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Methodology for estimation of meat production in North-East Hilly Region

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ABSTRACT

This article describes an alternative sampling methodology for estimation of meat production in North-East Hilly region, where existing approach leads to underestimation in meat production. The proposed methodology was implemented in East Khasi Hills district of Meghalaya to estimate the species-wise number of animals slaughtered and meat production from different sources. The estimates generated from the proposed approach were more realistic than the existing methodology.

Key words: Meat production, Meat market, NEH Region, Register butcher, Reliability, Survey design, Village

The integrated sample survey (ISS) scheme for estimation of livestock products and meat production is working well in the country where registered butcher/ slaughter houses are available. In North-East-Hilly (NEH) Region in general and Meghalaya in particular the estimates of meat production are underestimated because there are not registered butcher/slaughterhouses and meat markets are the only source of gathering information on animal slaughtered and meat production and the data on animal slaughtered are generally not collected in the villages. To overcome this problem of underestimation, meat production data are to be captured from slaughter/butcher shops located in meat markets as well as from the households residing in the villages (including unorganized butchers in the villages) and work out ratios between these 2 types of estimates. These ratios can be utilized to adjust the meat production figures collected from meat markets and to obtain reliable estimates of meat production from slaughter/butcher shops and households located in the villages without conducting sample surveys at village level every year. Ratios thus calculated need to be updated over a period of time to have the most reliable estimates of meat production in NEH Region.

Keeping in view the above, a pilot study entitled 'Sampling methodology for estimation of meat production in Meghalaya' was undertaken at Indian Agricultural Statistics Research Institute, New Delhi (Singh *et al.* 1989) . For this study, a survey was conducted in East Khasi Hills district of Meghalaya to estimate the species-wise number of animals slaughtered and meat production from different sources and to modify the existing sampling methodology (i.e., methodology based on ISS) for estimation of meat production. In particular, to work out the ratios of meat production between butcher/slaughter houses (meat markets) and households in the villages at district level with reasonable degree of precision in case of NEH-region only. The data collected under this study were utilized in this research paper. The paper presents the survey design used for collection of data; the estimation procedure for generating the estimates along with their measure of precision; results and discussion on interpretations; and finally, concluding remarks and recommendations from this research.

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MATERIALS AND METHODS

Meghalaya is divided into 7 districts namely: East Garo Hills, West Garo Hills, South Garo Hills, West Khasi Hills, Ri-Bhoi, East Khasi Hills and Jaintia Hills (Fig. 1). The East Khasi Hills district has maximum number of animals slaughtered as well as highest meat production from all sources (e.g. cattle, buffalos, pigs, sheep and goats and poultry) from 2005–06 to 2007–08. In particular, this district alone has contributed more than 50% of animals slaughtered as well as meat production from all sources in the Meghalaya during these years. It clearly indicated that East Khasi Hills district is the major meat producer in the State. Therefore, the data on animal slaughtered and species-wise meat production was collected from East Khasi Hills district to estimate the species-wise number of animals slaughtered and meat production from different sources and to work out the ratios of meat production between butcher/slaughter houses (meat markets) and households in the villages at district level with reasonable degree of precision.

The sampling design adopted in the villages was

stratified 2- stage random sampling with village as the primary sampling unit (psu) and households as the ultimate sampling unit (Singh *et al.* 1978, Sukhatme *et al.* 1984). The 8 blocks of the district were divided in 2 strata on the basis of geographical contiguity and livestock population according to *Livestock Census, 2007*. The total of 963 villages and total livestock population of 2,15,255 were also assigned to these 2 strata. Stratum-I comprises Mawphlang, Mawryngkeng, Mawsynram and Mylliem blocks and stratum-II comprises Shella-Bholaganj, Pynursla, Laitkroh and Mawkynrew blocks. There are 523 villages with 150,209 livestock population in Stratum-I and 440 villages with 65,046 livestock population Stratum-II out of total 963 villages and 215,255 livestock population in the selected district as per the Table 1.

Table 1. Allocation of different Blocks in to Stratum I and Stratum II

Name of block	Number of villages	Livestock population
Stratum I		
Mawphlang	197	67,131
Mawryngkeng	59	20,883
Mawsynram	161	29,522
Mylliem	106	32,673
Total	523	150,209
Stratum II		
Shella-Bholaganj	142	11,664
Pynursla	133	22,316
Laitkroh	98	16,022
Mawkynrew	67	15,044
Total	440	65,046

The data on number of animals and meat production were collected for 1 year from Nov. 2009 to Oct. 2010 consisting of three seasons each of 4 months in 4 rounds (each of one month duration) in each of the season as follows:

Season I- November 2009 to February 2010 (Round 1- Nov. 2009, Round 2- Dec. 2009, Round 3- Jan. 2010 and Round 4– Feb. 2010)

Season II- Mar. 2010 to Jun. 2010 (Round 1- Mar. 2010, Round 2- Apr. 2010, Round 3 May 2010 and Round 4- Jun. 2010)

Season III- Jul. 2010 to Oct. 2010 (Round 1- Jul. 2010, Round 2- Aug 2010, Round 3- Sep 2010 and Round 4- Oct. 2010)

From the selected district, a sample of 15% (5% villages in each season) villages (allocated to 2 strata in proportionate to their livestock population) was selected for recording information on livestock population using complete enumeration of the households in each of the selected village. The allocation of the sample of villages in each of the stratum was done in proportion to the livestock population in the stratum as per *Livestock Census, 2007*.

For complete enumeration, 78 villages (26 villages in each season) from stratum-1 and 66 (22 villages in each season) from stratum-2 were selected proportionally to the number of villages in each stratum. These villages were completely enumerated for recording the livestock population of species-wise livestock viz. cattle, buffalo, sheep, goat and pigs at initial stage of each season. From these selected villages in each of the season, a representative sample of 10 villages was randomly selected for detailed enquiry on species-wise number of animals slaughtered by the households. For collection of data from households in each of the selected village, 10 households were selected afresh in each round of each of the season. In case, if any, selected village did not exist (possible in the Hill areas of Meghalaya), the village has been replaced by the next nearby village for the data collection purpose.

It was mentioned earlier that unlike other States of India, there are no registered/recognized butcher/slaughter houses in Meghalaya. Here the meat markets are the major source for capturing the information on meat production in place of registered/recognized butcher/slaughterhouses. Therefore, meat markets were also considered as registered/ recognized source for collection of data on meat production. For the meat markets (daily and weekly), data are collected twice in a month on regular basis from the meat market shopowners. A complete list of 53 daily and 52 weekly meat markets in East Khasi Hills district was prepared and the enumeration of all butchers shops in all the meat markets was carried out once in a year. Note that 13 daily and 12 weekly meat markets were selected out of total daily and weekly meat markets for recording species-wise meat yield. Two butcher shops were randomly selected for recording data on meat yield for each category of animal mentioned above. The selection of butcher shops was done by the primary worker as per procedure given in instruction manual and explained in detail in the 2 training programmes held at Directorate of Animal Husbandry and Veterinary, Shillong, Meghalaya for the supervisors and field enumerators engaged in data collection work. From these enumerated meat markets, 13 weekly and 12 daily meat markets were randomly selected for collection of data on species-wise (cattle, buffalo, sheep, goat and pigs) meat yield. For estimating the species-wise average meat production per animal, i.e. meat yield from the selected district, a sample of 2 butcher/slaughter shops for each species were selected at random and information on meat production were recorded from a sample of 3 animals for each category of animals brought for slaughtering on the day of visit. In case, if less than 3 animals for any species were brought for slaughtering on the day of visit, information on available number of animals was recorded. For example, as buffalo's slaughtering was not observed as common as cattle, there were chances that less than 3 or no buffalos were slaughtered can be found on the day of visit. In such circumstances, the meat production for the total number of species-wise animal brought for slaughtering was recorded by enquiry on the day of visit.

For the purpose of collecting primary survey data, the field work was conducted with the help of Directorate of Animal Husbandry and Veterinary, Shillong, Meghalaya.

Prior to conduct the survey for collecting information on various parameters of interest, pre-testing of schedules was carried out in the village of the selected district. Intensive training to the supervisors and field investigators was imparted on the method of data collection and filling up of the different schedules designed.

ESTIMATION PROCEDURE

The information on the number of animals slaughtered is obtained from 2 sources namely, (i) from the sample of households reporting slaughter of animals and from all the butchers (if available) in randomly selected villages, and (ii) from records maintained at all the slaughterhouses/ butcher shops in daily and weekly meat markets in the selected district. Research workers fixed their notation. Let V be the number of villages in the district. n' be the total number of villages selected during the year which is 15% of total number of villages in each of the stratum of the selected district 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 district; V_h, total number of villages in h^{th} stratum; n_h, number of villages allocated to the h^{th} stratum for complete enumeration of livestock population. Thus,

$$n=\sum_{h=1}^{T} n_h=\sum_{h=1}^{2} n_h=n_1+n_2 \ .$$

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

x_{shi}, number of animals slaughtered by the households in i^{th} village during s^{th} season in h^{th} straum. 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.

Estimate of number of animals slaughtered: Estimated number of animals slaughtered in the villages by the households in a season is given by

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

and estimate of variance of $\hat{X}_{sp}$ is

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

$$S_{sh}^2 = \frac{1}{(n_h - 1)} \sum_{i=1}^{n_h} \left(x_{shi} - \bar{x}_{sh} \right)^2 \text{ and } . \ \bar{x}_{sh} = \frac{1}{n_h} \sum_{i=1}^{n_h} x_{shi}$$

Number of animals slaughtered by butcher shop owners in the meat markets is obtained as follows. Let X_{sr} be the total number of animals slaughtered in all the slaughter houses/butcher shops of the district during the s^{th} season. Then estimate of total number of animals slaughtered in the district during the s^{th} season is

$$\hat{X}_s = \hat{X}_{sp} + X_{sr} \ .$$

The estimate of variance of $\hat{X}_s$ is

$$\hat{V}(\hat{X}_s) = \hat{V}(\hat{X}_{sp}) \ .$$

Finally, estimate of total number of animals slaughtered in the district during the year is obtained as

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

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

$$\hat{V}(\hat{X}) = \sum_{s=1}^{3} \hat{V}(\hat{X}_s)$$

Estimate of average meat production per animal: The average meat production per animal in the l^{th} slaughter house/butcher shop of the h^{th} stratum during the m^{th} month of the s^{th} season is given by

$\bar{y}_{smhl} = \frac{1}{2} \sum_{k=1}^{2} y_{smhlk}$ (As 2 animals selected in each month). let X_{smhl} be the number of animals slaughtered in the l^{th} slaughter house/butcher shop of the hth stratum during m^{th} month of s^{th} season. The estimate of meat production in a month in the l^{th} slaughter house/butcher shop of the h^{th} stratum is

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

The estimate of average meat production from an animal in the s^{th} season in the district is

$$\bar{y}_s = \frac{\sum_{h}^{T} \sum_{m}^{d_s} P_{smhl}}{\sum_{h}^{T} \sum_{m}^{d_s} X_{smhl}} \ .$$

Here, d_s is the number of months in the s^{th} season, which is equal to 4 for all seasons. Estimate of variance of the $\bar{y}_s$ is

$\hat{\bar{x}}_s = \frac{1}{d_s T} \sum_{h}^{T} \sum_{m}^{d_s} x_{smhl}$, where $\hat{\bar{x}}_s = \frac{1}{d_s T} \sum_{h}^{T} \sum_{m}^{d_s} x_{smhl}$.

The estimate of average meat production from an animal in the district is given by

$$\hat{\bar{y}} = \frac{\sum_{s=1}^{3} \hat{X}_s \bar{y}_s}{\sum_{s=1}^{3} \hat{X}_s} = \frac{\hat{P}}{\hat{X}} \ , \text{ where } \hat{X}_s \text{ is already defined.}$$

Estimate of variance is approximately given by

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

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

Estimate of total meat production in the district: Now,

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

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

The estimate of variance of $\hat{P}$ is

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

RESULTS AND DISCUSSION

Authors in addition to the estimates, also reported the % standard error (SE) of the estimates to indicate their level of precision.

Estimates of species-wise number of animals slaughtered in the villages: The estimates of species-wise number of animals slaughtered by the households in different seasons of East Khasi Hills district are presented in Table 2. The results revealed that the estimate of number of pig slaughtered was maximum (15,548 with 7.56% SE) pooled over all the three seasons. The estimates of pig slaughtered were of the order of 3,420 with 4.12% SE, 5788 with 6.89% SE and 6340 with 8.37% SE in three seasons respectively. The estimates of number of goat slaughtered were observed 3,649 with 3.36% SE, 2683 with 8.74% SE and 3,238 with 5.80% SE in season 1, 2 and 3 respectively while these were to the tune of 3,300 with 4.17% SE, 837 with 5.10% SE and 1,395 with 4.68% S E in three seasons respectively for sheep. The estimates of total number of cattle slaughtered in three seasons were observed as 968 with 6.38% SE, 1,992 with 9.22% SE and 2,408 with 7.25% SE respectively. It is noteworthy that no slaughtering of buffalo was observed by the households in the villages. Pooled over all the three seasons, the estimates of animals slaughtered were 15,548 with 7.56% SE for pig followed by 9,570 with 6.14% standard error for goat, 5,532 with 4.36% SE for sheep and 5,368 with 7.95% SE for cattle. It is concluded that the small animals like sheep, goat and pig were generally slaughtered by the households and the big animals like buffalos were not slaughtered by the households in the district.

Table 2. Estimates of species-wise number of animals slaughtered in the villages

Seasons	Category-wise animals slaughtered				
	Sheep	Goat	Pig	Buffalo	Cattle
1	3300	3649	3420	0	968
	(4.17)	(3.36)	(4.12)		(6.38)
2	837	2683	5788	0	1992
	(5.10)	(8.74)	(6.89)		(9.22)
3	1395	3238	6340	0	2408
	(4.68)	(5.80)	(8.37)		(7.25)
Pooled	5532	9570	15548	0	5368
	(4.36)	(6.14)	(7.56)		(7.95)

Note: The figures in parenthesis are the corresponding% SE.

Table 3. Estimates of species-wise number of animals slaughtered in meat markets

Season	Meat market	Species-wise number of animals slaughtered				
		Sheep	Goat	Pig	Buffalo	Cattle
1	Daily	7020	29796	59540	0	49296
	Weekly	0	988	6552	0	2704
	Total	7020	30784	66092	0	52000
2	Daily	1456	27456	39052	208	43212
	Weekly	0	884	2600	104	3380
	Total	1456	28340	41652	312	46592
3	Daily	156	3068	19812	0	10712
	Weekly	0	0	1508	156	6604
	Total	156	3068	21320	156	17316
Pooled	Daily	8632	60320	118404	208	103220
	Weekly	0	1872	10660	260	12688
	Total	8632	62192	129064	468	115908

Estimates of species-wise number of animals slaughtered in meat markets: The estimates of species-wise total number of animals slaughtered in meat markets in 3 seasons are presented in (Table 3). Number of pigs slaughtered was highest in meat markets followed by cattle, goat and sheep. These were of the order of 66,092, 52,000, 30,784 and 7,020 respectively in season 1. There was no buffalos slaughtering reported from meat market. The estimates of different kind of animals slaughtered in season 2 were of the order of 46,592 for cattle, 41,652 for pig, 28,340 for goat, 1,456 for sheep and 312 for buffalo. The estimates were 21,320, 17,316, 3,068, 156 and 156 for pig, cattle, goat, buffalo and sheep respectively in season 3. Pooled over all the three seasons, these estimates were to the tune of 1,29,064, maximum for pig followed by 1,15,908 for cattle, 62,192 for goat, 8,632 for sheep and the minimum of the order of 468 for buffalo. It is concluded that the animals like pig and cattle were slaughtered while a less number of goat, sheep and buffalo were slaughtered in the meat markets.

Estimates of species-wise total number of animals

Table 4. Estimates of species-wise total number of animals slaughtered in the district

Seasons	Category of Animal slaughtered				
	Sheep	Goat	Pig	Buffalo	Cattle
1	10320	34433	69512	0	52968
	(4.17)	(3.36)	(4.12)		(6.38)
2	2293	31113	47440	312(*)	48584
	(5.10)	(8.74)	(6.89)		(9.22)
3	1551	6306	27660	156 (*)	19724
	(4.68)	(5.80)	(8.37)		(7.25)
Pooled	14164	71762	144612	468 (*)	121276
	(4.36)	(6.14)	(7.56)		(7.95)

Figures within parenthesis are corresponding% SE. * based on few observations.

slaughtered in the district: Estimates of total number of species-wise animals slaughtered in the villages and meat markets in East Khasi Hills district are given in Table 4. Table 4 revealed that the maximum numbers of pigs were slaughtered in one year from November 2009 to October 2010 in East Khasi Hills district of Meghalaya. The estimates of number of cattle slaughtered during the period of the survey were of the order of 52,968 with 6.38% SE in season 148,584 with 9.22% SE in season 2, 19,724 with 7.25%

SE in season 3 and 1,21,276 with 7.95% SE while pooled over all the 3 seasons. The estimates of goat slaughtered were 34,433 with 3.36% SE in season 1,31,113 with 8.74% SE in season 2 and 6,306 with 5.80% SE in season 3 followed by 10,320, 2,293 and 1,551 with% SEs 4.17, 5.10 and 4.68 respectively in the three seasons respectively for sheep. Pooled over all the seasons, these estimates were 71,762 with 6.14% SE for goat and 14,164 with 4.36% SE for sheep. The estimates of total number of buffaloes slaughtered in the district were based on very few observations and this estimate is observed as 468 during the complete year for all the seasons. It is concluded that slaughtering in meat markets was substantially higher as compared to the villages in the district.

Season-wise estimates of average yield (kg) of meat per animal: Season-wise estimates of average yield (kg) of meat per animal (species-wise) in East Khasi Hills were worked out on the basis of data collected from the butchers shops in daily and weekly meat markets and are presented in Table 5. For working out production estimates of sheep and goats, it was assumed that the weight of sheep and goat is approximately of same order. Pooled over all the seasons, the estimates of average yield of meat were 8.87 kg with 12.34% SE in case of sheep and goat, 70.30 kg/pig with 17.74% SE, 124.39 kg per buffalo and 85.90 per cattle with 13.70% SE in the district. The figures within square bracket [ ] represent the number of observations on which these estimates are based.

Table 5. Season-wise estimates of average yield (kg) of meat per animal

Season	Sheep	Goat	Pig	Buffalo	Cattle
1	8.34 (8.48)	8.34 [10] (8.48)	68.33 [12] (18.11)	-	90.47 [16] (12.52)
2	8.96 (12.53)	8.96 [12] (12.53)	67.25 [12] (13.65)	122.45 [2](*)	87.50 [8] (11.83)
3	9.34 (12.44)	9.34 [9] (12.44)	73.64 [18] (18.45)	125.68 [3](*)	78.09 [11] (11.64)
Pooled	8.87 (12.34)	8.87 [31] (12.34)	70.30 [42] (17.74)	124.39 [5](*)	85.90 [35] (13.70)

Figures within [ ] are the number of observations on which the estimates are based and with in () are corresponding% SE. * based on few observations.

Season-wise estimates of annual meat production (Mt Tones) of species-wise animals: Season-wise estimates of annual meat production in Mt tonnes of species-wise animals as worked out from the data collected from butcher shops in the daily and weekly meat markets are presented in Table 6. These annual estimate of meat production pertain to only East Khasi Hills district of Meghalaya from November 2009 to October 2010. The break-up of total meat production according to the different categories of animals in each of the 3 seasons and pooled over all the seasons are summarized in this Table 6.

The district level estimates of total annual meat production pooled over all the 3 seasons were 125.63 mt (49.07 mt in the villages and 76.56 mt in meat markets) from sheep, 636.53 mt (84.89 mt in the villages and 551.64 mt in meat markets) from goat, 10,166.22 mt (1,093.02 mt in the villages and 9,073.20 mt in meat markets) from pig, 58.21 mt from buffalos purely from meat markets and 10417.61 (461.11 mt in the villages and 9,956.50 mt in meat markets) from cattle. The total annual meat production in the district was estimated to the tune of 21,404.21 metric

Table 6. Season-wise estimates of annual meat production (Mt Tones) of species-wise animals

(Metric tones)

Season Village/	Market	Sheep		Goat		Pig		Buffalo		Cattle		Total Meat Production
		Number	Meat Prod.	Number	Meat Prod.	Number	Meat Prod.	Number	Meat Prod.	Number	Meat Prod.	
1	Village	3,300	27.52	3,649	30.43	3,420	233.69			968	87.57	379.22
	Market	7,020	58.55	30,784	256.74	66,092	4,516.07			52,000	4,704.44	9,535.79
	Total	10,320	86.07	34,433	287.17	69,512	4,749.75			52,968	4,792.01	9,915.01
2	Village	837	7.50	2,683	24.04	5,788	389.24			1,992	174.30	595.08
	Market	1,456	13.05	28,430	254.73	41,652	2,801.10	312	38.20	46,592	4,076.80	7,183.88
	Total	2,293	20.55	31,113	278.77	47,440	3,190.34	312	38.20	48,584	4,251.10	7,778.96
2	Village	1,395	13.03	3,238	30.24	6,340	466.88			2,408	188.04	698.19
	Market	156	1.46	3,068	28.66	21,320	1,570.00	156	19.61	17,316	1,352.21	2,971.93
	Total	1,551	14.49	6,306	58.90	27,660	2,036.88	156	19.61	19,724	1,540.25	3,670.12
Pooled	Village	5,532	49.07	9,570	84.89	15,548	1,093.02			5,368	461.11	1,688.09
	Market	8,632	76.57	62,192	551.64	1,29,064	9,073.20	468	58.21	1,15,908	9,956.50	19,716.12
	Total	14,164	125.63	71,762	636.53	1,44,612	10,166.22	468	58.21	1,21,276	10,417.61	21,404.21

Prod. – Production.

tonnes from all species of animals in which 1,688.09 mt was obtained in the villages and 19,716.12 mt in the meat markets. It is concluded that the maximum annual meat production occurred by slaughtering of cattle followed by pigs and goats. The minimum was observed in case of buffaloes followed by sheep.

It is observed that total percentage of meat production pooled over all the 3 seasons were 39.06% and 60.94% from sheep, 13.34% and 86.66% from goat, 10.75% and 89.25% from pig, 0% and 100% from buffalo and 4.43% and 95.57% from cattle in the villages and meat markets respectively. It is also observed that out of total annual meat production of 21,401.21 metric tones in the district, 7.89% (1,688.09 mt) meat was produced in the villages while 92.11% was from the meat markets.

Season-wise percentage contribution of annual meat production was maximum from cattle followed by pig in all the 3 seasons during the year. Both categories of animals contribute 96.23% meat production in season 1, 95.67% meat production in season 2 and 97.47% in season 3. A very nominal percentage of meat production was observed from other 3 categories of animals i.e. sheep, goat and buffalo. It was 3.77%, 4.33% and 2.53% in 3 seasons respectively.

The study established that a substantial percentage of meat production occurred in the villages. The annual meat production by the households was 1688.09 metric tonnes which is 7.89% of the total annual meat production in the district. Thus a significant percentage of meat production is not being counted by the State Government for estimating the meat production in the state. Small animals like sheep, goats and pigs were generally slaughtered by the households in the villages. Therefore, the data from the villages should be collected to estimate the meat production.

As North-East Hill Regions have their own difficulties to collect the data from villages, the data on animal slaughtered and meat production must be collected at a regular interval of time from the villages and a correction factor of 8.6% to the estimates of meat production from meat markets should be added as the annual meat production from villages for estimating the total annual meat production in the years for which data were not collected from the villages.

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