April 1995

ESTIMATING LIVESTOCK LOSSES

Charles Drain
U.S.D.A. National Agricultural Statistics Service

ESTIMATING LIVESTOCK LOSSES

CHARLES DRAIN, Agricultural Statistician, U.S.D.A. National Agricultural Statistics Service, Texas Agricultural Statistics Service, P.O. Box 70, Austin, TX 78767-0070

Abstract: Most information published by the Texas Agricultural Statistics Service (TASS) is based on data gathered through a system of Sample Surveys. TASS regularly surveys sampled farms and ranches and agricultural businesses in order to make statistical inference (estimates) for a total population. The alternative to using a sample survey would be to make a complete enumeration or count of the entire population. Both cost and timely results favor the survey approach. This discussion is an attempt to explain the concepts and sampling methods TASS employs in conducting basic surveys, for both inventory and death loss data for cattle, sheep and goats The discussion will include how estimates were developed for sheep and goat losses to predators and other causes during 1994.

Sampling frame

Every sample survey requires the availability of a sampling frame. The population to be sampled (for our discussion, cattle, sheep and goat operations in Texas) must be divided into sampling units. The sampling frame defines the population and identifies the operations that are available to be sampled Sampling units can be names of people representing farm or ranch operations, or units of land as delineated on photographs or maps. The basic requirements of an effective sampling frame are that its sample units, when aggregated, contain the entire population and that individual sample units do not overlap.

TASS surveys use 2 kinds of frames, the "Area Frame" and the "List Frame." The concept of area frame sampling is simple The land area to be surveyed (in this case the state of Texas) is divided into small blocks called segments, with unique and identifiable boundaries that can be delineated on aerial photographs or maps No segment has more than one chance of being selected The sample is a random selection of segments

The area frame provides a sampling vehicle for an unlimited variety of surveys The survey population can be composed of reporting units that are farm households, farm headquarters, animals, plants, grain storage facilities, or any other identifiable units that can be associated with segments of land. The primary advantage of area frame sampling is that it provides a complete frame; that is every acre of land in the state has a known chance to be selected, so all items being surveyed have a chance of being selected by their association with a unique segment An area frame does not grow out of date in terms of coverage of the population. With the area frame, extremely large samples are required to provide estimates for commodities that (a) appear in less than 20% of the segments, (b) are produced on less than 20% of the farms and ranches, or © if the farms and ranches vary widely in size.

The list frame is a list of farm or ranch operators or agribusinesses. The list frame contains names and addresses, along with control data that identify the relative size and type of the items of interest. The list frame has several advantages over the area frame. It permits the use of data collection by mail and telephone. It also allows the use of more efficient sampling methods, especially for items produced on a small percentage of farms and ranches or where there is extreme variability in size of operations, as for livestock. If the list frame of farm or ranch operators contains information on relative size, the extremely large operations can be selected with high probability, or certainty to minimize their impact on the sampling variability

A basic disadvantage of a list sampling frame is that it is nearly impossible to maintain a complete list that covers the entire population of interest, and has current classification data. In addition, maintaining a complete list frame with current names, ad-

dresses and control data for sampling purposes is very costly.

Multiple frame sampling is a survey technique that uses a combination of list and area frames to gain the advantages of both The list frame is extremely efficient for large operations and operations that produce rare items. The area frame ensures complete coverage and can be used as an independent estimator and also to estimate incompleteness of the list frame

Sample selection

A typical multiframe sample selection procedure for a commodity requires that a "frame of interest" be established for that commodity within the overall list frame For example, a cattle frame is established by identifying names with control data indicating the presence of cattle, or a sheep frame is established by identifying names with control data indicating the presence of sheep Names that do not have cattle control data are not members of the cattle frame.

The same is true for the sheep frame The classification process assigns sample units to size groups (strata) based on the relative size of previously-reported control data For example, all extremely large units are assigned to a different stratum than extremely small units An optimum allocation procedure distributes the list sample to the various strata This means that strata containing operations with large numbers of cattle may be sampled much more heavily than those having small herds The area frame segments selected are used for a measure of incompleteness.

For the January 1, 1995 cattle, sheep and goat survey, a random sample of 4,842 Texas cattle, sheep and goat producers were selected from the list frame and 5 19 tracts of land from the area frame. Survey procedures ensured that all cattle, sheep and goat producers, regardless of size, had a chance to be included in the survey The sample was selected to provide sufficient data to estimate the items of interest at the state level only Large operations were sampled more heavily than small operations (Table 1).

The survey was conducted during December 30, 1994 -January 16, 1995 by mail, telephone, and personal interview. Livestock operators were asked to report inventory data as well as total death losses for cattle and calves, and death losses by cause for sheep, lambs and goats for the 1994 calendar year.

Estimation methods and procedures

The computations and procedures for translating survey data into estimates involve technical considerations. Usually more than one method is available, but the choices are largely dictated by survey design. There are distinct differences between the way estimates are derived from probability and nonprobability surveys.

Probability surveys Probability surveys are designed on the premise that every unit in the population has a known probability of being selected The probabilities do not have to be equal, but they must be known and used in the selection process.

Estimates can be made from probability surveys without depending on prior survey information or benchmark data. Because probabilities of selection associated with the sample units are known, data collected from them can be used to obtain unbiased estimates of current agricultural activities such as sheep and goat losses to predators. Also sampling errors can be computed for probability surveys, providing the statistician with a tool for evaluating the reliability of the estimates

The factors involved in evaluating survey reliability are the sampling frame, survey design, and sample size Each is important in maintaining sampling errors at acceptable levels, although constraints on sample size are frequently imposed by budget limitations National Agricultural Statistics Service (NASS) minimizes potential nonsampling errors through survey training programs, questionnaire design and testing, simplified and uniform survey procedures, and comprehensive editing systems. The estimation model used in preparing estimates of cattle, sheep and goat death losses from the January 1, 1995 multiple frame livestock survey (area and list frame) is:

$$X\text{--}\ X_a + X_L$$

where:

X_a = the expanded total for the portion of the population included only in the area frame;

X_L = the expanded total for the portion of the population included only in the list frame.

Analysis of data

Outlier reports can influence survey expansions considerably Outlier reports are sampled operations that report either very small or very large answers that lie apart from the rest of the reports. In practice, only the extremely large reports are of concern. These reports present problems if not detected Detection is primarily limited to identifying operations with answers that vary a great deal from control data

Outliers (both list and area frame) are first identified in the machine edit List frame outliers are identified again in a special analysis summary which excludes these reports. The summary is used to measure the outliers' impact on the estimate The statistician evaluates the sampling errors associated with each estimate, with and without outliers, when establishing a range for the final estimate

Obtaining estimates of death losses

Once the survey has been conducted, data edited, summarized, and analyzed, the estimates are prepared for the items of interest, i.e., death losses by all causes for various kinds of livestock. Only total death losses were estimated for cattle and calves from the January 1, 1995 survey The survey questionnaire was not designed to obtain losses of cattle and calves by cause

Total sheep (1-year old and older) losses from all causes were estimated first using the multiple frame direct expansion and ratio to all sheep 1-year old and older inventory. The survey ratio of losses by all predators was then applied to total sheep losses to arrive at an estimate for losses by all predators The survey ratio of sheep losses by type of predator was applied to the estimate of losses by all predators to arrive at estimates by type of predator. Estimates of nonpredatory losses were prepared using the same procedure (Table 2).

Total estimates of lamb (under 1 year old) losses from all causes before and after marking, docking, or branding were prepared utilizing the multiple frame direct expansion and ratio to the 1994 lamb crop. The survey ratio of predator losses to all losses of lambs before marking, docking, or branding, and after marking, docking, or branding was applied to their respective estimate of losses from all causes to arrive at estimates of losses from predators and nonpredators. The survey ratio of losses by species of predator was applied to the estimate for each of the parts to arrive at estimates by predator species, and by cause for nonpredatory losses (Table 2).

Estimates of goat losses were not made at the state level by predator species. However estimates were prepared at the state level for all losses to predators, losses to other causes and total losses (Table 4). Combined estimates of losses by predator species were prepared for 5 states (Arizona, Michigan, New Mexico, Oklahoma and Texas) by our headquarters office in Washington, D C. (Table 3)

Literature Cited

NASS Staff Report. 1995. Sheep and Lambs Death Losses 1994.

Scope and Methods of the Statistical Reporting Service of the United States Department of Agriculture Misc. Publ No 1308.

Table 1. Texas sample allocation; 1 Jan 1995 cattle, sheep and goat survey.

Survey Strata	Strata Boundaries	Population	Sample Size	Interval	Total Reps	Sample Reps	Units per Rep
2	Cattle 1-49, Dairy 1-49	39,066	280	139.521	12	8	35
3	Cattle 50-99	14,348	216	66.425	12	8	27
4	Cattle 100-499	11,398	688	16.566	12	8	86
6	Dairy 50-199	1,125	104	10 817	12	8	13
7	Goats 1-499	2,901	160	18.131	20	16	10
13	Goats 500-2,499	272	128	2.125	20	16	8
15	Sheep 1-499	5,520	1,088	5.073	20	16	68
18	Cattle 500-2,999	2,411	560	43.305	12	8	70
19	Cattle on Feed 100-999	187	40	4.675	12	8	5
20	Sheep 500-2,499	814	640	1.271	20	16	40
21	Cattle 3,000-9,999	156	156	1.000	8	8	19
22	Dairy 200-499	451	64	7.046	12	8	8
30	Dairy 500-999	91	91	1.000	8	8	11
32	Goats 2,500-9,999	169	169	1 000	16	16	11
33	Sheep 2,500-4,999	135	135	1.000	16	16	9
34	Sheep on Feed 500-1,999	23	23	1.000	8	8	3

Table 1. (Con't.)

35	Cattle 10,000	22	22	1.000	1	1	22
36	Cattle on Feed 1,000+	137	137	1.000	1	1	137
37	Dairy 1,000	41	41	1.000	1	1	41
38	Sheep 5,000+ or Goats 10,000+	80	80	1.000	1	1	80
39	Sheep on Feed 2,000+	20	20	1 000	1	1	20
	Total List	79,367	4,842				
	Area Sample		519				
	Total Sample		5,361				

Table 2: Texas Losses of Sheep and Lambs From Predators and Other Causes, 1990 and 1994

Causes	Sheep				Lambs							
					Before marking, docking or branding				After marking, docking or branding			
	1990		1994		1990		1994		1990		1994	
	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total	Number	% of Total
	Head	*Percent*	*Head*	*Percent*	*Head*	*Percent*	*Head*	*Percent*	*Head*	*Percent*	*Head*	*Percent*
Total losses from predators	27,000	29 3	16,400	35 7	NA	--	57,000	63 1	80,000	66 7	31,000	58.4
Coyotes	16,000	59 2	7,400	45.1	NA	--	22,750	39 9	40,000	50	19,700	63.5
Dogs	4,000	14 8	2,300	14	NA	--	1,225	2 2	4,000	5	1,100	3.5
Mountain lions	1,500	5 5	3,300	20	NA	--	1,975	3 5	1,000	1.2	1,600	5.2
Bears	0	--	0	--	NA	--	75	0 1	0	--	100	0.3
Foxes	500	1 9	500	3 0	NA	--	4,175	7.3	6,000	7 5	2,000	6.5
Eagles	500	1 9	200	1 2	NA	--	13,525	23.7	8,000	10	3,200	10 3
Bobcats	500	1 9	1,400	8 5	NA	--	9,775	17 2	8,000	10	2,300	7.4
All other animals 1/	4,000	14 8	1,300	7 9	NA	--	3,500	6.1	13,000	16 3	1,000	3.2
Losses from other causes	65,000	70 7	29,600	64 3	NA	--	21,000	26 9	40,000	33 3	22,125	44.6
Digestive problems 2/	NA	--	4,575	15 5	NA	--	1,375	6 6	NA	--	2,700	12 2
Respiratory problems 3/	NA	--	325	1 1	NA	--	1,800	8 6	NA	--	800	3.6
Metabolic problems 4/	NA	--	375	1 3	NA	--	400	1 9	NA	--	200	0 9
Weather related causes 5/	NA	--	1,200	4 1	NA	--	4,250	20 2	NA	--	1,600	7.2
Theft	NA	--	500	1 7	NA	--	0	--	NA	--	700	3.2
Poisoning 6/	NA	--	925	3 1	NA	--	125	0 6	NA	--	400	1 8
Lambing problems 7/	NA	--	1,475	5 0	NA	--	--	--	NA	--	3,125	14.1
Other causes 8/	NA	--	9,700	32 8	NA	--	2,000	9 5	NA	--	3,300	14.9
Unknown causes	NA	--	10,525	35 6	NA	--	7,925	37 7	NA	--	9,300	42.1
Losses from all causes	92,000	100	46,000	100	NA	--	78,000	100	120,000	100	53,125	100

Table 2. Con't.

	Value of Losses From Predators			
	-- Dollars --		-- Dollars --	
Value per head 9/	59.00	55.00	35.00	39 00
Value	1 6 mil	0 9 mil	2.8 mil	1.2 mil

1/ Includes wolves, ravens, crows, pigs, etc
2/ Incudes bloat, scours, parasites, enterotoxemia, acidosis, etc
3/ Includes pneumonia, shipping fever, etc
4/ Include milk fever, twin lambs disease, pregnancy toxemia, etc
5/ Includes chilling, drowning, lighting
6/ Includes nitrate poisoning, noxious feed, noxious weeds, etc
7/ Includes all lambs before and after marking, docking and branding
8/ Include lameness, old age, on back, diseases not reported earlier, etc
9/ Sheep value per head based on a two-year straight average of the value of ewes one year old and older from the 1 Jan 94, and 1 Jan 95, NASS surveys Lamb value/head based on the USDA annual average price received by farmers and ranchers for 60-pound lambs

Table 3: Losses of All Goats by Specific Predators and Total Value, Five States, 1990 and 1994[1]

Year	Coyotes	Dogs	Mountain lions	Bears	Foxes	Eagles	Bobcats	All other predators	Total predators	Value 2/
					-- Head --					Dollars
1990	64,900	9,700	2,900	0	4,100	16,300	20,600	10,900	129,400	5,661,250
1994 . . .	41,000	15,000	5,000	1,000	7,000	25,000	21,000	25,000	140,000	5,481,000

[1] Includes Arizona, Michigan, New Mexico, Oklahoma and Texas. 2/ Goat value is based on a straight average of the value per head of all goats from 1990-91 and 1994-95 NASS surveys.

Table 4. Texas losses of all goats by cause, 1990 and 1994.

Year	Lost to Predators	Other causes[1]	Total losses
	No. head		
1990	121,000	45,000	166,000
1994	137,000	73,000	210,000

[1]Includes diseases, weather, theft and unknown.