

Sampling methodology for estimation of sheep population and wool production

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ABSTRACT

Sheep rearing is an important activity, and 6 million people, especially the poor and backward sections of the society living in rural areas are engaged in this activity. In view of this importance, a study to estimate the sheep number, wool production and its related activities was carried out to get the latest estimates and also the changes which occurred due to the implementation of cross-breeding programmes in the country. The study was carried out in the districts of Kolar (Karnataka) and Bikaner (Rajasthan). The sampling design adopted under the study was stratified multi-stage random sampling and at each stage the units were selected by simple random sampling without replacement (SRSWOR). This article deals with the sampling strategy used for estimation of sheep number and wool production at district level.

Key words: Sheep population, Stratified multistage random sampling, Wool production

The livestock sector plays an important role in Indian economy. The livestock wealth of the country is highly impressive. India's livestock population according to 2003 census is 187 million cattle, 96 million buffaloes, 62 million sheep, 120 million goats and 441 million poultry. Under small ruminants, especially the sheep play a vital role in Indian economy. A comparative picture of India's position (FAO 2000) sheep ranks third in the world. In India, the sheep are mostly concentrated in the arid and semi-arid zones, hilly tracts and Deccan plateau. Rajasthan is having the maximum sheep population (25%) followed by Andhra Pradesh (17%), Karnataka (14%) and Tamil Nadu (9%). The other important areas are Jammu and Kashmir and Maharashtra. Sheep rearing, an important activity in rural economy of our country provides livelihood to nearly 6 million people. Sheep with its multiple utility such as wool, meat, skin, manure and also milk to some extent, together with its added advantage of survival in low vegetation has been the mainstay of livelihood of poor people.

Sheep based farming is prevalent in the economically backward areas of our country. Though not lucrative, even on large scale, due to the poor quality of wool, the sheep happen to be the sole breadwinner for those who are at the end of the extreme poverty. Many a poor farmer in the far flung areas of arid Rajasthan to more tropic areas like Mandya and Kolar in Karnataka would give an evidence for this species of livestock for their subsistence. Policy makers often

grapple with the lack of availability of precise ground level information in framing up a productivity programme of action of policy. The crossbreeding programmes introduced at the village panchayat level by the state animal husbandry departments of various states have failed to create the desired impact. One such example is the state of Rajasthan, which has the maximum sheep population in the country, wherein, crossbreds are virtually non-existent at the village level.

The only source of livestock statistics in the country prior to 1950 was quinquennial livestock census, which was started in 1919. The last one, prior to the present study was conducted in 1997. Presently, the census provides statistics on age-wise, sex-wise, breed-wise (crossbred and non-descript) number of animals at one point of time. Since these censuses are normally conducted after every 5 years, inter-censal estimates are not available from this source. Sample surveys provide an answer to such problems. There is a need to undertake such surveys for collecting data on additional items, which are not covered in the census.

Before start of regular surveys for estimation of livestock products, the official estimates of production were obtained by the Directorate of Marketing and Inspection (DMI), Ministry of Food and Agriculture, Government of India through market surveys. These surveys were not based on any objective criterion and as such had limited utility. For obtaining reliable estimates of livestock population, IASRI, New Delhi, initiated a number of pilot investigations for evolving an appropriate sampling methodology for estimation of livestock numbers and also providing a plan of rationalized supervision for the census work to improve the quality of the data in few selected districts of the country

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during 1951 to 1953. Pilot sample surveys were carried out in Northern and Southern regions of the country for developing a sampling methodology for simultaneous estimation of all the principal livestock products in one single survey during 1969–72 and 1971–74 respectively. The studies undertaken in these two regions demonstrated the feasibility of obtaining reliable estimates of these four livestock products simultaneously in a single survey. This approach, however, had a limitation that the estimation was somewhat complex, and the approach was simplified to the extent possible so that it could be implemented conveniently through the State Animal Husbandry Departments. The methodology so developed is now being used by different states under the Centrally Sponsored Scheme for estimation of major livestock products. Department of Animal Husbandry and Dairying, Ministry of Agriculture, Government of India is coordinating these surveys at country level.

Owing to the implementation of crossbreeding programmes in the country, the data requirements have changed but no further work has been done by the research workers in this field to review the existing methodology.

With a view to review the existing methodology and also to meet the changing data requirements, a study entitled Estimation of Wool Production - Emerging Data Needs and a Methodological Reappraisal was undertaken in 2 districts Bikaner (Rajasthan) and Kolar (Karnataka) during 2001–02.

Sampling plan

The sampling design adopted for the survey was stratified 3-stage random sampling. Each district was divided into 4 strata. The groups of tehsils/talukas formed on the basis of geographical contiguity were taken as strata. From each stratum 5% of the villages were selected for complete enumeration of sheep in each season. Since the number of villages was quite high and village size in terms of sheep population was small, the primary stage unit (psu) in Kolar district was taken as the cluster of 3 villages. For making the cluster 1 village was selected at random and 2 nearby villages as per census records were clubbed to form the cluster. Thus, the primary sampling unit (psu) was a village in Bikaner district, whereas, in Kolar district, the cluster of 3 villages each was taken as psu. The unit at the second stage (ssu) was a flock having sheep and the third and ultimate unit of sampling was sheep. The selection at each stage was done with SRSWOR. For estimating sheep number a sample of 11 psu's in Bikaner district and 12 psu's in Kolar district was selected from each stratum using cumulative \sqrt{f} method*, f being the number of psu's falling in a certain class of sheep population according to 1997 census. (*The villages of a particular stratum are arranged according to sheep population in ascending order and are clubbed into different groups falling in certain population range. The frequency of villages falling in a particular group is noted down. Then square root of each frequency (number of

villages) is taken and cumulative total of square root of the frequencies are done. After that the stratum is divided into a number of sub-strata having equal spacing in cumulative \sqrt{f} and from each sub-stratum, a sample of villages are selected in proportional to number of villages falling in that sub-stratum to the total number of villages in the stratum.) This method helped to have a better representative sample of village having different sheep population. Each psu was completely enumerated and information on sheep number according to breed, sex, age and type of flock (stationary/migratory) was recorded. For detailed enquiry and for recording wool yield of selected sheep a sub-sample of 6 psu's was selected in both Bikaner and Kolar district out of the psu's selected for complete enumeration in each stratum. From each of the psu's selected for details enquiry, a sample of 5 flocks having indigenous/local sheep and 2 flocks having crossbred sheep was selected for recording information on wool yield and other practices. In Bikaner district, no crossbred sheep were found and, therefore, all the 7 flocks having indigenous sheep were studied. Two rams or two wethers or one ram and one wether, two ewes and two lambs were selected from each flock for recording wool yield of individual sheep. The information on disposal of sheep and wool, sheep rearing practices adopted by the flock owners and the socio-economic status of flock owners was also recorded.

In addition to the above, the only sheep breeding farm of CSWRI, Regional Center available in Bikaner district and private breeding farms near to the selected psu's in Kolar district were also covered for recording information on wool yield.

The shearing of sheep in Bikaner district is generally done thrice a year, whereas, in Kolar district, it is done twice in a year. The field work of the survey was commenced in such a way that all the shearing seasons in the districts were covered.

Estimation procedure

The procedure for estimating sheep numbers, average wool yield per sheep and total wool production and also the estimates for their variances are given below. The procedure is discussed for one category of sheep say (ewes) only. For others, the procedure is identical.

Notation

Let N , number of villages in the district; n , total number of villages selected during the year, which is 15% the total number of villages in the district i.e. $n = 0.15 \times N$.

n , number of villages selected in a season i.e. $n = \frac{n'}{3}$;
 t , number of strata formed in the district; v_h total number of villages in the h -th stratum; n_h , number of villages allotted to the h -th stratum for complete enumeration of households for sheep numbers in a season.

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

v_h , sub-sample of villages selected from the n_h villages in the h -th stratum for yield estimation; x_{shir} , 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, 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, h -th stratum and in the entire district as per the latest livestock census respectively i.e.

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

Estimation of sheep population

Estimation for a season: The 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

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

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,

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

Estimate of average sheep population in the district: The estimate of average sheep population in the h -th stratum pooled over season is given by,

$$\hat{X}_h = \frac{1}{3} \sum_{s=1}^3 \hat{X}_{sh} \quad (\text{say, } s = 3)$$

and the estimate of sheep population in the district is given by,

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

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 average wool yield per sheep

Estimation of average wool yield per sheep in a season: During each shearing season, v_h villages were covered and from each flock in a sample of selected flocks within a village, 2 rams or 2 wethers or 1 ram and 1 wether, 2 ewes and 2 lambs were selected for recording individual fleece weights. The following estimates are for a sheep wether or ram, ewe or lamb.

$$\text{Let } \bar{y}_{shi} = \frac{\sum_{j=1}^{f_{shi}} \sum_{k=1}^{x_{shij}} y_{shijk}}{\sum_{j=1}^{f_{shi}} x_{shij}}$$

denotes the average wool yield per sheep in the i -th village.

x_{shij} is the number of sheep selected in s -th season, h -th stratum, i -th village, j -th flock, f_{shi} is the number of flocks selected in the i -th village.

The estimate of wool production in the i -th village is given by

$$P_{shi} = X''_{shi} \bar{y}_{shi}$$

where,

$$X''_{shi} = (\% \text{ sheep shorn}) \times X_{shi}$$

and X''_{shi} denotes the number of sheep sheared in the i -th village.

The estimate of average wool yield per sheep for the h -th stratum is given by

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

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

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

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,

$$\hat{V}(\bar{y}_s) = \sum_{h=1}^T W_h^2 \hat{V}(\bar{y}_{sh})$$

Estimate of annual wool yield per sheep: The estimate of annual wool yield per sheep in the h-th stratum is given by,

$$\bar{y}_h = \sum_{s=1}^3 \bar{y}_{sh}$$

Estimate of variance of \bar{y}_h is given by,

$$\hat{V}(\bar{y}_h) = \hat{V}(\bar{y}_{1h}) + \hat{V}(\bar{y}_{2h}) + \hat{V}(\bar{y}_{3h})$$

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

An estimate of annual wool yield per sheep for the district is given by,

$$\bar{y} = \sum_{h=1}^T W_h \bar{y}_h$$

Estimate of variance of \bar{y} is given by,

$$\hat{V}(\bar{y}) = \sum_{h=1}^T W_h^2 \hat{V}(\bar{y}_h)$$

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

Estimate of total wool production in the district

Estimate of wool production in the district in a season: The estimate of wool production

$$\hat{P}_{sh} = \hat{X}_{sh}'' \bar{y}_{sh}$$

where, \hat{X}_{sh}'' be the estimated number of sheep shorn in the h-th stratum during the s-th season and is obtained by multiplying \hat{X}_{sh}'' with percentage of sheep shorn in the h-th stratum.

Estimate of variance of \hat{P}_{sh} is given by

$$\hat{V}(\hat{P}_{sh}) = X_{sh}''^2 \hat{V}(\bar{y}_{sh}) + \bar{y}_{sh}^2 \hat{V}(X_{sh}'')$$

where, $\hat{V}(\bar{y}_{sh})$ is as defined earlier. Let P_{sh}^* be the estimated total wool production in the h-th stratum during the s-th season obtained by adding the estimated wool production for rams, ewes and lambs. The estimate of variance of P_{sh}^* is obtained by adding the estimated variances of rams-wethers, ewes and lambs.

The estimated total wool production during the s-th season

is given by,

$$P_s^* = \sum_{h=1}^T P_{sh}^*$$

The estimate of variance of P_s^* is given by,

$$\hat{V}(P_s^*) = \sum_{h=1}^T \hat{V}(P_{sh}^*)$$

Estimate of wool production of the district in a year:

$$P^* = \sum_{s=1}^3 P_s^*$$

Estimate of variance of P^* is given by,

$$\hat{V}(P^*) = \sum_{s=1}^3 \hat{V}(P_s^*)$$

The results of the survey conducted in Kolar district of Karnataka state and Bikaner district of Rajasthan state are discussed in this section.

Kolar district

Estimates of sheep number, average wool yield and total wool production—Number of sheep: The estimates of number of adult sheep sex-wise and young sheep separately for indigenous and crossbred type in each shearing season along with estimates of their percentage standard errors and also for total sheep irrespective of breed were calculated as per the estimation procedure and are presented in Table 1.

The estimates of indigenous and crossbred sheep were 652 and 33 thousand with percentage standard errors of 4.8 and 2.7 respectively. The estimates of total sheep pooled over of breeds were found to be 685 thousand with standard error of 4.5%. The number of sheep showed a decline of about 4% from season-one to season-two, but this change was, however, not found to be significant. Moreover, the estimates of sheep number, if compared from 1997 census (725 thousand) also showed a declining trend of about 6%. The main decline was observed between adult male and young sheep.

Annual wool production: An estimate of annual wool production was obtained by taking into account the total number of breed-wise sheep enumerated in each shearing season in the sample psu's and the estimate of average wool yield obtained on the basis of the records of wool yield by actual weighment during each shearing season for the selected sheep from the sample of flocks.

The season-wise estimates and the annual estimates pooled over seasons of total wool production breed-wise, classification-wise and pooled over breed and classification along with their percentage standard errors were worked out in Table 2.

Table 1. Estimate of number of adult sheep sex-wise and young

(in thousand)

Shearing season	Indigenous				Crossbreed				Total			
	Adult male	Adult female	Young	Total	Adult male	Adult female	Young	Total	Adult male	Adult female	Young	Total
I (Nov-Apr)	78.30 (4.5)	395.65 (9.8)	188.38 (9.0)	662.33 (6.4)	5.04 (4.2)	21.31 (1.9)	7.30 (10.7)	33.66 (2.7)	83.35 (4.2)	416.96 (9.3)	195.68 (8.7)	695.99 (6.1)
II (May-Oct)	76.90 (5.2)	382.28 (11.5)	182.45 (7.5)	641.63 (7.2)	4.40 (12.6)	20.25 (4.5)	7.78 (13.9)	32.43 (4.7)	81.29 (5.0)	402.54 (10.9)	190.23 (6.9)	674.06 (6.7)
Overall	77.60 (3.4)	388.97 (7.5)	185.41 (5.9)	651.98 (4.8)	4.72 (6.3)	20.78 (2.4)	7.54 (8.9)	33.04 (2.7)	82.32 (3.3)	409.75 (7.1)	192.96 (5.7)	685.02 (4.5)

The figure in brackets indicates the percentage standard error of the estimate.

Table 2. Estimate of total wool production of adult sheep sex-wise and young sheep according to breed

(in tonnes)

Shearing season	Indigenous				Crossbreed				Total			
	Adult male	Adult female	Young	Total	Adult male	Adult female	Young	Total	Adult male	Adult female	Young	Total
I (Nov-Apr)	17.4 (5.98)	73.6 (8.54)	23.9 (8.99)	114.9 (5.85)	4.2 (4.64)	18.2 (2.04)	2.7 (8.83)	25.1 (1.92)	21.6 (4.91)	91.8 (6.86)	26.6 (8.13)	140.0 (4.81)
II (May-Oct)	16.9 (4.81)	72.6 (12.10)	20.4 (7.67)	109.9 (8.15)	3.8 (14.71)	12.9 (3.83)	2.5 (16.25)	19.3 (4.42)	20.7 (4.76)	85.5 (10.29)	22.9 (7.06)	129.2 (6.97)
Overall	34.4 (3.85)	146.1 (7.39)	44.3 (6.00)	224.8 (4.98)	8.0 (7.41)	31.2 (1.99)	5.2 (9.10)	44.3 (2.21)	42.3 (3.42)	177.3 (6.10)	49.5 (5.45)	269.2 (4.18)

The figure in brackets indicates the percentage standard error of the estimate.

Table 3. Estimate of average wool yield of adult sheep sex-wise and young sheep according to breed

(in kg)

Shearing season	Indigenous				Crossbreed				Total			
	Adult male	Adult female	Young	Total	Adult male	Adult female	Young	Total	Adult male	Adult female	Young	Total
I (Nov-Apr)	0.251 (3.71)	0.226 (1.04)	0.185 (1.11)	0.217 (0.88)	1.066 (1.75)	1.005 (0.97)	0.438 (3.52)	0.890 (0.85)	0.297 (2.99)	0.270 (0.85)	0.194 (1.06)	0.250 (0.74)
II (May-Oct)	0.258 (0.85)	0.238 (1.05)	0.173 (0.98)	0.221 (0.69)	1.044 (3.51)	0.926 (1.52)	0.407 (1.88)	0.830 (1.27)	0.301 (0.96)	0.277 (0.90)	0.182 (0.92)	0.251 (0.61)
Overall	0.509 (1.88)	0.464 (0.74)	0.358 (0.75)	0.438 (0.56)	2.109 (1.95)	1.932 (0.89)	0.846 (2.04)	1.720 (0.75)	0.598 (1.56)	0.547 (0.62)	0.376 (0.71)	0.502 (0.48)

The figure in brackets indicates the percentage standard error of the estimate.

The wool production in shearing season II was about 7% less than that in season I. This is due to the reason of declining number in sheep population as well as the number of sheep shorn in that season. The total wool production in the district was estimated at 269.2 tonnes with standard errors of the major part of the total production of wool i.e. 66% was contributed by adult females, young contributed about 19% and the remaining 15% was from adult males sheep. The

contribution from crossbred sheep was around 17% of the total production in the district.

Average wool yield of sheep: The average wool yield per sheep in a shearing season was obtained by dividing the estimate of wool production in a season by the corresponding estimate of number of sheep and the estimate of annual wool yield per sheep in the year was also obtained in a similar manner. The estimates of average wool yield per sheep breed-

wise and classification-wise and pooled over breeds and classifications using appropriate weights, weights being the number of sheep for a particular breed and classification according to 1997 census for each season and also for the whole year were calculated II and are presented in Table 3.

The estimates of average wool yield between seasons differed significantly in adult female in both the breeds and young in indigenous sheep. The estimate of annual wool yield per indigenous sheep was 0.509 kg, 0.464 kg and 0.358 kg for adult males, adult females and young respectively. The corresponding estimates for crossbred sheep were 2.109 kg, 1.932 kg and 0.846 kg. The estimates of indigenous sheep were accompanied with standard errors of 1.88, 0.74 and 0.75% respectively whereas the corresponding figures in crossbred sheep were 1.95, 0.89 and 2.04%. The estimates of average wool yield per indigenous sheep pooled over all the classifications were 0.217 kg, 0.221 kg and 0.438 kg for the year and in crossbred it was 0.890 kg, 0.830 kg and 1.720 kg in 2 shearing season respectively. These estimates were subject to very high precision corresponding to standard errors ranging between 1 to 2%. The estimates pooled over breeds and classifications were 0.250 kg and 0.251 kg in 2 shearing seasons with the standard errors of even less than 1%.

Bikaner district

Estimates of sheep number, average wool yield and total wool production—Number of sheep: The estimates of number of adult sheep sex-wise, young sheep and total sheep of indigenous type in each shearing season along with the estimates of their percentage standard errors are presented in Table 4.

The sheep population in the district was only of indigenous type and the total sheep population was estimated at 1390 thousand with a standard error of 4.8%. Out of the total population about 67% were adult female, 20% young and the remaining 13% adult male. The Z-test was used to find the difference in sheep number between season I and II and nonsignificant in other classifications between different seasons. The difference in number was non-significant when pooled over all the 3 classifications. Moreover, the livestock census showed an increase of about 8% in sheep number during the period from 1997 census (1286 thousand) to the year of survey i.e. 2002. The increase in population was observed in adult female whereas in young, it showed a decreasing trend.

Annual wool production: The annual wool production was estimated by taking into account the total number of sheep enumerated in each shearing season in the sample villages and the estimate of average wool yield obtained on the basis of the records of wool yield by actual weighment for the selected sheep from the sample of flocks. The season-wise estimates and annual estimates of total wool production classification-wise along with their percentages standard

Table 4. Estimate of number of adult sheep sex-wise and young sheep

Shearing season	Indigenous			Total
	Adult male	Adult female	Young	
I (Sep-Dec)	164.4 (8.06)	950.7 (6.15)	230.9 (11.17)	1346.2 (4.85)
II (Jan-Apr)	203.8 (10.86)	907.0 (16.46)	355.6 (15.94)	1466.5 (11.00)
Overall	175.3 (5.75)	933.2 (6.54)	281.7 (8.59)	1390.3 (4.78)

Figure in brackets indicates the percentage standard error of the estimate.

Table 5. Estimate of total wool production of adult sheep sex-wise and young sheep

Shearing season	Indigenous			Total
	Adult male	Adult female	Young	
I (Sep-Dec)	224.6 (8.36)	1007.8 (5.43)	231.6 (13.82)	1464.0 (4.52)
II (Jan-Apr)	181.4 (11.99)	760.1 (25.69)	260.8 (19.84)	1222.3 (16.71)
Overall	530.9 (6.50)	2425.9 (9.15)	727.2 (10.23)	3684.0 (6.42)

Figure in brackets indicates the percentage standard error of the estimate.

Table 6. Estimate of average wool yield of adult sheep sex-wise and young sheep

Shearing season	Indigenous			Total
	Adult male	Adult female	Young	
I (Sep-Dec)	1.330 (3.01)	1.030 (1.64)	1.058 (2.12)	1.080 (1.20)
II (Jan-Apr)	0.897 (1.22)	0.808 (4.00)	0.914 (1.79)	0.851 (2.25)
III (May-Aug)	0.851 (3.64)	0.642 (3.26)	0.805 (2.73)	0.718 (1.98)
Overall	3.078 (1.68)	2.480 (1.70)	2.777 (1.28)	2.649 (1.03)

Figure in brackets indicates the percentage standard error of the estimate.

errors are presented in Table 5.

The wool production in the first shearing season was more than that in second and third shearing seasons. This is due to the fact that the average yield per sheep in this season was

more in comparison to other shearing season. Total wool production was estimate at 3684 tonnes with a standard error of 6.4%. About two-thirds of the wool production was from adult female and the remaining one-third was from adult male and lamb in all the three seasons.

Average wool yield of sheep: The average wool yield per sheep in a shearing season was obtained by dividing the estimate of total wool production in a season by the corresponding estimate of number of sheep and the estimate of annual wool yield per sheep was also obtained in a similar manner. The season-wise and annual estimates of average wool yield classification-wise and pooled over classifications using appropriate weights, weights being the number of sheep for a particular classification according to 1997 census along with their percentage standard errors were calculated as per Table 6.

The estimates of average wool yield per adult male, adult female and young were more in the first shearing season in comparison to the corresponding estimates in other two seasons. The estimates were minimum in the third season. The estimates of annual wool yield per adult male, adult female and lamb were 3.078 kg, 2.480 kg and 2.777 kg with percentage standard errors of 1.68, 1.70 and 1.28 respectively. The estimate pooled over different classifications and season was estimated at 2.649 kg with standard errors of 1.03%. The seasonal effect in the average yield for the entire three classifications, viz. adult male, adult female and young was found to be significant.

CONCLUSION

The analysis of the data revealed that there was a seasonal and stratification effect on the productivity of wool per sheep. The difference was found to be significant in all the three classifications viz. adult male, adult female and young in indigenous type of sheep in both the districts and non-significant in crossbred sheep in Kolar district. This is due to fact that the different breeds found in these two districts were area specific and wool yield was different from one breed to another. It is, therefore, recommended that few more districts covering other parts of the country including hilly

tracts can be planned for inclusion under future investigation.

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