

# A Survey of Sheep Diseases in Canada

I.R. Dohoo, R.A. Curtis and G.G. Finley\*

## ABSTRACT

A mail survey of disease occurrence in Canadian sheep flocks was conducted. The survey, which covered the period from September 1982 to August 1983, utilized flocks on the Record of Performance (ROP) sheep program and relatively complete data were available from 116 flocks. Data about lambing rates, incidence of a variety of lamb and ewe diseases and reasons for culling were obtained. At the same time a retrospective evaluation of records of diagnoses of sheep diseases recorded at diagnostic laboratories across the country was performed. Data from the years 1978 to 1982 were obtained and summarized.

A lambing percentage of 153% (1.53 lambs live born per ewe lambing) was observed and an additional 0.05 lambs were stillborn. The major identified causes of mortality amongst lambs were starvation, pneumonia, scours and accidents. *Pasteurella* spp. were the etiological agents most commonly associated with pneumonia in lambs and *Escherichia coli* had the same predominant position with regards to nonparasitic scours. A large discrepancy existed between the proportional mortality rates for internal parasites and coccidiosis as determined from the farm survey data compared to diagnostic laboratory data. This suggests that clinical parasitism may not be adequately recognized at the farm level.

Abortions in ewes occurred in approximately half the flocks, but generally at a low level and no severe abortion storms occurred. Pneumonia was the most commonly identified cause of mortality in ewes and although *Pasteurella* spp. appear to be the most important etiological agents,

regional differences were apparent. Pneumonia was seldomly reported as a primary reason for culling. Mastitis had a high morbidity, moderate mortality and was relatively frequently cited as a reason for culling. Prolapse of the vagina and/or uterus was a common cause of mortality and also contributed substantially to culling. As with lambs, there was evidence that the importance of parasitism in ewes may be inadequately recognized at the farm level.

**Key words:** Sheep, disease survey, diagnoses, incidence, morbidity, mortality.

## RÉSUMÉ

Les auteurs ont effectué un relevé de l'incidence des maladies qui sévissent dans les troupeaux de moutons, au Canada, à l'aide d'un questionnaire postal. L'étude couvrait la période de septembre 1982 à août 1983; elle portait sur 116 troupeaux inscrits au programme de performance et pour lesquels on disposait de données relativement complètes sur le taux d'agnelage, l'incidence et la variété des maladies des agneaux et des brebis, ainsi que sur les raisons de la réforme des troupeaux. Ils réalisèrent en même temps une analyse rétrospective des dossiers des maladies ovines diagnostiquées, de 1978 à 1982, dans les divers laboratoires de diagnostic du pays.

Le relevé démontra un taux d'agnelage de 153%, i.e. la naissance de 1,53 rejeton par brebis, et en plus la mortalité de 0,05 agneau. Les principales causes de mortalité, chez les agneaux, incluaient l'inanition, la pneumonie, la diarrhée et les accidents. *Pasteurella* spp. représentaient

les principaux agents étiologiques des pneumonies, tandis qu'*Escherichia coli* était responsable de la majorité des cas de diarrhée non parasitaire. Il existait une différence marquée entre les taux proportionnels de mortalité, attribuables aux parasites internes et à la coccidiose, enregistrés par les éleveurs et ceux qui originaient des laboratoires de diagnostic, indice que le parasitisme clinique n'est probablement pas identifié de façon adéquate par les éleveurs.

Des avortements se produisirent dans environ 50% des troupeaux, mais il s'agissait surtout de cas isolés. La pneumonie s'avéra la cause la plus fréquente des mortalités, chez les brebis; même si *Pasteurella* spp. semblèrent les agents étiologiques les plus fréquents, on enregistra toutefois des différences régionales. La pneumonie se révéla par ailleurs rarement la raison principale de la réforme des troupeaux. La mammite présenta un taux élevé de morbidité, mais un taux modéré de mortalité et, assez fréquemment, la réforme des brebis qui en souffraient. Le parasitisme des brebis, tout comme celui des agneaux, ne sembla pas identifié de façon adéquate par les éleveurs.

**Mots clés:** moutons, maladie, relevé, diagnostics, incidence, morbidité, mortalité.

## INTRODUCTION

In 1961, it was estimated that Canada had a total of 1.5 million sheep in 38,500 flocks but by 1976 these numbers had fallen to approximately 600,000 sheep in only 10,600 flocks (1). Since that time there has been an increase in the numbers of both sheep

\*Animal Pathology Division, Agriculture Canada, 2255 Carling Avenue, Ottawa, Ontario K1A 0Y9 (Dohoo), Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario N1G 2W1 (Curtis) and Animal Pathology Laboratory, Agriculture Canada, P.O. Box 1410, Sackville, New Brunswick E0A 3C0 (Finley).

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and flocks to approximately 820,000 sheep in 13,000 flocks in 1981 (1). As the industry attempts to expand it has to become more productive in order to compete with imported lamb from both the United States and overseas.

One of the major factors limiting productivity in any livestock enterprise is loss due to various disease conditions. There is very little published information about the incidence or prevalence of diseases in the Canadian sheep population. The objective of this study was to determine the incidence of major disease categories on a sample of sheep flocks from across the country and to evaluate the relative importance of various specific etiologies within those categories through a review of Canadian veterinary diagnostic laboratory records.

## MATERIALS AND METHODS

### FARM SURVEY QUESTIONNAIRES

The sampling frame used for this survey consisted of all farms registered on the Record of Performance (ROP) program for sheep which weighed 50 or more lambs during 1982. The sampling frame contained 311 farms, consisting of 310 commercial farms and one research institute flock, and all were contacted.

Three questionnaires, designated flock, lamb and ewe questionnaires, were designed and sent to all participants. The flock questionnaire was a two page questionnaire containing a mixture of multiple choice and "fill in the box" questions dealing with demographic and management information. It covered flock size and composition, housing, feeding practices, lambing procedures, disease control procedures and deworming practices.

The lamb and ewe questionnaires were both single page questionnaires consisting mainly of "fill in the box" questions. The lamb sheet requested information about the number of ewes lambing, the number of lambs born and the occurrence of a variety of lamb diseases. (The term disease is used in a very broad context to cover a wide range of conditions.) For each disease the information requested was: number of cases in lambs less than seven days old, number of cases in

lambs one week to six months, and number of deaths. The ewe questionnaire requested information about the number of ewes bred, disease occurrence and culling. For each disease the information requested was number of cases and number of deaths. Culling data consisted of numbers of ewes culled and the reasons. The disease lists on the lamb and ewe questionnaires were created using two different orderings of diseases. Approximately one half of the questionnaires had the diseases listed in the order shown in Tables II and III while the remainder had the top and bottom halves of the disease lists reversed. The questionnaires were reviewed by sheep specialists from several provinces and then pretested on six commercial flock owners. The flock owners were mailed the questionnaires and then interviewed by the senior author to determine if any questions were confusing or misunderstood. All questionnaires then underwent a final revision before being distributed.

The survey was carried out in such a way that responding producers received a total of four mailings over a period of one year. The first mailing was to be completed on January 1, 1983 and covered the period of August to December, 1982. The remaining mailings were to be completed on March 1, May 1 and August 1, 1983 and covered the periods of January to February, March to April and May to July, 1983 respectively. The first mailing contained all three questionnaires. The second, the third and the fourth mailings contained only the lamb and ewe questionnaires. Farms which did not respond to the first mailing were sent the flock questionnaire again in the second mailing. Only farms responding to either or both the first or second mailing were sent the third and fourth.

### DATA VALIDATION AND ANALYSIS

All replies to the questionnaires were held until the end of the study period and then data were coded and keypunched onto a computer file. Production data were obtained directly from ROP in the form of an electronic file and the raw data from these two sources were manipulated and merged using a series of programs

written by the senior author. Data on the computer file were validated by comparing a selected sample of records against the original replies. Maximum and minimum values for all variables were also obtained and illogical values were validated or corrected as required. In order to assess the completeness of the questionnaire data, the number of ewes lambing reported on the questionnaires was divided by the number of ewes lambing according to ROP records and the result defined as the "reporting rate". All statistical analyses of the farm survey data were carried out using the Statistical Analysis System (2). Mean morbidity and mortality rates as well as production parameters were calculated as an average of flock specific rates.

### DIAGNOSTIC LABORATORY SURVEY

A list of the major diseases of ewes and lambs was compiled and sent to all provincial and veterinary school diagnostic laboratories. The recipients were asked to provide the number of diagnoses of each condition which had been made in their laboratories during the period 1978-1982. The data were broken down by year and if possible into two age groups (less than six months, greater than six months). These data were entered directly into a microcomputer based data base management program for storage and analysis.

## RESULTS

### RESPONSE TO FARM QUESTIONNAIRES

Of the 311 farms originally contacted ten either no longer had sheep or their address had changed. Of the 301 remaining 224 (74.4%) replied to one or more of the questionnaires and 116 (38.5%) replied to at least three of the questionnaires. Unless otherwise stated all subsequent analyses reported in this paper are based on the 116 farms for which relatively complete data were available.

### DATA VALIDATION

Complete production data were available for 91 of the 116 flocks studied and the "reporting rate" was calculated for these flocks. The rate was greater than or equal to 0.8 in 86% of

the flocks and 26% had a rate greater than or equal to 1.2.

Of the 116 farms whose data was used in the analyses, 60 had the diseases listed in one order and 56 had diseases listed with the top and bottom half of the list switched. The mean morbidity rates for these two groups were compared. For the 13 lamb diseases, seven had higher mean morbidity rates based on the questionnaires in which those diseases appeared in the top half of the list as compared to the rates obtained from the questionnaires in which they appeared in the bottom half. For the other six diseases the converse was true. The corresponding values for the 14 ewe diseases were ten and four. None of the rates observed when the condition appeared on the top half of the questionnaire were significantly different from rates observed in the bottom half.

#### DESCRIPTION OF FLOCKS

Of the 116 flocks studied 44 (38%) were primarily purebred (greater than 75% of ewes purebred), 49 (42%) were primarily crossbred (greater than 75% of ewes crossbred) and 23 (20%) were mixed flocks. Twenty-one (18%) of the flocks were in the Maritime provinces, 68 (59%) were in Quebec and Ontario and 27 (23%) were in the western provinces. The mean flock size on January 1, 1983 was 113 ewes and the range was 11 to 480. The use of various flock management practices and disease control procedures is given in Table I. These flocks had a mean lambing percentage of 153% (i.e. 1.53 lambs live born per ewe lambing) and an additional 4.9% were stillborn.

#### MORBIDITY AND MORTALITY

Data about lamb morbidity and mortality are given in Table II. The main identified causes of morbidity were orf (4%), starvation (3.7%), pneumonia (2.9%), scours (2.8%) and coccidiosis (2.7%). The main identified causes of mortality were: starvation (2.4%), pneumonia (1%) and scours (0.7%). Only starvation and pneumonia caused mortality on more than 40% of farms. A mortality rate of 1.6% was attributed to "other diseases" and the main causes of loss specified in this section were: accidents (46.0% of all "other diseases" specified), congenital defects (10.9%), navel ill and abscesses

(9.3%) and intestinal accidents (including rectal prolapse) (8.1%).

Data about ewe morbidity and mortality are given in Table III. The main identified causes of morbidity were foot problems (3.9%), parasitism (internal = 2.2% and external = 2.5%), mastitis (2.1%), pneumonia (1.9%) and vaginal/uterine prolapse (1.8%). The main identified causes of mortality were pneumonia (0.8%), predator attack (0.7%) and vaginal/uterine prolapse (0.4%). Mortality from each of these three conditions was reported on 13% or more of the flocks studied. A mortality rate of 1% was attributed to "other diseases" and the main causes of loss specified in this section were: accidents (38.5% of all "other diseases" specified), dystocia (17.8%) and bloat (12.4%).

Reasons for culling of ewes are given in Table IV. Old age, low production and poor conformation can be considered voluntary reasons for cul-

ling. Of the involuntary reasons stated, the most important were, mastitis (15.2% of all culls), poor mothering (10.9%) and infertility (9.8%). Infertility did not cover all reproductive problems as approximately half (50.5%) of animals listed as culled for "other reasons" were due to a history of prolapsed vagina or uterus, dystocia or abortion. Of the "other reasons" specified a further 18.8% were listed as sold for breeding stock and 15.6% as culled for chronic weight loss.

Tables V and VI contain data obtained from the provincial and veterinary college diagnostic laboratories. Data from the veterinary colleges have been incorporated into their respective provinces. Only conditions for which five or more diagnoses were made over the five years are included. Table V contains the annual totals, the grand total and the proportion of the total found in animals under six months of age. Only six provinces were able to

TABLE I. Flock Management Practices and Disease Control Procedures used in 116 Canadian Sheep Flocks (data from 1982-1983)

Practice	% of Flocks Using
Over 50% of ewes on accelerated lambing program	20
Total confinement housing of ewes year round	11
Lambing in individual pens	22
Use of individual claiming pens	94
Feeding grain to ewes:	
prior to and during breeding period	72
in early gestation	28
in late gestation	92
during lactation	92
Age of introduction of grain to lambs:	
less than 2 weeks	32
2 to 3 weeks	49
over 3 weeks	18
never	2
Age of weaning lambs:	
less than 7 weeks	10
7 to 8 weeks	28
9 to 12 weeks	39
over 12 weeks	22
Use of:	
clostridial vaccines	87
chlamydial (enzootic abortion) vaccine	3
contagious ecthyma (orf) vaccine	3
foot rot vaccine	8
Vit E and Se injection in lambs	77
lice and/or tick control products	70
Frequency of deworming of mature ewes:	
never	1
once a year	9
twice a year	42
three times per year	36
more than three times per year	12
Use different wormers on a rotational basis	70

**TABLE II. Lamb Morbidity and Mortality in 116 Canadian Sheep Flocks (data from 1982-1983)**

Condition	Morbidity				Mortality		
	Mean (%)	Flocks Reporting <sup>a</sup> (%)	Max (%)	% in Lambs 0-7 Days of Age	Mean (%)	Flocks Reporting <sup>a</sup> (%)	Max (%)
Starvation <sup>b</sup>	3.7	75	48	91	2.4	66	30
Predator attack	0.2	7	5	15	0.1	6	5
Scours	2.8	34	45	23	0.7	13	45
White muscle disease	0.2	10	5	24	0.1	5	2
Pneumonia <sup>c</sup>	2.9	54	55	18	1.0	41	13
Orf	4.0	24	100	3	0.0	2	1
Foot problems	0.4	12	17	1	0.0	0	0
Urinary calculi	0.1	9	3	5	0.1	5	2
Pulpy kidney	0.3	13	4	0	0.3	13	4
Clostridial disease <sup>d</sup>	0.0	1	1	33	0.0	1	1
External parasites <sup>c</sup>	0.9	3	46	56	0.0	0	0
Internal parasites <sup>c</sup>	1.0	13	38	0	0.1	6	6
Coccidiosis <sup>e</sup>	2.7	16	85	22	0.0	3	2
Other diseases	2.0	66	30	43	1.6	57	30
Diagnosis unknown	0.9	42	6	52	0.8	38	6

<sup>a</sup>% of flocks reporting one or more occurrence of the condition

<sup>b</sup>Includes weak lambs and rejected lambs and hypothermia

<sup>c</sup>Includes all respiratory diseases

<sup>d</sup>Includes blackleg, tetanus, malignant edema

<sup>e</sup>Only includes "clinically evident" cases of parasitism

**TABLE III. Ewe Morbidity and Mortality in 116 Canadian Sheep Flocks (data from 1982-1983)**

Condition	Morbidity			Mortality		
	Mean (%)	Flocks Reporting <sup>a</sup> (%)	Max (%)	Mean (%)	Flocks Reporting <sup>a</sup> (%)	Max (%)
Abortion	1.4	46	16	0.2	11	7
Pregnancy toxemia	0.5	19	9	0.2	7	6
Vaginal prolapse <sup>b</sup>	1.8	59	10	0.4	18	6
Orf	1.5	18	43	0.0	1	1
Mastitis	2.1	62	22	0.2	12	8
Pneumonia <sup>c</sup>	1.9	40	57	0.8	20	43
Scours	0.7	10	55	0.0	1	4
Foot problems	3.9	34	55	0.0	1	2
Listeriosis	0.2	9	5	0.1	7	3
Clostridial disease <sup>d</sup>	0.0	1	3	0.0	1	3
Abscess	1.4	33	30	0.1	7	4
External parasites <sup>c</sup>	2.2	6	100	0.0	0	0
Internal parasites <sup>c</sup>	2.5	12	100	0.0	2	2
Predator attack	0.8	13	47	0.7	13	47
Other diseases	1.8	53	15	1.0	29	7
Diagnosis unknown	1.0	37	19	0.5	41	6

<sup>a</sup>% of flocks reporting one or more occurrence of the condition

<sup>b</sup>Includes vaginal and uterine prolapses

<sup>c</sup>Includes all respiratory diseases

<sup>d</sup>Includes blackleg, tetanus, braxi

<sup>e</sup>Only includes "clinically evident" cases of parasitism

**TABLE IV. Reasons for Culling from 116 Canadian Sheep Flocks (data from 1982-1983)**

Reason	% of Total Culls	Reason	% of Total Culls
Old age	24.8	Poor conformation	4.8
Low production	15.3	Pneumonia	3.6
Mastitis	15.2	Lameness	2.0
Poor mothering	10.9	Bad teeth	1.7
Infertility	9.8	Other reasons	12.0

subdivide the cases into those occurring in lambs six months of age or younger versus those occurring in older animals and consequently the proportions given in the last column of Table V are based on data from those provinces only. Table VI contains proportional mortality rates for the same list of diseases broken down by geographic areas. The proportional mortality rate is the number of cases of a specific condition divided by the total number of diagnoses reported from the region.

## DISCUSSION

All of the flocks contacted in this survey were on the ROP testing program and consequently may represent a biased sample of Canadian sheep producers. However, use of ROP flocks was the only way to ensure that productivity data were available for the flocks studied and also enabled the sample to be aimed at only flocks of a certain minimum size. The overall response rate of 74.4% would normally be considered satisfactory for a survey using only mailed questionnaires. However, the analyses required complete data from flocks and consequently only the data from the 38.5% of the flocks which completed at least three of the questionnaires were used. The effects of using only the data provided by the most cooperative flock owners are unknown.

The 116 flocks for which relatively complete data were available represent approximately 1.1% of the flocks in the country but the 13,128 ewes that they contained on January 1, 1983 represented about 3.6% of the national flock.

Calculation of the "reporting rate" was a method of assessing the completeness of information obtained from the 116 study farms. The fact that data for at least 80% of ewes lambing were reported on 86% of the farms indicates the data used in the analyses were reasonably complete. The fact that 26% of farms had a rate over 120% is probably a result of not all ewes in a flock being part of the ROP program. For example, a farm with both purebred and crossbred ewes may only register the purebreds on ROP but may have provided information about all animals during the survey.

In a mail survey of reasons for culling of dairy cows it was found that reasons at the top of the list were more likely to be reported than reasons lower down (3). In order to determine if the order in which diseases were listed affected the results in this survey, two different orderings of disease were used. There was no consistent trend for the mean morbidity rate to be higher if the disease was in the top half of the list than in the bottom and none of the differences between rates obtained from the two orderings were significant. Consequently, it is concluded that the ordering of diseases had little effect on the rates reported.

No information is available regarding conception rates among ewes as this requires a cohort study to determine. The lambing rate of 153% is slightly lower than the rate (164%) observed in all flocks on the ROP sheep program (4) and is substantially less than the figure of 179% reported for some commercial flocks on an estrus synchronization program (5). The stillbirth rate of 4.9% is within generally accepted limits but, as with all morbidity and mortality rates presented in this paper, may be a conservative estimate. Not all flocks included in this study kept records of all illness and deaths and consequently some of the questionnaires were filled out from memory. It is more likely that some disease events or deaths would be forgotten than nonexistent ones listed and consequently all reported rates should be considered to be conservative estimates.

Data from the provincial and veterinary college diagnostic laboratories were obtained in order to estimate the relative importance of various etiologies within broad diagnostic groups. The number of diagnoses of a given condition reported by a laboratory is a function of both the incidence of the condition and the probability of the animal (or appropriate samples) being submitted to the laboratory. Consequently, conditions resulting in clinical signs which are alarming to the producer or veterinarian may be seen more frequently than more benign conditions. The diagnoses recorded also only represent the final cause of death. Underlying, predisposing or secondary conditions were not considered. In addition, not all laboratories

TABLE V. Summary of Number of Diagnoses of Selected Sheep Diseases in Canadian Diagnostic Laboratories by Year (data from 1978 to 1982)

	Year					Total <sup>a</sup>	C <sub>2</sub> in lambs < 6 mo
	78	79	80	81	82		
Abortions							
Chlamydia	7	5	15	17	23	67	0
Toxoplasmosis	0	8	32	11	9	60	0
<i>B. ovis</i>	3	0	0	2	6	11	0
Other	126	167	242	251	193	989	0
Clostridial Diseases							
Blackleg	2	4	2	1	1	10	40
Malignant edema	4	15	7	9	3	38	41
Braxi (septicum)	6	11	8	11	10	46	100
Black Disease (novyi)	2	4	4	4	2	16	27
Tetanus	3	3	7	4	6	23	100
Enterotoxemia (D)	43	62	32	30	37	204	71
Diarrheal Diseases							
<i>E. coli</i>	50	78	47	72	44	294	96
<i>Salmonella</i>	2	5	6	11	9	33	62
Cryptosporidiosis	0	0	7	0	2	10	100
Enterotoxemia (ABCE)	13	13	11	8	6	51	100
Pneumonia							
Mycoplasma	4	4	10	27	21	66	100
<i>Past. haemolytica</i>	84	278	182	142	129	820	83
<i>Past. multocida</i>	62	106	125	142	106	542	68
Maedi-visna	8	16	17	17	20	79	0
Mycotic	8	1	0	1	8	18	86
Pulmonary adenomatosis	0	1	28	22	3	54	4
Parasitic	22	24	35	117	52	258	30
Interstitial	46	43	66	75	43	282	51
Other	101	175	225	166	210	878	48
Septicemia							
Coliforms	62	39	61	82	33	277	91
<i>Pasteurella</i> spp.	21	26	17	29	25	118	75
<i>Salmonella</i>	3	10	7	7	4	31	73
Others	45	36	42	40	41	216	67
Mastitis							
<i>E. coli</i>	0	3	5	1	2	11	0
<i>Staph. aureus</i>	1	7	6	2	9	25	0
<i>Sirep.agalactia</i>	0	5	2	2	3	12	0
Other	10	10	15	15	9	60	0
Nutritional							
Starvation and/or emaciation	103	92	122	170	173	676	71
White muscle	80	77	112	129	105	505	89
Pregnancy toxemia	9	8	21	19	12	71	0
Copper deficiency	6	5	7	3	3	24	29
Copper toxicosis	12	15	26	21	34	112	19
Parasites — Internal							
Coccidiosis	81	77	102	137	120	519	85
Cestodiasis	14	8	15	19	11	71	68
Nematodiasis	115	113	186	292	174	886	55
Parasites — External							
Acariasis	7	0	1	4	1	13	67
Pediculosis	4	0	1	3	7	15	67
Myiasis	0	1	6	13	0	20	67
Miscellaneous Conditions							
Nasal adenocarcinoma	1	0	0	5	4	13	0
Other neoplasia	10	19	31	19	7	86	0
Listeriosis	50	42	51	62	49	257	31
Other neurological	26	49	51	56	38	231	38
Footrot	2	7	4	5	3	21	100
Other foot problems	28	4	1	0	7	40	25
Abomasitis	18	10	26	28	23	117	48
Johne's	15	13	23	25	33	113	0
Lymphadenitis	26	28	38	35	47	183	17
Nephritis	28	31	45	14	29	150	33
Omphalitis	8	4	16	11	11	51	92
Contagious ecthyma	22	18	9	14	11	76	67
Pericarditis	7	12	12	18	8	59	44
Rabies	0	1	1	2	2	6	0
Reticuloperitonitis	3	3	2	0	2	10	50
Rumenitis	7	15	12	17	26	79	36
Toxoplasmosis	0	1	4	1	2	8	100
Tuberculosis	4	1	0	0	1	6	0
Tympany (bloat)	20	39	41	43	40	185	32
Urinary calculi	5	8	7	14	6	40	57
Vaginal or uterine prolapse	20	16	5	2	8	51	0
Total Number of Diagnoses	1469	1876	2241	2499	2066	10296	

<sup>a</sup>Due to a relatively small number of diagnoses at the Ontario Veterinary College their data were not subdivided by year and consequently only appear in the total column

TABLE VI. Proportional Mortality Rates for Selected Sheep Diseases (Data from Canadian Diagnostic Laboratories,<sup>a</sup> 1978 to 1982)

	Maritime Provinces	Quebec	Ontario	Prairie Provinces	British Columbia	National Totals
Abortions						
Chlamydia	0.8	0.3	0.3	0.9	1.2	0.7
Toxoplasmosis	1.1	0.4	1.0	0	0	0.6
<i>B. ovis</i>	0	0	0	0.4	0	0.1
Other	9.6	5.9	11.1	12.6	7.9	9.6
Clostridial Diseases						
Blackleg	0.1	0.0	0.1	0.2	0	0.1
Malignant edema	0.1	0.2	0.3	0.6	1.7	0.4
Braxi (septicum)	0.2	0.2	0.1	1.4	0	0.5
Black Disease (novyi)	0	0	0	0.1	2.2	0.2
Tetanus	0.3	0.3	0.1	0.2	0.3	0.2
Enterotoxemia (D)	1.9	0.6	1.6	2.6	6.5	2.0
Diarrheic Diseases						
<i>E. coli</i>	3.7	1.6	1.6	4.2	3.3	2.9
<i>Salmonella</i>	0.5	0.1	0.4	0.2	1.0	0.3
Cryptosporidiosis	0	0.3	0.2	0	0	0.1
Enterotoxemia (ABCE)	0.4	0.1	0	0.6	0	0.5
Pneumonia						
Mycoplasma	0	1.1	0.6	0.3	1.2	0.6
<i>Past. haemolytica</i>	6.1	8.6	2.3	13.2	9.2	8.0
<i>Past. multocida</i>	4.1	5.5	11.1	2.4	1.8	5.2
Maedi-visna	0.2	2.0	0.6	0.4	0	0.8
Mycotic	0.2	1.5	0.1	0.1	0.3	0.2
Pulmonary adenomatosis	2.0	0	0	0.1	0	0.5
Parasitic	5.5	1.4	1.1	0.4	8.0	2.5
Interstitial	1.9	1.1	4.5	4.5	0.2	2.7
Other	7.7	14.4	0.1	10.9	4.2	8.5
Septicemia						
Coliforms	4.7	1.7	1.8	1.8	4.5	0
<i>Pasteurella</i> spp.	0.7	0.5	2.3	1.2	1.5	2.7
<i>Salmonella</i>	0.1	0.1	0.2	0.4	0.8	1.2
Others	0.9	0.6	4.6	2.4	4.2	0.3
						2.1
Mastitis						
<i>E. coli</i>	0.2	0.2	0	0.1	0	0.1
<i>Staph. aureus</i>	0.4	0	0	0.5	0	0.2
<i>Strep. agalactia</i>	0.2	0	0	0.2	0	0.1
Other	0.8	0.6	0.6	0.4	0.7	0.6
Nutritional						
Starvation and or emaciation	9.3	6.5	8.0	4.6	0	6.6
White muscle	6.4	5.4	4.2	2.7	6.8	4.9
Pregnancy toxemia	0.2	0.6	0.5	1.1	1.2	0.7
Copper deficiency	0	0	0.1	0.3	2.3	0.2
Copper toxicosis	0.4	1.0	3.4	0.3	0	1.1
Parasites — Internal						
Coccidiosis	4.4	8.4	4.5	2.3	4.5	5.0
Cestodiasis	1.2	0.7	0.8	0.2	0.8	0.7
Nematodiasis	7.8	14.9	10.3	1.2	7.8	8.6
Parasites — External						
Acariasis	1.5	0	0.1	0.1	0	0.1
Pediculosis	0.1	0.3	0.2	0	0.2	0.2
Myiasis	0.3	0	0.1	0.4	0	0.2
Miscellaneous Conditions						
Nasal adenocarcinoma	0.2	0.0	0.2	0	0	0.1
Other neoplasia	0.2	0.2	0	2.4	2.3	0.8
Listeriosis	1.3	2.7	4.5	1.8	3.5	2.5
Other neurological	1.3	1.6	4.8	1.5	4.0	2.3
Footrot	0	0	0.1	0.7	0	0.2
Other foot problems	1.4	0	0	0.2	0	0.4
Abomasitis	1.3	1.0	1.5	1.2	0	1.2
John's	0.2	0.6	1.3	2.3	0.8	1.1
Lymphadenitis	0.2	2.7	2.6	1.9	0.8	1.8
Nephritis	1.2	0.9	0.8	2.4	1.5	1.5
Omphalitis	0.5	0.6	0.3	0.4	0.5	0.5
Contagious ecthyma	1.5	0.4	0.4	0.6	0	0.7
Pericarditis	0.7	0.3	0.8	0.7	0	0.6
Rabies	0	0	0.3	0.1	0	0.0
Reticuloperitonitis	0.1	0	0.3	0.1	0	0.1
Rumenitis	0.3	0	1.1	1.9	0	0.8
Toxoplasmosis	0	0.1	0.2	0.1	0	0.1
Tuberculosis	0	0	0	0.2	0	0
Tympany (bloat)	1.1	0.5	0	3.8	1.8	1.8
Urinary calculi	0.3	0.4	0.3	0.5	0.5	0.4
Vaginal or uterine prolapse	1.4	0.3	0	0.2	0	0.5

<sup>a</sup>Data from the veterinary colleges are incorporated into their respective provinces

record diagnoses in the same manner so some interpretation had to be applied in order to summarize the information. For example, some provinces describe pneumonic conditions morphologically instead of etiologically. To combine this data with etiological diagnoses from other provinces the following assumptions were made: fibrinous pneumonia = *P. haemolytica*, bronchopneumonia = *P. multocida* and enzootic pneumonia = mycoplasma pneumonia. Although these assumptions may not be true for all specific cases they should give an indication as to the relative importance of various etiologies.

Data for individual years have been presented as number of cases but since the total numbers of diagnoses made was not constant over the years, comparison of one year to another must be made with caution. Data for geographic regions have been presented as proportional mortality rates which adjust for the differences in the total number of diagnoses made in the regions.

#### LAMB DISEASES

Total lamb losses (stillbirths plus lamb mortality) were estimated to be 12.1% (4.9% + 7.2%) but as previously indicated this is likely a conservative estimate. There is no published Canadian literature with which to compare this value but it has been suggested that losses of 15-20% are common in Australia (6) and a recent intensive study of losses in a large Scottish flock reported a total loss of 25.8%, of which 7.2% were stillbirths (7). The objective of this paper is to evaluate the relative importance of various conditions and unless there are different reporting rates for different diseases, their relative importance will be consistent even if estimates of incidence rates are conservative.

The category "starvation" included weak lambs, lambs rejected by their dam and cases of hypothermia. It is likely that some cases recorded as stillborn may have been early postnatal losses and vice versa since the two are difficult to distinguish clinically unless the lambing is observed. Virtually all cases (91%) occurred within the first seven days. A large proportion of losses reported under "other conditions" were also losses which generally

affect lambs less than one week of age (accidental crushing, congenital defects, intestinal accidents) so this first week of life is clearly the most critical for lambs. Unpublished data from a study of lamb losses in Nova Scotia attributed 78% of losses to dystocia and starvation. Relatively few lambs dying in this period are presented to diagnostic laboratories and the overall proportional morbidity for starvation in the laboratories was only 6.6%. Septicemias, particularly coliform septicemia, generally occur in lambs (Table V) and may contribute to these losses in the first week of life.

Pneumonia in lambs was the second most important cause of mortality and accounted for 13.9% of all lamb mortality. This is a higher proportion of mortality than has been reported in recent studies from the United Kingdom (4.4%) (7) and the United States (7.7%) (8). The condition appears to be widespread in that it occurred on 54% of farms but the maximum mortality rate for any one farm was 13%.

From an etiological stand point, pneumonias associated with *Pasteurella* spp. are clearly the most important, although approximately one half of the 273 cases of interstitial pneumonia reported, were in lambs. There is no clear trend in the number of cases observed over the five year period for which data were gathered (Table V) but *P. multocida* appears to be the greatest problem in Ontario and *P. haemolytica* the main agent in Western Canada. The large number of "other pneumonias" are likely to be those which were not cultured and for which an etiological agent was not identified. *Mycoplasma* spp. were not identified as the primary agents for very many cases of pneumonia, but when they were, they were invariably in lambs.

The clinical entity "scours" was reported to occur in 34% of flocks and caused a mortality of 0.7%. Separate categories were available for clinical internal parasitism and coccidiosis but some parasitic induced cases of diarrhea are likely to be included in the category scours if the owner was unaware of the specific diagnosis. Approximately one quarter of the morbidity was reported in lambs under one week of age and based on the data from diagnostic laboratories

*E. coli* was the most frequently isolated infectious agent in all regions of Canada.

Clinical parasitism (internal) and coccidiosis were reported in lambs on 13% and 16% of farms respectively and caused mortality on 6% and 3% of farms. As indicated previously some cases of diarrhea recorded simply as scours may in fact have been due to internal parasites. Further evidence of the importance of nematodiasis and coccidiosis as causes of mortality in lambs is provided by the diagnostic laboratory data. These two conditions accounted for 8.6% and 5.0% of all deaths respectively (with 55% and 85% occurring in lambs) and only the prairie provinces had relatively low proportional mortality rates (Table VI). By comparison only 1.4% of all mortality on the farms was attributed to parasitism, suggesting that the problem may not be adequately recognized at the farm level. There is no published information dealing with the prevalence of parasitism on a national basis but heavy infestations have been reported in one region of Quebec (9,10). Examination of the data in Table V suggests that internal parasitism may be increasing in importance as a cause of lamb mortality. Mortality is likely to be the "tip of the iceberg" in terms of economic loss (11) which make these observations even more alarming. There appears to be substantial variation in the frequency with which ewes are dewormed and 30% of the producers did not indicate that wormers were used on a rotational basis.

Clinical illness due to external parasitism was reported in only 3% of flocks but affected up to 40% of animals in an affected flock. No mortality was attributed to external parasites on the farms and they were seldom identified as a cause of death in diagnostic laboratories. As with internal parasites, their major economic effect may be through reduced productivity (11). Use of lice and/or tick control products was reported by 70% of producers.

Pulpy kidney (*Clostridium perfringens* type D) was reported in 13% of flocks and when it occurred was invariably fatal (both morbidity and mortality rates equal to 0.3%). Based on regional proportional mortality rates

(Table VI) the problem appeared to be most serious in British Columbia. Other clostridial diseases were rarely reported from farms and were diagnosed infrequently at diagnostic laboratories. This may be related to the widespread use of multivalent clostridial vaccines (87% of flocks).

#### EWE DISEASES

Abortions were reported to occur in 46% of flocks and affected 1.4% of ewes with a maximum of 16% of ewes affected in any one flock during the study year. These values are not cause for alarm as an overall abortion rate of less than 2% is generally considered acceptable but abortion storms more severe than any occurring during this study may still cause severe hardship for individual producers. The mortality rate of 0.2% may be erroneous in that some producers may have included lamb mortality in that category. Very few of the abortions investigated by diagnostic laboratories are attributed to specific infectious agents (Note: *Campylobacter* abortion was inadvertently omitted from the list of specific agents) but it appears that *Chlamydia* may be relatively important in western Canada. Flock outbreaks of chlamydial abortion have been reported from Alberta (12) and Ontario (13). Toxoplasmosis appears to be relatively important in central and eastern Canada (Table VI). Toxoplasma antibodies have been shown to be prevalent among sheep in Ontario (14) and the western United States (15).

The most important single cause of mortality in ewes was pneumonia. It accounts for close to 20% of all ewe mortality and in one flock resulted in the death of 43% of the ewes. As with lambs, *Pasteurella* spp. appear to be the most commonly isolated agents, although parasitic pneumonia has a major role and maedi-visna and pulmonary adenomatosis are also involved. Parasitic pneumonia occurred primarily in the coastal regions (Table VI) and pulmonary adenomatosis was almost exclusively confined to the Maritime provinces. Maedi-visna was most frequently diagnosed in Quebec and the disease has been shown to have a high prevalence in that province (16). Approximately half of the cases classified as interstitial

pneumonia were in animals over six months of age and some cases of maedi-visna may have been included in that group.

Vaginal and uterine prolapses were both widespread (morbidity reported on 59% of farms) and costly (mortality = 0.4%). These conditions also had a substantial impact on culling (discussed below) which increases their economic importance.

Mastitis was the disease reported to occur on the largest proportion of farms (62%) and was the fourth most important condition as a cause of mortality. It also resulted in a substantial amount of involuntary culling and probably results in considerable loss of productivity through its adverse effects on a ewe's milk supply. Few cases are seen by diagnostic laboratories but of the causes specified, *Staphylococcus aureus* appears to be the most important pathogen although *P. hemolytica* (included in the "other" category) may play an important role. *Histophilus ovis* has also been reported as an etiological agent in Canada (17).

Predator attacks on ewes were limited to 13% of farms but contributed substantially to mortality (0.7%). On the other hand, foot problems (presumably primarily foot rot) were frequently reported (34% of flocks affected) but caused little mortality. Only 8% of producers used a foot rot vaccine in attempting to control the condition.

Pregnancy toxemia was blamed for an overall mortality rate of 0.2% and based on data from regional diagnostic laboratories it appears to be more of a problem in western Canada than in the eastern and central regions. Abscesses also contributed to ewe mortality but their main economic impact may be related to their association with "thin ewe syndrome" and their effects on condemnations at slaughter (18). Lymphadenitis may be under-represented in the diagnostic laboratory data because it may frequently be present without being recorded as the cause of death. A recent survey of caseous lymphadenitis in culled sheep in the western United States found an overall prevalence of 42% (18).

As with lambs, clinical parasitism (both internal and external) resulted in

substantial morbidity but little mortality was attributed to it. However, it was found that 8.6% of cases presented to diagnostic laboratories were nematodiasis and it is estimated that approximately half (45%) of those were in animals over six months of age. This suggests that parasitism may not be adequately recognized as a cause of death among ewes on sheep farms.

#### CULLING

In flocks in this study an average of 18.2% of ewes were culled during the year. Since the questionnaire did not include a category "sold for breeding stock" and that reason was relatively infrequently specified in the "other reasons" section, animals in this category may have been omitted. Consequently, the total removal rate may have been higher than the 18.2% reported.

Culling on the basis of old age, poor production and poor conformation along with sale of breeding stock can be considered as voluntary removal since it allows for replacement of ewes with genetically superior young stock. On the other hand, involuntary culling may remove genetically valuable animals and, if large numbers of ewes are culled, may substantially reduce the amount of choice a producer has in selecting replacements. Based on data from this study, 47% of removals were voluntary and 53% involuntary. Mastitis was identified as the most important single reason for involuntary culling (15.3%) but when infertility and other reproductive conditions specified as "other reasons" (6.0%) are combined it can be seen that reproductive problems are equally as important (15.8%).

Despite the fact that pneumonia was a major cause of mortality among ewes, it was seldom cited as a reason for removal. Chronic respiratory diseases (such as maedi-visna) may result in chronic ill thrift as opposed to obvious respiratory symptoms and consequently some of the animals specified as "chronic weight loss" in the "other diseases" category may have been chronic respiratory problems. Other conditions resulting in chronic weight loss could include parasitism, caseous lymphadenitis and Johne's disease and bad teeth. However,

chronic weight loss was only estimated to be responsible for 1.9% (15.8% x 12.0%) of all culling.

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## BOOK REVIEW

**ANIMAL HEALTH IN AUSTRALIA. VOLUME 3. NUTRITIONAL DEFICIENCIES AND DISEASES OF LIVESTOCK.** E.A. *Campbell*. Published by the Australian Government Publishing Service, Canberra. 1983. 277 pages.

This is a soft cover book divided into three parts. Part one is entitled Performance and Nutrition and deals with various aspects of commercial feeds, intensive livestock production and the procedures required in an investigation of nutritional deficiency.

Part two is entitled Failure to Meet Production Requirements. Nutritional and noninfectious diseases such as acetonaemia, bloat and abomasal displacement are discussed as well as the role of nutrition and infectious diseases. These areas are dealt with in depth and new information and theories have been put forward. Part two

also presents an in depth discussion on calcium, phosphorus and magnesium.

Part three carries the heading Failure to Meet Maintenance Requirements, and subtitles include: starvation and nutritional deprivation, drought feeding, role of trace elements, diagnosis of trace element deficiency, trace element deficiencies and cellular function, newly discovered trace elements and vitamin deficiencies.

The traditional role of the veterinarian dealing with nutrition of animals has been with advanced inadequacies and their corrections. This volume puts forward the suggestion that we should be more aware of failure to achieve maximum performance. This failure is just as likely to be the result of nutritional inadequacy as it is the presence of subclinical disease. To the intensive livestock producer, poor performance is as great a worry as clinical infectious disease. The purpose of this volume seems to be to present information useful in ensuring that deficiencies do not lead to a disease as

opposed to simply effecting a cure when faced with an advanced deficiency.

The background material is presented clearly and in surprising depth for a reference volume directed towards practitioners. The work that has gone into making the volume useful for practitioners in Australia has however limited its use to North American practitioners. The management systems and feedstuffs discussed are Australian and in some cases the terminology is very colloquial.

The general information is well presented and the purpose of this volume has been well served through the various chapters. For anyone contemplating working with production animals in Australia, this volume would provide excellent information and background material. For the North American practitioner, this volume has a limited role because of the geographical restrictions of the clinical material.

*J. Pritchard.*