RAF-AFCAS-19–E-53-AFRISTAT **E**

November 2019

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Agricultura y la Alimentación

# AFRICAN COMMISSION ON AGRICULTURAL STATISTICS

## Twenty-Sixth session

## Libreville, Gabon, 4 – 8 November 2019

**AGENDA ITEM 5**

# USING FOOD BALANCE SHEETS TO IMPROVE FOOD SECURITY AND INFORMATION ON SDG INDICATORS ON THE PREVALENCE OF UNDER-NOURISHMENT AND POST-HARVEST LOSSES: CASE OF BENIN, GUINEA AND MALI

**Madior FALL**
**Technical Advisor to the Director-General**
**AFRISTAT**

## ABSTRACT

This paper is presented as part of the project to support the monitoring of sustainable development goals in Africa (SODDA Project), which provided support for the analysis of Food Balance Sheets (FBS) prepared under the Memorandum of Understanding between FAO/SM and AFRISTAT.

The self-sufficiency ratio (SSR) between 2010 and 2015 shows that Mali was closer to achieving food self-sufficiency, compared to Benin and Guinea. About 43.2% of food products on Guinea's domestic market are imported. A significant volume of plant products in the three countries are imported, resulting in an annual average import dependency ratio (IDR) of 48.2%, while 12.5% of their animal products are imported.

With the use of FAO's food balance sheets and other related indicators, it was possible to estimate the prevalence of undernourishment under SDG 2 and the food loss index under SDG 12.

Figures for 2015 show that Benin and Guinea had a higher prevalence of undernourishment (14.23% and 15.6% respectively), compared to Mali's 5%. The estimates per capita also show that some 1.5 million Beninese, 12.09 million Guineans and 0.9 million Malians were undernourished in 2015.

## I. Introduction

Farming is a key sector, especially in developing countries. However, agricultural and rural statistics remain peripheral to national statistical systems. The initiative to develop a Global Strategy to improve Agricultural and Rural Statistics was in response to the lack of capacity in developing countries to collect reliable statistical data on agriculture and food and develop a reference framework for sustainable and long-term agricultural statistical systems.

To address these challenges in developing countries, a Global Strategy (FAO/Global Strategy) was developed to improve agricultural and rural statistics and adopted by the United Nations Statistical Commission in February 2010. The Strategy seeks to strengthen the statistical capacities of developing countries to produce reliable statistics on agriculture, food and rural development, which are vital for the formulation, monitoring and evaluation of development policies.

As part of an accelerated technical assistance plan, the Food and Agriculture Organization of the United Nations (FAO) and the Economic and Statistical Observatory for Sub-Saharan Africa (AFRISTAT) signed a two-part Memorandum of Understanding in December 2016 to scale-up the implementation of certain activities under the Global Strategy and improve Agricultural and Rural Statistics in the areas of training and technical assistance. Components of the MoU include:

*(1) The creation and use of main sampling frames in agricultural surveys such as those provided for in the integrated agricultural survey;*
*(2) Preparation of Food Balance Sheets using the new methodology developed by FAO.*

More specifically, four countries (Benin, Guinea, Madagascar and Mali) received support for the preparation of their food balance sheet for the 2015 reference year. Following this exercise, the SODDA Project, in line with its objectives, provided the framework for in-depth analysis of food balance sheets. These food balance sheets were used to provide information on two indicators of the Sustainable Development Goals (SDGs): Indicator 2.1.1 on the prevalence of undernourishment (PoU). Target 1 of SDG 2 states that "By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round" and Indicator 12.3.1: Index of global food losses of target 3 of SDG 12 seeks to "halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses, by 2030".

## II. Methodology and findings

Four indicators based on the FAO's methodology were used to estimate the Food Balance Sheets of Benin, Guinea and Mali. These indicators include: (i) self-sufficiency rate; (ii) import dependency ratio; (iii) prevalence of undernourishment; and (iv) food losses.

### 1. *Self-sufficiency Ratio (SSR)*

The SSR expresses the ratio national production to domestic consumption. It is defined as:

$$\boldsymbol{SSR = \frac{Production}{Production + Imports - Exportations + \Delta Stocks} * 100}$$

Within the context of food security, the SSR is often used to calculate the extent to which a country is self-sufficient in its own domestic products. The higher the SSR, the closer the country is to achieving self-sufficiency. It is often be very high when the country relies heavily on imports to feed its population. This may also occur when a significant volume of domestic production is exported.

**Table 1: Food Self-sufficiency Ratio (%) 2010 - 2015**

| | Benin | | Guinea | | Mali | |
|---|---|---|---|---|---|---|
| **Year** | **Animal products** | **Plant products** | **Animal products** | **Plan products** | **Animal products** | **Plant products** |
| 2010 | 41.1 | 84.1 | 87.9 | 6.9 | 98 | 94 |
| 2011 | 44.2 | 76.2 | 86.9 | 33.4 | 98 | 94 |
| 2012 | 41.3 | 86.3 | 87.5 | 75.2 | 97 | 89 |
| 2013 | 40.6 | 80.6 | 86.7 | 92.7 | 98 | 93 |
| 2014 | 51.8 | 82.3 | 88.8 | 76.8 | 98 | 91 |
| **2015** | **53.4** | **85.9** | **87.8** | **48.1** | **99** | **90** |

The above table shows that Mali is close to achieving self-sufficiency, with its SSR for both plant and animal products close to 100.

However, 60% of the products on Guinea's the domestic market were produced locally. The country's self-sufficiency ratio was higher in 2015 with animal products accounting for 87.8%, while plant products stood at 48.1%.

### *2. Import Dependency Ratio (IDR)*

The Import Dependency Ratio expresses the share of available domestic supplies that come from imports. It is defined as:

$$IDR = \frac{Imports}{Production + Imports - Exports + \Delta Stocks} * 100$$

This ratio is only significant where imports are exclusively for domestic consumption and not re-exported.

**Table 2: IDR from 2010 to 2015**

| | Benin | | Guinea | | Mali | |
|---|---|---|---|---|---|---|
| **Year** | **Animal product** | **Plant products** | **Animal products** | **Plant products** | **Animal products** | **Plant products** |
| 2010 | 64 | 13 | 12.2 | 45 | 2 | 6 |
| 2011 | 56 | 19 | 13.2 | 52.9 | 2 | 6 |
| 2012 | 59 | 12 | 12.6 | 47.5 | 3 | 11 |
| 2013 | 59 | 15 | 13.4 | 45.9 | 2 | 7 |
| 2014 | 48 | 17 | 11.2 | 49.2 | 2 | 9 |
| **2015** | **47** | **15** | **12.3** | **47.8** | **1** | **10** |

Guinea imports about 43.2% of the products on its domestic market. Most of the plant products are imported with an annual average IDR of 48.2% compared to 12.5% for animal products.

Mali, on the other hand, imports more plant products than animal products. It should be noted, however, that fish products (fish and seafood products) are not yet included in the new approach to the preparation of food balance sheets.

### 3. *Prevalence of Undernourishment (PoU)*

The prevalence of undernourishment is an indicator of access to food and an indicator of the Sustainable Development Goals (SDGs). It measures the attainment of target 1 of SDG 2, which seeks tot: '*end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round, by 2030'.*

FAO defines undernourishment as *"the situation in which an individual's usual food consumption is insufficient to provide the dietary energy consumption (DEC) necessary for a normal, healthy and active life"*. The corresponding indicator is the prevalence of undernourishment (PoU), which estimates the percentage of people in the total population who are undernourished.

The methodology is explained in Annex 1. Coefficients of variation have been estimated for Benin and Guinea, which have household consumption surveys.

Data on household food consumption are not available for Mali to estimate the computation parameters for 2010-2015. The coefficients of variation are provided by FAO and a log-normal probability density function was assumed to characterize the distribution of DEC. Minimum dietary energy requirements (MDER) are determined using standards established by the FAO/WHO[1] Expert Group on Energy Requirements. The distribution of the population by age group and gender is given by the United Nations population outlook (2017 estimates). Data on the size of persons was obtained from WHO, while data on birth rates were obtained from the National Statistical Institutes (INSAE[2] in Benin, INS[3] in Guinea and INSTAT[4] in Mali). The MDER was estimated by combining all this data using the online EXCEL model provided by FAO for this purpose. The daily per capita dietary energy on the Food Balance Sheets is an indicator of the average dietary energy consumption (DEC).

### 4. *Global Food Loss Index*

SDG12, seeks to "ensure sustainable consumption and production patterns", together with Target 3, which calls for" cutting in half per capita global food waste at the retail and consumer level and reducing food losses along production and supply chains, including post-harvest losses, by 2030'. To achieve this objective will require a capacity to assess food losses in order to identity solutions to the problem. The United Nations agencies involved in assessing food losses (FAO and the United Nations Environmental Programme) have proposed to divide them into two parts: food losses measured by the Global Food Loss Index and food wastage measured by the Food Waste Index.

The selection of food products is determined by national objectives. It is in fact difficult to estimate losses for all food products consumed in all the countries in order to estimate the overall index and facilitate international comparisons. It is however important to note that the key objective in calculating the GFLI is to promote diversity of food and achieve food security.

The basket of food products for the three countries was selected according to their calorie content. Two of the food products with the highest calorie content per item in the base year (2010 as part of this exercise) are used. Some adjustments were however made to the basket of products due to the importance of certain food products in the diet of each country.

The outcomes for the three countries are as follows.

[1] World Health Organization
[2] National Institute of Statistics and Economic Analysis
[3] National Institute of Statistics
[4] National Institute of Statistics

**Benin**

The table below provides estimates for the percentage losses in 2010 and 2015 as well as the loss index for 2015 compared to 2010.

**Table 3: Percentages of food loss and food loss index**

| Product | % loss in 2010 | % loss in 2015 | Loss index 2015/2010 |
|---|---|---|---|
| | | | |
| Maize | 25.83% | 15.03% | 58.19 |
| Rice (parboiled, milled) | 8.01% | 6.95% | 86.81 |
| Wheat | 1.52% | 6.19% | 408.25 |
| Sorghum | 11.42% | 8.93% | 78.18 |
| Dry beans | 31.38% | 0.10% | 0.32 |
| Pineapple | 9.99% | 3.11% | 31.13 |
| Coconut | 10.05% | 10.05% | 100.00 |
| Tomato | 4.54% | 4.54% | 100.00 |
| Yam | 10.00% | 8.75% | 87.45 |
| Cassava | 13.00% | 14.63% | 112.53 |
| Soya | 4.00% | 32.17% | 804.15 |
| Other vegetables | 10.05% | 3.55% | 35.35 |
| Groundnuts | 17.01% | 17.01% | 100 |

*Source: INSAE, Food balance sheet 2015*

The country lost 12.45% of the food produced in 2010 either during production, storage or processing. In 2015, this percentage stood at 10.58%, reflecting a loss index of 85.03% that year compared to 2010. The percentage of losses dropped averagely by 14.97% between 2010 and 2015[5]. Maize and beans were the main contributors to this decrease in the loss rate with food loss indices of 58.19% and 0.32% respectively, while cassava contributed to its increase with a loss index of 112.53%.

**Guinea**

Cereal products recorded the highest losses, accounting for 55.6% of the average losses over the six year period. This was followed by starchy roots and fruits, each representing 17.9% in the average loss expressed in metric tonnes (MT).

The country recorded particularly high losses for rice and rice products. The average volume of loss for rice alone accounted for more than a third (35.7%) of the food losses over 6 years. Cassava was the second most affected product (12%), followed by maize (11%). Bananas and plantains recorded 10.3 losses on average over the period considered.

**Mali**

The rate of food loss increased to around 13.8% between 2010 and 2015. The highest percentage of food losses recorded in 2010 was 14%. This situation however improved between 2011 and 2012 when the loss index fell from 13.8% to 13.6% before rising to 13.8% in 2013 and 2014, mainly due to the decrease in the percentage of rice loss from 10.6% to 9.7% between 2011 and 2012, i.e. a decrease of 8.7 percentage points.

The table below provides a summary of the results obtained in the three countries.

[5] Note: This variation may be because 2010 to 2014 have more estimates than 2015.

**Evolution and Loss Index table**

| | Benin | | Guinea | | Mali | |
|---|---|---|---|---|---|---|
| | **Percentage** | **Index** | **Percentage** | **Index** | **Percentage** | **Index** |
| 2010 | 12.45 | 100 | 12.5 | 100 | 14 | **100** |
| **2015** | **10.58** | **85.0** | **11.3** | **90.4** | **13.9** | **99.1** |

## III. CONCLUSION AND RECOMMENDATIONS

This pilot exercise facilitated the preparation of the 2015 food balance sheet for Benin, Guinea and Mali, using FAO's Shiny New Agricultural Data and Information Sharing Tool. The exercise also provided an insight into food availability in Benin in terms of quantity and macronutrients. The SODDA Project continued the exercise with special emphasis on the SDGs. However, the lack of data and information on the uses of broken rice hampered the preparation of a complete food balance sheet for 2015. With the change in the structure of rice imports, it would be important to include broken rice in the food supply.

Also, much of the information on industrial uses was not available at the national level. Thus, in order to obtain a complete food balance sheet, it is recommended that the Benin TWG continue to search for information on the uses of broken rice, particularly the quantity used for food. The Benin TWG has started developing the 2016, 2017 and 2018 food balance sheet, which will facilitate the monitoring of SDG indicators.

The undernourishment indicator for Guinea, which declined during the Ebola outbreak, shows the significant impact of the socio-political climate on improving the conditions of the population. This is proof that implementing policies based on projects and programmes is just one step in the fighting against food insecurity. It is equally important to create a favourable socio-political and economic environment by preventing disruptive phenomena so as to have lasting impacts of these policies and reduce the vulnerability of the population.

The substantial loss of plant products compared to animal products reflects the lack of a food storage system and mechanism. The rice example is a telling illustration of this phenomenon; with losses of around one-fifth of the food products on the domestic market. These challenges call for a number of measures to be put in place to:

- Improve the production of statistics for the sectors concerned by preparing the food balance sheet so as to obtain quality data;
- Continue the training and assistance of the Technical Working Group for sustained monitoring of policy-relevant aggregates in the fight against food insecurity and undernourishment;
- Establish food storage facilities to reduce losses in general, particularly for rice and cassava;
- Support the agricultural sector at the national level by investing in research and development, manpower training and equipment to increase the sector's productivity;
- Support policies aimed at combating undernourishment by promoting a resilient socio-political, economic and health environment.

The recommendations for Mali, which has had a previous practice of compiling food balance sheets, are as follows:

- Support the development and analysis of food balance sheets by the TWG;
- Adopt measures to reduce Mali's heavy dependence on imports of certain commodities such as sugar, palm oil, wheat and rice. This can be done by increasing local production;

- Take into account population growth to substantially increase national production of crops with a high SSR in order to maintain the current supply of macronutrients and to close the gap between dietary energy needs and supply. This improves the value of the PoU and facilitates achievement of the "zero hunger" objective*;*
- Promote good practices in harvesting, storage, and processing of crops to reduce food losses given that an average of over 13.5% of the produce is lost along the food chain.
- Carry out censuses to collect data on the volume of products actually consumed per household. Such a census would facilitate the estimation of parameters for the calculation of the PoU as well as the actual level of household energy consumption and facilitate calculations at the disaggregated level to fine-tune the analyses;
- Develop methods of estimating percentage food losses per food item. The existing data is generally based on expert opinions, since no studies have been conducted to estimate the percentage losses per product, and pay particular attention to the food loss index values.

**ANNEX: Methodology for estimating the Prevalence of Undernourishment**

The PoU indicator is the probability that an individual's daily dietary energy intake (x), taken at random from the reference population, is below the Minimum Dietary Energy Requirement (MDER) for a normal, healthy and active life. The formula is as follows:

$$PSA = \int_{x<MDER} f(x|\theta)\, dx \ ;$$

Where $f(x)$ is the function of the probability distribution of daily per capita energy consumption (Dietary Energy Consumption, DEC) and θ a vector of parameters of this function. The number of parameters depends on the law followed by the function *f*. In most cases, the distribution is considered to follow a lognormal distribution in which case it is determined by two parameters, namely the average DEC and the coefficient of variation (CV). In other cases where a normal asymmetric or lognormal distribution is considered, there will be the need to include the two previous parameters, the asymmetric coefficient (Skewness, SK).

Thus, to calculate the PoU, it is first necessary to choose a functional form of the food consumption distribution *f(x)* and to have the following parameters at hand: the daily dietary energy consumption (DEC); the minimum food energy requirement threshold (MDER); the coefficient of variation which reflects the inequality in food consumption between the different layers of the reference population and the asymmetry coefficient (in cases where the distribution of daily consumption is not symmetrical to a transformation).

***Calculating the function of f***

Until 2012, the probability distribution f (x) was modelled as a lognormal probability distribution function, with only two parameters: average and coefficient of variation. In its most recent formulation, it is modelled as a three-parameter probability distribution, representing different degrees of asymmetry, ranging from a symmetric normal distribution to an asymmetric lognormal distribution.

Estimating different degrees of asymmetry must be flexible given the fact that dietary energy consumption levels are naturally affected by the physiological state of individuals. It is therefore conceivable that, when average consumption increases, the asymmetry of the distribution may decrease. It gradually moves from (positively asymmetric) lognormal distributions, typical of populations where average food consumption is relatively low, to normal (symmetric) distributions. The asymmetric-normal and asymmetric lognormal distribution families characterize all possible intermediate degrees of positive asymmetry.
(See http://www.fao.org/3/ai4046e.pdf for a detailed description).

***Estimated average dietary energy consumption (DEC)***

There are three main sources of information for estimating dietary energy consumption (DEC): These are:

i. Individual food consumption surveys that capture daily food consumption for each individual.
ii. Household expenditure and consumption surveys that provide information on the quantities of products consumed and household expenditure. Using such data, it is possible to calculate the average food consumption per capita by dividing the total food consumption of households by their size.
iii. Food balance sheets from which the per capita dietary energy supply is used to represent DEC.

***Estimated Minimum Dietary Energy Requirement (MDER)***

A person's dietary energy requirement, based on gender and age, are estimated by multiplying the normalized needs associated with the basal metabolic rate (expressed per kilogram of body weight) by the ideal weight of a healthy person (taking into account their height). The values obtained are then multiplied by a coefficient corresponding to the physical activity level (PAL) to take into account the latter. Since body mass index (BMI) and PAL vary within active and healthy sex-age groups, only one range of energy requirement can be estimated for each sex-age group in the population. The MDERs of the total population are the weighted average of the

MDERs for each sex-age group, with the share of the population represented by each group serving as the weighting coefficient (FAO, 2018). The quantity obtained from this calculation is increased by a surplus consumption for pregnant women using the birth rate in the population in question.

***Estimating the coefficient of variation (CV) and skewness (SK)***

The CV and SK coefficients are based on nationally representative household surveys. Where such data are available, they should be processed to eliminate any observations that may lead to high variability in food consumption. It therefore appears that food balance sheets cannot be used to estimate the SK of the CV, as they do not provide information on the distribution of food consumption within a population (FAO, 2018).
It should be noted that the CV is broken down into two orthogonal components, namely variations in food energy consumption attributable to income (CV|y) and variations attributable to any other orthogonal income factor (CV|r) including weight, physical activity etc.:

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

The (CV|y) is directly calculated using household census data by adjusting the distribution of household food consumption by variability due to the number of people consuming the meal (which is often different from the size of the household); household composition; and the sample design. The CV of this corrected distribution can be used to represent (CV|y).

In the past, a comparison of (CV|r) over time and between countries had resulted in a value of 0.2 (FAO, 2014). To take into account the change in the population structure by sex-age grouping, the dietary energy needs of each group and the corresponding population ratios (share of each group in the total population) are used as weights to estimate the (CV|r).

The asymmetry coefficient is estimated from household food consumption census data (if available and reliable). When there are no available household consumption data or the available data cannot be used to calculate household food consumption in terms of food energy (quantities consumed are not available or cannot be estimated), the lognormal distribution can be assumed, in which case the asymmetry coefficient is not used.

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