

Combining different sampling frames for Agricultural Statistics



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Overview of the presentation

- **Area frames and list frames major characteristics: advantages and disadvantages**
- **Linking frames at the estimation stage of a survey**
 - Dual Frame Design
 - Multiple Frame Design
- **Multiple frame design for agricultural surveys**
 - Operational Challenges

Area and List Frames

Area Frames



Area and List Frames

Encuesta Nacional de Agricultura

AGRONOMIA

DANE - Colombia



População

Cadastro A (área)



Area Frames

Area and List Frames

Area Frames

- Sampling units can assume a variety of forms
- Built upon GPS/GIS/Remote sensing type of data
- ★ • Furnishes complete population coverage
- ★ • Keeps updated over time
- Provides indirect access to reporting units
- ★ • Needs maintenance for stratification purposes
- ★ • High costs to build an area frame
- ★ • Finding reporting units can require high efforts

Area and List Frames

List Frames

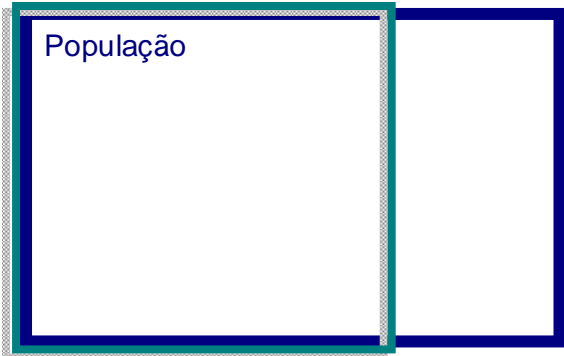
Id	Name	Address	2014 Production (ton)	2014 Cultivated Area (ha)
23452	G.B.A.	S.4 th St.	200	15
12541	H.I.J.	North St.	250	20
32123	K.J.L.	Taina Road	180	25
43212	J.J.Lil	R.67	240	12
45786	I.J.K.	Rain Road	250	15
56432	A.B.R.	Abbey R.	350	25
12423	U.O.L.	T.R.St.	400	20

Area and List Frames

Encuesta de Legumes

AGRONOMIA

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Cadastro B (lista de produtores)



List Frames

Area and List Frames

List Frames

- Usually a list of holdings or holders addresses
- Built upon censuses and/or administrative data
- ★ • Perhaps incorporates auxiliary information
- ★ • Do not require much effort to find reporting units
- ★ • Needs maintenance
- ★ • Degenerates quickly over time
- ★ • Often incomplete coverage of target population

Linking Frames?

Can we have some gain linking area and list frames?

From area frames:

- ★ • Furnishes complete population coverage
- ★ • Keeps updated over time

From list frames:

- ★ • Perhaps incorporates auxiliary information
- ★ • Do not require much effort to find reporting units

If linking is done at the estimation stage:

- ★ • Flexibility to use sample design according to frame type

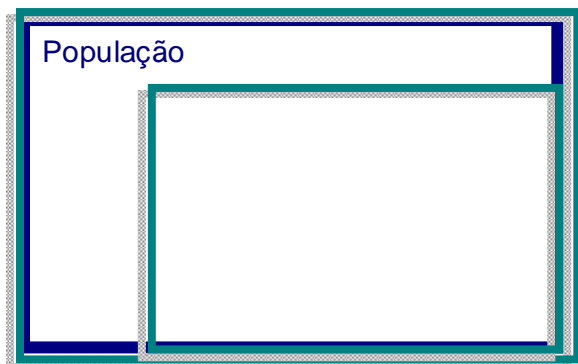
Linking Frames?

Potencial de uso de cadastro duplo **AGRONOMIA**

DANE - Colombia



Cadastro A (área)



Cadastro B (lista de produtores)

Dual Frame Design

Frame A

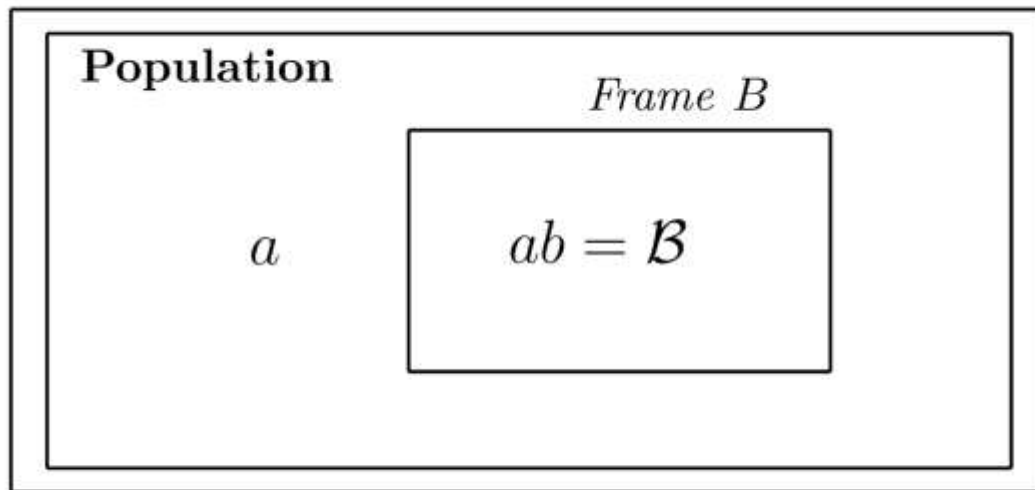


Figure 2: Special case dual frame scenario based on area frame and list frame

Dual Frame Design

$$\hat{t} = \hat{t}_a + \hat{t}_{ab}$$

Frame A

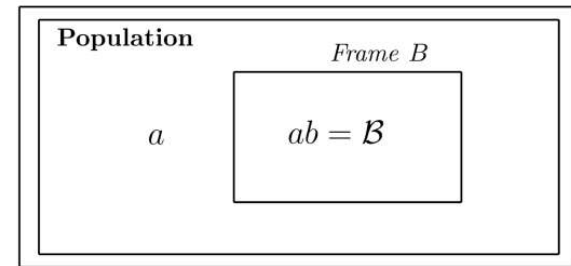


Figure 2: Special case dual frame scenario based on area frame and list frame

$$Var(\hat{t}) = Var(\hat{t}_a) + Var(\hat{t}_{ab}) + 2Cov(\hat{t}_a, \hat{t}_{ab})$$

Dual Frame Design

$$\hat{t} = \hat{t}_a + \hat{t}_{ab}$$

Frame A

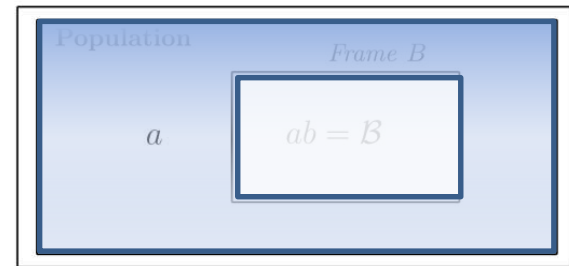


Figure 2: Special case dual frame scenario based on area frame and list frame

$$Var(\hat{t}) = Var(\hat{t}_a) + Var(\hat{t}_{ab}) + 2Cov(\hat{t}_a, \hat{t}_{ab})$$

Dual Frame Design

$$\hat{t} = \hat{t}_a + \hat{t}_{ab}$$

Frame A

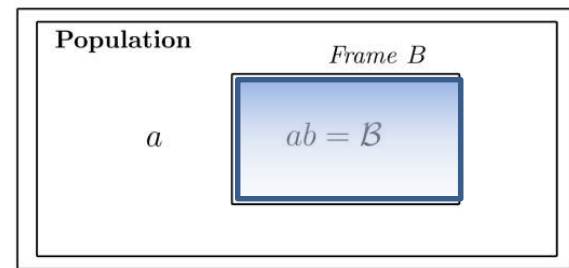


Figure 2: Special case dual frame scenario based on area frame and list frame

$$Var(\hat{t}) = Var(\hat{t}_a) + Var(\hat{t}_{ab}) + 2Cov(\hat{t}_a, \hat{t}_{ab})$$

Multiple Frame Design

Population

Multiple Frame Design

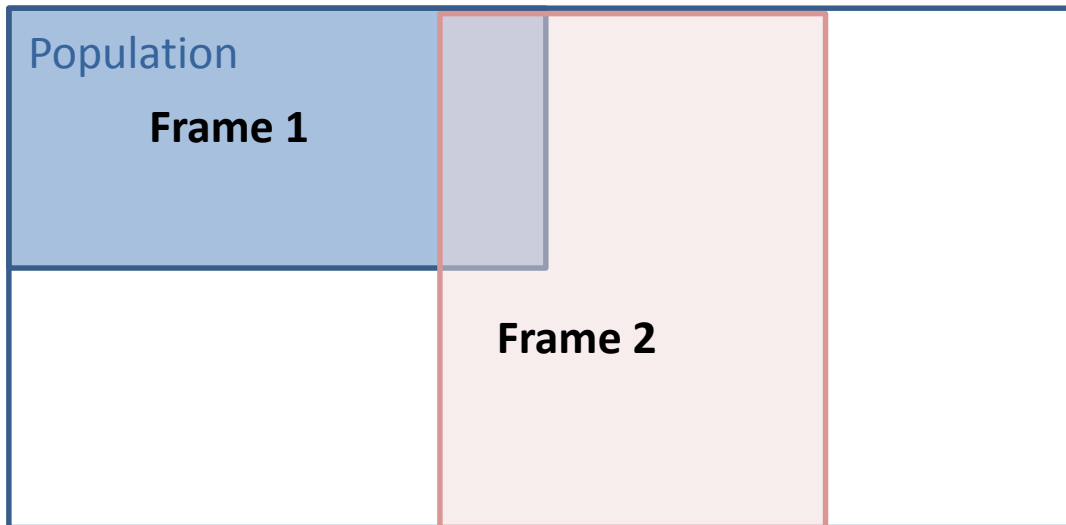
Population

Frame 1

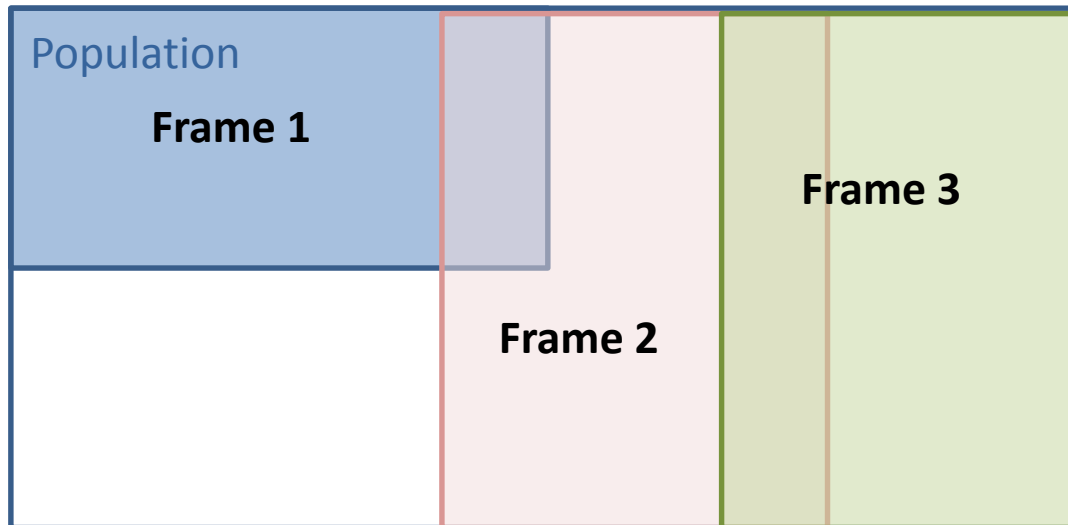


The diagram illustrates a multiple frame design. It consists of a large outer rectangle representing the population. Inside the top-left corner of this rectangle is a smaller, shaded rectangle labeled 'Frame 1'. The text 'Population' is positioned above the shaded area, and 'Frame 1' is centered within the shaded area. The rest of the large rectangle is empty, representing the remaining population not covered by Frame 1.

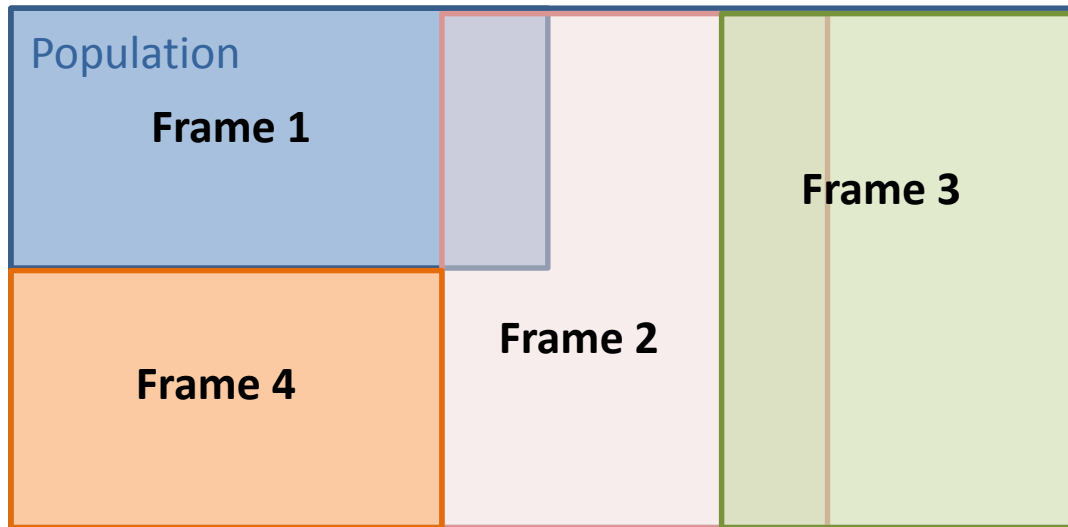
Multiple Frame Design



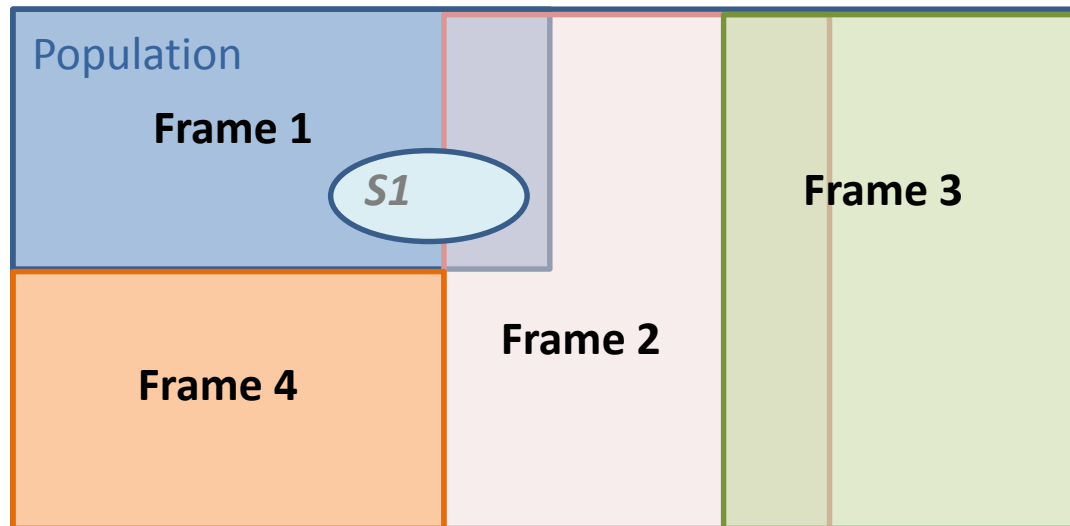
Multiple Frame Design



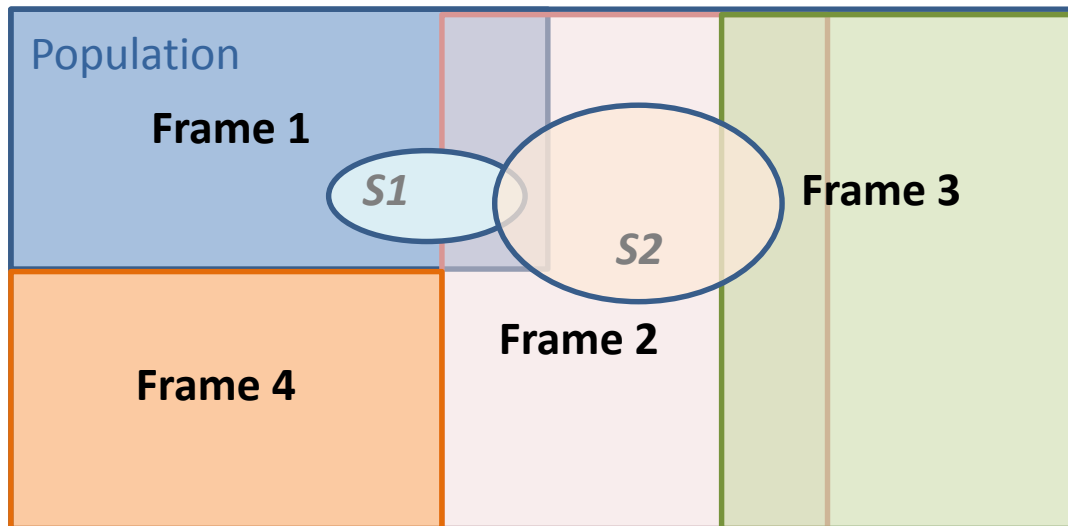
Multiple Frame Design



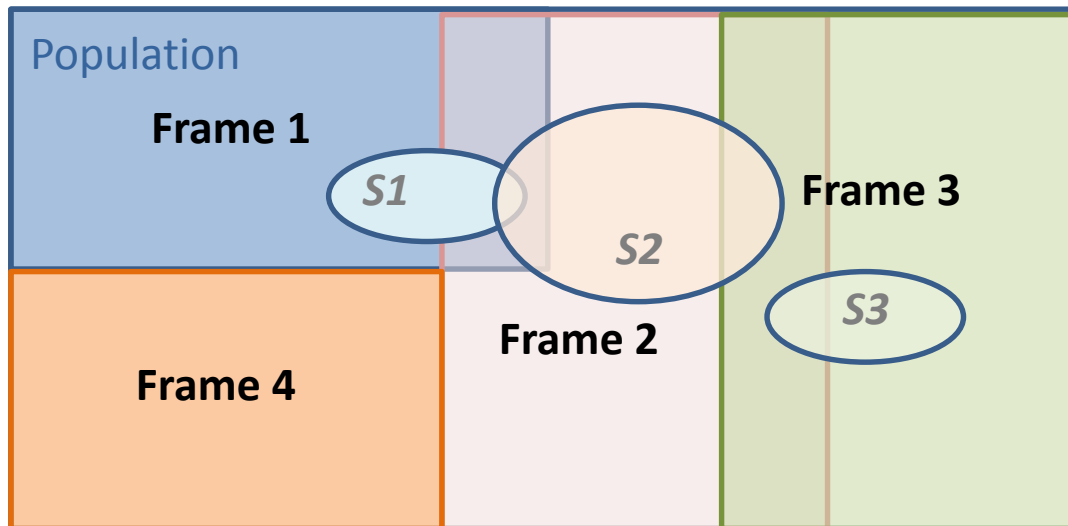
Multiple Frame Design



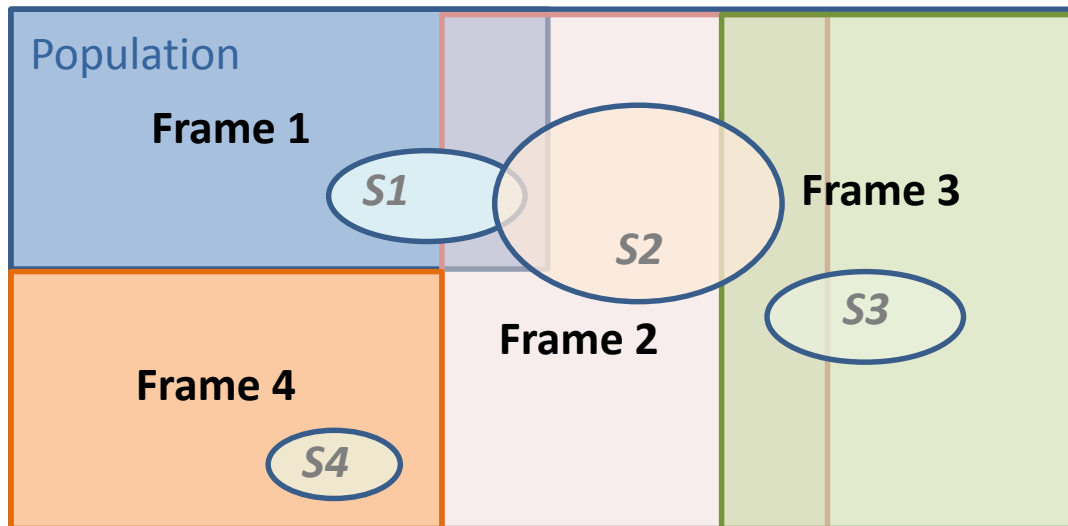
Multiple Frame Design



Multiple Frame Design



Multiple Frame Design



Multiple Frame Estimation

Let $U_1, U_2, \dots, U_q, \dots, U_Q$ be a collection of frames covering the same target population U :

$$\bigcup_{q=1}^Q U_q = U$$

Multiple Frame Estimation

Let $S_1, S_2, \dots, S_q, \dots, S_Q$ be a collection of independent probability samples, taken from the respective frame index, under a multiple frame design.

Multiple Frame Estimation

The Multiplicity Approach (Mecatti, 2007)

Parameter: Population Total

$$Y = \sum_{q=1}^Q \sum_{k \in U_q} y_k m_k^{-1}$$

Simple multiplicity estimator:

$$\hat{Y}_{SM} = \sum_{q=1}^Q \sum_{k \in s_q} y_k (m_k \pi_k)^{-1}$$

Multiple Frame Estimation

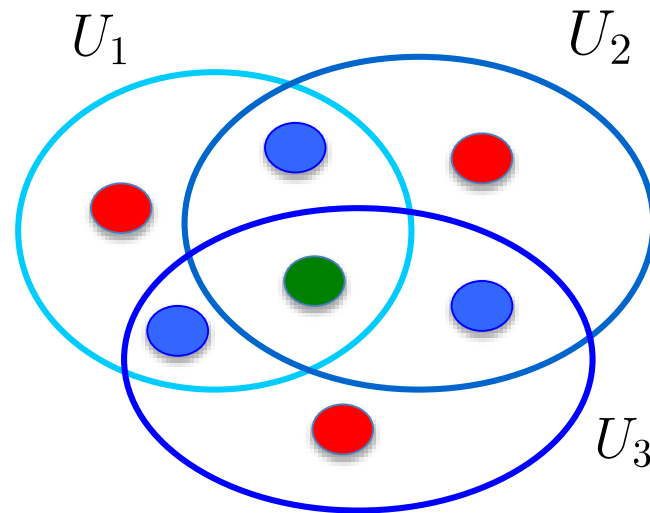
The Multiplicity Approach (Mecatti, 2007)

$$m_k = \sum_{q=1}^Q \mathbf{1}_{k \in U_q}$$

$$m_k = 1$$

$$m_k = 2$$

$$m_k = 3$$



“How many frames?”

Multiple Frame Estimation

Nice Features about The Multiplicity Estimator:

- **Sum of independent multiplicity adjusted Horvitz-Thompson estimators**
- **No need for sample classification into domains, given the multiplicity factor is known**
- **Provides an extension to a dual frame approach**

Multiple Frame Design for Agricultural Surveys

Population

Multiple Frame Design for Agricultural Surveys

Population

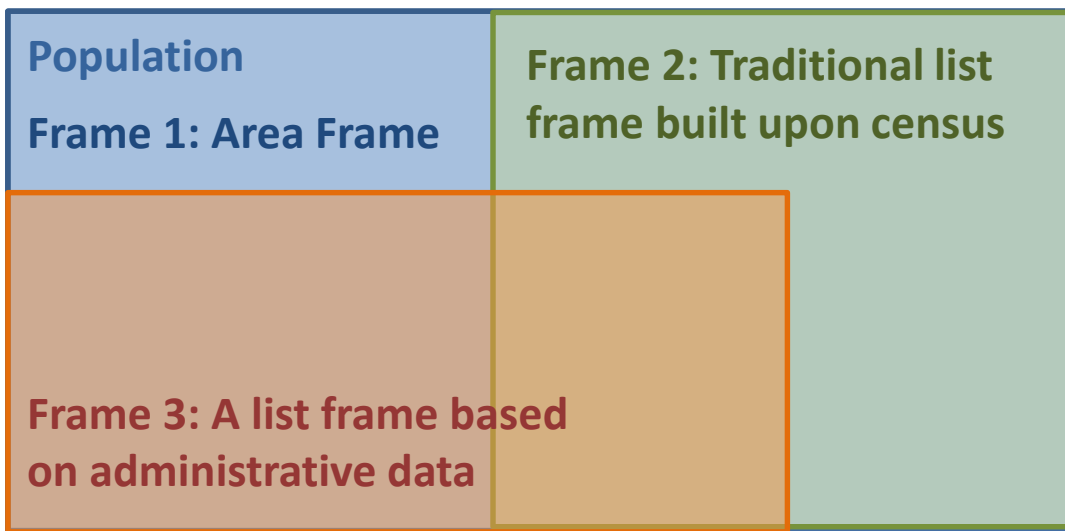
Frame 1: Area Frame

Multiple Frame Design for Agricultural Surveys

Population
Frame 1: Area Frame

**Frame 2: Traditional list
frame built upon census**

Multiple Frame Design for Agricultural Surveys





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Multiple Frame Operational Challenges

Multiple Frame Assumptions:

1. Completeness
2. Identifiability

Population

Multiple Frame Operational Challenges

Multiple Frame Assumptions:

1. Completeness

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Population

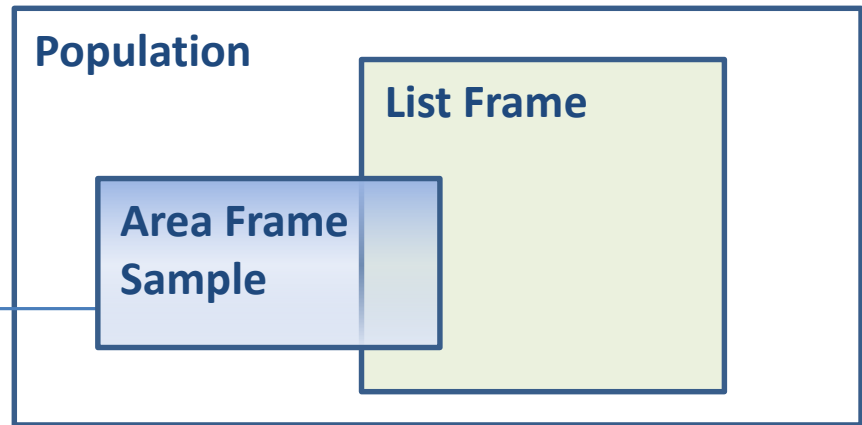
**Area Frame
provides full
coverage**

Multiple Frame Operational Challenges

Multiple Frame Assumptions:

1. Completeness

2. Identifiability

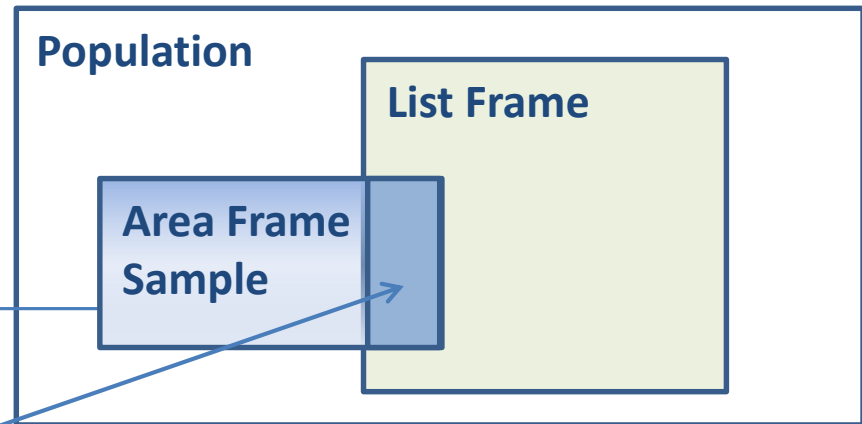


Multiple Frame Operational Challenges

Multiple Frame Assumptions:

1. Completeness

2. Identifiability



Area Frame Sampled
Elements Identified at
List Frame



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Thank you!



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