# Food Balance Sheets

## Introduction to Food Balance Sheets

# Outline

I. Basic identity and approach

II. Definitions of FBS components

III. Additional variables

IV. Supply Utilization Accounts (SUAs) and link with FBS

V. Balancing mechanisms

# Learning objective

At the end of this session, the participants will:

a) Know the historical background of the FBS framework

b) Understand the basic SUA/FBS equation

c) Be informed about some of the potential uses of FBS

d) Be aware of the major caution on FBS interpretation and of the fundamental principles of FBS construction



# Outline

1. History
2. Definition of SUA and FBS
3. Potential Uses
4. Caution in interpreting FBS estimates
5. Fundamental principles of FBS construction

# 1. History

- World War I: first attempts at preparing FBS
- 1936: preparation of a systematic international comparison of food consumption data (requested by the *League of Nations Mixed Committee on the Problem of Nutrition - Sub-Committee on Nutritional Statistics*)
- 1942-43: 1st intensive use of FBS to analyze the food security situation after the World War II
- 1948: FAO Conference encouraged governments to develop their own FBS with FAO assistance



# 1. History

- 1949: printing of the *Handbook for the Preparation of Food Balance Sheets*
  - FBS were published for 41 countries and since then it's regularly prepared and published
- 1957: for methodological reasons, it was decided to publish three-year average FBS (instead of annual)
- 1977: food balance sheets for 162 countries
  - table of per caput food supplies showed [cal., prot., fat] the supply by food groups of selected minerals and vitamins

# 1. History

- ≈ 2015: intensive focus of finalizing the revised FBS methodology.

  Same overall framework, but important innovations.

  Main changes:

  a) Updating the overall approach solve the balance (more refined)

  b) Updating/refining the imputation methods of the FBS components – harness links between the various FBS variables/elements and information from outside the FBS

     e.g. the new feed use imputation method (animal number, type of breeding…)

  c) More accuracy with the various variables

     e.g. other utilization → tourist food, other utilizations

  d) Less discretion of the compiler

  e) International classifications adopted (FCL replaced by CPC and HS)



# 2. Definition of SUA and FBS

The **FBS** is a national accounting/statistical framework, presenting a comprehensive picture of the pattern of a country's food supply during a specified reference period.

**SUPPLY = UTILIZATION**

*P + I - dSt = X + Fo + Fe + Se + T + IU + Lo + ROU + food processing*

**Where:**

P = production

*I = imports*

*dSt* = Δ stocks

*Fo = food*

*Fe = feed*

*Se= seed*

*T= tourist food*

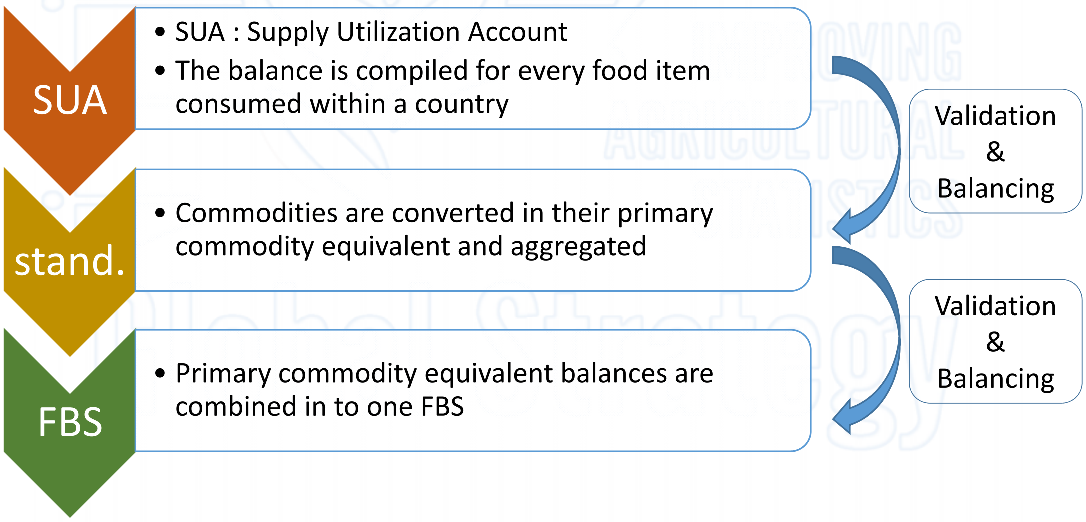
*IU= industrial Use*

*Lo= Loss*

*Rou= Residual or other uses*

# 2. Definition of SUA and FBS

**FBSs** are derived from the SUAs





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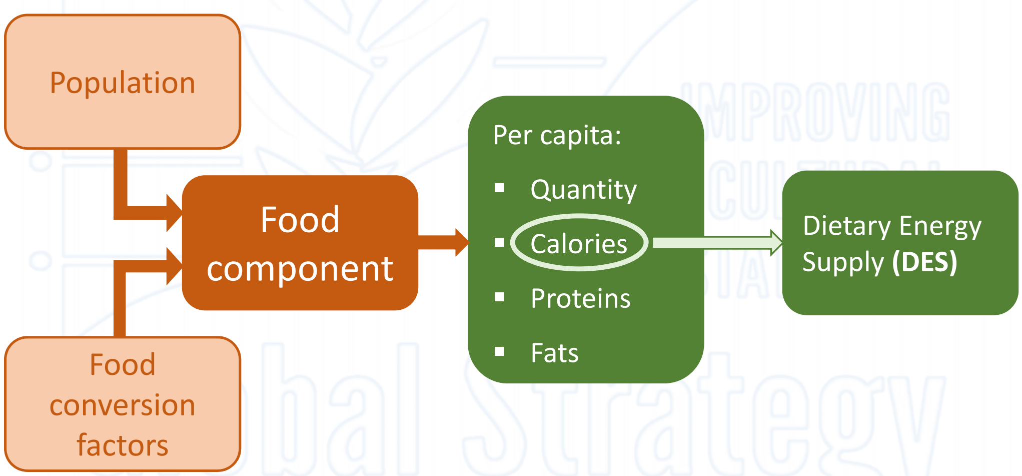
# 2. Definition of SUA and FBS





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# 2. Definition of SUA and FBS

**Côte d'Ivoire** — *2013* — **Bilans Alimentaires**

FILTRE | EXPORT EXCEL | PLEIN ECRAN — Population: 20316.0

| Produits | Offre interieure | | | | | Utilisation domestique | | | | | | Approvisionnements par habitant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1000 Tonnes | | | | | | | | | | | Total | | Protein | Fat |
| | Prod. | Impo. | Stock Var. | Exp. | Total | Food | Food Manu | Feed | Seed | Waste | Oth. Uses | Kg / Yr | KCal / Day | Gr / Day | Gr / Day |
| Population | | | | | | | | | | | | | | | |
| Total General | | | | | | | | | | | | | 2799 | 58.51 | 59.33 |
| Produits Vegetaux | | | | | | | | | | | | | 2685 | 44.84 | 53.67 |
| Produits Animaux | | | | | | | | | | | | | 114 | 13.67 | 5.66 |
| Céréales - Excl Bière | 2068 | 1526 | -480 | 178 | 2936 | 2249 | 75 | 209 | 67 | 332 | 5 | 110.68 | 971 | 22.41 | 5.32 |
| Blé | | 568 | -19 | 117 | 433 | 421 | 0 | | | 11 | 0 | 20.75 | 168 | 4.79 | 1.73 |
| Riz (Eq Blanchi) | 1290 | 892 | -462 | 44 | 1677 | 1291 | 25 | 133 | 28 | 198 | 0 | 63.56 | 577 | 11.69 | 1.23 |
| Orge | | 36 | 0 | 0 | 36 | 0 | 36 | | | | | 0 | 0 | 0 | |
| Maïs | 661 | 18 | 0 | 16 | 663 | 447 | | 67 | 36 | 109 | 5 | 21.99 | 191 | 5.04 | 2.06 |
| Seigle | | 0 | 0 | 0 | 0 | 0 | | | | | | 0 | 0 | 0 | 0 |
| Avoine | | 3 | | 0 | 3 | 3 | | | | | | 0.14 | 1 | 0.03 | 0.01 |
| Millet | 50 | 1 | 0 | 0 | 51 | 31 | 14 | | 1 | 6 | | 1.53 | 13 | 0.31 | 0.14 |
| Sorgho | 50 | 1 | 0 | 0 | 51 | 35 | | 9 | 2 | 6 | | 1.7 | 13 | 0.35 | 0.1 |



**Vietnam**
**Food Balance Sheet**
**2013**

Population ('000): **91,680**

| | DOMESTIC SUPPLY (1000 MT) | | | | | DOMESTIC UTILIZATION (1000 MT) | | | | | | PER CAPITA SUPPLY | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Prod. | Imports | Stock change | Exports | Total D.S. | Feed | Seed | Processed | Waste | Oth.Util. | Food | PER YEAR FOOD | PER DAY Calories | Proteins | Fats |
| Products | 1000 Metric Tons | | | | | | | | | | | Kg. | units | grams | grams |
| Grand total | | | | | | | | | | | | | 2883 | 64 | |
| Vegetable prod. | | | | | | | | | | | | | 2271 | 44 | |
| Animal prod. | | | | | | | | | | | | | 612 | 20 | |
| Cereals (excl. beer) | 34568 | 4618 | -3102 | 3834 | 32250 | 27490 | 562 | 6688 | 3105 | 1481 | 17892 | 195 | 1822 | 37 | |
| Wheat | 0 | 1957 | 0 | 32 | 1925 | 800 | 0 | -16 | 30 | 0 | 1111 | 12 | 92 | 3 | |
| Maize | 5191 | 2626 | 0 | 3 | 7814 | 5500 | 35 | -6 | 372 | 0 | 1913 | 21 | 171 | 4 | |
| Rice (Milled Eq.) | 29375 | 5 | -3102 | 3798 | 22479 | 21189 | 527 | 6681 | 2703 | 1481 | 14868 | 162 | 1560 | 30 | |
| Barley | 0 | 30 | 0 | 0 | 29 | 1 | 0 | 28 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Rye | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Oats | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Millet | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | |
| Sorghum | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Cereals, other | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Starchy roots | 11429 | 87 | 1143 | 4828 | 7831 | 5684 | 18 | 0 | 576 | 0 | 1554 | 17 | 45 | 1 | |
| Cassava | 9758 | 0 | 1143 | 4827 | 6073 | 4844 | 0 | 0 | 488 | 0 | 742 | 8 | 24 | 0 | |
| Potatoes | 313 | 87 | 0 | 0 | 400 | 0 | 18 | 0 | 20 | 0 | 362 | 4 | 8 | 0 | |
| Sweet Potatoes | 1358 | 0 | 0 | 0 | 1358 | 840 | 0 | 0 | 68 | 0 | 450 | 5 | 13 | 0 | |
| Yams | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Roots, other | - | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Sugar crops | 20131 | 0 | 0 | 0 | 20131 | 0 | 621 | 18504 | 0 | 0 | 1007 | 11 | 8 | 0 | |
| Sugar cane | 20131 | 0 | 0 | 0 | 20131 | 0 | 621 | 18504 | 0 | 0 | 1007 | 11 | 8 | 0 | |
| Sugar beet | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Sugar & Sweeteners | 1780 | 149 | 0 | 92 | 1838 | 0 | 0 | -57 | 0 | 0 | 1895 | 21 | 200 | 0 | |

# 2. Definition of SUA and FBS

The SUA/FBS is an analytical dataset that :

- shows the sources of supply and its utilization for each food item;
- provides the availability for human consumption;
- shows the changes in the types of food consumed.



# 2. Definition of SUA and FBS

The two pillars of the SUA/FBS:

1. Production data (Annual production Questionnaire)
2. Trade data (COMTRADE)

Link on the FAOSTAT webpage:
http://www.fao.org/faostat/en/#home

# 3. Potential Uses

- **Basis for policy analysis aimed at ensuring food security:**
  - o Estimate the food shortages/surpluses
  - o Estimate the amount of food aid
  - o Estimate a country's overall DES and macronutrient availability (proxy of food consumption)
  - o Determine the availability of a certain class of food
  - o Analyze livestock policies (e.g. the degree to which primary food resources are used to produce animal feed)



# 3. Potential Uses

- **Calculation of derived indicators:**
  - o Prevalence of Undernourishment (PoU)
  - o Self-sufficiency ratio (SSR)

$$SSR = \frac{\text{Production}}{\text{Production + Imports – Exports + } \Delta \text{ Stock}}$$

  - o Import dependency ratio (IDR)

$$IDR = \frac{\text{Imports}}{\text{Production + Imports -Exports + } \Delta \text{ Stock}}$$

# 3. Potential Uses

- **Statistical proposes:**
  - o Framework for data reconciliation (≠ sources)
  - o Harmonization of data collection efforts
  - o Data validation (supply and demand picture) - validate the national statistics
  - o Improve National Account estimates (through the agricultural production measurement/estimation)



# 3. Potential Uses

- o Means of comparing food availability (from FBS) and food consumption (from HH surveys)

e.g. to cross-check the data on food consumption (and *vice versa*)

e.g. as a proxy of food consumption in the absence of data.

# 3. Potential Uses

- Other potential uses:
  - Benchmarking (compare food availability across countries)
  - Comparing food availability over time
  - Track changes in dietary composition & growth of consumption in new products
  - Determine how prices affect food availability
  - Link to two SDG indicators (2.1.1 & 12.3.1)



# 4. Caution in interpreting FBS estimates

- " Food availability", not "food consumption"
  - DES is likely to overestimate the amount of food actually consumed
- FBS food availability takes into accounts all consumption within a country (HH, schools, hospitals….)
- Average of food/nutrient availability (distribution among different groups of people is not considered)

# 4. Caution in interpreting FBS estimates

Commodity Balances ≠ FBS

- FBS : only food-related commodities (e.g. rubber is not included)
- FBS : the quantity estimates of food must be reported in their caloric equivalent
- FBS : contains aggregated estimates of both a primary commodity *and* all of its derived products (expressed at the primary commodity equivalent level)
  - many countries produce commodity balances for primary products, but do not account for goods derived from those primary products → underestimate total consumption



IMPROVING AGRICULTURAL & RURAL STATISTICS
Global Strategy

# Food Balance Sheets

## Methodological framework

# Learning objectives

a) At the end of this session, the participants will:

b) Know all the relevant concepts involved in compiling FBS

c) Be able to understand the difference between supply utilization accounts (SUA) and Food Balance Sheets (FBS)

d) Understand how commodity trees link SUA back to the primary commodity equivalent-level FBS

e) Know the recommended balancing mechanism and their alternatives



# I. The basic identity and approach

# I.1. The basic identities

- FBS are built on the two basic premises:
  - Sum of all aspects in the supply of a given product = sum of utilizations for that product
  - It is compiled for a given country in a given year

- Two different basic identities:
  - Total domestic supply = Total domestic demand
  - Total supply = Total demand



# I.1. The basic identities

Domestic supply = Domestic utilization

$$OS_t + P + I - X = F_o + F_e + S_e + T + IU + L_o + ROU + CS_t$$

Total supply = Total utilization

$$OS_t + P + I = X + F_o + F_e + S_e + T + IU + L_o + ROU + CS_t$$

$OS_t$= opening stocks, *P* = production, *I* = imports, *X* = exports, $F_o$ = food, $F_e$ = feed, $S_e$ = seed, *T* = tourist food, *IU* = industrial use, $L_o$ = Loss, *ROU* = residual other use, and $CS_t$ = closing stocks

**Food processing could be including in the utilization part of the equation but this variable is typically dropped in the final stages of FBS compilation**

# I.1. The basic identities

| Supply (t) | Utilization (t) |
|---|---|
| opening stocks<br>production<br>imports | exports<br>feed<br>seed<br>loss<br>processing<br>food<br>industrial use<br>other utilization<br>closing stocks<br>tourist food |
| Total supply | Total utilization |

| Supply (t) | Utilization (t) |
|---|---|
| opening stocks<br>production<br>imports - exports | feed<br>seed<br>loss<br>processing<br>food<br>industrial use<br>other utilization<br>closing stocks<br>tourist food |
| Domestic supply | Domestic utilization |



# I.2. Recommended approach

- Many countries do not collect data on stock levels for the majority of products
- For this reason
  - supply = utilization identity is often expressed using some **estimate of the change in stock levels** during the reference period

# I.2. Recommended approach

Domestic supply = Domestic utilization

$$P + I - X - dS_t = F_o + F_e + S_e + T + IU + L_o + ROU$$

Total supply = Total utilization

$$P + I - dS_t = X + F_o + F_e + S_e + T + IU + L_o + ROU$$

Where $dS_t = CS_t - OS_t$



# II. Definitions of FBS approach

# II.1. Supply and use variables: Introduction

- Exact definition of the concepts is warranted
- Countries should try to adhere to the guideline's definitions where possible
- Example of not adherent definitions:

  ➡ Underestimation of the supply of some products when reporting only commercial production



# II.2. Supply and use variables: Production

- Data for production should include:
  - all production quantities of a given commodity within the country
  - both commercial and non-commercial production
- Production of primary products:
  - reported at the farm gate level (so it does not include harvest losses)
    - It should include: any post-harvest on-farm loss occurring during the different farm operations, such as threshing, cleaning/winnowing or storage
- Data for meat production:
  - both commercial and farm slaughter
  - production should be expressed in terms of carcass weight

# II.2. Supply and use variables: Production

- Production of derived or processed commodities:
  - refers to the total output of the product after transformation
  - may occur either at the household or at a commercial establishment

- The standard unit for the reporting of agricultural production is metric tonnes (MT)
  - But many countries also use local units



# II.3. Supply and use variables: Imports and exports

- Imports
  - transboundary flows of goods destined for a given final destination country that add to the total supply of goods available in that country

- Exports
  - transboundary flows of goods from a given country of origin that take away from the total availability of goods in that country

Goods that come in and exit a given country without having undergone any type of transformation are therefore excluded from these definitions. These exits are categorized as re-exports

# II.4. Supply and use variables: Stocks

- Stocks
  - aggregate total of product allocated to storage for use at some future point in time.
  - can be held by a variety of actors (governments, manufacturers, importers, exporters, resale or wholesale merchants, farmers)

- Two ways for accounting stocks:
  - stock levels at both the beginning and end of the period
  - estimating the change in stocks from one time period to the next (as a component of supply)



# II.5. Supply and use variables: Food availability

- Food availability
  - quantity of an edible product that is available for human consumption during a given reference period

- Include:
  1) amount of food that is available for consumption at the retail level
  2) food consumed in restaurants and institutions (hospitals, schools, military bases, prisons, etc.)
  3) may include non-edible parts (the calorie conversions applied should take this fact into account)

# II.5. Supply and use variables: Food availability

- Waste (and/or loss) that occurs at the retail or consumer levels is not included in this quantity
- The quantities reported represent those available for food (typically higher than quantities reported through household-level surveys)



# II.6. Supply and use variables: Food processing

- Definition of Food Processing:
  - quantities of an edible product that are directed toward a manufacturing process and are then transformed into a different edible commodity with a separate entry in the food balance sheet
- Food processing commodities:
  - might be structured within the same commodity tree or food group (e.g., tomatoes that are processed into tomato paste)
  - Or they could be completely separate

Example: barley is processed into beer, which typically is aggregated into an alcoholic beverages category and not into the barley balance

# II.6. Supply and use variables: Food processing

- The food processing variable should disappear in the final stages of FBS compilation to avoid double-counting

- The food processing variable should remain in the final account

- Quantities devoted to the manufacture of non-edible products (such as soap or biofuels):
  - accounted for under *industrial use* and not *food processing*



# II.7. Supply and use variables: Feed

- Feed
  - Quantities of commodities—both domestically produced and imported—that are available for feeding to livestock
  - Mainly products of industrial process (oilcake, dregs, or distiller's dried grains with solubles)
  - Included in initial calculations but most will not be aggregated up to the primary commodity level in order to avoid double counting

# II.8. Supply and use variables: Seed

- Seed
  - ➢ any quantity of a commodity set aside for reproductive purposes in the following year
  - ➢ seed for sowing, plants for transplanting, eggs for hatching, and fish used as bait
  - ➢ double or successive sowing should be also take into account

- Must be non-zero if production (area harvested) in *t+1* is nonzero

- Strongly correlated with production (area harvested) in *t+1*



# II.9. Supply and use variables: Tourist food

- tourist food
  - ➢ food that is consumed by non-resident visitors to a given country during the course of their stay
  - ➢ expressed in net terms: consumption of incoming tourists minus consumption of residents as tourists in other countries

- Countries with negligible numbers of visitors may choose not to estimate tourist food

- Example of small island states
  - ➢ accounting for tourist food is essential to accurately estimating local consumption patterns.

# II.10. Supply and use variables: Industrial use

- Industrial use
  - Any quantity of a given product used in some non-food transformation or manufacturing process
  - Includes biofuels, cosmetics, detergents, or paints



# II.11. Supply and use variables: Loss

- Loss
  - any quantity of a product that leaves the supply chain and is not diverted to other uses
  - result from an involuntary activity
  - can occur at any node of the supply chain after the harvest and up to (but excluding) the retail/consumption stage
  - Include both edible and non-edible parts
  - can also be referred to as *post-harvest* or *post-slaughter* losses

- Don't include any quantities of food wasted or lost at the consumer or retail level

# II.11. Supply and use variables: Loss

- Volume of product lost in the transformation of primary products into processed products is accounted
  - Taken into account in extraction rates and conversion factors

- Loss that occur in all other utilizations (particularly during storage and transportation) are included



# II.12. Supply and use variables: Residual and other uses

- Residual and other uses:
  - any uses other than those described above
  - more appropriately defined by what it is not rather than what it is

- Utilize this category to capture small amounts of product use that are otherwise unaccounted for

Example: for countries with negligible numbers of tourists, tourist food could be included under this residual category

# III. Additional variables



# III.1. Additional variables

Additional variables are needed for the estimates of per capita nutrient availability

- Population (UNPD)
  - Population in a country, area or region as of 1 July of the year indicated
- Nutrient Estimates
  - Estimates derived from the final food estimates in the balance sheet for each product by applying certain conversion factors to those quantities

# III.3. Additional variables: Nutrient estimates

- Nutrient conversion tables:

(http://www.fao.org/fileadmin/templates/ess/ess_test_folder/Food_security/Excel_sheets/Nutritive_Factors.xls)

- ➢ Food: total calorie equivalent
- ➢ Calories per capita per day
- ➢ Food: total protein equivalent
- ➢ Proteins per capita per day
- ➢ Food: total fat equivalent
- ➢ Fats per capita per day



# III.4. Additional variables: Activity and productivity variables

Compilers should also collect data on other relevant variables that could be necessary for:

1. The imputation of missing values
2. Validation of main production variables

| Activity variables | Productivity variables |
| --- | --- |
| • Crops: area sown, area harvested<br>• Livestock: number of animals | • Crops: Yield in MT/HA<br>• Livestock: carcass weight and take-off |

# III.5. Additional variables: Extraction rates

- *Extraction rates* (an element of **technical conversion factors**)
  - parameters that reflect the loss in weight in the conversion (or processing) of one product into another

- Expressed as a percentage

$$Extraction\ rate = \frac{Quantity\ of\ output}{Quantity\ of\ input}$$

- Example:
  - To produce 65 MT of rice, 100 MT of paddy are needed: the extraction rate is 65 percent.



# III.5. Additional variables: Extraction rates

- Key components of FBS
  - calculation the production of processed products from primary ones
  - conversion of derived product quantities back up to primary product equivalent

- Several output products may be produced from a single transformation process of one input good

- The cumulative extraction rate is less than 100 percent

- Example of maize flour
  - transformation process: production of flour, maize bran and maize germ

# III.6. Additional variables: Processing shares

- Percentages of the amount of a given commodity sent to processing

- Necessary for FBS
  - ➢ goods can be processed into an array of derived products
  - ➢ the input used for the production of these derived goods is seldom known with certainty

- Processing shares + extraction rates ⟶ estimate of the production of derived goods when very little information exists



# IV. Supply Utilization Accounts (SUAs) and link with FBS through standardization using commodity trees

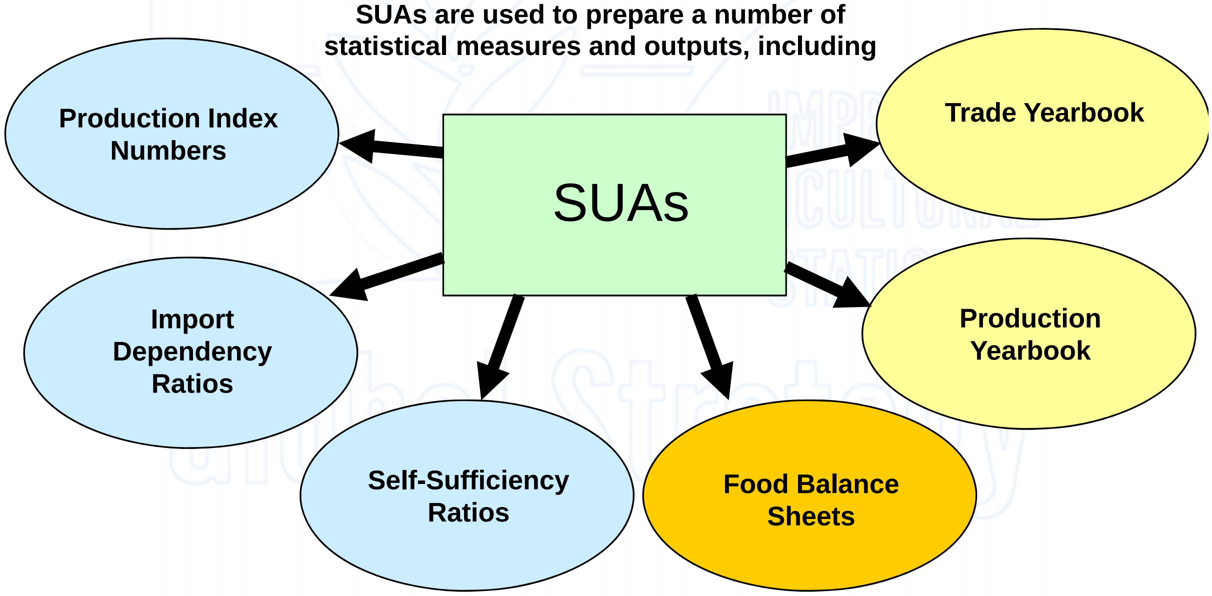
# IV.1. Supply Utilization Accounts (SUAs)

| FBS | SUA |
| --- | --- |
| ➢ Publish at the primary commodity equivalent level<br><br>➢ Doesn't provide a holistic picture on how the commodity is being consumed, traded, or otherwise used after being processed into various derived products | ➢ The accounting balances for individual products are called Supply Utilization Accounts (SUAs)<br><br>➢ Supply and demand occurring for each products, both primary and derived |



# IV.1. Supply Utilization Accounts (SUAs)

**SUAs are used to prepare a number of statistical measures and outputs, including**



# IV.1. Supply Utilization Accounts (SUAs)

- Example of a sample blank SUA table for Soyabeans:

| Product | Production | Imports | Exports | Stock change | Food | Food processing | Feed | Seed | Net Tourist Cons. | Industrial Use | Loss |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Soybeans | - | - | - | - | - | - | - | - | - | - | - |
| Oil of soybeans | - | - | - | - | - | - | - | - | - | - | - |
| Cake of soybeans | - | - | - | - | - | - | - | - | - | - | - |
| Soy sauce | - | - | - | - | - | - | - | - | - | - | - |
| Margarine & shortening | - | - | - | - | - | - | - | - | - | - | - |
| Hydrogenated oils and fats | - | - | - | - | - | - | - | - | - | - | - |



# IV.1. Supply Utilization Accounts (SUAs)

- SUAs can include several different levels of processing

## Example

Soybean :

- ➢ processed into soybean oil and cake, or processed into soy sauce

Soybean oil

- ➢ processed into margarine/shortening or hydrogenated oils and fats

- Each of these subsequent processing levels is linked back to the previous level through an extraction rate

# IV.1. Supply Utilization Accounts (SUAs)

- The accounts cannot simply be added together to arrive at one primary equivalent balance
  - Balances are elaborated by weight in MT of primary commodity-equivalents
  - One MT of a derived product is not equivalent to one MT of the primary commodity
- Example of a hypothetical customer who is interested in buying a large quantity of orange juice
  - Company X sells both fresh oranges and orange juice
  - They offer to sell the customer either 100 MT of fresh oranges or 100 MT of orange juice for the same price



# IV.1. Supply Utilization Accounts (SUAs)

- Company X offers to process the fresh oranges into juice free of charge at an extraction rate of 55 percent (that is, 0.55 MT of juice output per 1 MT of fresh orange input).
- FBS compilers will recognize that the customer should most definitely choose the juice instead of the fresh oranges
  - because 100 MT of fresh oranges will only yield around 55 MT of juice after processing
- This calculation can be done by:

$$Quantity\ of\ output = Quantity\ of\ input * Extraction\ rate$$

$$Quantity\ of\ output = 100\text{ MT fresh orange} * \frac{0.55\text{ MT orange juice}}{1\text{ MT fresh orange}}$$

$$Quantity\ of\ output = 55\text{ MT orange juice}$$

# IV.1. Supply Utilization Accounts (SUAs)

- Non-equivalence between 100 MT of orange juice and 100 MT of oranges can also be seen by working backward from the amount of juice.

- In order to produce 100 MT of orange juice, about 182 MT of fresh oranges would be needed as input.

$$Quantity\ of\ input = \frac{Quantity\ of\ output}{Extraction\ rate}$$

$$Quantity\ of\ input = \frac{100\ \text{MT orange juice}}{\frac{0.55\ \text{MT orange juice}}{1\ \text{MT fresh orange}}}$$

$$Quantity\ of\ input = 182\ \text{MT fresh orange}$$



# IV.1. Supply Utilization Accounts (SUAs)

- Steps:
  1) Derived products converted back to their "primary commodity equivalent"
  2) All of the primary commodity equivalents can be added together to arrive at one overall balance

- Derived products can be converted back to their primary commodity equivalents simply by dividing by the extraction rate (as in the example)

# IV.1. Supply Utilization Accounts (SUAs)

- This process of converting derived products to a primary equivalent so that they can be added up is called "vertical standardization."
- FBS for primary equivalent products are created by standardizing and adding up individual SUAs for derived products

$$\textit{Primary commodity equivalent} = \frac{\textit{Quantity of derived product}}{\textit{Extraction rate}}$$



# IV.1. Supply Utilization Accounts (SUAs)

- This linking of primary to derived commodities using extraction rates is fundamental to the FBS compilation process.
- Simple to understand if there is only one derived good.
- Most food manufacturing commodities produce multiple outputs
  - Even possible for those outputs to undergo further transformation into second-tier derived goods.
- "Commodity trees" to better conceptualize and organize the compilation of FBS

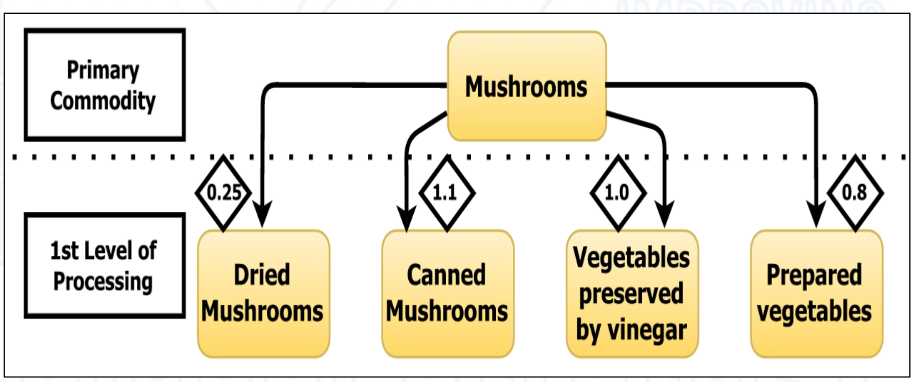
# IV.2. Commodity trees

- Commodity trees
  - "stem" from one primary product and then branch out into one or successive levels of processed products
  - each level linked by extraction rates
- Designed to be exhaustive, such that all processing uses of a particular commodity are covered



# IV.2. Commodity trees

Example of mushroom commodity tree



# IV.2. Commodity trees

- The transformation processes for many derived products commonly have two (or even three) outputs.

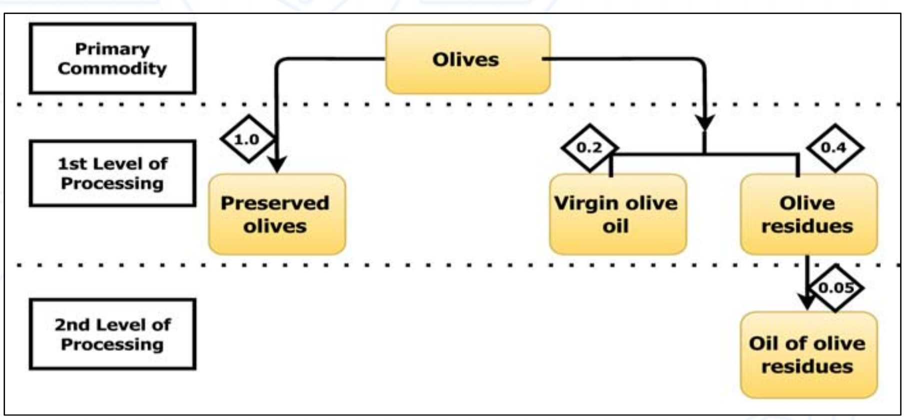
- Multiple products that are produced from a single transformation process are called **co-products**

- Co-products commonly produced in:
  - ➢ milling of cereals (flour milling also produces bran)
  - ➢ oilseed crushing (where both oil and cake are produced), among others



# IV.2. Commodity trees

- Example of olive commodity tree



# IV.2. Commodity trees

- The tree structures for nearly all commodities that undergo processing are available on FAO's website (http://www.fao.org/fileadmin/templates/ess/documents/methodology/tcf.pdf)
- Countries are encouraged to review those trees and update them as necessary for their purposes.
  - country-specific extraction rates should be added.
- Extraction rates of neighboring countries in absence of extraction rate estimates for the country



# IV.3. Processing shares

- Processing share:
  - percentage of the amount of a given commodity sent to processing that is thought to be dedicated to a specific transformation process
- Used to calculate the amount of input used for a given transformation process, as below

$$Q\ Input\ for\ B = Q\ of\ A\ sent\ to\ processing * B's\ Processing\ share$$

# IV.3. Processing shares

- Key points to keep in mind:

  - for co-products (that is, two or more products that are outputs of the same transformation process of a single input good), their processing shares will be identical.

  - the processing shares must sum to 100
    - all of the higher-level good sent to processing is, by definition, transformed into some other good.



# IV.4. Example

- Using just the first level of processing in the olive commodity tree described above, consider the following example

- FBS compilers in Country A know that olives are processed domestically into both preserved olives and virgin olive oil

- Although the FBS compilers know that the amount of olives sent to processing is 150,000 MT (as olives are not consumed fresh, all olives produced, net of trade, will be sent to processing), but they do not know exactly what quantities are directed to each of the different transformation processes

- By using value chain studies and consulting with market experts, the compilers learn that only a small fraction of olives are processed into preserved olives—around 10 percent, indicating that 90 percent of olives are milled for olive oil

# IV.4. Example

Calculation of processing input for derived olive goods using processing shares

| | | Olives | Preserved olives | Virgin olive oil | Olive residues |
|---|---|---|---|---|---|
| A | Amount Processed | 150,000 | | | |
| B | Processing Share | | 10% | 90% | 90% |
| C | Amount of Input | | 15,000 | 135,000 | 135,000 |

Calculation of production of derived goods using inputs and extraction rates

| | | Olives | Preserved olives | Virgin olive oil | Olive residues |
|---|---|---|---|---|---|
| A | Amount Processed | 150,000 | | | |
| B | Processing Share | | 10% | 90% | 90% |
| C | Amount of Input | | 15,000 | 135,000 | 135,000 |
| D | Extraction Rate | | 100% | 20% | 40% |
| E | Production | | 15,000 | 27,000 | 54,000 |



# V. The balancing mechanisms

# V.1. The balancing mechanism: Introduction

- Main objective of balancing: supply = utilization
- Balancing the equation in practice is not so straightforward, for many reasons
- Reason 1: limited number of cases in which countries measure all the supply and demand variables
  - Most of the time, supply-side variables are measured, while more of the demand-side variables are imputed or estimated
  - If all of the demand side variables were to be estimated in order to balance out the supply side
    - affect the accuracy and potentially increasing the uncertainty or volatility of demand-side estimates



# V.1. The balancing mechanism: Introduction

- Reason 2: in the rare cases where all supply and demand variables are measured independently, it is not likely that the point estimates alone would lead to a precisely-balanced supply and demand equation
  - discrepancies in data sources
  - data collection and compilation methods
  - reference periods and measurement errors occurring at any if these stages

# V.1. The balancing mechanism: Introduction

- Historic approach:
  - ➢ assign one element of the equation as the balancing item
  - ➢ Variable used for balancing vary but feed or food are commonly used
  - ➢ most appropriate method when all of the variables are measured *except* for the balancing item
- As an example, in their balance sheets for coarse grains, USDA estimates "feed and residual" use as the balancer to the equation.



# V.1. The balancing mechanism: Introduction

Drawbacks of this approach

- ➢ in most countries, few of the utilization variables are measured, such that the supply = utilization equation will actually have more than one unknown
- ➢ estimates for the balancing item could fluctuate wildly from year to year
- ➢ if the errors are biased, those annual errors accumulate, and it may become difficult to distinguish from the error itself
- ➢ the choice of variable to use as the balancer can be problematic

# V.1. The balancing mechanism: Introduction

- Preferred approach
  - not only acknowledges measurement error
  - but also seeks to use these errors of individual variables to help balancing the overall identity

- Specifying each of the variables as a range of possible values according to their measurement errors

$$P^* + I^* - dSt^* = X^* + Fo^* + Fe^* + Se^* + T^* + IU^* + Lo^* + ROU^*$$

where $variable^*$=variable + e (variable)

e (variable) is the measurement error of the variable



# V.1. The balancing mechanism: Introduction

- Several approaches to this imbalance distribution are offered but they all follow three basic steps:

Step 1. After estimation of all elements, calculate the imbalance from the supply = utilization identity, where the imbalance for a given commodity in the country in question, *Imb*, is defined as:

$$\boldsymbol{Imb = P + I - dSt - X - Fo - Fe - Se - T - IU - Lo - ROU}$$

It is important to note that in this step, the imbalance is calculated from the variable point estimates

# V.1. The balancing mechanism: Introduction

- Step 2. Distribute the imbalance throughout the supply = utilization identity:

  - Can be more or less complicated or computationally demanding, and it is here that the methodological approaches of countries may differ

  - The optimal approach will consider all of the information contained within the underlying variable estimates

  - The direction of adjustments in the point estimates will depend upon the sign on the imbalance calculated in Step 1



# V.1. The balancing mechanism: Introduction

- Step 3. Check that all balanced quantities are within any set bounded values, and rebalance if necessary:

  - The balancing process will produce results where certain balanced quantities are estimated outside of bounded (or likely) values

  - This problem is resolved by:
    - setting the value in question at the boundary level
    - assigning that value a zero standard deviation (so, a fixed, “balanced” value)
    - repeating Steps 1 and 2 in order to redistribute the imbalance

# V.2. The recommended balancing mechanism: distribute imbalance proportionally based on aggregate error

## Recommended approach for imbalance distribution:

- Step 1: Use measurement error percentages and point estimates to quantify the error of each variable
- Step 2: Sum up the individual errors of each variable to calculate an aggregated error for the equation
- Step 3: Calculate the proportion of the aggregated error for each of the elements
- Step 4: Distribute the imbalance proportionally
- Step 5: Ensure that any constraints are met, and recalculate if necessary



# V.2. The recommended balancing mechanism: Example

FBS compilers in Country Z have produced the following unbalanced supply and utilization table for sorghum in their country (for the purposes of this illustration, sorghum is not consumed or processed in Country Z, but is mostly destined for feed).

Note the point estimates on Line A and the measurement errors on Line C

| Line | Product | Production (1) | Imports (2) | Exports (3) | Feed (4) | Seed (5) | Loss (6) | |
|---|---|---|---|---|---|---|---|---|
| A | Sorghum | 892 | 307 | 48 | 1061 | 3 | 44 | |
| B | Imbalance for A [A=A1+A2-A3-A4-A5-A6] | | | | | | | 43 |
| C | Measurement error (in %) | 15.0% | 0.0% | 0.0% | 40.0% | 15.0% | 15.0% | |

# V.2. The recommended balancing mechanism: Example

Step 1: Unbalanced sorghum table with quantified error

| Line | Product | Production (1) | Imports (2) | Exports (3) | Feed (4) | Seed (5) | Loss (6) | |
|---|---|---|---|---|---|---|---|---|
| A | Sorghum | 892 | 307 | 48 | 1061 | 3 | 44 | |
| B | Imbalance for A [A=A1+A2-A3-A4-A5-A6] | | | | | | | 43 |
| C | Measurement error (in %) | 15.0% | 0.0% | 0.0% | 40.0% | 15.0% | 15.0% | |
| D | Error [D=A*C] | 133.8 | 0 | 0 | 424.4 | 0.5 | 6.6 | |

Step 2: Sum individual variable errors to calculate aggregated error

| Line | Product | Production (1) | Imports (2) | Exports (3) | Feed (4) | Seed (5) | Loss (6) | |
|---|---|---|---|---|---|---|---|---|
| A | Sorghum | 892 | 307 | 48 | 1061 | 3 | 44 | |
| B | Imbalance for A [A=A1+A2-A3-A4-A5-A6] | | | | | | | 43 |
| C | Measurement error (in %) | 15.0% | 0.0% | 0.0% | 40.0% | 15.0% | 15.0% | |
| D | Error [D=A*C] | 133.8 | 0 | 0 | 424.4 | 0.5 | 6.6 | |
| E | Aggregated error [E=D1+D2+D3+D4+D5+D6] | | | | | | | 565.3 |



# V.2. The recommended balancing mechanism: Example

Step 3: Calculate proportion of aggregated error for each individual variable

| Line | Product | Production (1) | Imports (2) | Exports (3) | Feed (4) | Seed (5) | Loss (6) | |
|---|---|---|---|---|---|---|---|---|
| A | Sorghum | 892 | 307 | 48 | 1061 | 3 | 44 | |
| B | Imbalance for A [A=A1+A2-A3-A4-A5-A6] | | | | | | | 43 |
| C | Measurement error (in %) | 15.0% | 0.0% | 0.0% | 40.0% | 15.0% | 15.0% | |
| D | Error [D=A*C] | 133.8 | 0 | 0 | 424.4 | 0.5 | 6.6 | |
| E | Aggregated error [E=D1+D2+D3+D4+D5+D6] | | | | | | | 565.3 |
| F | Proportion of aggregated error [F=D/E] | 23.7% | 0.0% | 0.0% | 75.1% | 0.1% | 1.2% | |

# V.2. The recommended balancing mechanism: Example

## Step 4: Distribute the imbalance proportionally

| Line | Product | Production (1) | Imports (2) | Exports (3) | Feed (4) | Seed (5) | Loss (6) | |
|---|---|---|---|---|---|---|---|---|
| A | Sorghum | 892 | 307 | 48 | 1061 | 3 | 44 | |
| B | Imbalance for A [A=A1+A2-A3-A4-A5-A6] | | | | | | | 43 |
| C | Measurement error (in %) | 15.0% | 0.0% | 0.0% | 40.0% | 15.0% | 15.0% | |
| D | Error [D=A*C] | 133.8 | 0 | 0 | 424.4 | 0.5 | 6.6 | |
| E | Aggregated error [E=D1+D2+D3+D4+D5+D6] | | | | | | | 565.3 |
| F | Proportion of aggregated error [F=D/E] | 23.7% | 0.0% | 0.0% | 75.1% | 0.1% | 1.2% | |
| G | Adjustment [G=B*F] | 10.2 | 0.0 | 0.0 | 32.3 | 0.0 | 0.5 | |
| H | Sorghum adjusted values [for (1) and (2), H=A-G, for remaining, H=A+G] | 881.8 | 307.0 | 48.0 | 1093.3 | 3.0 | 44.5 | |
| I | Imbalance for H [I=H1+H2-H3-H4-H5-H6] | | | | | | | 0 |

- The final step in this method is to ensure that any constraints are met and recalculate if necessary



# V.3. Other balancing mechanism

## Assigning small, positive imbalances to a residual use category

- Could be utilized in cases where a positive imbalance is below an *a priori* threshold of less than 5 percent of total supply or total demand
- Should not be used for imbalances greater than a small threshold level
- Residual or other uses

# V.3. Other balancing mechanism

## Single balancer approach

- Not all variables are appropriate as balancers in the single balancer approach
- The degree of appropriateness may even differ from product to product



# V.4. Constraints on the balancing process

## Row constraints

- For each commodity supply must be equal to utilization
- As an extension of this row constraint, a country's exports of a given commodity cannot exceed their supply of that commodity
- Can be a useful way of either identifying errors in trade data

# V.4. Constraints on the balancing process

## Column constraints

- Constraints may need to be imposed on changes in quantities over time
- Compilers should note whether or not year-to-year changes are within the bounds of feasibility (single year constraints)
- Multiple-year column constraints should also be considered



# V.4. Constraints on the balancing process

## Imbalance exceeds aggregate measurement error

- Can result from much larger error in one of the point estimates than is indicated by the assigned measurement error
- It does indicate that the confidence intervals are set too conserve

# Conclusions of the $2^{nd}$ chapter

1. Food balance sheets:
   - based on an overall supply = utilization identity
   - accounts of primary and derived products are organized into commodity trees and linked by extraction rates

2. Individual supply utilization accounts of derived products are filled and balanced, then aggregated up to the primary commodity equivalent level

3. Accounts at the primary commodity equivalent level are then balanced

4. The recommended approach



# References


- Global Strategy to improve agricultural and rural statistics, 2017. *Handbook of Food Balance Sheet*., pp 22-44., Rome, Italy

- FAO, 2016. *Technical Conversion Factors for Agricultural Commodities,* Rome, Italy

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# Thank You