

# **Sampling Methods for Crop Cutting Surveys- Part-I**

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# Crop Estimation – Back ground

- Objective methods for estimating crop production instead of eye estimates have been evolved in various countries over time
- Where crop area statistics are available as an administrative statistics the crop production for important crops is obtained as a product of crop area and productivity (average yield per hectare) for each of the crops
- Productivity or average yield per hectare estimate of a crop is obtained through Crop Cutting Experiments (CCE) making use of efficient Sampling designs that are appropriate for the crop in the country
- Estimates of output of the crop is obtained by multiplying Production and average price

# Crop Estimation – Back ground (Contd.)

- We shall discuss mainly the practices adopted in Indian Agricultural Statistics System since it may be appropriate for most countries in the region. Practices followed in few other countries will also be referred
- In several African countries eye estimation is the practice instead of conducting CCE on sample basis

## Indian Agricultural Statistics System

- Arth Shastra of Kotalya; Moghul period: Aine-Akbari
- British period 18<sup>th</sup> Century: Ryotwari system
- 1860 Famine—need for statistical information felt
- 1866 Collection of agricultural statistics initiated

# Crop Estimation – Back ground (Contd.)

## Indian Agricultural Statistics System (Contd.)

- 1884 – Trade interests: **Forecasting** of Wheat
- 1900 – Oilseeds, rice, cotton, jute, indigo, sugarcane  
(commercially important crops)
- 1926 – Royal Commission on Agriculture (RCA)
- 1928 - RCA report:- Imperial (Indian) Council of Agri. Research
- 1943 – Bengal famine: Timely, reliable food statistics keenly felt
- 1948- Initiation of crop-cutting experiments based on random sample surveys for estimation of yield rates of principal crops for replacing the traditional eye-appraisal method
- 1949 – TCCAS (Tech Committee on Coord of Agri. Stat. Schemes)

# Crop Estimation – Back ground (Contd.)

## Indian Agricultural Statistics System (Contd.)

- 1950s–Initiation of new schemes for improvements of Agricultural Statistics under Planning Process:
- 1960s – Organizational developments – NSSO, ISI, IASRI, DES in Min. of Agriculture at Center and State DESs at State level
- 1961 – Committee on Improvement of Agricultural Statistics
- Agriculture is a State subject and Statistics is in the concurrent list
- Indian Agricultural Statistics System is decentralized
- State Agric. Stat Authorities (SASAs) are the State DESs- collection and compilation of data is their responsibility
- DES, Min of Agriculture – Coordination and compilation at the national level

# Crop Estimation – Crop Area Statistics (Contd.)

## System of Collection of Area Statistics

**Classification of States in four categories** based on revenue system

- **Temporarily settled States** (introduced in 1892 with a view to fix land revenue for a period, which was subject to change at the time of the next settlement):-**Land Record States**:- 18 States, 5 UTs, (cover 86% reported area)
- **Permanently settled States (Non-land record States, land revenue permanently fixed)**: Kerala, Orissa and W. B. (cover 9% reported area)
- **Other Regions – NE Region** (5% reported area)
- **Non-reporting areas** (7% of the total geographic area)

# Crop Area Statistics in Land Record States (Temporarily settled States)

- Cadastral surveyed (complete enumeration of all survey numbers of village based on cadastral map, with ownerships)
- Village accountants– Patwaris/Krmachari/Telathi, as permanent revenue staff
- Khasara registers (village Form Register recording crop area statistics)
- Girdawari (crop area statistics collected by village accountant complete enumeration of operational holdings)
- Jinswar statement – abstract of crop-wise area
- Village, revenue circle, tehsil, district, SASAs, DES (MoA)
- Land utilization statistics (9- fold classification- Forests, Non-agric, Barren, Pastures, Misc Tree, Culturable Waste, Current Fellow, Fellow, Net Area Sown)

# Crop Area Statistics in Non-Land Record States (Permanently settled States)

- Revenue permanently settled
- No permanent revenue staff – no uniform system of collecting area statistics
- Chaukidar or Village headman used to provide area statistics (guess-work)
- **EARAS** (Establishment of an Agency for Reporting Agriculture Statistics Scheme) initiated in 1968-69
- Girdawari conducted every year in 20% randomly selected villages of the State
- Entire State covered in 5 years



# Crop Area Statistics in Other Regions

- Areas which do not have reporting system include: North East Region (Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura); Andaman and Nicobar Islands and Lakshdweep
- These States are cadastrally surveyed
- Conventional methods – estimates as reported by village Chaukidars based on personal assessment
- This category covers around 5% of total reported area of the country

# Estimation of Area and Production

- In land record States - Area estimation based on complete enumeration
- Crop yield based on Crop Cutting Experiments (CCE)
- Crop production estimated as a product of area and yield estimates
- Any delay in area estimation results in delayed estimates of crop production

# Timely Reporting Scheme (TRS)

- TRS introduced in 1968–69 (for area and production of major crops)
- To reduce the time lag for area statistics for major crops
- To provide the sample frame of fields for CCEs
- Villages in each stratum (sub-district level) randomly divided in five non-overlapping sets (nearly equal sets)
- One set of randomly selected villages chosen for crop inspection on priority basis
- The estimates based on these sets are used for advance area estimates for major crops
- All the villages are covered in five years

## TRS (Contd.)

- TRS provides for recording area under irrigation as well as under High Yielding Variety
- The statistical staff in the scheme is required to inspect the CCEs and ensure timely dispatch of the results
- Thus, TRS helps in timeliness as well as quality of the area and production estimates

# EARAS (Establishment of Agency for Reporting Agric Statistics Scheme)

- In Non-Land Record States (Permanently Settled States) of Kerala, Orissa and West Bengal, EARAS introduced
- 20% sampling of villages selected similar to TRS
- The scheme provides for setting up whole time agency to cover 20% villages every year, so that all the villages of State are covered in five years (EARAS)

# General Crop Estimation Surveys (GCES)

- Crop yield and production estimates provided at the district level
- Yield estimates through Crop Cutting Experiments (CCEs)
- 68 Crops (52 food and 16 non-food crops)
- Around 500,000 CCEs conducted every year
- Currently, about 95% of the production of food grains is estimated on the basis of yield rates obtained from (CCE)
- NSSO coordinates work under GCES in all States/ UT's and provides necessary guidance on crop estimation surveys

# Sampling Design in GCES

- **Stratified multi-stage random sampling design**
- Tehsils/ taluks/ revenue inspector circles/ CD blocks,etc. of a District as **strata**
- Revenue Villages within a stratum as the **first stage unit** of sampling
- Survey numbers/ fields within each selected village as sampling unit at the **second stage unit**
- Experimental plot of a specified shape and size as the **ultimate unit of sampling**

# Sampling Design in GCES (Contd.)

- Generally 80-120 experiments conducted for a crop in a major district and 44- 46 experiments in a minor district
- Around 500,000 CCEs conducted every year
- Number of experiments allotted to a district is distributed among the strata within the district roughly in proportion to the area under the crop in the stratum
- Villages for conducting CCE are randomly selected from TRS villages



# Sampling Design in GCES (Contd.)

- In each of these randomly selected villages two crop cutting experiments of specified size are conducted on two randomly located distinct survey/sub-survey numbers

## Plot shapes and sizes – initial experimentations – measurement errors

- Generally 5mx5m, 5mx10m plots
- In UP, equilateral triangles of 10 m sides
- In WB, circular plot of radius 1.745 meters

# Procedure of Data Collection in CCE

- Locating and marking of experimental plot of specified size in a field selected on the principles of random sampling
- Harvesting and threshing of its produce
- Recording weight of the produce in the prescribed forms
- Driage experiments
- Sampling design adopted for GCES is a multistage stratified random sampling with tehsils/taluks/CD blocks as strata
- Villages within a stratum as primary sampling unit

## Procedure of Data Collection in CCE (Contd.)

- Experiments to be planned on a particular crop in a district are determined in **psu**, fields within a village as **ssu**
- Experimental plot of specified size within a field as the ultimate sampling in proportion to the area under crop in different districts
- Within districts the number of experiments to be conducted in a stratum is determined on the basis of area under a particular crop in different strata
- Villages for conducting CCEs are randomly selected from TRS villages

# Procedure for Selection of villages

- In each of these randomly selected villages two CCEs of specified size are conducted on two randomly located distinct survey/sub-survey numbers from each selected village
- Thus number of villages to be selected for CES is half of the number of CCE planned for the crop
- It is not necessary to select a fresh set of villages for each crop
- After allocation of the experiments to different stratum for different crops for each season in proportion to the area under the crop, highest number of experiments to be conducted on any single crop during any season in each stratum has to be worked out

## Procedure for Selection of villages (Contd.)

- No. of villages to be selected is thus = half of this highest number
- These sets of villages are retained for conducting CCEs on all the crops during all seasons
- Number of villages for conducting CCE on other crops are to be randomly selected from the villages of major crop
- After determination of the sample size of villages in each stratum, the villages are randomly selected from the list of villages coming under TRS by SRSWOR

## Procedure for Selection of villages (Contd.)

- For every one of these selected villages two more additional villages are to be selected by SRSWOR
- Attempt should be made to select additional villages from TRS villages of same revenue circle to which the original village belongs
- In the case of non-availability of TRS villages in the same circle the selection of additional village can be made from the list of TRS villages of the stratum

## Procedure for Selection of villages (Contd.)

- If experimental crop is absent in the selected village(s), then at district level select 3 more additional villages for each originally selected village from the list of TRS villages
- Procedure is repeated till the TRS villages are exhausted
- In the event of non-availability of experimental crops in any of the TRS villages, non-TRS villages is substituted

# Procedure for Selection of villages (Contd.)

- After selection of villages, supervisor at district level prepares a plan of experiments and provide four important information:
  - (i) village-wise allocation of experiments among primary workers
  - (ii) three digital random numbers for selection of survey numbers/sub-survey numbers
  - (iii) pair of three digit random numbers for location of plot for each experiment and
  - (iv) experiments which have to be supervised by different agencies



# Procedure for Selection of villages for Data Collection (Contd)

## In short,

- District wise allocation of CCEs done in proportion to the crop area in respective districts
- Further allocation to respective strata also done proportionately to the crop area
- Villages for conducting CCEs selected from TRS villages
- Two CCEs conducted in two randomly selected survey/ sub survey numbers in selected Village

# Procedure for selection of survey numbers

- Procedure for selection of survey numbers for all crops is same
- If the random number provided for selection of survey number as per plan  $\leq$  the highest survey number, then the survey number corresponding to the random number itself is selected
- If the random number is  $>$  highest survey number, the random number is divided by the highest survey number and the remainder is noted, the survey number corresponding to this remainder is selected
- If the two random numbers lead to selection of same survey number, then the next highest survey number growing the experimental crop is selected for the second experiment

# Procedure for selection of survey numbers (Contd)

- Selected survey number is identified with the help of village accountant / village cadastral map. If, experimental crop is not grown in the selected survey number, then the next higher survey number growing experimental crop is selected.
- In case, the experimental crop is not grown in any higher survey numbers (including the highest survey number) then starting from the lowest survey number, the first survey number growing the experimental crop is selected
- If in this process if the same survey number is selected for both the experiments then next higher survey number growing the experimental crop is selected for the second experiment

# Procedure for selection of field

- For CCE, a field is a distinct patch of land clearly demarcated on all sides. Different mixtures of the experimental crop with other crop(s) on the same patch of land constitute different fields
- If the selected survey number contains more than one field growing the experimental crop, the field nearest to the south-west corner of the survey number which satisfies following conditions is selected

Area of the field is at least equal to the size of experimental plot

If mixed crop, the experimental crop must constitute at least 10% of its crops area

The experimental plot crop is not meant for prize competition / seed production / demonstration, and

The experimental crop is not grown for fodder purpose

# Procedure for selection of field (Contd)

- If the experimental crop is recorded by Village Accountant and it has failed/not germinated; or damaged partially/ completely by wild life; affected by pests/diseases/ heavy rainfall/inadequate rainfall, the field is still considered for conduct of CCE and yield obtained from the plot is recorded. In case, damaged completely then yield is recorded as zero
- In cases, area is not recorded by the Village Accountant, then the field is not considered for selection
- In case two or more fields are equidistant from the South-West corner of the selected survey number, then the Southern most field is selected

## Procedure for selection of field (Contd)

- If selected field is already harvested, the experiment is treated as lost
- If none of the fields in selected survey number is big enough to accommodate experimental crop, the survey number is rejected and the next higher survey number growing the experimental crop is selected
- After completion of process of selecting survey number and field for both the experiments on the given crop in selected villages, the concerned district supervisor is informed at least in one-month advance of the harvesting period

# Procedure for location of experimental plot

- Primary worker get in touch with the cultivator before he starts harvesting
- In selected field, the experimental plot of specified size is located at random with help of pair of random numbers given in the plan

## Identification of plot size of size 5Mx5M:

- Identify South-West corner of selected field. Beginning from this point, the length and breadth of the field is measured in steps
- From the length and breadth, 7 steps are deducted and the reduced numbers noted. The reduced number of length and breadth (in steps) so obtained are compared with the pair of random numbers given for length and breadth in the plan of experiments, and

# Procedure for location of experimental plot (Contd)

## Identification of plot size of size 5Mx5M (Contd.)

- if the random numbers given for  $l$  and  $b \leq$  corresponding numbers then these random numbers determine the starting point (i.e., south-west corner) of the experimental plot
- if the random numbers given for  $l$  and  $b$  are  $>$  reduced length and reduced breadth (after deducting 7 steps), the random numbers for length and breadth are divided by the reduced length and breadth respectively and corresponding remainders are obtained. The remainders thus obtained determine the starting point of the experimental plot



# Procedure for location of experimental plot (Contd)

## Identification of plot of size 10Mx5M

- The plot size of 10Mx5M is generally selected for those crops which are sown in rows. If the experimental crop is not sown in rows the procedure for identification of plot remains the same as in case of 5Mx5M plot
- Otherwise, after identifying the South-West corner of the field, measure the length and breadth of the selected field, in steps, from the length, deduct 13 steps and deduct 7 steps from breadth and note down the reduced length and breadth

# Procedure for location of experimental plot (Contd)

## Identification of plot of size 10Mx5M (Contd.)

- As these crops are generally grown in rows, the plot is so formed as to have its longer side parallel to the rows
- South-West corner of the plot is located with reference to the random numbers given in the plan
- First, using the random number for row, one of the rows is selected
- Using the random number for length the starting point of the experimental plot is located on the selected row
- The method of marking the experimental plot when rows are 10 meters or longer differs slightly from the one when the rows are less than 10 meters long, as explained in next slide:

# Procedure for location of experimental plot (Contd)

## Identification of plot of size 10Mx5M (Contd.)

### (i) When the length of rows is 10 M or longer

- Starting from South-West corner of field, count number of rows, let it be N
- Find how many rows are there in a width of 5 meters. This observation may be made randomly thrice and let its average be  $R = (R_1 + R_2 + R_3) / 3$
- Compare the number  $(N+1-R)$ , with the random number given for row
- If the random number is  $\leq (N+1-R)$ , then select the row corresponding to the random number
- If the random number  $> (N+1-R)$ , then divide the former by the latter and obtain remainder. Select the row corresponding to this remainder

# Procedure for location of experimental plot (Contd)

Identification of plot of size 10Mx5M : (i) When the length of rows is 10 M or longer (Contd.)

- After selecting the row, measure length of row in steps by walking in between selected row and previous row, note down number of steps
- Deduct 13 steps from this number and note the reduced number
- Compare the reduced number with the random number given for length
- If the random number  $\leq$  the reduced number, then the random number is considered as the random step, which determines the starting point on selected row

# Procedure for location of experimental plot (Contd)

Identification of plot of size  $10M \times 5M$  : (i) When the length of rows is  $10M$  or longer (Contd.)

- If the random number  $>$  the reduced number, then divide the former by the later and obtain remainder. This remainder is the random step in this case
- Starting from beginning of selected row measure the distance in steps, along the row, equal to the random step number and fix a peg ( $P_1$ ) here, i.e. in the space between the selected row and proceeding row

# Procedure for location of experimental plot (Contd)

## Identification of plot of size 10Mx5M : (i) When the length of rows is 10 M or longer (Contd.)

- $P_1$  is the southwest corner and the starting point of the experimental plot. From this point measure a distance of 10 meters along the row and fix the second peg ( $P_2$ ) opposite to  $P_1$ .
- From  $P_2$ , count 'R' number of rows coming in 5 meters width and fix a peg ( $P_3$ ) in between rows opposite to  $P_2$
- From  $P_3$  measure 10 meters and fix a peg  $P_4$  opposite to  $P_1$ .
- Thus,  $P_1 P_2 P_3 P_4$  is the required experimental plot. These pegs should not be disturbed until the last picking is completed

# Procedure of harvesting experimental plot

- After fixing pegs  $P_1$  ,  $P_2$  ,  $P_3$  ,  $P_4$  at corners of experimental plots, tie a string connecting these pegs all around
- String stretched tight and plants along border examined. In case of border plants, if more than 50 % of plants bottom fall within experimental plot, then such plants are completely included in the experimental plot. If otherwise, the border plants are completely excluded from experimental plot
- Experimental plot must be harvested on the day when the cultivator harvests the field, but prior to harvesting of field
- In case of mixture crop, experimental crop alone is harvested

# Procedure of conducting driage experiments

- Weight of harvested produce reported at the time of harvest, relates to weight of the crop immediately after harvest
- Except for sugarcane, cotton and other similar crops, it is necessary to carryout driage experiments to obtain estimates of yield in terms of final dried produce
- In case of sugarcane, final produce is expressed in terms of cane only
- In case of cotton, final produce is expressed in terms of lint after adopting ginning percentage (kapas to lint) as obtained from the ginning factories



# Procedure of conducting driage experiments (Contd.)

- Driage experiments are conducted at the district statistical office in respect to different crops
- Driage experiments are conducted in respect of 15 % of the experiments planned for specified crops or subject to a minimum of four experiments per crop. For it, CCEs supervised by State statistical staff at harvest stage are selected
- One kg. of harvested produce, taken at random is taken for drying to the District Statistical Supervisor. When the produce from experimental plot is less than one kg., the entire produce is to be taken for drying

# Some special features of sampling design in Permanently settled States

- In case of non-land record states (Kerala, Orissa & WB) both area and yield are estimated on the basis of sample surveys
- CCE are planned in a sub-sample of the primary units selected for the purpose of area enumeration
- General procedure of selecting sampling units remains same at different stages as in that of other states. Some special features:-
- In Kerala blocks/municipalities with an area of 10 Sq- Kms. and above are treated as separate stratum. Blocks with an area of less than 10 Sq. Kms. are merged with adjoining blocks and treated as a single stratum

# Some special features of sampling design in Permanently settled States (Contd.)

- These blocks are divided into a number of Investigator Zones depending on the area of a block, nature of land, etc.
- City Corporation area is divided into three Investigator Zones. Each municipality with an area more than 10 Sq, Kms. is treated as a single Investigator Zone.
- Number of CCE conducted in each Investigator Zone is 6 per season for paddy, 3 each for Coconut, Banana and 2 each for Tapioca, Arecanut, Cashewnut, Pepper, Plantain & Jackfruit in an year

## Some special features of sampling design in Permanently settled States (Contd.)

- In a municipal area having separate Investigator Zone, 10 CCE are conducted for paddy per season and 5 for Coconut per year. For City Corporation areas, 6 CCE for paddy per season and 5 for coconut per year in one Investigator Zone
- In Orissa, CCE for paddy are conducted in a sub-sample of 40% of EARAS villages in each block and for other crops, in 50% of sample villages during Autumn & Winter seasons. In summer season, all the villages selected for area enumeration under EARAS are covered under CES for paddy and other crops

# Some special features of sampling design in Permanently settled States (Contd.)

- For paddy, CCE are planned in proportion to crop area subject to minimum of 2 and maximum 4 CCE in a village. For other crops, only one experiment is conducted in a village
- In West Bengal, EARAS is now primary source for area statistics and source to provide frame for selection of villages for conduct of CCEs under GCES
- Ten mouzas out of all the EARAS mouza in a block are randomly selected for CCE

# Some special features of sampling design in Permanently settled States (Contd.)

- A sub-frame of plots cultivating each crop is prepared for each such mouza. If the number of plots growing a crop in a mouza is too small, all plots growing the crop are enumerated
- Plots for conducting CCEs are sampled out of this sub-frame. In all, 20 plots are taken in the form of two inter-penetrating sub-samples of size 10 each for each block for a crop.
- On the basis of the above, two independent estimates of yield rate are obtained for a block and these are later combined to give an overall estimate



***THANKS***