



Food and Agriculture Organization  
of the United Nations

# MASTER SAMPLING FRAME (MSF) FOR AGRICULTURAL STATISTICS

## Module 1 - Session 3:

### Using different frames to build and use a Master Sampling Frame

# Objectives of the presentation

- Discuss the types of master sampling frames and data sources
- Discuss the advantages and disadvantages of using an Area frame as an MSF
- Discuss the advantages and disadvantages of using an List frame as an MSF
- Discuss the advantages and disadvantages of using a Multiple frame as an MSF

# Outline

- 1) Type of master sampling frames and data sources
- 2) Using an Area frame as an MSF: Pros and Cons
- 3) Using a List frame as an MSF: Pros and Cons
- 4) Using a Multiple frame as an MSF: Pros and Cons



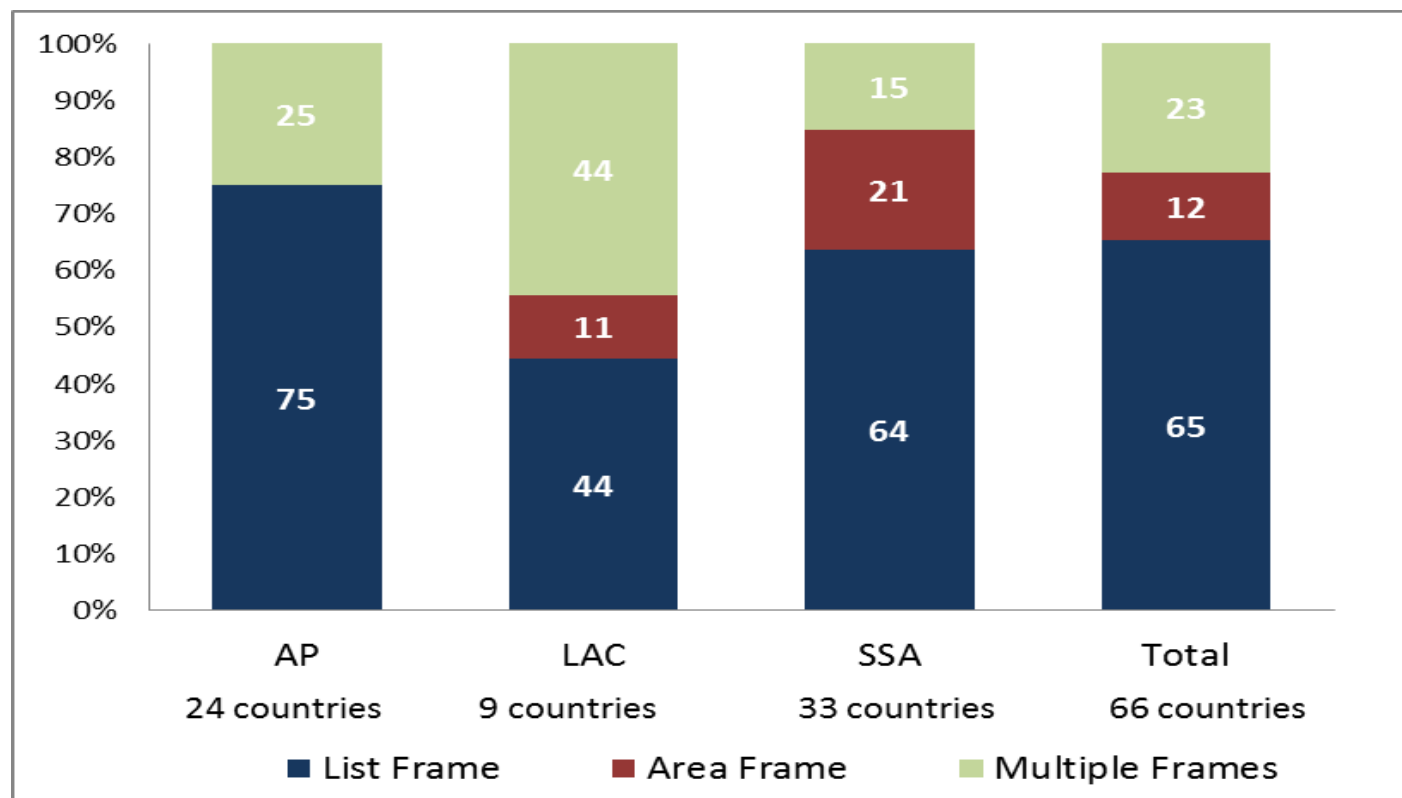
# Types of master sampling frames and data sources

# 1.1 Types of master sampling frames

## Three types of Master Sampling Frames:

1. List frame: Exhaustive list of units in the survey population
2. Area frame: Set of geographical unit which may be either points, transects or segments of land. Some examples:
  - Segments with Physical boundaries: a river, a sequence of mountain peaks, etc.
  - Regular grids
  - Points (unclustered)
  - Hierarchy of geographical unit. In this case the area frame units at one level can be subdivided to form the units at the next level: region and EA within a region or a department.
3. Multiple frame: Joint use of two or more area and/or list frames

# 1.2 Types of frames used per countries in different regions



Ref: AP: Asia-Pacific; LAC: Latin America and Caribbean; SSA: Sub-Saharan Africa.

# 1.2 Data Sources to build an MSF

- Examples of List frames used to build an MSF
  - List Frame (LF) based on population census data (e.g. *Population and Housing Census with an agricultural module*)
  - List frame based on an agricultural census
  - List frame based on business registers of farms
- Examples of Areas frames used to build an MSF
  - Geo-referenced population census or agricultural census enumeration areas (EA)
  - Land cover maps with boundary information and satellites images of the entire country
- Examples of Multiple frames used to build an MSF
  - All of the above

# 1.2 Data Sources to build an MSF

Frame type	Frame description	Unit component	Unit type example
1	List frame	Holding	Holder addresses
2	List frame	Cluster	Villages or Enumeration Areas
3	Area frame	Segment	Holding area
4	Area frame	Map grid (cluster)	Point
5	Area frame	Land area (cluster)	Physical boundaries
6	Area frame	Point	Area around the point



# 1.3 Country experiences in the Handbook

- **BRAZIL:** Use of list frame and area frame to build a Master Sampling Frame.
- **CHINA:** Use of area frame to build a master sampling frame.
- **ETHIOPIA:** Use of list frame and area frame to build a Master Sampling Frame.
- **EU MARS PROJECT:** Use of square segments to build an area frame for agricultural surveys.
- **EUROSTAT LAND USE AND COVER SURVEY (LUCAS):** Use of point frame to build an area frame for agricultural surveys
- **GUATEMALA:** Building an area sampling frame for agricultural surveys
- **LESOTHO:** Use of list frame to build a Master Sampling Frame
- **THE UNITED STATES:** Use of area frame for agricultural surveys

More details on these experiences and lessons learned in the *Handbook on Master Sampling Frames for Agricultural Statistics* (Global strategy, 2015) and *countries experiences* (Global strategy, 2017)



## Using an area frame as an MSF: pros and cons

## 2.1 What is an Area frame?

- An area frame is a set of land elements, which may be either points or segments of land, that geographically cover a target population (e.g. agricultural land)
- The sampling process may involve single or multiple stages. It consists in selecting segments or points of land and collect information directly on them (direct observations/measurements) and on the farming activities related to this land element (usually done through an interview with their holders)
- Rules of association are used to link the land in the segment or point to a farm that is also found on the list frame, usually using the name of the farm operator

## 2.2 Area frame: Advantages

- Complete coverage of the target population
- Remain stable over a long period of time with reduced maintenance cost
- Efficient sampling design can be adopted depending on survey variable and type of AF

## 2.2 Area frame: Advantages

- Possibility of collecting data through direct observation substantially eliminate some sources of bias relating to the reliability of farmers replies on cultivated area or yield
- When same points or segments are observed every year, AF allows the monitoring of land conditions and the inventory of natural resources
- Technological tools can be used to support AF building and surveys (aerial photographs, remote sensing and satellite images, GPS and GIS)

## 2.3 Area frame: Disadvantages

- Initial cost of building an AF may be high
- Area sampling frames are considered to have a major weakness for items that are not proportionately associated with cultivated land use, such as specialty or rare crops
- Sampling errors (respective to list frames) may be high for rare items
- The method is also considered to be less representative for small areas and for crops which are usually grown on small farms such as tobacco, vegetables, orchards and vineyards.

## 2.3 Area frame: Disadvantages

- Difficulty in localizing the selected segments
- Deficiencies in roads and paths, making it difficult to access selected segments in several cases
- Difficulty on localizing respondents; difficulty in determining the existence of the household/headquarters

## 2.3 Area frame: Disadvantages

- Other practical issues such as farmers living far away from holdings, deciding if the farm should be included in a segment or not in case of close segment...
- Some variables like livestock may raise challenges when using AF, the same for large farms
- When points are used, linking points to farmers may be challenging



## 2.4 Area frame: Examples of issues

- Difficult to survey farms with livestock that use common pastures – in particular **nomadic livestock**
- The exclusion from the sampling process of strata labelled as **purely non-agricultural**
- **Extended segment:** when a segment is sampled, the observation unit is defined considering the full parcels for all plots that intersect the square segment
- The overestimation is obvious when an expansion factor of the type  $(N/n)$  is used

# Illustration of extended segment



# Discussions



## Using a list frame as an MSF: pros and cons

# 3.1 What is a List frame?

- List frame is a list of all those within a population who can be sampled, and may include individuals, households, institutions...
- In agricultural statistics, list frames are lists of farms and/or households obtained from agricultural or population censuses and/or administrative data.
- The ultimate sampling units are lists of names of holders or agricultural households (Global Strategy, 2015).
- Typically, the sampling unit from the list frame is a name of a farm operator, while the reporting unit is the holding operated by the name.

# 3.1 What is a List frame?

- Combination of list frames is used to cover the holdings in both the household and the non-household sectors.
- The main strategies proposed include:
  - List frame based on the population census;
  - List frame based on the agricultural census;
  - List frame based on the business register of farms;

## 3.2 List frame: Advantages

- Easy to use
- Enable in-depth analysis of alternative sampling designs
- Their use in sampling is usually cheaper than building area frames
- A great advantage of list frames lies in the existence of ancillary information for improving sampling designs and estimators

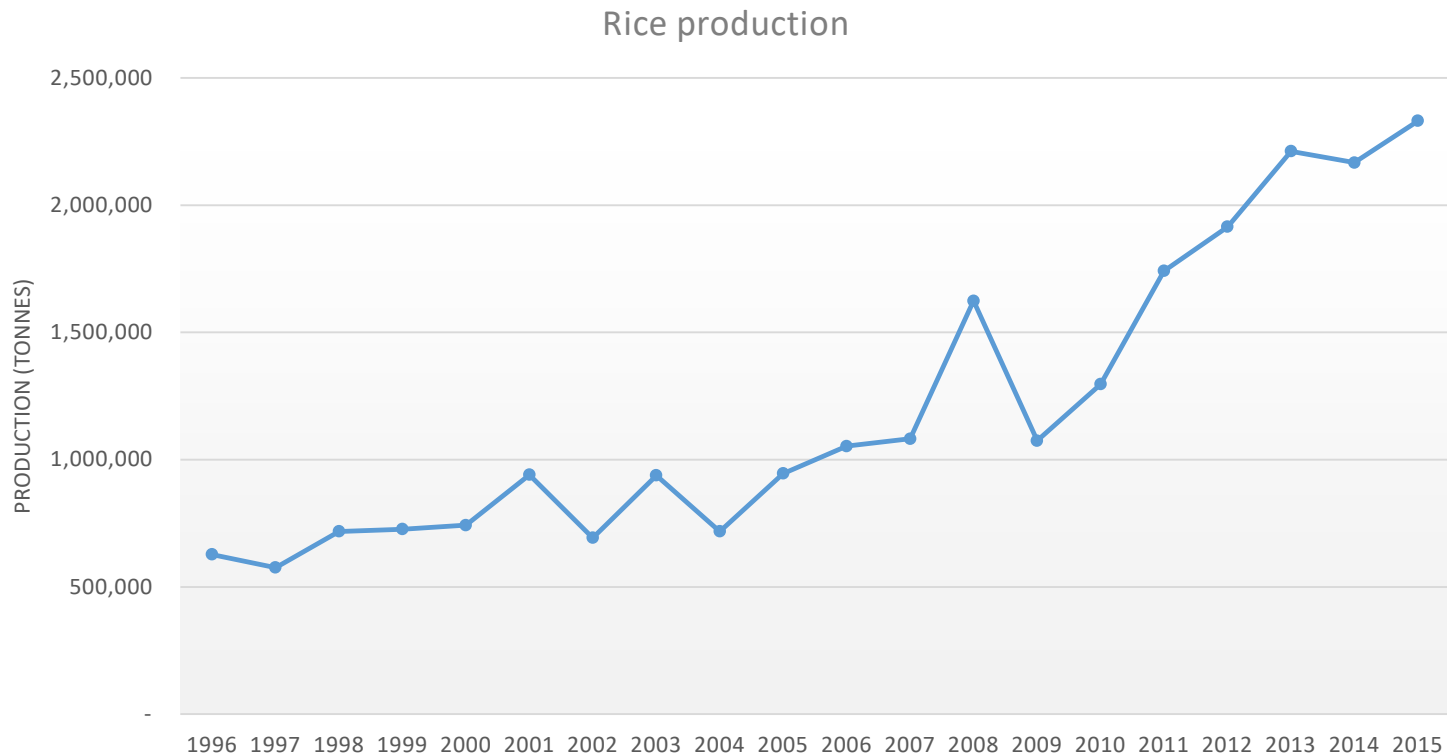
## 3.3 List frame: Disadvantages

- Association between frame units and target population units and issues of multiplicity and impact on inferences to be made
- Imperfection in the list frame (under coverage or over coverage)
- Need for maintaining and regularly updating the list frame



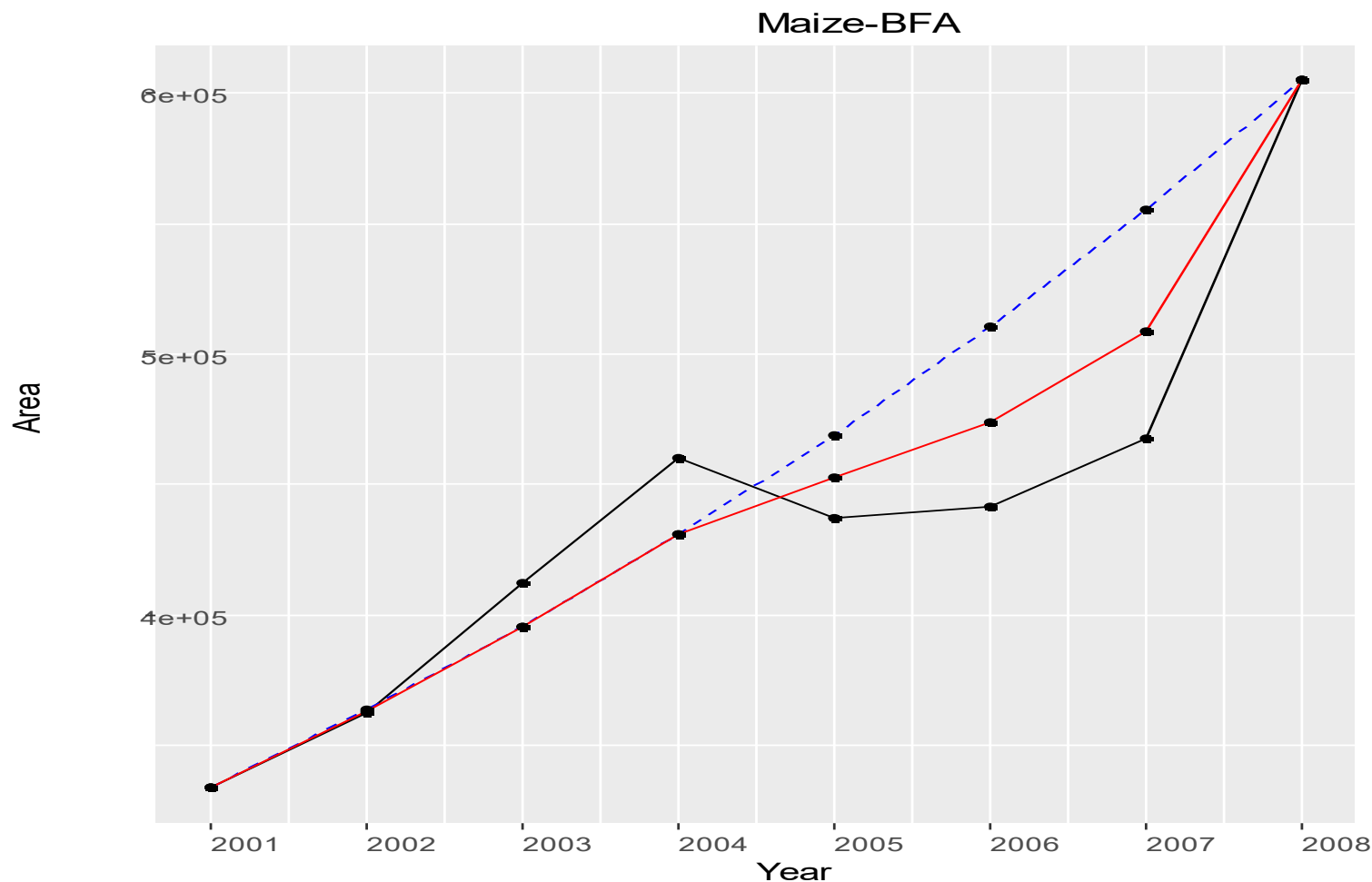
# 3.4 List Frames: Examples of issues

- Evolution of the rice production in Mali (Source: CountrySTAT-Mali)



# Discrepancy due to Obsolescence: Experience from Burkina Faso

Evolution of the Maize area in Burkina Faso (Source: CountrySTAT-Burkina Faso)



--- Survey Estimates

--- Adjusted Data (CE)

--- Estimates Using Growth Rate Method

# Discussions



## Using a multiple frame as an MSF: pros and cons

# 3.1 What is a Multiple frame?

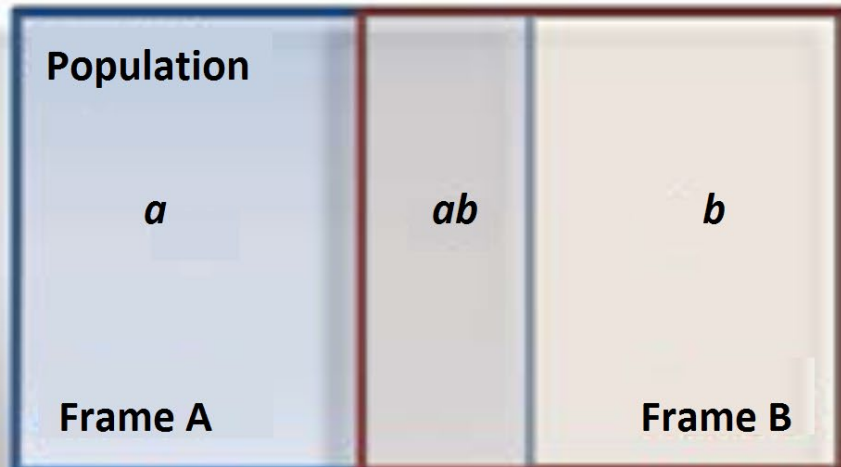
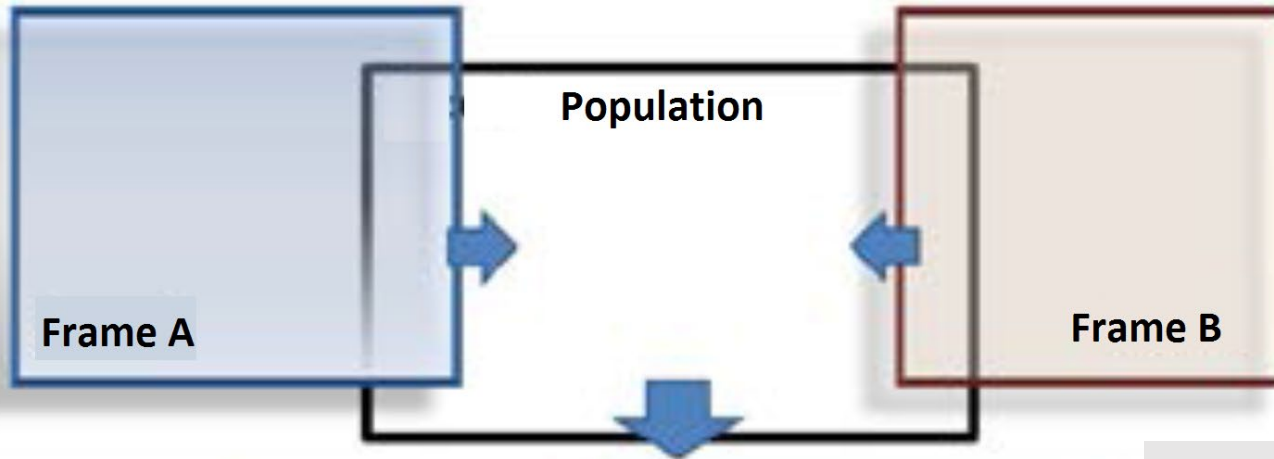
- Multiple frame sampling involves the joint use of two or more sample frames.
- For agricultural purposes, this usually involves the joint use of area and one or more list frames.
- The frames are usually not independent of one another; some of the frame units in one frame may be present in another.

# 3.1 What is a Multiple frame?

- The basic theory of multiple frame sampling (Hartley, 1962; Kott and Vogel, 1995) begins with dividing the population into mutually exclusive domains
- Following figure shows two sampling frames that cover the same target population and form three domains

# 3.1 What is a Multiple frame?

Special case of Dual frame (two frames)



**General dual frame estimation approach:**

Population total  $Y$  can be written as:

$$Y = Y_a + Y_{ab} + Y_b$$

# 3.1 What is a Multiple frame?

## Special case of Dual frame

*Frame A*

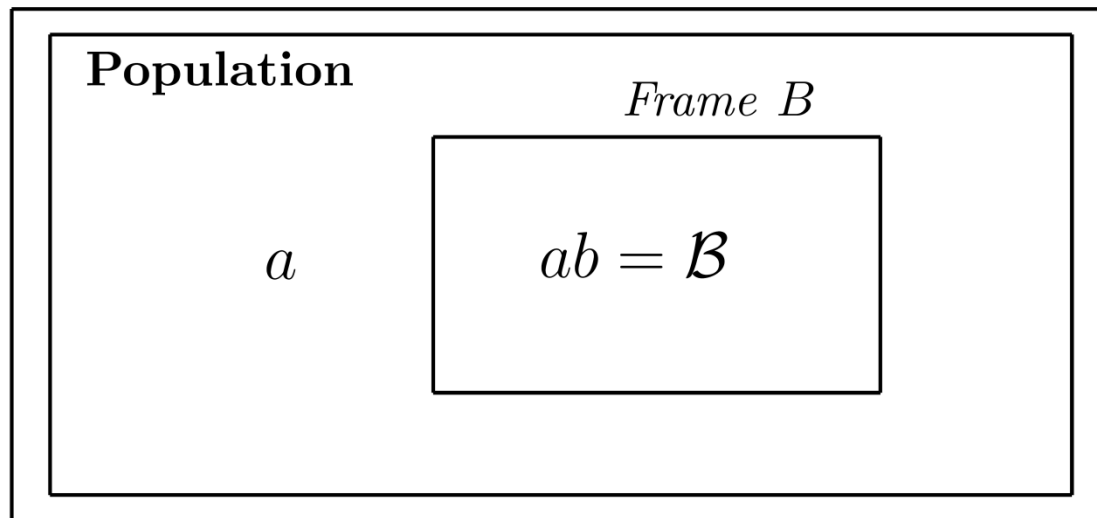


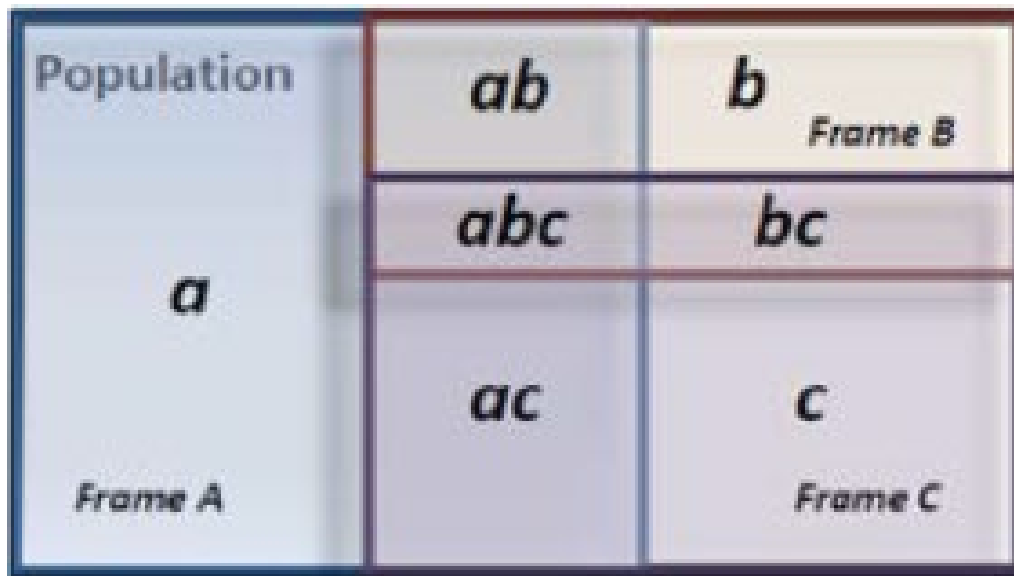
Figure 2: Special case dual frame scenario based on area frame and list frame

$$\hat{Y} = \hat{Y}_a + \hat{Y}_{ab} = \hat{Y}_a + \hat{Y}_L$$



# 3.1 What is a Multiple frame?

Multiple frames (three frames)



➔ More complex estimators...

## 3.1 What is a Multiple frame?

In the context of an MSF for agricultural surveys, the combination of area and list frames can take one of two forms:

1. A list of “special holdings” complements the part of the population covered by the area frame. Usually, these are commercial holdings that are included in farm registers.
2. When PSUs are land areas (such as census EAs), and at subsequent stages, the sampling units are holdings, households or parcels, the list are constructed only for selected PSUs. Indeed, it is possible (and usually efficient) to build a list frame of SSUs at a later stage, after the first-stage sample is selected, by collecting information on the population elements belonging to the sampled areas.

## 3.2 Multiple frames: Advantages

- Builds on strengths of AF and LF and minimize their weaknesses
- Allows the easy and not expensive creation of lists of agricultural holdings only in the selected areas, instead of making it in the entire country
- Data collection can be inexpensive because sample units are conglomerated in the selected areas, instead of being spread in all the country's territory
- Variability can be controlled and measured
- Enables the study of special or rare products

## 3.3 Multiple frames: Disadvantages

**Mains issues associated with Multiple Frame Sampling are :**

- **Completeness:** every holding in the population must be in at least one frame.
- **Identifiability:** The overlap of sampling units between frames must be determined to avoid duplication=> bias in the estimation if such overlapping is incorrect.
- **Updating:** Lists and area frames should be updated independently.
- **Estimators:** Estimation formulas can be complex.

# Discussions

# Summary

- This module discussed the types of frames that can be used to build an MSF and the main advantages and disadvantages of each type MSF.
- Use multiple frame can allow to manage weakness of both list frame and area frame.
- Two important requirements must be met with multiple frame:
  - **Completeness:** every holding in the population must be in at least one frame.
  - **Identifiability:** for any sample unit from any frame, it is possible to determine whether the reporting unit belongs to any other frame.

# References

- FAO, 2017. *Master Sampling Frames for Agriculture- Supplement on selected Country Experiences* . Rome.
- FAO. 2015. *World Programme for Census of Agriculture 2020*, Rome
- Global Strategy to improve Agricultural and Rural Statistics. 2015. *Handbook on Master Sampling Frames for Agricultural Statistics*. Global Strategy Publication, Rome.
- Global Strategy to improve Agricultural and Rural Statistics. 2016. *Guidelines for the integrated survey framework*. Rome.

# References

- The Department of Economic and Social Affairs of the United Nations Secretariat. 2005. *Designing Household Survey Samples: Practical Guidelines*. New York.
- The Department of Economic and Social Affairs of the United Nations Secretariat. 2005. *Household Sample Surveys in Developing and Transition Countries*. New York.
- UNSD, World Bank, FAO. 2010. *Global Strategy to improve Agricultural and Rural Statistics*. Rome.
- See: <http://www.gsars.org>



Thank You