

## **Note on sample design and estimation procedure of NSS 58<sup>th</sup> round**

### **1. Introduction**

1.1 The National Sample Survey Organisation (NSSO), engaged in collection of socio-economic data employing scientific sampling methods, started its fifty-eighth round from 1<sup>st</sup> July 2002. The survey continued till December 2002. The primary objective of this survey was to gather information on social indicators like disability and housing condition. Besides, annual round of data on household consumer expenditure and employment-unemployment were also collected.

### **2. Subject coverage**

2.1 The survey covered both mental and physical disabilities. Among the physical disabilities speech, hearing, visual and locomotor disabilities were considered. The other major topics covered were housing conditions, village facilities, slum particulars etc.

In addition, the annual consumer expenditure enquiry covering some key characteristics of employment-unemployment were also carried out on a sample of four households in each sample FSU.

2.2 **Geographical coverage:** The survey covered the whole of the Indian Union *except* (i) Leh and Kargil districts of Jammu & Kashmir, (ii) interior villages of Nagaland situated beyond five kilometres of the bus route and (iii) villages in Andaman and Nicobar Islands which remain inaccessible throughout the year.

2.3 **Period of survey and work programme:** The survey period of this round was divided into two sub-rounds of three months duration each as follows:

Sub-round 1: July-September 2002

Sub-round 2: October-December 2002

As far as possible, equal number of sample FSUs was allotted for survey in each of the two sub-rounds to ensure uniform spread of sample FSUs over the entire round. Attempt was made to cover each such FSU during the sub-round to which was allotted. *Because of the arduous field conditions, this sub-round restriction was relaxed in Andaman and Nicobar Islands, Lakshadweep, rural areas of Arunachal Pradesh and Nagaland.*

2.4 **Schedules of enquiry:** The following are lists the schedules of enquiry for this round:

schedule 0.0:	list of households
schedule 3.1:	village facilities
schedule 0.21:	particulars of slum
schedule 26:	survey of disabled persons
schedule 1.2:	housing condition
schedule 1.0:	household consumer expenditure

2.5 **Participation of States:** In this round all the States and Union Territories except Andaman & Nicobar Islands, Dadra & Nagar Haveli and Lakshadweep participated at least on an equal matching basis. The following gives the prevalent matching pattern of the participating States/UTs:

Nagaland (U):	triple
J & K , Manipur, Delhi:	double
Goa, Maharashtra (U):	one and half
remaining States and UTs:	equal

### 3. Sample Design

**3.1 Outline of Sample Design:** A stratified multi-stage design was adopted for the conduct of survey of NSS 58<sup>th</sup> round. The first-stage units were census villages (panchayat wards for Kerala) in the rural sector and the NSSO Urban Frame Survey (UFS) blocks in the urban sector. The ultimate stage units were households in both the sectors.

**3.2 Sampling Frame for First-Stage Units:** *For the rural sector*, the list of Census 1991 villages (panchayat wards for Kerala) and Census 1981 villages for J & K constituted the sampling frame. *For the urban sector*, the list of latest available Urban Frame Survey (UFS) blocks was considered as the sampling frame.

### 3.3 Stratification

**3.3.1 Rural sector:** Two **special strata** were formed as given below at the State/ UT level on the basis of Population Census 1991 viz.

Stratum 1: all FSUs with population between 0 to 50, and

Stratum 2: FSUs with population more than 15,000

The special stratum 1 was formed if at least 50 such FSU's were found in a State/UT. Similarly, special stratum 2 was formed if at least 4 such FSUs were found in a State/UT. Otherwise, such FSUs were merged with the general strata.

From the remaining FSUs (not covered under stratum 1 & 2) **general strata** (hereafter, stratum will refer to general stratum unless otherwise mentioned) was formed and numbered 3, 4, 5 .... etc. (even if no special strata have been formed). Each district of a State/UT was normally treated as a separate stratum. However, if the provisional population of the district was greater than or equal to 2.5 million *as per Census 2001*, the district was divided into two or more strata with more or less equal population as per population census 1991 by grouping contiguous tehsils. However, in Gujarat, some districts were not wholly included in an NSS region. In such cases, the part of the district falling in an NSS region constituted a separate stratum.

**3.3.2 Urban sector:** In the urban sector, stratum was formed within each NSS region on the basis of size class of towns as per *Census 1991 town population except for towns specified in Table 4. The stratum number and their composition (within each region) are given below:*

stratum 1:	all towns with population (P) < 0.1 million
stratum 2:	all towns with $0.1 \leq P < 0.5$ million
stratum 3:	all towns with $0.5 \leq P < 1$ million
stratum 4,5,6, ...	each town with $P \geq 1$ million

*The stratum numbers was retained as above even if, in some regions, some of the stratum is not formed.*

**3.4 Sub-stratification:** *There was no sub-stratification in the rural sector.* However, to cover more number of households living in slums, in urban sector each stratum was divided into 2 sub-strata as follows:

sub-stratum 1: all UFS blocks having area type 'slum area'

sub-stratum 2: remaining UFS blocks

If there was one UFS block with area type 'slum area' within a stratum, sub-stratum 1 was not formed; it was merged with sub-stratum 2.

**3.5 Total sample size (FSUs):** A total number of 8338 and 9076 first-stage units were selected for survey in the Central and State samples respectively. The sample size by State and Sector is given in the Annexure

**3.6 Allocation of total sample to States and UTs:** The total sample FSUs was allocated to the States and UTs in proportion to provisional population as per Census 2001 subject to the availability of investigators ensuring more or less uniform work-load.

**3.7 Allocation of State/ UT level sample to Rural and Urban sectors:** State/UT level sample was allocated between two sectors in proportion to provisional population *as per Census 2001* with double weightage to urban sector.

**3.8 Allocation of Rural /Urban sector level sample size to strata / sub-strata:** Both rural and urban sector samples allotted to a State/UT were allocated to different strata in proportion to population of the stratum. All the stratum-level allocations were adjusted to multiple of 2. Stratum-level sample size in the urban sector was further allocated to 2 sub-strata in proportion to the number of UFS blocks in them with double weightage to sub-stratum 1 subject to a minimum sample size of 2 or 4 to sub-stratum 1 according as stratum-level allocation is 4 or greater than 4. Sub-stratum level allocations in the urban sector were made even.

**3.9 Selection of FSUs:** FSUs were selected in the form of two independent sub-samples in both the sectors. For special stratum 2 and all the general strata of rural sector, FSUs were selected by probability proportional to size with replacement (PPSWR) where size was the 1991 census population. For urban sector and special stratum 1 of rural sector, FSUs were selected by simple random sampling without replacement (SRSWOR).

#### 4. Selection of hamlet-groups/sub-blocks / households

**4.1 Formation of hamlet-group/sub-block:** Large villages/ blocks having approximate *present population* 1200 or more were divided into a suitable number of hamlet-groups/sub-blocks as given below:

approximate present population	no. of hamlet-groups/ sub-blocks formed
less than 1200	1 (no hamlet-group/sub-block formation)
1200 to 1799	3
1800 to 2399	4
2400 to 2999	5
3000 to 3599	6
....and so on	

*For rural areas of Himachal Pradesh, Sikkim and Poonch, Rajouri, Udhampur and Doda districts of Jammu and Kashmir and Idukki district of Kerala where habitation pattern causes difficulty in listing due to topography of the area, hg formation criterion was relaxed for which number of hamlet groups formed as per population criterion is given below:*

approximate present population	no. of hamlet-groups/ sub-blocks formed
less than 600	1 (no hamlet-group/sub-block formation)
600 to 899	3
900 to 1199	4
1200 to 1499	5
....and so on	

Hamlet-groups / sub-blocks were formed by more or less equalising population. *For large urban blocks*, the sub-block (sb) having slum dwellers, if any, was selected with probability 1 and was termed as *segment 1*. However, if there were more than one sb having slum dwellers, the sb having maximum number of slum dwellers was selected as *segment 1*. After selection of sb for segment 1, one more sb was selected by simple random sampling (SRS) from the remaining sb's of the block and was termed as *segment 2*. *For large blocks (having no slum areas)* two sub-blocks were selected by simple random sampling without replacement (SRSWOR) and *were combined* to form *segment 2*. For urban blocks without sub-block formation, segment number was 1 or 2 depending on whether the block was having a slum or not. *For large villages* two hamlet-groups were selected by SRSWOR and *were combined* to form *segment 2*. For villages without hamlet-group formation, segment number was also 2. The segments were considered *separately* for listing and selection of the ultimate-stage units.

**4.2 Formation of Second Stage Strata (SSS) and selection of households for schedules 1.2 and 1.0:** In each selected village/block/segment, three and two second stage strata (SSS) were formed for schedule 1.2 and schedule 1.0 respectively on the basis of structure type in rural areas and household MPCE in urban areas. The number of households selected for each FSU is given below:

#### Schedule 1.2

	without segment formation	with segment formation (for each segment)
<i>rural</i>		
SSS 1: households having pucca dwelling structure	4	-
SSS 2: households having semi-pucca dwelling structure	4	-
SSS 3: other households	4	-
<i>urban</i>		
SSS 1: households having MPCE of top 10% of urban population	4	2
SSS 2: households having MPCE of middle 60% of urban population	4	2
SSS 3: households having MPCE of bottom 30% of urban population	4	2

The sample households were selected by SRSWOR from each SSS.

**Schedule 1.0**

	without segment formation	with segment formation (for each segment)
<i>rural</i>		
SSS 1: households having pucca dwelling structure	2	-
SSS 2: other households	2	-
<i>urban</i>		
SSS 1: households having MPCE of top 10% of urban population	2	1
SSS 2: other households	2	1

The sample households were selected by SRSWOR from each SSS.

**4.3 Formation of Second Stage Strata (SSS) and selection of households for schedule 26:** In each selected village/block/segment, three second stage strata (SSS) were formed on the basis of disability type. The number of households selected is given below:

**Schedule 26**

	Without segment formation	with segment formation (for each segment)
SSS 1: households having at least one person with mental disability	4	2
SSS 2: households having at least one person with speech/hearing/visual disability out of remaining households	4	2
SSS 3: households having at least one person with locomotor disability out of remaining households	4	2

The sample households were selected by SRSWOR from each SSS.

For a household having a person with more than one disability (i.e. multiple disability), SSS was assigned by priority criterion e.g. a household having a person with mental disability as well as locomotor disability was classified under SSS 1 and a household having one person with speech disability and another person with locomotor disability was classified under SSS 2.

#### 4. Estimation Procedure

##### 4.1 Notations:

s = subscript for s-th stratum

t = subscript for t-th sub-stratum of an urban stratum ( t = 1, 2)

m = subscript for sub-sample (m = 1, 2)

i = subscript for i-th FSU [village (panchayat ward) / block]

u = subscript for a segment (u = 1, 2)

j = subscript for j-th second stage stratum of an FSU

k = subscript for k-th sample household under a particular second stage stratum within an FSU D = total number of hg's / sb's formed in the sample village (panchayat ward) / block

$D^* = 1$  if  $D = 1$

=  $D / 2$  for rural FSUs with  $D > 1$

=  $(D - 1)$  for urban FSUs with  $D > 1$  and with segment 1

=  $D / 2$  for urban FSUs with  $D > 1$  and without segment 1

N = total number of FSUs in an urban stratum / sub-stratum or rural stratum 1

Z = total size of a general stratum or special stratum 2 of rural sector (= sum of sizes for all the FSUs of a stratum )

z = size of sample village used for selection.

n = number of sample village / block surveyed including zero cases but excluding casualty for a particular sub-sample and stratum / sub-stratum.

H = total number of households listed in a second-stage stratum of a segment of a sample FSU

h = number of households surveyed in a second-stage stratum of a segment of a sample FSU

x, y = observed value of characteristics x, y under estimation

$\hat{X}$  ,  $\hat{Y}$  = estimate of population total X, Y for the characteristics x, y

Under the above symbols,

$y_{smiujk}$  = observed value of the characteristic y for the k-th household in the j-th second stage stratum of the u-th segment (u = 1, 2) of the i-th FSU belonging to the m-th sub-sample for the s-th rural stratum;

$y_{stmiujk}$  = observed value of the characteristic y for the k-th household in the j-th second stage stratum of the u-th segment (u = 1, 2) of the i-th FSU belonging to the m-th sub-sample for the the t-th sub-stratum of s-th urban stratum

However, for ease of understanding, a few symbols have been suppressed in following paragraphs where they are obvious.

#### 4.2 Formulae for estimation of aggregates for a particular sub-sample and stratum / sub-stratum in Rural / Urban sector:

##### A) Schedule 0.0 / 3.1 / 0.21:

###### Rural:

(a) Estimation formula for stratum 1 (i.e. special stratum at State/UT level):

i) For estimating the number of households possessing a characteristic:

$$\hat{Y} = \frac{N}{n} \sum_{i=1}^n \left[ D_i^* \times y_{i2} \right]$$

where  $y_{i2}$  is the total of observed values for the characteristic  $y$  belonging to segment 2 of the  $i$ -th FSU.

ii) For estimating the number of villages possessing a characteristic:

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

where  $y_i$  is taken as 1 for sample villages possessing the characteristic and 0 otherwise.

(b) Estimation formula for other strata:

i) For estimating the number of households possessing a characteristic:

$$\hat{Y} = \frac{Z}{n} \sum_{i=1}^n \frac{1}{z_i} \left[ D_i^* \times y_{i2} \right]$$

ii) For estimating the number of villages possessing a characteristic:

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

###### Urban:

(a) Estimation formula for a sub-stratum of an urban stratum:

$$\hat{Y} = \frac{N}{n} \sum_{i=1}^n \left[ y_{i1} + D_i^* \times y_{i2} \right] ,$$

where  $y_{i1}$  and  $y_{i2}$  are the totals of observed values for the characteristic  $y$  belonging to segments 1 and 2 respectively, of the  $i$ -th FSU in the  $t^{\text{th}}$  sub-stratum and  $s^{\text{th}}$  stratum .

(b) For the  $s^{\text{th}}$  stratum:

$\hat{Y}_s = \sum_{t=1}^2 \hat{Y}_{st}$  , where  $\hat{Y}_{st}$  denotes the estimate of  $Y$  for the  $t$ -th sub-stratum of the  $s$ -th stratum.

## B) Schedule 1.0:

### Rural:

(a) Estimation formula for stratum 1:

(i) For households selected in  $j$ -th second stage stratum:

$$\hat{Y}_j = \frac{N}{n_j} \sum_{i=1}^{n_j} \left[ D_i^* \times \frac{H_{i2j}}{h_{i2j}} \sum_{k=1}^{h_{i2j}} y_{i2jk} \right] , (j = 1, 2)$$

(ii) For all selected households:

$$\hat{Y} = \sum_{j=1}^2 \hat{Y}_j$$

(b) Estimation formula for general strata:

(i) For households selected in  $j$ -th second stage stratum:

$$\hat{Y}_j = \frac{Z}{n_j} \sum_{i=1}^{n_j} \frac{1}{z_i} \left[ D_i^* \times \frac{H_{i2j}}{h_{i2j}} \sum_{k=1}^{h_{i2j}} y_{i2jk} \right] , (j = 1, 2)$$

(ii) For all selected households:

$$\hat{Y} = \sum_{j=1}^2 \hat{Y}_j$$

### Urban:

(a) Estimation formula for a sub-stratum of urban stratum

(i) For households selected in  $j$ -th second stage stratum:

$$\hat{Y}_j = \frac{N}{n_j} \sum_{i=1}^{n_j} \left[ \frac{H_{i1j}}{h_{i1j}} \sum_{k=1}^{h_{i1j}} y_{i1jk} + D_i^* \times \frac{H_{i2j}}{h_{i2j}} \sum_{k=1}^{h_{i2j}} y_{i2jk} \right] , (j = 1, 2)$$

(ii) For all selected households:

$$\hat{Y} = \sum_{j=1}^2 \hat{Y}_j$$

(b) For the s<sup>th</sup> stratum:

$$\hat{Y}_s = \sum_{t=1}^2 \hat{Y}_{st}$$

**C) Schedule 26 / 1.2:**

**Rural:**

(a) Estimation formula for stratum 1:

(i) For households selected in j-th second stage stratum:

$$\hat{Y}_j = \frac{N}{n_j} \sum_{i=1}^{n_j} \left[ D_i^* \times \frac{H_{i2j}}{h_{i2j}} \sum_{k=1}^{h_{i2j}} y_{i2jk} \right], (j = 1, 2 \text{ or } 3)$$

(ii) For all selected households:

$$\hat{Y} = \sum_{j=1}^3 \hat{Y}_j$$

(b) Estimation formulae for general strata:

(i) For households selected in j-th second stage stratum:

$$\hat{Y}_j = \frac{Z}{n_j} \sum_{i=1}^{n_j} \frac{1}{z_i} \left[ D_i^* \times \frac{H_{i2j}}{h_{i2j}} \sum_{k=1}^{h_{i2j}} y_{i2jk} \right], (j = 1, 2 \text{ or } 3)$$

(ii) For all selected households:

$$\hat{Y} = \sum_{j=1}^3 \hat{Y}_j$$

**Urban:**

(a) Estimation formula for a sub-stratum of urban stratum

(i) For households selected in j-th second stage stratum:

$$\hat{Y}_j = \frac{N}{n_j} \sum_{i=1}^{n_j} \left[ \frac{H_{i1j}}{h_{i1j}} \sum_{k=1}^{h_{i1j}} y_{i1jk} + D_i^* \times \frac{H_{i2j}}{h_{i2j}} \sum_{k=1}^{h_{i2j}} y_{i2jk} \right], (j = 1, 2 \text{ or } 3)$$

(ii) For all selected households:

$$\hat{Y} = \sum_{j=1}^3 \hat{Y}_j$$

(b) For the s<sup>th</sup> stratum:

$$\hat{Y}_s = \sum_{t=1}^2 \hat{Y}_{st}$$

#### 4.3 Overall estimate for aggregates:

Overall estimate for aggregates for a stratum ( $\hat{Y}_s$ ) / sub-stratum ( $\hat{Y}_{st}$ ) based on two sub-samples is obtained as:

$$(i) \quad \hat{Y}_s = \frac{1}{2} \sum_{m=1}^2 \hat{Y}_{sm} \quad \text{for rural stratum,}$$

$$(ii) \quad \hat{Y}_{st} = \frac{1}{2} \sum_{m=1}^2 \hat{Y}_{stm} \quad \text{for urban sub-stratum and}$$

$$(iii) \quad \hat{Y}_s = \sum_{t=1}^2 \hat{Y}_{st} \quad \text{for urban stratum}$$

#### 4.4 Overall estimate of aggregates at State/UT/all-India level:

The overall estimate  $\hat{Y}$  at the State/ UT/ all-India level is obtained by summing the stratum estimates  $\hat{Y}_s$  over all strata belonging to the State/ UT/ all-India.

#### 4.5 Estimates of ratios:

Let  $\hat{Y}$  and  $\hat{X}$  be the overall estimate of the aggregates Y and X for two characteristics y and x respectively at the State/ UT/ all-India level.

Then the combined ratio estimate ( $\hat{R}$ ) of the ratio ( $R = \frac{Y}{X}$ ) will be obtained as

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

#### 4.6 Estimates of error:

The estimated variances of the above estimates will be as follows:

A) For aggregate  $\hat{Y}$ :

$$V\hat{a}r(\hat{Y}) = \sum_s V\hat{a}r(\hat{Y}_s) = \sum_s \sum_j V\hat{a}r(\hat{Y}_{sj})$$

where  $\hat{V}ar(\hat{Y}_{sj})$  are as given below.

a) For strata with PPSWR selection at first stage (for all rural strata except stratum 1):

$$\hat{V}ar_{ppswr}(\hat{Y}_{sj}) = \sum_s \frac{1}{n_{sj}(n_{sj}-1)} \left[ \sum_{i=1}^{n_{sj}} \frac{Z_s^2 \hat{Y}_{sij}^2}{Z_{si}^2} - n_{sj} \hat{Y}_{sj}^2 \right],$$

$$\text{where } \hat{Y}_{sij} = \left[ D_{si}^* \frac{H_{si2j}}{h_{si2j}} \sum_{k=1}^{h_{si2j}} y_{si2jk} \right]$$

b) For strata with SRSWOR selection at first stage (for rural stratum 1 and all urban strata):

$$\hat{V}ar_{srswor}(\hat{Y}_{sj}) = \frac{N_s^2}{n_{sj}} \left( 1 - \frac{n_{sj}}{N_s} \right) s_{bsj}^2 + \frac{N_s}{n_{sj}} \left[ \sum_{i=1}^{n_{sj}} (v_{wsilj} + v_{wsi2j}) \right]$$

where

$$s_{bsj}^2 = \frac{1}{n_{sj}-1} \left[ \sum_{i=1}^{n_{sj}} \hat{Y}_{sij}^2 - \frac{(\sum_{i=1}^{n_{sj}} \hat{Y}_{sij})^2}{n_{sj}} \right],$$

$$v_{wsilj} = \frac{H_{si1j}^2}{h_{si1j}} \left( 1 - \frac{h_{si1j}}{H_{si1j}} \right) \frac{1}{h_{si1j}-1} \left[ \sum_{k=1}^{h_{si1j}} y_{si1jk}^2 - \frac{(\sum_{k=1}^{h_{si1j}} y_{si1jk})^2}{h_{si1j}} \right],$$

$$v_{wsi2j} = \frac{(D_{si}^* H_{si2j})^2}{h_{si2j}} \left( 1 - \frac{h_{si2j}}{D_{si}^* H_{si2j}} \right) \frac{1}{h_{si2j}-1} \left[ \sum_{k=1}^{h_{si2j}} y_{si2jk}^2 - \frac{(\sum_{k=1}^{h_{si2j}} y_{si2jk})^2}{h_{si2j}} \right],$$

$$\hat{Y}_{sij} = \left[ \frac{H_{si1j}}{h_{si1j}} \sum_{k=1}^{h_{si1j}} y_{si1jk} + D_{si}^* \frac{H_{si2j}}{h_{si2j}} \sum_{k=1}^{h_{si2j}} y_{si2jk} \right],$$

c) For urban stratum with sub-stratum formation:

$$\hat{V}ar(\hat{Y}_j) = \sum_{t=1}^2 \hat{V}ar_{srswor}(\hat{Y}_{stj})$$

where  $\hat{V}ar_{srswor}(\hat{Y}_{stj})$  can be obtained from the formula given in (b) above with appropriate choice of N, n, H, h, y etc. relating to the sub-stratum 't' only of stratum 's'.

B) For ratio  $\hat{R}$  :

$$M\hat{S}E(\hat{R}) = \frac{1}{(\hat{X})^2} \left[ \sum_s M\hat{S}E_s(\hat{R}) + \sum_{s'} M\hat{S}E_{s'}(\hat{R}) \right]$$

where s, s' indicate respectively the strata with PPSWR and SRSWOR selection at first stage.

a) For strata with PPSWR selection at first stage (for all rural strata except stratum 1):

$$M\hat{S}E_s(\hat{R}) = \frac{1}{n_s(n_s - 1)} \sum_{i=1}^{n_s} \left[ \frac{Z_s}{Z_{si}} (\hat{Y}_{si} - \hat{R}\hat{X}_{si}) - \frac{1}{n_s} \sum_{i=1}^{n_s} \frac{Z_s}{Z_{si}} (\hat{Y}_{si} - \hat{R}\hat{X}_{si}) \right]^2$$

where

$$\hat{Y}_{si} = \sum_j \hat{Y}_{sij} , \quad \hat{X}_{si} = \sum_j \hat{X}_{sij} ,$$

$$\hat{Y}_{sij} = \left[ D_{si}^* \frac{H_{si2j}}{h_{si2j}} \sum_{k=1}^{h_{si2j}} y_{si2jk} \right] , \quad \hat{X}_{sij} = \left[ D_{si}^* \frac{H_{si2j}}{h_{si2j}} \sum_{k=1}^{h_{si2j}} x_{si2jk} \right]$$

b) For strata with SRSWOR selection at first stage (for rural stratum 1 and all urban strata):

$$M\hat{S}E_{s'}(\hat{R}) = \frac{N_{s'}^2}{n_{s'}} \left( 1 - \frac{n_{s'}}{N_{s'}} \right) \frac{1}{n_{s'} - 1} \sum_{i=1}^{n_{s'}} \left[ (\hat{Y}_{s'i} - \hat{R}\hat{X}_{s'i}) - \frac{\sum_{i=1}^{n_{s'}} (\hat{Y}_{s'i} - \hat{R}\hat{X}_{s'i})}{n_{s'}} \right]^2 + \frac{N_{s'}}{n_{s'}} \sum_{i=1}^{n_{s'}} [v_{ws'i1} + v_{ws'i2}]$$

where

$$\hat{Y}_{s'i} = \sum_j \hat{Y}_{s'ij} , \quad \hat{X}_{s'i} = \sum_j \hat{X}_{s'ij} ,$$

$$\hat{Y}_{s'ij} = \left[ \frac{H_{s'i1j}}{h_{s'i1j}} \sum_{k=1}^{h_{s'i1j}} y_{s'i1jk} + D_{s'i}^* \frac{H_{s'i2j}}{h_{s'i2j}} \sum_{k=1}^{h_{s'i2j}} y_{s'i2jk} \right],$$

$$\hat{X}_{s'ij} = \left[ \frac{H_{s'i1j}}{h_{s'i1j}} \sum_{k=1}^{h_{s'i1j}} x_{s'i1jk} + D_{s'i}^* \frac{H_{s'i2j}}{h_{s'i2j}} \sum_{k=1}^{h_{s'i2j}} x_{s'i2jk} \right],$$

$$v_{ws'i1} = \sum_j v_{ws'i1j}, \quad v_{ws'i2} = \sum_j v_{ws'i2j},$$

$$v_{ws'i1j} = \frac{H_{s'i1j}^2}{h_{s'i1j}} \left( 1 - \frac{h_{s'i1j}}{H_{s'i1j}} \right) \frac{1}{h_{s'i1j} - 1} \sum_{k=1}^{h_{s'i1j}} \left[ (y_{s'i1jk} - \hat{R} \times x_{s'ij1k}) - \frac{\sum_{k=1}^{h_{s'i1j}} (y_{s'i1jk} - \hat{R} \times x_{s'ij1k})}{h_{s'i1j}} \right]^2$$

$$v_{ws'i2j} = \frac{(D_{s'i}^* H_{s'i2j})^2}{h_{s'i2j}} \left( 1 - \frac{h_{s'i2j}}{D_{s'i}^* H_{s'i2j}} \right) \frac{1}{h_{s'i2j} - 1} \sum_{k=1}^{h_{s'i2j}} \left[ (y_{s'i2jk} - \hat{R} \times x_{s'ij2k}) - \frac{\sum_{k=1}^{h_{s'i2j}} (y_{s'i2jk} - \hat{R} \times x_{s'ij2k})}{h_{s'i2j}} \right]^2$$

c) For urban stratum with sub-stratum formation:

$$M\hat{SE}_{s'}(\hat{R}) = \sum_{t=1}^2 M\hat{SE}_{s't}(\hat{R}) \quad \text{where} \quad M\hat{SE}_{s't}(\hat{R}) \quad \text{can be obtained from the formula}$$

given in (b) above with appropriate choice of N, n, H, h, y etc. relating to the sub-stratum 't' only of stratum 's'.

C) Estimates of RSE:

$$R\hat{SE}(\hat{Y}) = \frac{\sqrt{\hat{V}\hat{a}r(\hat{Y})}}{\hat{Y}} \times 100$$

$$R\hat{SE}(\hat{R}) = \frac{\sqrt{M\hat{SE}(\hat{R})}}{\hat{R}} \times 100$$

#### 4.7 Alternative estimates of errors:

Since samples have been drawn in the form of two independent sub-samples, estimates of errors for  $\hat{Y}$  and  $\hat{R}$  may also be obtained from differences of sub-sample estimates using indirect formulae.

5. **Multipliers:** The formulae for multipliers for a sub-sample m and schedule type are given below.

(i) Rural FSUs:

sch type	stratum	formula for multipliers
		segment 2
0.0 / 3.1 <sup>@</sup>	s=1	$\frac{N_s}{n_{sm}} \times D_{smi}^*$
	s ≠ 1	$\frac{Z_s}{n_{sm}} \times \frac{1}{z_{smi}} \times D_{smi}^*$
1.0	s=1	$\frac{N_s}{n_{smj}} \times D_{smi}^* \times \frac{H_{smi2j}}{h_{smi2j}}, j = 1, 2$
	s ≠ 1	$\frac{Z_s}{n_{smj}} \times \frac{1}{z_{smi}} \times D_{smi}^* \times \frac{H_{smi2j}}{h_{smi2j}}, j = 1, 2$
26 / 1.2	s=1	$\frac{N_s}{n_{smj}} \times D_{smi}^* \times \frac{H_{smi2j}}{h_{smi2j}}, j = 1, 2, 3$
	s ≠ 1	$\frac{Z_s}{n_{smj}} \times \frac{1}{z_{smi}} \times D_{smi}^* \times \frac{H_{smi2j}}{h_{smi2j}}, j = 1, 2, 3$

@ For sch. 3.1,  $D_{smi}^*$  is to be taken as 1.

(ii) Urban FSUs:

sch type	stratum	sub-stratum	formula for multipliers	
			segment 1	segment 2
0.0	s	t (t=1, 2)	$\frac{N_{st}}{n_{stm}}$	$\frac{N_{st}}{n_{stm}} \times D_{stmi}^*$
0.21	s	t (t=1, 2)	$\frac{N_{st}}{n_{stm}}$	
1.0	s	t (t=1, 2)	$\frac{N_{st}}{n_{stmj}} \times \frac{H_{stmi1j}}{h_{stmi1j}}, j = 1, 2$	$\frac{N_{st}}{n_{stm}} \times D_{stmi}^* \times \frac{H_{stmi2j}}{h_{stmi2j}}, j = 1, 2$
26 / 1.2	s	t (t=1, 2)	$\frac{N_{st}}{n_{stmj}} \times \frac{H_{stmi1j}}{h_{stmi1j}}, j = 1, 2, 3$	$\frac{N_{st}}{n_{stm}} \times D_{stmi}^* \times \frac{H_{stmi2j}}{h_{stmi2j}}, j = 1, 2, 3$

Note: (i) For estimating any characteristic for any domain not specifically considered in sample design, indicator variable may be used.

(ii) Multipliers have to be computed on the basis of information available in the listing schedule irrespective of any mismatch observed between the listing schedule and detailed enquiry schedule

## 6. Treatment for zero cases, casualty cases etc.:

6.1 While counting the number of FSUs surveyed ( $n_{stm}$ ) in a stratum/sub-stratum, all the FSUs with survey codes 1 to 6 in schedule 0.0 will be considered. In addition, for a particular schedule if no USU is available in the frame then also that FSU will be treated as surveyed in respect of that schedule. However, if the USUs of a particular schedule type are available in the frame of the FSU but none of these could be surveyed then that FSU has to be treated as casualty and it will not be treated as surveyed in respect of that schedule.

6.2 *Casualty cases*: FSUs with survey code 7 as per schedule 0.0 are treated as casualties. In addition to this, an FSU, although surveyed, may have to be treated as casualties for a particular schedule type and a particular *second stage stratum* as given in the following para:

6.2.1 FSUs with survey codes 1 and 4 as per schedule 0.0 having number of households in the frame of j-th second stage stratum greater than 0 but number of households surveyed according to data file, considering both segments together, as nil (i.e.  $H_{i1j} + H_{i2j} > 0$  but  $h_{i1j} + h_{i2j} = 0$ ) will be taken as casualties for j-th second stage stratum.

*All the FSUs with survey codes 1 to 6 as per schedule 0.0 minus the number of casualties as identified above will be taken as the number of surveyed FSUs ( $n_{stmj}$ ) for that stratum (or sub-stratum)  $\times$  second stage stratum.*

When casualty for j-th second stage stratum occurs for a particular segments but not for the other segments, the FSU will not be treated as casualty but some adjustments in the value of H for the other segments will be done as follows:

- (i) Suppose for segment 1,  $H_{i1j} > 0$  but  $h_{i1j} = 0$  while for segment 2,  $H_{i2j} > 0$  and  $h_{i2j} > 0$ . In that case  $D_i^* \times H_{i2j}$  will be replaced by  $H_{i1j} + D_i^* \times H_{i2j}$  in the formula for multiplier of segment 2.
- (ii) Suppose for segment 1,  $H_{stm1j} > 0$  and  $h_{stm1j} > 0$  while for segment 2,  $H_{i2j} > 0$  but  $h_{i2j} = 0$ . In that case  $H_{i1j}$  will be replaced by  $H_{i1j} + D_i^* \times H_{i2j}$  in the formula for multiplier of segments 1.

*It may be noted that  $n_{stmj}$  will be same for segments 1 & 2 of an FSU.*

## 7. Treatment in cases of void second-stage strata/sub-strata /strata/NSS region at FSU or enterprise level;

7.1 A stratum/ sub-stratum may be void because of the casualty of all the FSUs belonging to the stratum/ sub-stratum. This may occur in one sub-sample or in both the sub-samples. If it relates to only one sub-sample, then estimate for the void stratum/ sub-stratum may be replaced with the estimate as obtained from the other sub-sample for the same stratum/sub-stratum.

7.3 When a stratum /sub-stratum is void in both the sub-samples, the following procedure is recommended:

*Case(I): Stratum/sub-stratum void cases at FSU levels (i.e. all FSUs having survey code 7):*

- i) If a rural stratum, except stratum 1, is void then it may be merged with a similar stratum within the same NSS region.

- ii) If sub-stratum 1 of an urban stratum is void then it may be merged with sub-stratum 2 of the same stratum. If sub-stratum 2 is void or both the sub-strata are void, merging may be done with another stratum within the same NSS region sub-stratum wise.
- iii) If all the strata within an NSS region is void, it may be excluded from the coverage of the survey. The state level estimates will be based on the estimates of NSS regions for which estimates are available.

*Case (II): Stratum/ sub-stratum void case at second stage stratum level (i.e. all the FSUs are casualties for a particular second stage stratum):*

An FSU may be a casualty for a particular *second stage stratum* although survey code is not 7. If all the FSUs of a stratum/ sub-stratum become casualties in this manner for a particular *second stage stratum*, the stratum/sub-stratum will become void. The adjustment for this type of stratum /sub-stratum void case may be done according to the following guidelines.

The adjustment will be made involving other strata (within NSS region) of the State/U.T. Suppose A, B, C, and D are the four strata in the State/UT and stratum C is void for j-th *second stage stratum*. If  $\hat{Y}_{aj}$ ,  $\hat{Y}_{bj}$  and  $\hat{Y}_{dj}$  are the aggregate estimates for the strata A, B and D

respectively, then the estimate  $\hat{Y}_{cj}$  for stratum C may be obtained as  $\left( \frac{\hat{Y}_{aj} + \hat{Y}_{bj} + \hat{Y}_{dj}}{Z_a + Z_b + Z_d} \times Z_c \right)$  where  $Z_a$ ,

$Z_b$ ,  $Z_c$  and  $Z_d$  are the sizes of strata A, B, C and D respectively. Similar procedure may be adopted when j-th *second stage stratum* of a sub-stratum is void.

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