant-based products with hygienic standards.[[4]](#footnote-4) It should be ensured that food aid obtained from relief agencies is appropriately measured, and in case that not, imputations should be done, for instance with data from the if Food Aid Information System maintained by the World Food Programme (WFP 2015). Finally, the data may be reconciled with the values recorded for the same trade flows by the trading partner country (mirror data). Comparison of exports with mirror data is considered to be particularly helpful, as imports are usually documented more exhaustively and checked more accurately than data on exports (UNSD 2004, chapter 13).

Data on international trade are also compiled and disseminated by international organizations and corporations. The FAO Statistics Division and UNSD regularly collect the official trade files of around 180 countries. The records relating to trade in agricultural products are thoroughly edited, quality-checked and reconciled with statistics from other sources by the FAO Statistics Division. Data gaps are filled by imputation of mirror data from trading partners or of values provided by multinational industry organization, and the final data are published on the FAOSTAT website (FAO 2015). UNSD disseminates the collected trade files in raw form on the Comtrade Database (United Nations 2015). Also the Global Trade Information System, a private sector company, collects official trade files from around 80 countries and makes them accessible on their website (GTIS 2015).

A particular obstacle for the compilation of statistics on agricultural foreign trade consists in the inclusion of shadow trade, especially in developing countries. Shadow trade comprises all trade in goods that has not been subjected to statutory border formalities such as customs clearance (Afrika and Ajumbo, 2012. p. 2). It is therefore not included in the statistics compiled on the basis of customs records. Although it is estimated that in Africa shadow trade is an important source of income for a large share of the population and makes a remarkable contribution to food security (*ibd.*, p.1), only few developing countries regularly compile data on shadow trade and take these data into account in their official trade statistics. A survey on informal cross-border trade in Africa, recently carried out by UNSD among 22 compilers of national statistics on international merchandise trade, revealed that only two countries in Africa, namely Rwanda and Cameroon, regularly compile statistics on informal trade (Muryavan and Iversen 2014). For Eastern and Southern Africa, the Famine Early Warning Systems Network (FEWS Net), funded by USAID and WFP, compiles non-official data on shadow trade each quarter year and publishes the results in its reports (FEWS Net 2012, 2015). The aforementioned approaches to measuring shadow trade rely on monitoring the main border points and surveying persons crossing the borders carrying goods. In Rwanda, such surveys are carried out each day of the year at all major border points of the country (Habinshuti 2014). In Cameroun the data collection is less complete and complemented by econometric estimation (Nguingnang 2014). In Rwanda, it is estimated that informal trade makes up for 1% of all imports and 24% of all exports, while in Cameroon 10% of all imports and 2% of all exports are informal, according to the compiled data (Muryavan and Iversen 2014).

## Stocks

Stocks of agricultural products are held by a variety of market participants, such as farms, processing or trading companies, government agencies or even international relief organizations such as the WFP. In most cases, the decision on the amount of stocks held back from markets is driven by a variety of incentives. Farmers in developing countries store their produce in order to smooth consumption or to keep a reserve for insurance against food shortage. Similarly, the WFP holds certain amounts of staple foods ensuring supplies for emergency reliefs to prevent food crises. Other stakeholders pile up stocks in order to improve bargaining positions or even strengthen market capacities/power.

One option to measure the stocks held by agricultural holdings is through agricultural censuses. Unfortunately, stocks are rarely an integral part of those. Out of 196 national censuses, only 30 collect information on storage infrastructure and capacities, while only 7 directly include stock levels (Fonteneau 2014). Agricultural censuses are carried out with large time intervals, usually of ten years, between the different survey rounds. The fact that stock levels exhibit significant short term variations limits the usefulness of censuses for the assessment of stocks, as interpolations are difficult to undertake.

Data on the stocks held by government agencies and private sector companies, such as warehouses, retail traders and wholesalers, can be collected from the respective offices or companies. As regards the stocks of agricultural holdings, agricultural surveys are usually the most suited data collection method. Efforts to develop surveys covering stocks in all countries are currently made by AMIS as well as the by the Global Strategy.

The combination of both, farm survey data and data collected from institutional stock holders provides a fairly accurate estimate of stocks on a national level. Indeed, the USDA is operating such an approach where farms are surveyed bi-annually. The East African Community is also adopting this methodology for the compilation of monthly FBS.

## Feed

Farmers feed their animals with agricultural products which they purchase from elsewhere as well as with products which form part of their own agricultural production. The importance of both components in the overall feed supplied varies across countries, depending on the type of prevailing livestock production systems, in particular by their degree of specialization, commercialization and intensification.

A comprehensive measurement of feed should cover self-produced as well as purchased feed. Therefore, accurate collection of feed data requires inquiring from all animal farmers, or at least from farmers included in a representative sample, how much of the different types of agricultural products they supply to their animals as feed. As such surveys are costly, in the past they have are scarcely conducted (Westcott and Norton 2012, p. 5).[[5]](#footnote-5) In some cases, exhaustive surveys of feed use are included as one-off modules annexed to the regular agricultural survey in a certain year.[[6]](#footnote-6)

In the absence of such comprehensive surveys, useful information may be obtained by including questions about the amounts which respondents used from the crops they produced for feeding their animals into the regular national agricultural survey. This may be a useful second best method especially in developing countries where a large proportion of the livestock is reared by smallholders and the proportion of purchased feed can be considered to be comparatively low. [[7]](#footnote-7) Furthermore, feed data can be collected from feed producers. Combined with the statistics on external trade, such data collection may provide a worthwhile substitute for a data collection on total feed use, particularly in countries with highly commercialized livestock production, where most feed is purchased on the market.[[8]](#footnote-8)

## Food

For the measurement of food consumption, household budget surveys and nutritional surveys are the main and mostly the only available data source. These surveys are usually carried out once every three or five years, in many developing countries less frequently. They are usually based on a generally representative sample of the population. However, some specific population subgroups are typically under-represented. This is the case particularly for the homeless and persons in institutionalized households, such as military camps, prisons, hospitals or seniority centres, as they are usually not included in the sampling frame. Also illiterate persons, immigrants and high-income earners are usually under-represented due to high non-response rates. With the exception of the high-income earners, most members of the aforementioned groups belong to the poorest segments of the population. For that reason, household budget surveys tend to be affected by a middle-class bias.

To obtain population totals, the responses from household surveys need to be scaled up by applying extrapolation weights, which should reflect the inverse sampling probability, to each single observation. Under-representation of particular population groups is mostly adjusted for by means of re-calculation of those weights. However, as typically only one vector of weights is applied, this requires a choice of the variable with respect to which under-representation is aimed to be eliminated, such as employment status, total income or total expenditure. In most cases the chosen variable is another one than ‘food consumption in quantities’. This creates a certain bias in the estimate of the population total.

Food consumption measured in household surveys has typically a different coverage compared to the way the variable is defined in FBS.[[9]](#footnote-9) On the one hand, food consumed outside the household, for instance in restaurants and canteens, is difficult to capture in household surveys. Even if, conceptually, it should be included, respondents tend not to take that part of consumption fully into account. This is the case also for small snacks taken by the different household members between the meals. On the other hand, household budget surveys often explicitly measure consumption of own production, an element which is often considered to be easily omitted in FBS (Grünberger 2014, p. 2f).

Both, the way by which the results from household surveys are scaled up to the total population as well as the difference in coverage of the variable food consumption are likely to cause discrepancies to food consumption as to be recorded in FBS. Empirically, the data obtained from the two types of sources are only modestly correlated across countries. Throughout a sample of 64 analysed countries, the data on food consumption compiled from FBS turn out to be on average higher than those obtained from household surveys. In some extreme cases, that difference amounts to up to two thirds of the value obtained from household surveys. In other cases the value derived from FBS is by up to one fifth smaller than the household-survey result. In contrast to the limited correlation in levels, the shares of the individual types of food in total consumption appear to match more closely between the two sources of data (FAO Statistics Division 2015b).

Based on the evidence above, FBS compilers should definitely make use of the information provided by household expenditure surveys, particularly as better information on food consumption is seldom available. However, they should be aware that considerable discrepancies may exist between food consumption compiled on the basis of these surveys and food consumption to be recorded in FBS, and that these discrepancies are, at least partly, attributable to the way food consumption in household surveys is measured and scaled up. It is therefore recommendable to use figures on food consumption derived from household surveys, and particularly the proportions of individual food groups in that consumption as well as changes over time, as meaningful points of orientation. However, when other variables suggest deviating from these figures to a certain extent, FBS compilers should not be too reluctant to do so.

## Losses

Measurement of food losses should cover all the different stages of the food supply chain at which they can occur and which are covered by the definition of food losses in FBS (see above). For planning the collection of data, it is key to identify the main processes from which food losses emerge, considering all the different stages of the food chain between production and arrival of the good at the final consumer, the main actors involved in these processes, as well as records kept by government or private sector entities which can be used. Before setting up the data collection system, it is recommended to conduct a general baseline study (FAO 2015, p. 13; O’Connor *et al.*, 2015).

Whenever data, that can be expected to account for a significant proportion of the food losses in the country, cannot be obtained from records kept by public or private entities, studies based on samples are considered to be the most efficient way to collect those data. The sampling design should take account of the main characteristics and structure of the targeted subsector of the food industry. As regards the data collection instruments, objective measurement, based on weighing, counting or assessment of volume, is commonly acknowledged to be the preferred one, even if that may require more time than others. Use of questionnaires and oral interviews with product owners can be useful for cross-checking the results of the measurement, but they are not recommended as stand-alone instruments, as non-response rates and reporting error are usually high. Product owners are often reluctant to admit large amounts of losses.[[10]](#footnote-10)

Objective measurement can be carried out in a number of ways, depending on the type of the prevalent food loss in the particular process of the food supply chain. Food losses can take the form of *disappearances*, in the case of which pieces of the product drop out of the food chain, or *biodegradation*, in the case of which pieces lose their adequacy to be used as food. Disappearance occurs mainly as a result of actions to which the product is exposed over the food supply chain, for example during stacking, stooking, threshing, shelling, cleaning, winnowing and drying of crops on farm, during transport, during processing as well as during commissioning of food in wholesale and retail. Biodegradation occurs mainly over time as a result of biological or chemical transformations or infestation by insects. These take place mainly during storage, to a certain extent also during drying and longer transports.[[11]](#footnote-11)

Measurement of disappearance can be carried out by the following methods:

* *collecting the dropouts caused by a certain activity*, for example by laying out plastic sheets on the floor during the stacking, stooking and threshing of cereals on farm, to catch the scattered grains, by analysing the grain that has remained on the straw after threshing, in catering companies, by collecting the food left on counters for selling at the end of the serving period, by analysing the business waste container, or, when scanning-based systems are in place, for example in wholesale and retail trade, by extracting the records of food items classified as losses from the database;
* *following up units or sets of food products and comparing their state before and after the activity*, which is the predominant method for the estimation of losses during transport, and which can also be easily applied for example to measuring losses during wholesale and retail trading when scanning-systems are in place;[[12]](#footnote-12)
* *comparison of the outcomes of an activity with and without taking particular care for prevention of losses,* which has been recommended, for example, for measurement of the grain damage caused by threshing.[[13]](#footnote-13)

In the later stages of the food supply chain, where agricultural products often occur in mixed form with other products, waste composition analysis may be required, to separate the losses of different products from each other of from materials not to be recorded as food loss (FLWP 2015, chapter 13.6).

For the measurement of biodegradation, a traditional, and relatively precise, method consists in the, so called, count-and weigh method initially recommended for the measurement of grain loss during storage. Under this method, first, a sample of the damaged grain is analyzed in a laboratory to assess the weight loss per grain, under the perspective of adequacy for consumption as food; then, the weight loss per grain is extrapolated to the total weight loss in the sample by taking into account the proportion of damaged grain (Harris and Lindblad 1978, p. 90f). A main disadvantage of the count-and weigh method consists in the high amount of time and work required. Furthermore, the facts that parts of the produce need to be removed from the food chain for analysis in the laboratory and that the product owners are not involved in the assessment may considerably reduce their willingness to agree to the loss measurement. To overcome these disadvantages, the African Postharvest Losses Information System (APHLIS) suggests a simplified method based on visual scales (Hodges 2013). A visual scale consists in a set of images of grain samples, representing different intensities of losses, and the associated expected weight loss expressed as percentages of the total depicted grain. These percentages have been established previously on the basis of laboratory analysis. For the measurement of the loss, the enumerator compares the grain with the pictures on the visual scale, together with the grain owner, and applies the respective percentage weight loss to calculate to total loss in the sample.

## Seed

The most common method for measuring seed use is to include questions on seed use in the questionnaire of an agricultural survey. These usually address only the use of own production for seed. Farmers may also buy seeds on the market, but these seeds consist mostly of so-called ‘improved’ seed which are commonly not suited for human consumption and should therefore not taken into account in FBS. [to be confirmed] Data on the use of seed purchased on the market may be obtained from the records of commercial seed companies.

As the amount of seed for a specific type of crop is strongly determined by the area sawn, it may be sufficient to measure the size of that area, based on some of the techniques outlined above for the measurement of area harvested (see section “Production”), and multiply by a seed rate. The seed rate is defined as quantity of seed used per hectare. It may be surveyed from farmers or known from other sources, taking into account this rate usually do not change much from one year to the next. If the area sawn is not known, it may, as a second best option, be approximated by measuring area harvested, although the area sawn is in some cases smaller, and seldom larger, than the area harvested. Differences between area harvested and area sawn can result from damage of the crop while it is grown, due to natural disasters, pests, poor germination, animal grazing or floods. Furthermore, farmers may decline from harvesting due to lack of labour, lack of demand or, in the case of cassava, with the purpose to keep a reserve for times with drought or food shortage (Sud *et al.* 2015, p. 9f.).

## Tourist Consumption

Naturally, surveys carried out among tourists to retrieve detailed data, in particular on types of food consumed, represent the superior way to measure the food consumption of tourists. However, in case this is not easily feasible, estimating tourist consumption through tourism data represents an adequate alternative. Such data may be collected from the large hotels and travel agencies of the country. Hotels may be requested to share their records on meals supplied to their guests.

Data on the number of tourists entering a given country, including their origin and duration of stay, is collected at country boarders and globally gathered by the United Nations World Tourist Organization (UNWTO 2015). These datasets provide a useful basis for estimating the amounts of food consumed by tourists. In some small islands states which are popular holiday destinations, such as the Maldives or Seychelles, foreign visitors consume the largest share of available food. In these cases, accurate measurement of tourist consumption is particularly important to identify the amount of food available for consumption by the resident population.

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1. The method recommended by the FAO Statistics Division for balancing the FBS is explained below in section 2.2. [↑](#footnote-ref-1)
2. The review below is based on two unpublished reports recently prepared in the context of the Global Strategy to Improve Agricultural and Rural Statistics – for crops production by Sud *et al.* (2015) and for production of livestock products by Moss *et al.* (2015). [↑](#footnote-ref-2)
3. See chapter 5 below for details about the Harmonized System classification. [↑](#footnote-ref-3)
4. Information gathered during a country visit by the FAO Statistics Division in the Democratic Republic of the Congo in 2011. [↑](#footnote-ref-4)
5. An exception consists in the compulsory data collection “Annual Data of Agricultural Enterprises” carried out by the CSO of Hungary among all organizations carrying out agricultural activities except agricultural surveys. (KSH 2014). [↑](#footnote-ref-5)
6. Such module has been added for example to the Agricultural Survey among Agricultural Smallholders in Moldova in 2012. [↑](#footnote-ref-6)
7. This approach is followed for example in the Seasonal Agricultural Survey of Rwanda (NISR 2014). [↑](#footnote-ref-7)
8. This approach is followed for example in Germany, Hungary, China and Spain. In Germany, cereal producers and other agricultural holdings have a legal obligation to regularly report their stocks, production, inflows and outflows of fodder products (Marktordnungswaren-Meldeverordnung 2009; BLE 2011, pp. 1-4). Also in Hungary agricultural enterprises have the duty to report the amounts of sold feed to the national statistical office (KSH 2014). In China, the Chinese Feed Industry Association, in charge of the Ministry of Agriculture, conducts a regular survey among large feed manufacturers (FIO and CFIA 2012). In Spain the sub-national statistical offices carry out oral interviews, not based on a written questionnaire, with feed producers (Klapp 2010, p. 76). [↑](#footnote-ref-8)
9. See the description above at the beginning of chapter 2. [↑](#footnote-ref-9)
10. Detailed guidelines on the design and implementation of food loss surveys can be found in FLWP (2015, chapters 5, 6, 13) and, tailored to the crops sector in African countries, in Hodges (2013, chapter 2.4). [↑](#footnote-ref-10)
11. See Harris and Lindblad (1978, chapter 5) for a more detailed description of the various types of grain losses, and O’Connor *et al.* (2015, chapters 6-8) for a description of food losses caused by wholesalers, retail, markets and food services. [↑](#footnote-ref-11)
12. This method can involve more than one activity. With the “load tracking” method, a sample of the primary product is followed throughout the entire supply chain (FLWP 2015, chapter 13.3). [↑](#footnote-ref-12)
13. Detailed descriptions of the aforementioned methods can be found in: Harris and Lindblad (1978, chapter 5); Møller *et al.* (2014, chapter 5), FLWP (2015, chapter 13). [↑](#footnote-ref-13)