Sampling Methods for Production of Livestock Statistics- Part-II

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Estimation of Wool Production

- The procedure for estimating sheep numbers, average wool yield per sheep and total wool production in a district and also the estimates for their variances are discussed
- The procedure is discussed for one category of sheep say (ewes) only
- For others the procedure is identical
- Estimates are derived for a **District** and **not State** as was done for milk and eggs production

Estimation of Wool Production (Contd.)

Notations- Let,

N : total number of villages in the **district**

n' : total number of villages selected during the year which is 15 per cent of the total number of villages in the district i.e. n'= 0.15 x N

n : number of villages selected in a season i.e. n = n' / 3

T : number of strata formed in the district

V_h : total number of villages in the h^{th} stratum (Tehsils/sub-district)

n_h : number of villages allotted to the h^{th} stratum for complete enumeration of households for sheep numbers in a season

Thus $$n = \sum_{h=1}^{T} n_h$$

Estimation of Wool Production (Contd.)

Notations (Contd.)

v_h : sub-sample of villages selected from the n_h villages in the h^{th} stratum for yield estimation

X_{shi} : enumerated number of sheep in the s^{th} season, h^{th} stratum and i^{th} village

y_{shijk} : wool yield in the s^{th} season, h^{th} stratum and i^{th} village, j^{th} flock and k^{th} sheep

Let X'_{hi}, X'_h *and* X' be the number of sheep in the i^{th} village h^{th} stratum and in the entire district as per the latest livestock census respectively . *Further denote*

$$W_h = \frac{X'_h}{X'}$$

Estimation of Wool Production (Contd.)

Estimation of sheep population

(i) Estimation for a season

Estimate of sheep population in the s[th] season is given by: $\hat{X}_s = \sum_{h=1}^{T} \hat{X}_{sh}$

Where $\hat{X}_{sh}$ is the estimate for the h[th] stratum in the s-season and is given by

$$\hat{X}_{sh} = \frac{\sum_{i=1}^{n_h} \hat{X}_{shi}}{\sum X'_{hi}} X'_h \qquad \text{or,} \quad \hat{X}_{sh} = \hat{R}_{sh} \times \hat{X}'_h$$

Estimate of variance of $\hat{X}_{sh}$ is given by $\hat{V}(\hat{X}_{sh}) = \frac{V_h^2 \sum_{i=1}^{n_h} (X_{shi} - \hat{R}_{sh} X'_{hi})^2}{n_h (n_h - 1)}$

Estimate of variance of $\hat{X}_s$ is given by $\hat{V}(\hat{X}_s) = \sum_{h=1}^{T} \hat{V}(\hat{X}_{sh})$

Estimation of Wool Production (Contd.)

Estimation of sheep population (Contd.)

(ii) Estimate of average sheep population in the district

Estimate of average sheep population in the h^{th} stratum is: $\hat{X}_h = \frac{1}{3}\sum_{s=1}^{3} \hat{X}_{sh}$

Estimate of sheep population in the district is : $\hat{X} = \sum_{h=1}^{T} \hat{X}_h$

Estimate of variance of $\hat{X}_h$ is given by

$$\hat{V}(\hat{X}_h) = \frac{1}{9}\sum_{s=1}^{3} \hat{V}(\hat{X}_{sh}) = \frac{1}{9}[\hat{V}(\hat{X}_{1h}) + \hat{V}(\hat{X}_{2h}) + \hat{V}(\hat{X}_{3h})]$$

and

$$\hat{V}(\hat{X}) = \sum_{h=1}^{T} \hat{V}(\hat{X}_h)$$

Estimation of Wool Production (Contd.)

Estimation of average wool yield per sheep

(i) Estimation of average wool yield per sheep in a season

- During each shearing season, v_h villages would be covered
- From each flock in a sample of selected flocks within a village:
  - 2 rams or 2 wethers, or
  - 1 ram and 1 wether, or
  - 2 ewes and 2 lambs

  are selected for recording individual fleece weights

The following estimates are for a sheep, wether or ram, ewe or lamb

Let $\bar{y}_{shi} = \dfrac{\sum_{j=1}^{f_{shi}} \sum_{k=1}^{x_{shij}} y_{shijk}}{\sum_{j=1}^{f_{shi}} x_{shij}}$ the average wool yield per sheep in the i^{th} village

Estimation of Wool Production (Contd.)

Estimation of average wool yield per sheep

(i) Estimation of average wool yield per sheep in a season (Contd.)

x_{shij} : number of sheep selected in the s^{th} season, h^{th} stratum, i^{th} village, j^{th} flock,

f_{shi} : number of flocks selected in the i^{th} village

The estimate of wool production in the i^{th} village is given by:

$$P_{shi} = X''_{shi}\,\bar{y}_{shi} \quad , \qquad X''_{shi} = (\%\ \text{Sheep shorn}) \times X_{shi}$$

where X''_{shi} is the number of sheep sheared in the i^{th} village. This is obtained by multiplying X_{shi} with percentage of sheep shorn in the i^{th} village

Estimate of average wool yield per sheep is

$$\bar{y}_{sh} = \frac{\sum_{i=1}^{v_h} P_{shi}}{\sum_{i=1}^{v_h} X''_{shi}} \quad \text{for } h^{th} \text{ stratum}$$

Estimation of Wool Production (Contd.)

Estimation of average wool yield per sheep (contd.)

(i) Estimation of average wool yield per sheep in a season (Contd.)

Estimate of variance of $\bar{y}_{sh}$ is approximately given by

$$\hat{V}(\bar{y}_{sh}) = \frac{1}{v_h(v_h - 1)} - \frac{1}{\bar{X}''^{\,2}_{sh}} \sum_{i=1}^{v_h} (P_{shi} - \bar{y}_{sh} X''_{shi})^2$$

Where, $\bar{X}''_{sh} = \frac{1}{v_h} \sum_{i=1}^{v_h} X''_{shi}$

Estimate of average wool yield per sheep during the s^{th} season in the district is given by:

$$\bar{y}_s = \sum_{h=1}^{T} W_h \bar{y}_{sh}$$

Estimate of variance is given by $\hat{V}(\bar{y}_s) = \sum_{h=1}^{T} W_h^2 \hat{V}(\bar{y}_{sh})$

Estimation of Wool Production (Contd.)

Estimation of average wool yield per sheep (contd.)

(ii) Estimate of annual wool yield per sheep(Contd.)

Estimate of annual wool yield per sheep in the h[th] stratum: $\bar{y}_h = \sum_{s=1}^{3} \bar{y}_{sh}$

Estimate of variance of $\bar{y}_h$ is: $\hat{V}(\bar{y}_h) = \hat{V}(\bar{y}_{1h}) + \hat{V}(\bar{y}_{2h}) + \hat{V}(\bar{y}_{3h})$

$\hat{V}(\bar{y}_{1h}), \hat{V}(\bar{y}_{2h}), \hat{V}(\bar{y}_{3h})$ are as given earlier.

Estimate of annual wool yield per sheep for the district : $\bar{y} = \sum_{h=1}^{T} W_h \bar{y}_h$

Estimate of variance of $\bar{y}$ is: $\hat{V}(\bar{y}) = \sum_{h=1}^{T} W_h^2 \hat{V}(\bar{y}_h)$

Similarly estimate of annual wool yield per ram, ewe and lamb can be obtained

Estimation of Wool Production (Contd.)

Estimate of annual wool production

(i) Estimate of total wool production of the district in a season

Estimate of wool production $\hat{P}_{sh} = \hat{X}''_{sh}\bar{y}_{sh}$

where $\hat{X}''_{sh}$ is the estimated number of sheep shorn in the hth stratum during the sth season and is obtained by multiplying $\hat{X}_{sh}$ with percentage of sheep shorn in the hth stratum.

Estimate of variance of $\hat{P}_{sh}$ is: $\hat{V}(\hat{P}_{sh}) = \hat{X}''^{2}_{sh}\hat{V}(\bar{y}_{sh}) + \bar{y}^{2}_{sh}\hat{V}(\hat{X}''_{sh})$

where $\hat{V}(\hat{X}''_{sh}) = (\%\ sheep\ shorn)^2 \times \hat{V}(\hat{X}_{sh})$

Where $\hat{V}(\bar{y}_{sh})$ has already been defined earlier

Estimation of Wool Production (Contd.)

Estimate of annual wool production

Let $\hat{P}_{sh}$ be the estimated total wool production in the hth stratum during the sth season obtained by adding the estimated wool production for rams, ewes and lambs. The estimate of variance of $\hat{P}_{sh}$ is obtained by adding the estimated variances of rams-wethers, ewes and lambs

Estimated total wool production during the sth season is: $P_s^* = \sum_{h=1}^{T} P_{sh}^*$

Estimate of variance of P_s^* is: $V(P_s^*) = \sum_{h=1}^{T} \hat{V}(P_{sh}^*)$

Estimate of annual wool production for the district is: $P^* = \sum_{s=1}^{3} P_s^*$

Estimate of variance of P* is given by $\hat{V}(P^*) = \sum_{s=1}^{3} \hat{V}(P_s^*)$

Estimation of Meat Production

- The procedure of estimating:

  (a) the total number of animals slaughtered

  (b) the average meat production per animal; and

  (c) the total meat production

  are presented

- Information on the number of animals slaughtered is obtained from two sources:
  - sample of households reporting slaughter of animals and from all the butchers and other agencies in the villages selected in the sample, and
  - records maintained at all the slaughter houses in State

Estimation of Meat Production

Notations- Let,

V : number of villages in the State

n' : total number of villages selected during the year which is 15 percent of total number of villages in the State i.e. n' = 0.15 × V

n : number of villages selected in a season i.e. n = n'/3

T : number of strata in the State

V_h : total number of villages in the h^{th} stratum

n_h : number of villages allocated to the h^{th} stratum for complete enumeration of livestock.

Thus, $$n = \sum_{h=1}^{T} n_h$$

Estimation of Meat Production (Cond.)

Notations (Contd.)- Let

v_h : sub-sample of villages selected out of n_h villages in the h^{th} stratum for yield estimation.

U_h : number of registered slaughter houses in the h-th stratum

u : number of registered slaughter houses selected out of U_h in the s^{th} season

x'_{shi} : number of animals slaughtered by butchers and other agencies in the i^{th} village during s^{th} season in the h^{th} stratum

x''_{shi} : number of animals slaughtered by the household in the i^{th} village during s^{th} season in the h^{th} stratum.

y_{smhlk} : meat production from the k^{th} animal of l^{th} slaughter house of h^{th} stratum during m^{th} month of the s^{th} season

Estimation of Meat Production (Contd.)

Number of animals slaughtered

(i) Estimated number of animals slaughtered in households of butchers and chamars **privately** in a season is

$$\hat{X}_{sp} = \sum_{h=1}^{T} \frac{V_h}{n_h} \sum_{i=1}^{n_h} x_{shi}$$

where x_{shi} is the total number of animals slaughtered in the ith village and is $x_{shi} = x''_{shi} + x'_{shi}$

Estimate of variance of $\hat{X}_{sp}$ is approximately given by

$$\hat{V}(\hat{X}_{sp}) = \sum_{h=1}^{T} \left(\frac{1}{n_h} - \frac{1}{V_h}\right) V_h^2 S_{sh}^2$$

where, $S_{sh}^2 = \frac{1}{(n_h - 1)} \sum_{i=1}^{T} (x_{shi} - \bar{x}_{sh})^2$ and

$$\bar{x}_{sh} = \frac{1}{n_h} \sum_{i=1}^{n_h} x_{shi}$$

Estimation of Meat Production (Contd.)

Number of animals slaughtered (Contd.)

(ii) Number of animals slaughtered in register slaughter houses

Let X_{sr} be the total number of animals slaughtered in all the **registered slaughter** houses of the state during the s^{th} season

(iii) Estimate of total number of animals slaughtered in the state during the s^{th} season is : $\hat{X}_s = \hat{X}_{sp} + X_{sr}$

Estimate of variance of $\hat{X}_s$ is given by $\hat{V}(\hat{X}_s) = \hat{V}(\hat{X}_{sp})$

(iv) Estimate of total number of animals slaughtered in the state during the year is: $\hat{X} = \sum_{s=1}^{3} \hat{X}_s$

Estimate of variance $\hat{X}$ of is: $\hat{V}(\hat{X}) = \sum_{s=1}^{3} \hat{V}(\hat{X}_s)$

Estimation of Meat Production (Contd.)

Estimate of average meat production per animal

Average meat production per animal in the l^{th} slaughter house of the h^{th} stratum during the m^{th} month of the s^{th} season is

$$\bar{y}_{smhl} = \frac{1}{3}\sum_{k=1}^{3} y_{smhlk}$$ (as 3 animals are selected in each month)

Let x_{smhl} be the number of animals slaughtered in the l^{th} slaughter house of the h^{th} stratum during m^{th} month of s^{th} season.

Estimate of meat production in a month in the l^{th} slaughter house of the h^{th} stratum during m^{th} month of s^{th} season is

$$P_{smhl} = \bar{y}_{smhl} \times x_{smhl}$$

Estimation of Meat Production (Contd.)

Estimate of average meat production per animal (Contd.)

(i) Estimate of average meat production from an animal in the s^{th} season in the state is given by

$$\bar{y}_s = \frac{\sum_{h}^{T}\sum_{m}^{d_s}\sum_{l}^{u} P_{smhl}}{\sum_{h}^{T}\sum_{m}^{d_s}\sum_{l}^{u} x_{smhl}}$$

d_s is the number of months in the s^{th} season, which is equal to 4 for all s

Estimate of variance of the $\bar{y}_s$ is approximately

$$\hat{V}(\bar{y}_s) = \frac{1}{\hat{\bar{X}}^2}\sum_{h=1}^{T}\sum_{m}^{d_s}\left(\frac{1}{u}-\frac{1}{U_h}\right)\frac{1}{(u-1)}\sum_{l=1}^{u}(P_{smhl}-\bar{y}_s x_{smhl})^2$$

Where $\hat{\bar{x}}_s = \frac{1}{d_s uT}\sum_{h}^{T}\sum_{m}^{d_s}\sum_{l}^{u} x_{smhl}$, d_s is number of months in s^{th} season

Estimation of Meat Production (Contd.)

Estimate of average meat production per animal (Contd.)

(ii) Estimate of average meat production from an animal in the state is :

$$\bar{y} = \frac{\sum_{s=1}^{3} \hat{X}_s \bar{y}_s}{\sum_{s=1}^{3} \hat{X}_s} = \frac{\hat{P}}{\hat{X}}$$

, where X_S is already defined

Estimate of variance of $\hat{\bar{y}}$ is approximately given by

$$\hat{V}(\hat{\bar{y}}) = \frac{1}{\hat{X}^2}[\hat{V}(\hat{P}) + \bar{y}^2 \hat{V}(\hat{X}) - 2\bar{y} Cov.(\hat{P}, \hat{X})$$

Where, $$Cov.(\hat{P}, \hat{X}) = \sum_{s=1}^{3} Cov.(\hat{P}_s, \hat{X}_s) = \sum_{s=1}^{3} \bar{y}_s \hat{V}(\hat{X}_s)$$

Estimation of Meat Production (Contd.)

Estimate of total meat production

Estimate of total meat production in a state is obtained by multiplying the estimated number of animals slaughtered in the s^{th} season in a State with the average meat production per animal in the s^{th} season and added over the different seasons and is given by

$$\hat{P} = \sum_{s=1}^{3} \hat{X}_s \bar{y}_s$$

and estimate of variance of is $\hat{P}$ is given by

$$\hat{V}(\hat{P}) = \sum_{s=1}^{3} [\bar{y}_s^2 \hat{V}(\hat{X}_s) + \hat{X}_s^2 \hat{V}(\bar{y}_s)]$$

Estimation of Cost of Production of Milk, Egg

Sampling Design

In estimation of production of livestock products same p.s.u.'s (villages) are observed and s.s.u's (households) vary from round to round in a season

In Cost of production surveys same p.s.u.'s and s.s.u.'s are observed throughout the period of study; information on cost aspects are collected

From districts which are selected for preparation of district level estimates of production of milk / egg,

- Two villages (not already selected for production estimates) are selected randomly in each district for conducting Cost of production studies
- Each of these villages along with two neighboring villages comprise as one group
- Thus, there are two such groups which are kept under constant study throughout the period (30 months) of survey

Estimation of Cost of Production of Milk, Egg(Contd.)

Sampling Design (Contd)

From each of the groups of villages thus selected

- two clusters of two households/stalls are selected for milk and
- two clusters of five households/farms are selected for egg

Information is collected for all the animals (cow, buffalo and goat) and birds in selected households once every fortnight, which constitutes a round

Whenever during the period of cost survey, selected households/farms ceases to have at least one breeding animal in case of milk and at least 5 female birds in case of egg and also the head of the household has no intention of obtaining the same, then in that case the household may be replaced by another, preferably of the same category and from the same village

Estimation of Cost of Production of Milk, Egg(Contd.)

Sampling Design (Contd): Field-work

One Enumerator assigned 2 groups of 3 villages each [in which complete enumeration of hhs is done in the beginning and particulars recorded in village Sch. I & II]

Milk: Enumerator collects data for (2 cluster of 2 hhs)x 6 Villages = 24 stalls/hhs located in two groups of villages at an interval of fortnight. [Collects detailed data from two stalls/hhs in a village per day visiting both in the morning and evening, thus covering the 12 stalls in a group of villages in 6 days. Thereafter he proceeds to second group and records similar data] Reports back to first group for another round.

Egg: Enumerator collects data for (2 cluster of 5 hhs)x 6 Villages = 60 farms/hhs located in two groups of villages at an interval of fortnight. [Collects detailed data from 5 farms/hhs in a village per day visiting both in the morning and evening, thus covering the 30 farms/hhs in a group of villages in 6 days. Thereafter he proceeds to second group and records similar data] Reports back to first group for another round

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Milk Production (Contd.)

Components of Cost : The overall cost of milk production is an aggregate of expenditure incurred on feeds, paid labour, family labour, depreciation on animals, interest on fixed and working capital, depreciation on assets and equipment and miscellaneous recurring expenses. From this the income on account of the dung produced is subtracted. Each cost component is evaluated as per SNA concepts

Notations:

i : p.s.u (clusters of villages) i=1,2

j : s.s.u. (milk producer household) j = 1, 2, 3, 4 . . . 12

y_{ij} : Value of the Cost Component for milch animals in the j^{th} household of i^{th} p.s.u.

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Milk Production (Contd.)

Notations (Contd.):

x_{ij} : The corresponding milk yield in the j^{th} s.s.u. of i^{th} p.s.u.

H_i : Total number of s.s.u. in the i^{th} p.s.u.

h_i : Number of selected s.s.u.'s in the i^{th} p.s.u.

N : Total number of p.s.u.'s in the population

n : Total number of p.s.u.'s in the sample

Estimate of cost of per kg of milk $\hat{C} = \frac{\hat{Y}}{\hat{X}}$

Where, $\hat{Y} = \frac{N}{n}\sum_{1}^{n}\frac{H_i}{h_i}\sum_{j=1}^{n} y_{ij}$ and $\hat{X} = \frac{N}{n}\sum_{1}^{n}\frac{H_i}{h_i}\sum_{j=1}^{n} x_{ij}$

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of per Kg of Milk Production (Contd.)

Estimate of variance of $\hat{C}$ is given by $\hat{C} = \frac{\hat{Y}}{\hat{X}}$

$$\hat{V}(\hat{C}) = \frac{1}{(\hat{X})^2}[\hat{V}(\hat{Y}) + \left(\frac{\hat{Y}}{\hat{X}}\right)^2 \hat{V}(\hat{X}) - 2\left(\frac{\hat{Y}}{\hat{X}}\right) \hat{Cov}(\hat{Y}, \hat{X})]$$

$$\hat{V}(\hat{Y}) = N^2\left[\frac{1}{n} - \frac{1}{N}\right]s_{by}^2 + \frac{N}{n}\sum_{i=1}^{n} H_i^2\left(\frac{1}{h_i} - \frac{1}{H_i}\right)s_{iy}^2$$

$$\hat{V}(\hat{X}) = N^2\left[\frac{1}{n} - \frac{1}{N}\right]s_{bx}^2 + \frac{N}{n}\sum_{i=1}^{n} H_i^2\left(\frac{1}{h_i} - \frac{1}{H_i}\right)s_{ix}^2$$

$$\hat{Cov}(\hat{Y}, \hat{X}) = N^2\left[\frac{1}{n} - \frac{1}{N}\right]s_{byx} + \frac{N}{n}\sum_{i=1}^{n} H_i^2\left(\frac{1}{h_i} - \frac{1}{H_i}\right)s_{iyx}$$

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of per Kg of Milk Production (Contd.)

$$\hat{C} = \frac{\hat{Y}}{\hat{X}}$$

Where,

$$s_{by}^2 = \frac{1}{(n-1)}\sum_{i=1}^{n}(H_i\bar{Y}_i - \hat{\bar{Y}})^2 \qquad s_{iy}^2 = \frac{1}{(h_i-1)}\sum_{j=1}^{h_i}(y_{ij} - \bar{y}_i)^2$$

$$s_{bx}^2 = \frac{1}{(n-1)}\sum_{i=1}^{n}(H_i\bar{X}_i - \hat{\bar{X}})^2 \qquad s_{ix}^2 = \frac{1}{(h_i-1)}\sum_{j=1}^{h_i}(x_{ij} - \bar{x}_i)^2$$

$$s_{byx} = \frac{1}{(n-1)}\sum_{i=1}^{n}(H_i\bar{y}_i - \hat{\bar{Y}})(H_i\bar{x}_i - \hat{\bar{X}}) \qquad s_{iyx} = \frac{1}{(h_i-1)}\sum_{j=1}^{h_i}(y_{ij} - \bar{y}_i)(x_{ij} - \bar{x}_i)$$

$$\bar{y}_i = \frac{1}{h_i}\sum_{j=1}^{h_i} y_{ij} \qquad \bar{Y} = \frac{1}{n}\sum_{i=1}^{n} H_i\bar{y}_i$$

$$\bar{x}_i = \frac{1}{h_i}\sum_{j=1}^{h_i} x_{ij} \qquad \hat{\bar{X}} = \frac{1}{n}\sum_{i=1}^{n} H_i\bar{x}_i$$

Above procedure leads to the cost per kg of milk $\hat{C}$ in one district

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of per Kg of Milk Production (Contd.)

If there is D number of districts then the overall cost for all the districts together will be $\hat{C}ost = \sum_{d=1}^{D} W_d \hat{C}_d$

where $\hat{C}_d$ = Cost estimated in the dth district

and $W_d = \frac{M_d}{M}$; M_d are the milch animals in the dth district and

and $M = \sum_{d=1}^{D} M_d$

The estimate of V (cost) is $\hat{V}(\hat{C}ost) = \sum_{d=1}^{D} W_d^2 \hat{V}(\hat{C}_d)$

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

Basic information: Number of adult birds of both sexes, eggs produced, number of day old chicks, unsexed chicks up to 8 weeks of age, young birds between 8-12 weeks, 12-16 weeks, 16-20 weeks and 20-24 weeks

Cost of categories of bird: Cost of maintenance of an adult bird, cost of production of a day old chick and cost of rearing of young birds

Components of cost: Maintenance cost of birds includes:

- Feed cost
- Miscellaneous management expenditure
- Labour cost
- Interest on fixed assets and working capitals
- Depreciation on Fixed assets and adult birds

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

Method of calculation for average of different costs incurred for maintaining a bird:

Total Maintenance Cost of an adult layer bird

= feed cost per bird + labour cost per bird + interest on working and fixed capital + depreciation on fixed assets and birds + miscellaneous expenses per bird – other income

Feed cost per layer per day = (total feed cost for layers)/ No. of layer days

For one year (365 days)

Total Maintenance Cost of a layer

= Maintenance Cost of a layer per day x 365

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

Costs of production per egg

(i) Productivity of a layer = (Total egg production of hh/farm) / (# layer days)

(ii) Total egg production of a layer in a year= (i) x 365

(iii) Cost of production per egg (excluding labour cost on collection of egg)
= [total maintenance of cost of a layer in a year] / (ii)

(iv) Cost of production per egg including labour accounted for egg collection
= (iv) + labour cost per egg incurred on egg collection

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

Costs of production of hatching type egg

(i) Let for hatching, the ratio of hens and cocks be (8:1)

(ii) Take 1/9 cost of maintenance of a cock towards costs of production of hatching eggs (maintenance of a cock is obtained similarly as in the case of the maintenance of the layer)

(iii) Components towards maintenance of cock for hatching eggs

=1/9 of the cost of maintenance for cock during a year ÷ total number of hatching eggs produced per layer in a year

(iv) Total cost of production of hatching egg

= cost of production of an egg + components towards maintenance of a cock for hatching eggs

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

Let C_p denote cost of maintenance of p^{th} category bird

r : particular round in the survey; p : category bird;

q : particular component of the cost

Therefore $$C_p = \sum_q \sum_r C'_{pqr} \div \sum_q \sum_r b_{pqr}$$

C'_{pqr} denotes the q^{th} component of cost of the p^{th} category in the r^{th} round and b_{pqr} denotes the number of birds, accordingly.

Variance of C_p is : $$V(C_p) = \frac{1}{b_p^2}[V(C'_p) + C_p^2 V(b_p) - 2C_p \; Cov\,(C'_p, b_p)]$$

This is so far as the variance of a particular component over time observation is concerned

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

Let us have a look at the analysis variance arrived from the survey design

Source of variation	Degree of freedom
Between group of villages	1
Within groups between villages	4
Within villages between cluster of households	6
Within clusters and between households	48
Total	59

Let X_{ijkm} denote Cost of a particular component in m^{th} household of the k^{th} cluster in the j^{th} village of i^{th} group

As per our sampling design:

(a) Number of households/farms (m = 5)

(b) Number of clusters in a village (k = 2)

(c) Number of villages (j = 3) in each group

(d) Number of groups of villages in each district (i = 2)

Estimation of Cost of Production of Milk, Egg (Contd.)

Estimation of Cost of Egg Production (Contd.)

$$\bar{x}_{ijk} = \frac{1}{5}\sum_{m=1}^{5} x_{ijkm} \; ; \quad \bar{\bar{x}}_{ij} = \frac{1}{2}\sum_{k=1}^{2} \bar{x}_{ijk} \; ; \quad \bar{\bar{\bar{x}}}_{i} = \frac{1}{2}\sum_{k=1}^{2} \bar{\bar{x}}_{ij} \; ; \quad \bar{\bar{\bar{\bar{x}}}} = \frac{1}{2}\sum_{i=1}^{2} \bar{\bar{\bar{x}}}_{i}$$

Let in the i^{th} village there are S_i possible clusters of households. Out of which s are selected. At the i^{th} village level, the variance will have the expression

$$G_{wi}^2 = \left[\frac{(s-1)\sigma_b^2 + s(m-1)\sigma_w^2}{sm-1}\right]\left[\frac{S_i - s}{S_i \times s}\right]$$

$$G_{wi}^2 = \left[\sum (\bar{x}_{ijk} - \bar{x}_{ij})^2 + \frac{\sum_s \sum_m (x_{ijkm} - \bar{x}_{ijk})^2}{sm-1}\right]\left[\frac{S_i - s}{S_i \times s}\right]$$

i = 1, 2, 3, 4, 5, 6

where

$$\sigma_w^2 = \frac{1}{s(m-1)}\sum_s \sum_m (x_{ijkm} - \bar{x}_{ijk})^2 \quad , \quad \sigma_b^2 = \frac{1}{(s-1)}\sum_s (\bar{x}_{ijk} - \bar{x}_{ij})^2$$

Estimation of Cost of Production of Egg(Contd.)

Let σ_v^2 : Between village variance and G_{wi}^2 : Within village variance

N groups of villages are possible and we select n (in our case 2) with z units (in our case 3) within each n .

Variance is: $\hat{V}(\bar{x}) = \left(\frac{N-n}{Nn}\right)\left[\frac{(n-1)\sigma_v^2 + n(z-1)G_w^2}{(nz-1)}\right]$,Where $G_w^2 = \frac{1}{nz} = \sum_{i=1}^{n} G_{wi}^2$

As σ_v^2 is between villages variance, which have S_i sub-units each in the i^{th} , σ_v^2 has to be estimated basing on both between village and within village components as in the case of a sub-sampling set up. If S_{bv}^2 is the survey estimate for this variance:

$$\hat{\sigma}_v^2 = \frac{S_{bv}^2}{n} + \frac{1}{ns} G_w^2 \qquad \text{where} \quad S_{bv}^2 = \frac{1}{n-1}\sum(\bar{x}_i - \bar{x})^2$$

We get seasonal estimates of variance. When we want for a year or for pooled over two similar seasons, variance will be obtained as in the normal case of obtaining pooled variance

Estimation of Production of Hides & Skins

Sampling Design: Stratified Two Stage Random Sampling

- Each district was divided into four strata, group of taluks formed on the basis of geographical contiguity were taken as strata
- A cluster of three adjoining villages was the **p.s.u.** Clusters of villages formed by first selecting villages with equal probability and wor and then clubbing with each of them two nearest villages, avoiding overlapping
- Households having livestock within the cluster of villages were the s.s.u's which were selected with equal probability and wor
- From each stratum, a sample of four p.s.u's was selected and from each p.s.u's a sample of 60 households having livestock were observed for detailed enquiry.

Estimation of Production of Hides & Skins (Contd.)

Sampling Design:

- In respect of selected p.s.u's all the butchers were covered under the survey
- For collecting data in respect of fallen or dead animals all the charmars in the selected p.s.u's were also covered
- A fresh sample was selected in each season
- In addition, a sample of two registered slaughter houses in each district was selected randomly every month and information on the number of animals slaughtered on the day of visit and those during the last one month was collected along with the data on various practices relating to the slaughter of animals and production of hide and skins

Estimation of Production of Hides & Skins (Contd.)

Type of data collected

- From each of the households in the sample, information of number of animals slaughtered during the previous month was collected
- From the butcher's establishment and chamar's households, information on practices of flaying animals and curing of hides and skins was collected. From such households additional information on disposal of hides and skins and their prices etc. was also collected.

Estimation Procedure

- Information on quantum of hides and skin is obtained from (i) clusters of villages as recorded from the sample of households keeping livestock (ii) all butchers (iii) all chamars handling dead and slaughtered animals and (iv) registered slaughter houses in the region

Estimation procedure is given for hides obtained from cattle/buffaloes. Procedure for estimation of skins from sheep/goats is identical.

Estimation of Production of Hides & Skins (Contd.)

Estimation Procedure (Contd.) Notations:

L : number of strata

V_i : total number of clusters of villages in the i^{th} stratum

v_i : number of clusters of villages selected out of V_i in the i^{th} stratum

H_{ij} : total number of households keeping livestock in the j^{th} cluster of villages of i^{th} stratum

h : number of households selected out of H_{ij}

x''_{sijk} : quantum of hides obtained from the animals slaughtered in the k^{th} household of the j^{th} cluster of villages in the i^{th} stratum during the s^{th} season

x'_{sij} : quantum of hides obtained from animals slaughtered by the butchers and fallen/dead animals received by the chamars in the j^{th} clusters of villages of the i^{th} stratum during the s^{th} season

Estimation of Production of Hides & Skins (Contd.)

Estimate of quantum of Hides/Skins (Contd.)

(i) From private slaughter and dead animals

Estimate of the quantum of hides obtained from animals slaughtered in households by butchers and the dead animals received by chamars during the s^{th} season is given by

$$\hat{x}_{sp} = \sum_{i=1}^{L} \frac{V_i}{v_i} \sum_{j=1}^{v_i} x_{sij}$$

where x_{sij} is the estimate of hides obtained in the j^{th} cluster of villages of i^{th} stratum during the s^{th} season and is: $x_{sij} = x'_{sij} + x''_{sij}$

where x''_{sij} is the estimate of quantum of hides from the animals slaughtered in the households and is:

$$x''_{sij} = \frac{H_{ij}}{h} \sum_{k=1}^{h} x''_{sijk}$$

Estimate of hides during the year is: $\hat{x}_p = \sum_{s=1}^{3} \hat{x}_{sp}$

Estimation of Production of Hides & Skins (Contd.)

Estimate of Hides/Skins from private slaughter & dead animals (Contd.)

Estimate of variance of $\hat{X}_{sp}$ is given by

$$\hat{V}(\hat{X}_{sp}) = \sum_{i=1}^{L} V_i^2 \left(\frac{1}{v_i} - \frac{1}{V_i}\right) s_i^2 + \sum_{i=1}^{L} \frac{V_i}{v_i} \sum_{j=1}^{v_i} H_{ij}^2 \left(\frac{1}{h} - \frac{1}{H_{ij}}\right) s_{ij}^2$$

Where $s_i^2 = \frac{1}{v_i - 1} \sum_{j=1}^{v_i} (x_{sij} - \bar{x}_{si})^2$, $\bar{x}_{si} = \frac{1}{v_i} \sum_{j=1}^{v_i} x_{sij}$

and $s_{ij}^2 = \frac{1}{h-1} \sum_{k=1}^{h} (x''_{sijk} - \bar{x}''_{sij})^2$, $\bar{x}''_{sij} = \frac{1}{h} \sum_{k=1}^{h} x''_{sijk}$

Estimate of variance of $\hat{X}_p$ is given by

$$\hat{V}(\hat{X}_p) = \sum_{s=1}^{3} \hat{V}(\hat{X}_{sp})$$

Estimation of Production of Hides & Skins (Contd.)

Estimate of quantum of Hides/Skins (Contd.)

(ii) From registered slaughter houses

Let X_R be the quantum of hides obtained from animals slaughtered in all the registered slaughtered houses in the area during the year based on complete records maintained by the state Directorate of Animal Husbandry

(iii) Estimate of quantum of hides and the estimate of its variance

The estimate of the quantum of hides is : $\hat{X} = \hat{X}_p + X_R$

Estimate of variance of $\hat{X}$ is given by

$$\hat{V}(\hat{X}) = \hat{V}(\hat{X}_p)$$

THANKS