Pacific Training on Sampling Methods for Producing Core Data Items for Agricultural and Rural Statistics

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Module 2: Review of Basics of Sampling Methods
Session 2.3: Systematic Sampling

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Topics Covered

- **Different Types of Systematic Sampling**
  - **Linear systematic sampling**
    - **With N/n = Integer**
    - **Without N/n = integer**
  - **Circular systematic sampling**

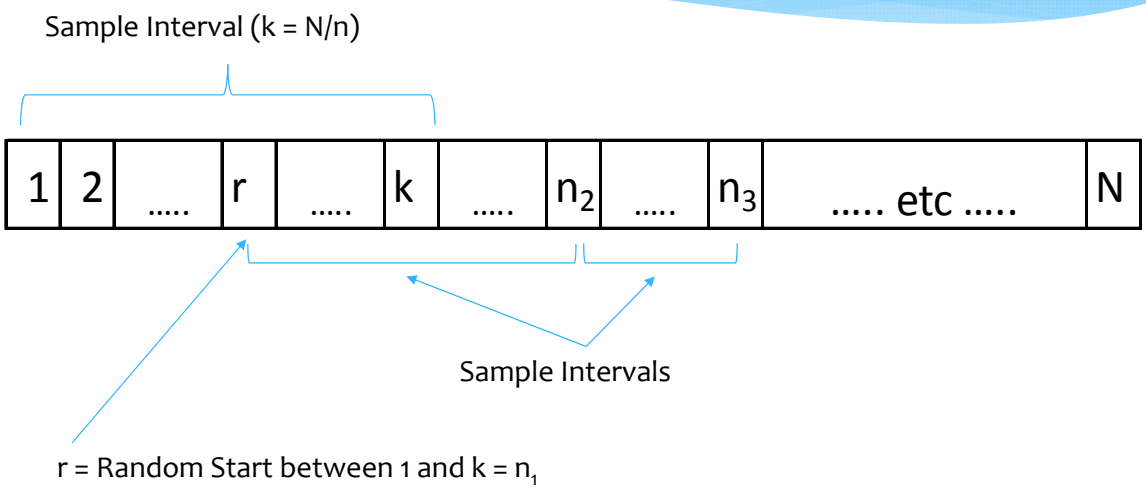
Linear systematic sampling

* Systematic Sampling (SYS), like SRS, involves selecting ***n*** sampling units from a population of ***N*** units
* Instead of randomly choosing the ***n*** units in the sample, a skip pattern is run through a list (frame) of the ***N*** units to select the sample
* The *skip* or *sampling interval*, ***k*** = ***N***/***n***

Linear systematic sampling: Selection process

1) Form a **sequential list** of population units
2) Decide on a sample size *n* and compute the skip (***sampling interval***), ***k*** = ***N***/***n***
3) Choose a random number, ***r*** (***random start***) between 1 and ***k*** (inclusive)
4) Add "***k***" to selected random number to select the second unit and continue to add "***k***" repeatedly to previously selected unit number to select the remainder of the sample

Linear systematic sampling: Selection process



Linear systematic sampling

* Previous example assumed that k = N/n is an integer
* Question: What if k = N/n is NOT an integer?
  * Solution 1: Work with decimal places and round
  * Solution 2: Circular sampling

Example – working with decimals and rounding

N	32	
n	7	
skip	4.571429	
R.Start	2.636695	
Sel1	2.636695	3
Sel2	7.208123	8
Sel3	11.77955	12
Sel4	16.35098	17
Sel5	20.92241	21
Sel6	25.49384	26
Sel7	30.06527	31

=32/7

=RAND()*4.571429

Same as the random start

=roundup(2.636695,0)

Circular sampling

1) Determine the interval ***k*** – rounding down to the integer nearest to ***N***/***n***
   (If ***N*** = 15 and ***n*** = 4, then ***k*** is taken as 3 and not 4)

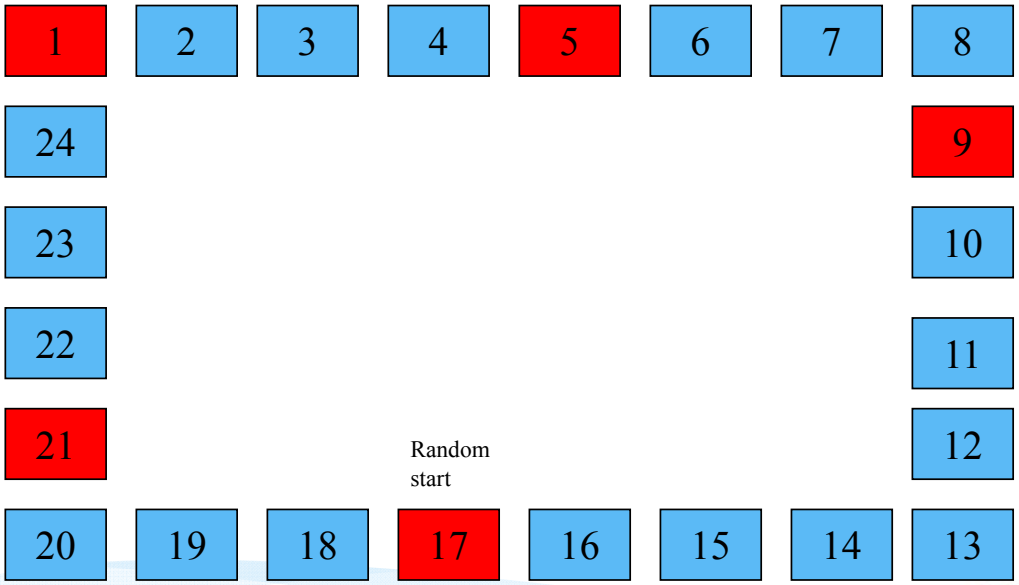
2) Take a random start between 1 and ***N***

3) Skip through the circle by ***k*** units each time to select the next unit until ***n*** units are selected

4) Thus there could be ***N*** possible distinct samples instead of ***k***

Circular sampling illustration

Population = 24, Sample = 5, Skip = Int(24/5=4.6) = 4



Estimation with Systematic Sampling

The weight for a systematic sample is the same as Simple Random Sampling

Estimate of a total

$$\hat{Y} = N \times \sum_{i=1}^{n} \frac{y_i}{n} \quad = \sum_{i=1}^{n} \frac{N}{n} y_i \quad = \sum_{i=1}^{n} w y_i$$

Estimate of a mean

$$\hat{\bar{Y}} = \sum_{i=1}^{n} \frac{y_i}{n}$$

Estimation with Systematic Sampling (cont)

Estimate of a proportion

$$y_i = \begin{cases} 1 & i^{th} \text{ sample unit has characteristic} \\ 0 & \text{otherwise} \end{cases}$$

$$\hat{Y} = \frac{N}{n}\sum_{i=1}^{n} y_i = \hat{N}_c$$

$$\hat{\bar{Y}} = \frac{1}{n}\sum_{i=1}^{n} y_i = \hat{P}_c$$