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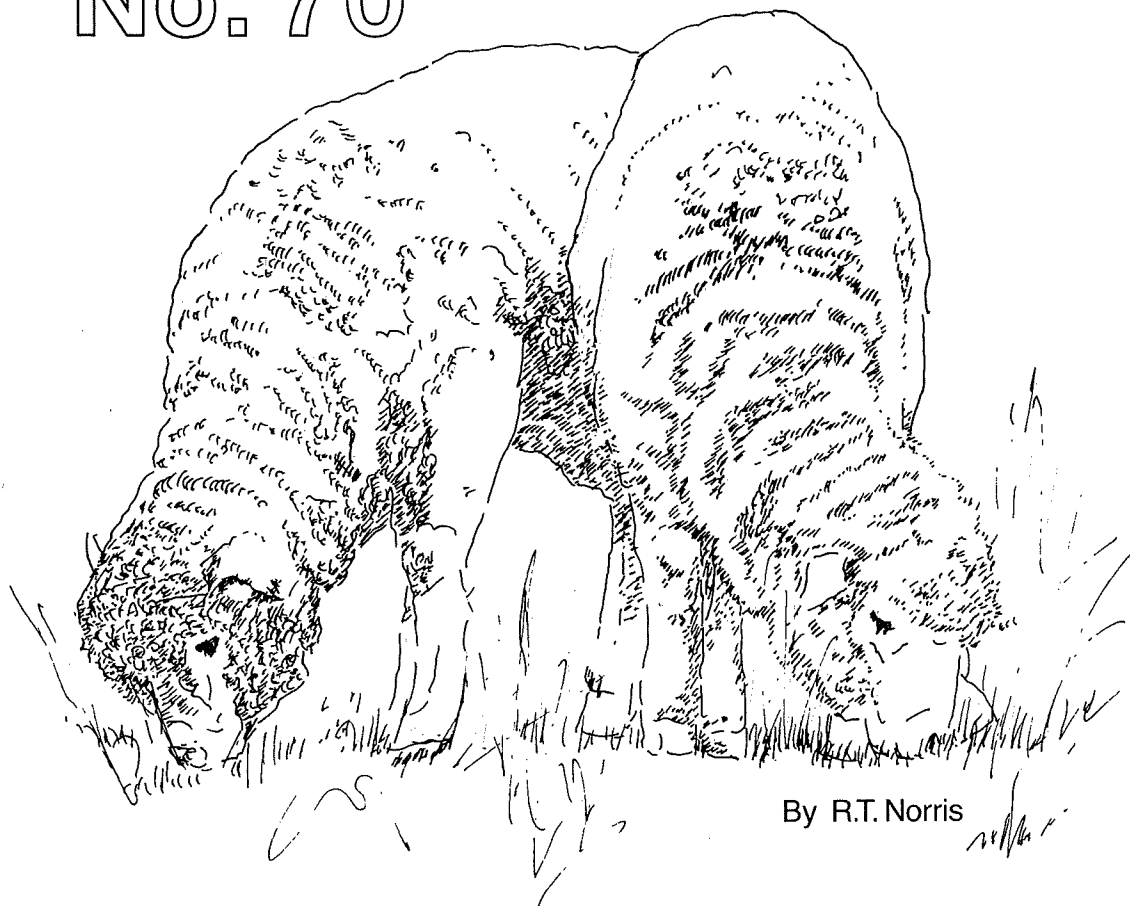
Department of Primary Industries and Regional Development, Western Australia, Perth. Technical Bulletin 70.

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Technical Bulletin

Survey of post-weaning management, growth and mortality of Merino weaners

No. 70



By R.T. Norris

Survey of post-weaning management, growth and mortality of Merino weaners

By: R.T. Norris

Editor: D. A. W. Johnston

Weaner management, growth and mortality were recorded in ten flocks within the Katanning Advisory District, Western Australia during each of the three years 1978/79 to 1980/81. The growth of sheep from weaning to about 9 to 12 months of age and associated husbandry practices and their costs were surveyed. Areas of inefficiency were identified and recommendations made for improvement in management practices.

Summary

Flock owner's excessive use of supplementary feed, especially of hay (up to 63 kg/head), lack of knowledge of nutritional requirements of weaners and failure to follow recommended methods of internal parasite control were the main areas of inefficient management. The average variable cost of feeding and husbandry in each year was \$5.58, \$4.07 and \$4.32/head. Variable cost in two flocks was reduced from \$12.72 and \$10.41/head in year one to <\$7.50/head in subsequent years. All values as at 1982 prices.

Management of the weaners as observed in the first year, suggested that previous advice by the Department of Agriculture was not well accepted or had not reached some producers. The flock owners made major changes in management, particularly in the reduced use of cereal hay as a feed supplement, following personal advice at the end of the first year. The use of locally obtained results was valuable in encouraging adoption of this advice. If inefficient management of weaners is common in similar areas of Western Australia, then greater efforts to define management practices and proffer information are urgently required.

Technical Bulletin No. 70
March, 1986

Department of Agriculture
Baron-Hay Court, South Perth, 6151

ISSN 0083-8675

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Norris, R.T. (Richard Thomas), 1952-. Survey of post-weaning management, growth; growth and mortality of Merino weaners.

Bibliography.
ISBN 0 7244 8870 7.

1. Merino sheep.

2. Lambs—Feeding and feeds.

I. Western Australia. Department of Agriculture.

II. Title. (Series: Technical Bulletin (Western Australia. Department of Agriculture); No. 70).

636.3'68

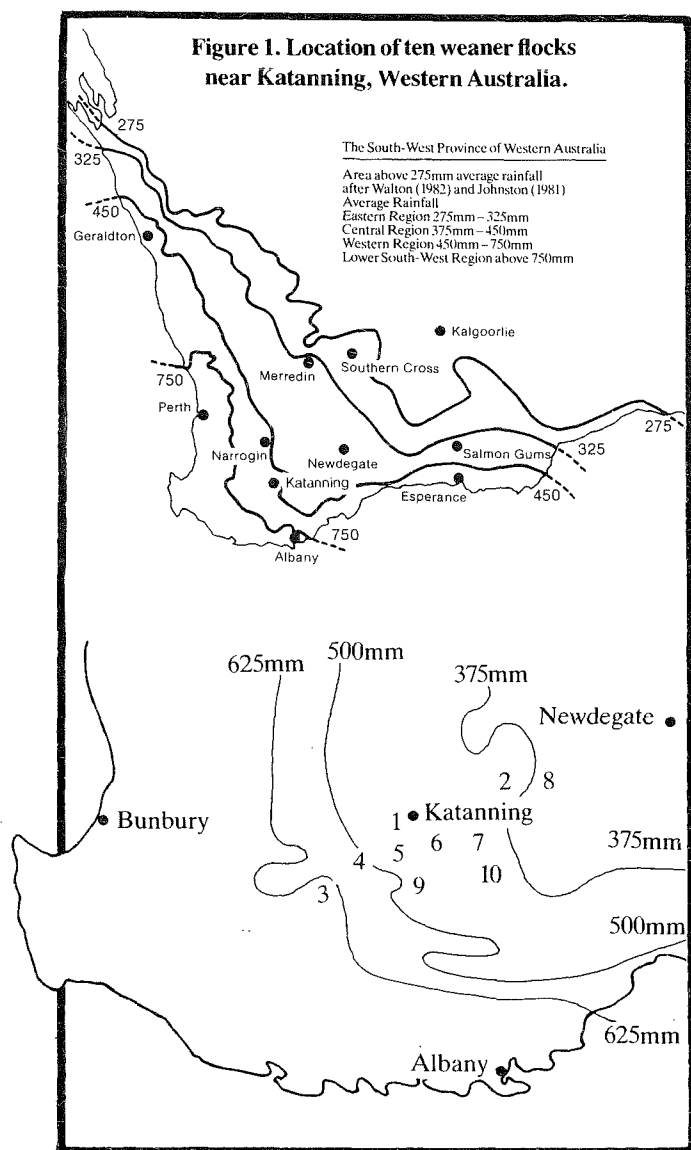
Manuscript received October, 1984.

Introduction

Inadequate nutrition and disease frequently lead to ill-thrift (failure to grow) and death in young sheep, especially during the summer-autumn period when grazing is frequently limiting in quality and quantity (Mulhearn 1958, Bennetts 1958). Recommendations on the provision of adequate nutrition (Davis 1977, Marshall 1980) and methods of controlling internal parasites of weaner sheep (de Chaneet 1977) have been available to producers, but little is known of how well these recommendations have been adopted. When ill-thrift in weaners, which are weaned sheep up to 12 months of age, is investigated, there is usually little information about recent weight changes and management of the flock or how its performance relates to that of other flocks in the Katanning Advisory District.

The aim of the investigation was to record the growth of weaner sheep, the level of mortality and the cost of husbandry practices for the purpose of determining the rate of adoption of present recommendations. Such information would provide a basis for future recommendations and extension needs as well as providing production benchmarks for weaner sheep in the Katanning district.

Materials and methods



Ten Merino flocks in the Katanning Advisory District in the South-West Province of Western Australia (figure 1) were selected on the basis of owner co-operation and suitable handling facilities. The area experiences a Mediterranean type climate. All stock grazed pastures containing capeweed (*Cryptostemma calendula*), barley grass (*Hordeum leporinum* and *H. hystrix*), geranium (*Erodium botrys*) annual ryegrass (*Lolium rigidum*) and brome grass (*Bromus rigidum*), with up to 30% of subterranean clover (*Trifolium subterraneum*).

In each of three years (year 1, 1978/79; year 2, 1979/80; year 3, 1980/81), 100 Merino ewe lambs were randomly selected in each flock and ear tagged at lamb marking (June to September). The lambs were mulesed and the tail removed. The lambs were reunited with their mothers until weaning which varied from August to January. After weaning, they were run with the rest of the weaner flock and received no special treatment.

Each flock was inspected monthly from weaning until May of the following year. At each visit the sheep were counted, weighed and examined for overt signs of ill-health including diarrhoea; flystrike; arthritis; annual ryegrass toxicity; intradermal penetration of grass seeds and dermatophilosis. Ear tags from dead sheep were collected by the owner.

Information on the history of each flock was collected at lamb marking (appendix 1), and at each subsequent visit details on the management of the flock were recorded (appendix 2). No attempt was made to influence management in the first year of the survey. The data collected included details on flock size; paddock size; supplementary feeding and veterinary preparations used. Variable costs of production were calculated for each flock. Lambing date (day lambing commenced); weaning weight; age at weaning; flock size and total variable costs (cost of management procedures and supplementary feeding) were averaged annually for each flock. Regressions of each variable on final weight (weight in May or weight when last weighed) were calculated and those variables with significant correlation coefficients were fitted to a stepwise multiple regression to determine those which contributed most to final weight.

No data were collected from flocks 4 and 8 in the third year. A summary of the recommendations for the management of young sheep in the Katanning Advisory District for 1978/79 is given in appendix 3.

Tables 1a, 1b, and 1c shows monthly rainfall data for the properties where the ten flocks were located over the three years of the investigation. The break of season varied between locations, but was about mid-May in 1978/79, February in 1979/80 and June 1980/81. In 1979/80 rainfall after February allowed continued growth of green pasture.

Table 1a. Monthly rainfall (mm) for 1978/79 at sites where survey flocks located.

Year 1978/79	Flock									
	1	2	3	4	5	6	7	8	9	10
Sept.	NR	NR	27	NR	14	49	30	NR	NR	NR
Oct.	NR	26	40	NR	34	10	7	5	25	NR
Nov.	10	7	0	3	7	0	5	12	23	NR
Dec.	29	3	5	16	22	21	26	16	20	36
Jan.	6	16	9	9	11	0	12	27	17	9
Feb.	9	15	1	11	4	24	14	44	16	24
Mar.	4	1	27	5	3	6	6	9	9	17
Apr.	13	0	21	18	8	3	0	5	6	4
May	0	33	52	59	20	48	38	22	52	49

Table 1b. Monthly rainfall (mm) for 1979/80 at sites where survey flocks located.

Year 1979/80	Flock									
	1	2	3	4	5	6	7	8	9	10
Sept.	NR	5	34	60	NR	24	16	30	30	NR
Oct.	NR	7	32	35	NR	17	11	7	16	NR
Nov.	NR	0	39	NR	NR	22	23	19	33	28
Dec.	NR	0	0	6	0	0	1	1	1	1
Jan.	0	0	7	4	2	2	10	1	0	18
Feb.	58	68	20	57	68	45	43	58	84	60
Mar.	12	10	2	1	4	19	16	3	0	0
Apr.	67	37	16	48	13	47	34	41	39	43
May	8	2	3	NR	3	10	6	21	3	30

Table 1c. Monthly rainfall (mm) for 1980/81 at sites where survey flocks located.

Year 1980/81	Flock							
	1	2	3	5	6	7	9	10
Sept.	NR	55	NR	NR	18	NR	NR	NR
Oct.	NR	10	NR	NR	61	4	63	NR
Nov.	4	0	1	NR	9	3	5	NR
Dec.	29	38	68	37	33	33	38	NR
Jan.	0	0	NR	NR	0	0	0	NR
Feb.	10	16	NR	NR	0	9	7	6
Mar.	7	0	12	4	4	1	6	6
Apr.	13	4	33	NR	NR	7	NR	7
May	9	11	NR	NR	NR	16	13	NR

NR = Not recorded

their liveweights were lower than other flocks. Flock 2 in the first year (1978/79) had the lowest average weight of 20 kg.

Results

Table 2 shows that lambing commenced in April or May in most flocks with the latest time of lambing in flock 10. There was little change in time of lambing between years except for flock 1. Most flocks were weaned in October or November at about 21 weeks of age (range 14-33 weeks) and 27 kg liveweight (range 20-32 kg). The earliest time of weaning was August and the latest was January. Flock 10 lambed late each year resulting in the lambs being relatively young when weaned in December; consequently

The monthly average weights (and range) for the flocks in all years are shown in figure 2. In the first year, average weight increased by 20% from September to October and then remained constant at about 29 kg until May. In the second year the weaners continued growing until November, then weight declined until January when the average liveweight of 28 kg was similar to the first year. Average weight then increased by 10% from February to May. Green pasture was available from February to May in 1979/80 as a result of unseasonal summer rain. In the third year, liveweights increased until November when they were similar to those obtained in the second year. Average weight

Figure 2. Mean (and range) monthly liveweights of ten flocks of weaner sheep from weaning (August to January) to May.

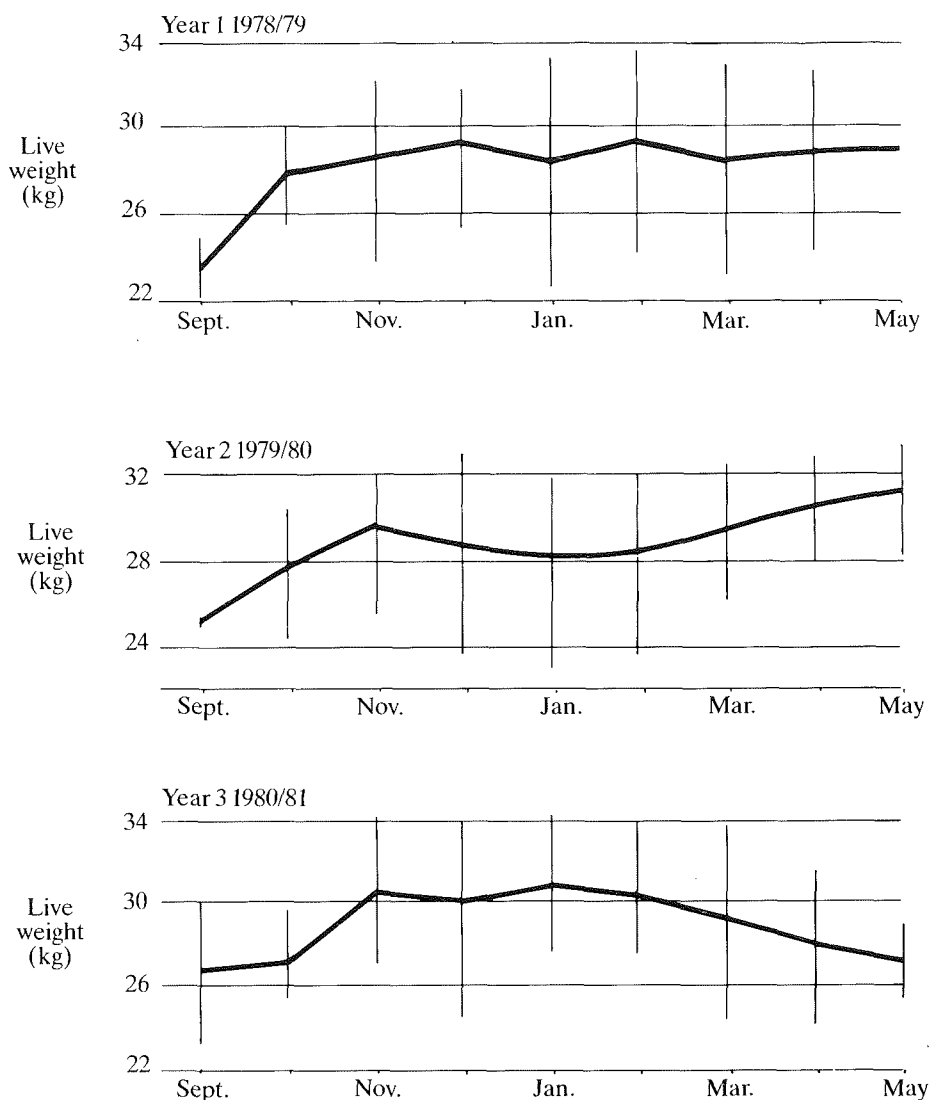


Table 2. Time of lambing and weaning, age at weaning, weight† at weaning, and final weight†† in ten flocks of weaner sheep (n = 100) in each of three years 1978/79 to 1980/81.

	Year	Flock										Average all flocks
		1	2	3	4	5	6	7	8	9	10	
Lambing commenced	1 2 3	July Apr. June	Apr. May June	May Apr. May	May June NR	May May May	Apr. Apr. Apr.	May May May	Apr. May NR	June June June	Aug Aug Aug.	
Weaning	1 2 3	Nov. Jan. Dec.	Aug. Oct. Sept.	Sept. Oct. Nov.	Nov. Nov. NR	Oct. Oct. Oct.	Oct. Oct. Sept.	Oct. Oct. Oct.	Nov. Oct. NR	Nov. Oct. Oct.	Dec. Dec. Dec.	
Weaning age (weeks)	1 2 3	17 33 24	16 18 15	18 24 26	24 20 NR	18 19 20	23 24 20	23 23 23	27 20 NR	20 17 18	14 16 17	20.0 21.4 20.3
Weaning weight (kg)	1 2 3	28 28 27	20 27 30	22 26 32	24 25 NR	26 24 30	30 30 23	27 30 25	29 29 NR	NR 28 27	NR 23 24	25.7 27.0 27.2
Final weight (kg)	1 2 3	32 34 28	29 30 28	22 28 32	26 28 NR	28 29 30	31 33 NR	30 33 26	31 31 NR	33 34 28	25 28 24	28.7 30.8 28.0

† = mean weight
NR = Not recorded

was constant from November until February and then declined by 10% from February to May.

Mean monthly liveweights for all flocks are shown in tables 3a, 3b and 3c for all three years. In year 1978/79, the liveweight of flock 3 peaked in October, declined to January, peaked again in February and then declined to May when liveweights were similar to the average weaning weight of 22 kg eight months previously. In 1979/80 and 1980/81 there was little fluctuation in liveweight in this flock compared with 1978/79 and weights were constant at about 27 and 32 kg in these years. In the first year, 1978/79, flock 2 had the lowest weight at weaning in August, but had the heaviest weight in November.

Most flocks were offered a supplement of cereal hay or grain and feeding usually began in February or March (table 4). Duration of hand-feeding averaged 14 weeks (range 4-26 weeks). Average weight per head at the commencement of hand-feeding was 28 kg (range 23-33 kg) and there was wide variation in liveweight change during hand-feeding (maximum gain 9.6 kg, maximum loss 2.9 kg).

The type and maximum rate of supplement and the total amount of feed offered are shown in table 5. Fifty per cent of the flocks were fed hay in the first year at rates up to 6 kg/head/week. Flocks 2 and 9 received 63 and 44 kg of hay/head in the first year. Hay feeding was reduced or eliminated in four flocks (2, 4, 7 and 9) in subsequent years. Of the flocks receiving grain or other seeds; oats were fed most frequently followed by barley and lupin seed. Wheat grain was not fed. The quantities of grain fed to most flocks were less in the second and third years of the survey than the first year.

Table 3a. Monthly mean liveweight (kg) in ten flocks of weaner sheep in year 1. (1978/79).

Month	Flock										All Flocks
	1	2	3	4	5	6	7	8	9	10	
Aug.		19.6									19.6
Sept.		25.0	21.9								23.4
Oct.		29.8	27.2		25.7	30.0	26.8				27.9
Nov.	28.0	32.2	26.7	23.8	27.1	30.8		29.5			28.5
Dec.	NR	31.4	25.3	NR	26.3	31.2	29.9	21.7	29.1		29.3
Jan.	29.3	31.1	24.7	25.2	26.6	31.9	27.4	32.0	33.2	22.5	28.4
Feb.	30.7	30.5	28.7	24.7	28.9	33.7	28.0	31.1	33.4	24.1	29.4
Mar.	31.6	27.3†	27.3	25.4	26.7	32.0	28.2	29.6	33.2	23.2	28.4
Apr.	31.4	27.7	24.1	25.1	28.9	32.5	30.0	30.6	32.9	24.4	28.8
May	31.8	28.8	22.1	25.6	28.4	31.4	30.5	30.7	37.2	25.3	28.7

NR = Not recorded

† = Post shearing weight

Table 3b. Monthly mean liveweight (kg) in ten flocks of weaner sheep in year 2. (1979/80).

Month	Flock										All flocks
	1	2	3	4	5	6	7	8	9	10	
Sept.						25.0					25.0
Oct.		27.4	25.8		24.4	30.0	30.0	28.9	27.6		27.7
Nov.		31.6	27.4	25.5	NR	31.9	29.2	31.7	29.7		29.6
Dec.		32.1	NR	26.3	23.9	30.9	28.3	32.0	33.2	23.0	28.7
Jan.	28.1	30.6	27.8	28.6	24.5	31.9	28.1	31.4	NR	23.0	28.2
Feb.	29.1	29.8	28.2	27.6	25.9	30.2	28.4	28.5	32.3	23.7	28.4
Mar.	32.7	30.5	28.8	28.5	27.3	32.6	29.6	28.2	29.9	26.2	29.5
Apr.	33.8	NR		29.4	27.7	32.6	31.9	30.0	33.0	28.0	30.6
May	34.5	30.1†		28.3	29.4	32.9	33.5	31.1	33.7		31.3

NR = Not recorded

† = Post shearing weight

Table 3c. Monthly mean liveweight (kg) in ten flocks of weaner sheep in year 3. (1980/81).

Month	Flock ⁺								All flocks
	1	2	3	5	6	7	9	10	
Sept.		30.1			23.1				26.6
Oct.		NR		29.6	26.0	25.3			27.0
Nov.		34.3	30.7	NR	33.5	27.8	26.8		30.6
Dec.	27.3	34.3	33.0	NR	33.6	28.6	30.1	24.6	30.2
Jan.	28.5	34.1	32.3	31.2	33.1	27.5	30.4	NR	31.0
Feb.	31.3	30.0†	NR	NR	35.1	28.6	27.7	NR	30.5
Mar.	30.2	30.4	31.7	31.2	34.5	27.5	27.7	23.8	29.6
Apr.	NR	28.6	31.8	30.0		26.4	27.4	24.1	28.0
May	28.6	27.9				25.3	28.2		27.5

⁺ = Flocks 4 and 8 not included

† = Post shearing weight

NR = Not recorded

Table 4. Supplementary feeding: start of feeding, number of weeks fed, liveweight (mean) at the start of feeding and liveweight change (mean) during feeding in ten flocks of weaner sheep for each of three years 1978/79 to 1980/81.

	Year	Flock										Average all flocks
		1	2	3	4	5	6	7	8	9	10	
Start of feeding	1 2 3	NF NF Feb.	Jan. Feb. Feb.	Apr. Mar. Mar.	Feb. Mar. NR	NF Apr. Jan.	Mar. NF NF	Feb. Feb. Mar.	Mar. Jan. NR	Feb. Jan. Jan.	Feb. Jan. Feb.	
Weeks fed	1 2 3	NF NF 13	22 13 13	9 16 9	13 9 NR	NF 4 NR	9 NF NF	17 12 9	13 17 NR	19 17 17	17 26 11	15 14 12
Liveweight at start of feeding (kg)	1 2 3	NF NF 31	31 30 30	24 29 32	25 28 NR	NF 27 31	32 NF NF	28 28 27	30 28 NR	33 32 28	24 23 25	28 28 29
Liveweight change during feeding (kg)	1 2 3	NF NF -2.7	-2.3 0.4 -2.0	-2.9 -0.4 -0.5	0.3 -0.2 NR	NF 2.1 -1.2	-2.0 NF NF	0.4 5.1 -2.2	-0.5 2.6 NR	-1.5 1.4 0.1	0.2 9.6 -0.5	-1.0 2.6 -1.3

NF = Not fed

NR = Not recorded

Table 5. Type and maximum rate of supplementary feeding and the total amount of supplement fed to ten flocks of weaner sheep in each of three years, 1978/79 to 1980/81.

	Year	Flock									
		1	2	3	4	5	6	7	8	9	10
Type and rate of feeding (kg/head/week)	1	NF	B-2.0 H-6.0	O-2.0 B-1.0	O-1.5 H-1.0	NF	O-1.3	O-1.6 H-1.4	B-0.5	O-2.8 H-2.3	O-2.0 H-2.0
	2	NF	O-0.4 H-1.0	L-0.9 O-2.3 H-4.0	O-1.4	O-0.8	NF	O-1.8	B-0.9	O-0.4 H-1.5	O-1.3 H-2.5
	3	O-3.6 H-1.7	O-1.4 B-1.7	O/L-3.4 O-1.5 H-1.5	NR	NR	NF	B-1.6	NR	O-1.9 B-2.4 H-1.3	O-1.3 H-2.9
Total feed (kg/head)	1	NF	B-26 H-63	O-4 B-5	O-24 H-4	NF	O-12	O-24 H-15	B-5	O-24 H-44	O-24 H-12
	2	NF	O-8 H-4	L-2 O/L-14 O-4 H-20	O-9	O-2	NF	O-11	B-12	O-3 H-21	O-18 H-27
	3	O-14 H-22	O-11 B-5	O/L-3 O-2	NR	NR	NF	B-13	NR	O-13 B-9 H-15	O-5 H-12

NR = Not recorded
 NF = Not fed
 O = Oat grain
 B = Barley grain
 L = Lupin seed
 H = Cereal hay

Table 6. Cost ± (\$/head) of husbandry, grain and hay supplements, and total cost (husbandry, grain and hay) in ten flocks of weaner sheep in each of three years, 1978/79 to 1980/81.

	Year	Flock										Average of incurring costs
		1	2	3	4	5	6	7	8	9	10	
Husbandry	1	2.05	2.50	2.22	2.59	2.61	2.52	2.34	2.41	2.51	0.89	2.26
	2	0.50	2.12	2.80	2.62	2.30	2.71	2.39	2.40	2.67	0.55	2.11
	3	2.39	2.19	2.33	NR	1.01	2.52	2.34	NR	2.59	0.42	1.97
Grain	1	Nil	3.64	1.31	3.30	Nil	1.65	3.33	0.77	3.30	3.43	2.59
	2	Nil	1.17	3.50	1.33	0.22	Nil	1.59	1.66	0.43	2.52	1.55
	3	1.61	2.35	0.74	NR	NR	Nil	1.86	NR	3.16	0.72	1.74
Hay	1	Nil	6.58	Nil	0.44	Nil	Nil	1.59	Nil	4.60	1.25	2.89
	2	Nil	0.42	1.74	Nil	Nil	Nil	Nil	Nil	2.17	2.88	1.80
	3	0.74	Nil	1.47	NR	NR	Nil	Nil	NR	1.59	1.24	1.26
Total	1	2.05	12.72	3.53	6.33	2.61	4.17	7.26	3.18	10.41	5.57	5.78
	2	0.50	3.71	8.04	3.95	2.52	2.71	3.98	4.06	5.27	5.95	4.07
	3	4.74	4.54	4.54	NR	1.01	2.52	4.20	NR	7.34	2.38	4.32

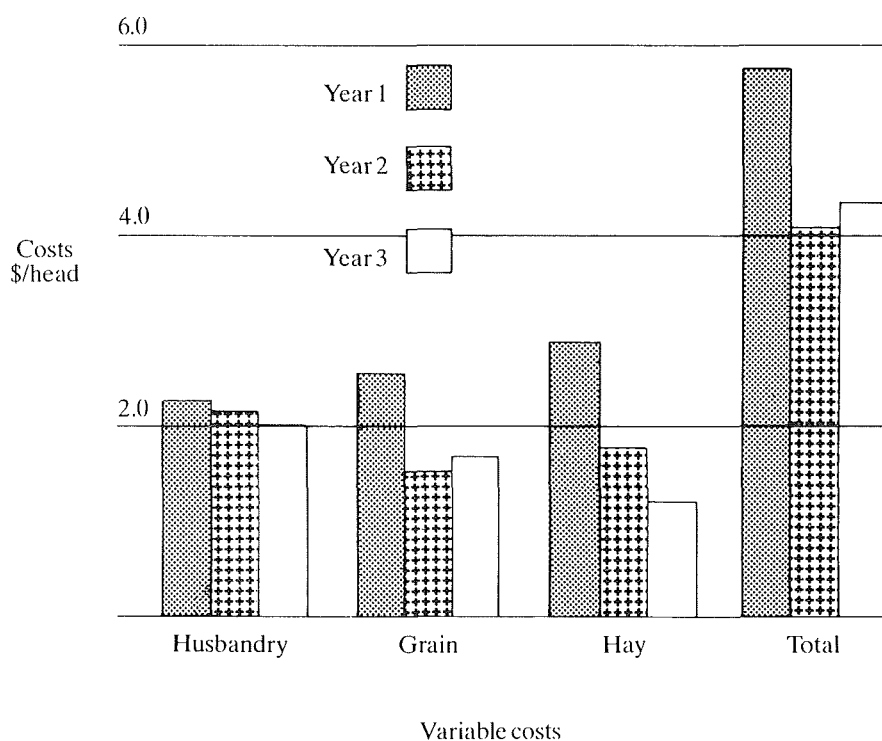
± Cost of veterinary preparations, husbandry and supplementary feed used in calculation of variable costs. Values were taken from the Farm Budget Guide (1982).

Veterinary preparations		Cents/head		Husbandry		Cents/head		Supplementary feed		\$ /tonne	
Pulpy kidney, tetanus vaccine		4.6		Jet		10		Oat grain		140	
Pulpy kidney, tetanus plus selenium vaccine		5.6		Dip		11		Barley grain		140	
Five in one vaccine		8.0		Shear		160		Lupin seed		240	
Anthelmintic		4.5		Crutch		28		Cereal hay		105	
				Mules		19					

Costs associated with management and supplementary feeding of grain and hay are shown in table 6. Flocks 2 and 9 showed highest total costs in the first year (\$12.72 and \$10.41) and this was due mainly to cost associated with hay feeding (\$6.58 and \$4.60). Six flocks (1, 2, 4, 6, 7, and 9) reduced total variable costs by more than 33% in the second year compared with the first year, with the greatest per cent reduction in flock 1 (76%) and the greatest saving in flock 2 (\$9.01/head).

Figure 3 shows that the reduction in average total costs in the last two years of the survey, compared with the first, was due to reduced costs associated with feeding hay and grain. Hay costs were less in the second and third year with the average cost of hay fed in the third year being about 40% of that in the first.

Figure 3. Variable costs in ten flocks of weaner sheep in each of three years, 1978/79 to 1980/81.



The histograms represent the average of flocks incurring costs.

Table 7. Sheep dead or missing in ten flocks of weaner sheep in each of three years, 1978/79 to 1980/81.

	Year	Flock										Average all flocks (%)
		1	2	3	4	5	6	7	8	9	10	
No. dead marking to weaning	1 2 3	1 0 2	2 0 0	0 1 2	2 0 NR	0 0 2	0 1 1	0 0 3	1 0 NR	0 0 2	0 0 3	0.6 0.2 1.8
No. dead weaning to May	1 2 3	0 0 0	1 1 1	0 0 1	0 0 NR	0 1 0	2 1 0	2 1 0	1 1 NR	0 0 2	0 1 0	0.6 0.6 0.5
No. missing	1 2 3	1 5 4	2 1 5	2 13 5	1 0 NR	0 5 8	5 0 2	0 2 6	4 0 NR	3 2 0	9 7 5	2.7 3.5 4.4
No. remaining at May	1 2 3	99 95 94	95 98 94	98 86 92	97 100 NR	100 94 90	93 98 97	98 97 91	94 99 NR	97 98 96	91 92 92	96.2 95.7 93.2
Average no. dead or missing all years %		4.0	4.3	8.0	1.5	5.3	4.0	4.6	3.5	3.0	8.3	4.6

NR = Not recorded

Table 7 shows the per cent of sheep dead or missing from marking to weaning, and from weaning to May of the following year. In most flocks, confirmed deaths to May were <3%. There was great variation in numbers of sheep missing (range 0-13%) with 40% of the flocks over all years of the survey showing 5% or more sheep missing. Included in the missing category were sheep which had strayed, lost their tags or were missing presumed dead, but the death was not confirmed. The number of sheep present in the flock at May was variable (range 86-100%) with average values being about 95%. The mean per cent of sheep dead or missing for all three years was 4.6%.

The number of times anthelmintic treatments were given to each flock, the anthelmintic group used and a comparison of the worm control programme with that recommended for the Advisory District are shown in table 8. All flocks were drenched at weaning and all except flock 10 routinely received at least two 'summer' drenches (drenches given between November and March inclusive). The average number of drenches given each year was about four. Flock 7 located in area receiving < 500 mm rainfall per year, received an average of six drenches. Different anthelmintic groups were used in at least four flocks each year. Only three flocks each year were drenched as recommended. This was give at least two 'summer' drenches and to avoid changing the drench groups during 'summer', (de Chaneet 1977, Pritchard *et al.* 1980).

Note: The 'summer' period referred to here is not the same as that officially designated. The seasons are:

Summer—December, January, February
Autumn—March, April, May
Winter—June, July August
Spring—September, October, November

Sheep husbandry practices are summarised in table 9. All flocks were mulesed at lamb marking and 50% of the flocks were mulesed by a contractor. Most flocks were mulesed in July or August, except for flock 10. All flocks, except flock 7, were vaccinated against enterotoxaemia at lamb marking. Only four

flocks (1, 2, 8 and 9) received a second vaccination 4 to 6 weeks later as recommended. Four flocks (3, 5, 6, and 10) did not receive a second vaccination in at least two years. Five flocks (6 to 10) were crutched in at least two years, usually in March and four flocks were crutched only in one year. Two flocks (2 and 10) were jetted. All flocks, except flock 10, were shorn between weaning and May with most being shorn on October. Five flocks (4, 5, 6, 8 and 10) were dipped following shearing in the first or second year, but none were dipped in the third year.

Weight at weaning and weight in November, (at about the time of pasture senescence) were the only variables correlated with final weight (table 10). There was no relationship between other variables (lambing date; age at weaning; flock size; duration of hand-feeding; cost of supplement feed and total variable costs) and final weight.

Table 10. Regression of variables averaged over three years on final liveweight in ten weaner flocks.

Variable	r	P
Weaning weight	0.618	**
Weight in November	0.489	*
Lambing date	-0.191	NS
Age at weaning	0.166	NS
Mob size	0.13	NS
Duration of hand-feeding	0.312	NS
Cost of supplement feed	0.101	NS
Total variable cost	0.068	NS

r = Regression coefficient

P = Level of significance

*P < 0.05

**P < 0.01

NS = Not significant

Table 8. Number of drenches (anthelmintics), drench group and agreement of drenching programme with recommended programmes in ten flocks of weaner sheep in each of three years, 1978/79 to 1980/81.

	Year	Flock										Average all flocks
		1	2	3	4	5	6	7	8	9	10	
No. of drenches +	1	2	3	5	5	6	3	6	4	3	3	4.0
	2	3	2	6	7	4	3	7	3	4	1	3.8
	3	3	4	5	NR	3	3	5	NR	6	2	3.8
Drench group #	1	B	B/L	B/L	B	L	B/L	L	B/L	B/L	L	
	2	B	B/L	B/L	B	L	B	L	B/L	B/L	L	
	3	B/L	B/L	L	NR	L	B	B/L	NR	L	B/L	
Recommendation*	1	R	N	N	R	N	N	N	N	N	R	
	2	R	N	N	N	R	R	N	N	N	N	
	3	N	N	R	NR	R	R	N	NR	N	N	

+ Number of oral anthelmintics (drenches) given between August and May.

Drench given from either benzimidazole (B) or levamisole group (L), or both groups (B/L).

* Drenching programme as recommended (R) or not recommended (N) by the W.A. Department of Agriculture based on the number of drenches, drench group used and location of the flock.

NR = Not recorded.

Table 9. Husbandry practices in ten flocks of weaner sheep in each of three years, 1978/79 to 1980/81.

	Year	Flock									
		1	2	3	4	5	6	7	8	9	10
Month of mulesing	1 2 3	Aug. June Feb.	Aug. July July	July July July	Aug. Aug. NR	Aug. Aug. Aug.	July July July	July June June	July July NR	Aug. July Aug.	Sept. Sept. Dec.
Type of vaccination	1 2 3	PK/T PK/T PK/T/Se	PK/T PK/T PK/T	PK/T/Se PK/T/Se PK/T	PK/T/Se PK/T/Se NR	PK/T/Se PK/T/Se PK/T/Se	PK/T PK/T PK/T	Nil Nil Nil	PK PK NR	PK 5 in 1 5 in 1	PK PK PK
Month of crutching	1 2 3	Nil Nil Feb.	Dec. Nil Nil	Nil Mar. Nil	Nil Nil NR	Nil Nil Feb.	Mar. Feb. Mar.	Mar. Mar. Mar.	May Mar. NR	May Apr. May	Mar. Dec. Nil
Month of jetting	1 2 3	Nil Nil Nil	Aug. Nil Oct.	Nil Nil Nil	Nil Nil NR	Nil Nil Nil	Nil Nil Nil	Nil Nil Nil	Nil Nil Nr	Nil Nil Nil	Sept. Nil Dec.
Month of shearing	1 2 3	Sept. Nil Oct.	March Oct. + Apr. Feb.	Nov. Oct. Nov.	Oct. Oct. NR	Oct. Oct.	Oct. Oct. Oct.	Oct. Sept. Oct.	Nov. Oct. NR	Oct. Oct. Oct.	Nil Nil Nil
Month of dipping	1 2 3	Nil Nil Nil	Nil Nil Nil	Nil Nil Nil	Nov. Nil NR	Nov. Nil Nil	Nil Oct. Nil	Nil Nil Nil	Nil Nov. NR	Nov. Nil Nil	Nil Nil Nil

NR = Not recorded

PK = Enterotoxaemia vaccine

PK/T = Enterotoxaemia vaccine/Tetanus vaccine

PK/T/Se = Enterotoxaemia vaccine/Tetanus vaccine plus selenium

5 in 1 = Enterotoxaemia/Tetanus/Blackleg/Black disease/Malignant Oedema vaccine

Discussion

The main finding of this investigation was the excessive use, and cost, up to \$10.22/head, of supplementary feeding particularly in flocks where hay was fed (table 5 and 6). There was no relationship between total variable costs and liveweight performance (table 10). It is unlikely that the cost of the supplements used in many flocks was economically justified in terms of extra wool production, improved reproductive performance in the future, or reduced mortality. Many workers (Donald and Allden 1959, Allden 1968a, Allden 1968b, McLaughlin 1973) have shown that feeding a supplement to weaner sheep grazing dry pasture in summer and autumn can increase body growth and wool production, but such advantages are usually temporary. In most cases the value of the extra wool produced is less than the cost of the supplement. Allden (1979), found that severe nutritional deprivation early in life did not affect the reproductive performance of Merino ewes or the birth weights or weaning weights of their progeny. Information is lacking concerning the effect of supplementary feeding on mortality of weaners; Allden (1968b) was unable to show an effect of undernutrition in the first or second six months of life on mortality. Supplementary feeding costs were less in the third year compared with the first under similar conditions. This suggests increased awareness and adoption of advice on supplementary feeding.

The high feeding rates of hay in several flocks (table 5) suggested that some owners did not understand the requirements of weaners for energy and protein or that they overestimated the nutritional value of the hay. Provided that energy is not limiting, Merino weaners require about 18% crude protein in the diet for maximum growth (Weston 1971; McGregor and McLaughlin 1980). Cereal hay grown near Katanning is low (3-9%) in crude protein (W. J. Burdass, personal communication) and is therefore suitable primarily as a source of roughage for sheep. Weston (1974) showed that lambs fed a whole wheat grain diet had a low (2%) requirement for roughage when supplied as ground straw. Paddock roughage was available on most occasions during the survey and the provision of additional roughage as hay would not have been recommended (appendix 3). Thus, the high rates of hay feeding were probably unnecessary and, because of the generally low level of crude protein in locally grown cereal

hay, the high intake of hay could have predisposed the weaners to nutritional ill-thrift.

A programme involving regular flock inspection and consultation should lead to more efficient management of weaner sheep. Several field days were held at the end of the 1978/79 season and areas of management which differed from recommended practices were outlined. Major changes were made in several flocks, particularly the type and rate of supplementary feeding (table 5) where potential costs savings were possible (table 6). Areas where recommended practices were not well adopted include; the quantity and duration of supplementary feeding in some flocks in 1979/80 (tables 4 and 5) when most were gaining weight (figure 2) whilst grazing green pasture; drenching policy where only three flocks each year were drenched in accordance with district recommendations (table 8) and vaccination against clostridial disease where only four flocks were vaccinated as recommended (table 9). The low average liveweights in flock 10 each year (tables 2a, 2b and 2c) were probably the result of late time of lambing (table 2). Advice tailored to individual producers and given over a longer period may have led to adoption of these recommendations.

The level of mortality observed (table 7) was probably lower than the actual losses, especially in flocks where the number of sheep in the missing category was high (4%). A problem with the method used was that sheep may stray or die without being detected. It was difficult to determine whether missing sheep had lost tags, had merely strayed from the flock or were dead, but unobserved. This made analysis of mortality data unreliable. The best result would be that all of the missing sheep were alive giving an observed mortality rate of 1.4% from marking to weaning. With the worst result the missing sheep could be considered dead giving a mortality rate of 4.8% for the same period.

Clinical signs of several diseases such as contagious ophthalmia, annual ryegrass toxicity and dermatophilosis were observed, but it was not possible to measure the effects of the diseases on production characters such as liveweight or wool growth. This was due to the low prevalence of the diseases and to the limitations of the survey method which did not set out to alleviate the effects of disease on production. An alternative approach, tailored to specific diseases, is necessary to

determine incidence and prevalence, and to measure possible effects on production. This would involve a survey of randomly selected flocks, incorporating production studies. The low prevalence of disease suggests that the ill-thrift seen in some flocks was probably nutritional.

The survey provided a basis for advice to producers in the Katanning Advisory District. Several field days were held which resulted in considerable discussion of relevant aspects of weaner management. Improved contact with producers and the application of published information to the local situation, using locally obtained data for comparison, were important benefits of the survey. The investigation identified areas of weaner management which differed from recommended practices and which were likely to be inefficient. Similar methods may assist future investigators unfamiliar with a district and its problems.

Several deficiencies in the survey method emerged. Those related to the measurement of effects of disease on production and the inaccuracy of mortality counts were the most important. It was not possible to statistically support the findings because of the absence of control treatments, or to compare body growth and management data between flocks and between years. Data relating to wool growth, pasture production, quality of pasture and of supplementary feed, and calculation of gross margins would have contributed to the development of production profiles for the flocks.

Conclusions

These were:

- Producers had failed to adopt advice on weaner sheep management advocated before 1978/79 in respect of using poor quality feed (hay); high cost of feedstuff; drenching and vaccination practices. The change in management following advice at the end of 1978/79 suggests that previous extension efforts had not reached many producers or that they did not heed the advice.
- Producers did not adequately understand the requirements of weaner sheep for energy and protein during summer and autumn as suggested by their excessive use of cereal hay in four flocks in 1978/79.
- Improved efficiency of weaner management is likely to result from a programme of regular flock inspection and consultation. Most producers reduced or ceased supplementary feeding following advice on weaner management at the end of 1978/79.
- If inefficient weaner management is common in similar areas of Western Australia, then greater efforts to define management practices and offer advice to producers are urgently required.
- The use of locally obtained results in conjunction with published information was valuable in encouraging producers to adopt management advice.

Acknowledgments

The co-operation of the flock owners, Messrs. W. N. Anderson, K. G. Cunningham, L. V. Drake-Brockman, A. E. Fethers, J. Hassell, N. L. Illingworth, S. T. James, M. G. Watterson, R. B. White and R. H. Wilcox is greatly appreciated. The assistance and encouragement of Messrs. J. R. Edwards, R. V. R. Gwynn and F. C. Wilkinson is acknowledged and Messrs. J. F. Sears and G. F. Morrow are thanked for their technical assistance.

The design and graphics were done by Ms. F. Roberts and the manuscript typed by the Word Processing Centre, Western Australian Department of Agriculture.

References

- Allden, W. G. (1968a). Undernutrition of the Merino sheep and its sequelae. III. The effect on lifetime productivity of growth restrictions imposed at two stages of early post natal life in a mediterranean environment. *Australian Journal of Agricultural Research*, **19**: 981-996.
- Allden, W. G. (1968b). Undernutrition of the Merino sheep and its sequelae. IV. Herbage consumption and utilization of feed for wool production following growth restrictions imposed at two stages of early post natal life in a mediterranean environment. *Australian Journal of Agricultural Research*, **19**: 997-1007.
- Allden, W. G. (1979). Undernutrition of the Merino sheep and its sequelae. V. The influence of severe growth restriction during early post natal life on reproduction and growth in later life. *Australian Journal of Agricultural Research*, **30**: 939-948.
- Bennetts, H. W. (1958). Unfruitfulness of weaner sheep in Western Australia. *Australian Veterinary Journal*, **34**: 398-400.
- Davis, C. (1977). Production feeding of weaner lambs. *Wool Technology and Sheep Breeding*, **25**: 3-5.
- de Chanee, G. C. (1977). The philosophy of drenching sheep in Western Australia. *Journal of Agriculture, Western Australia*, (4th Series) **18**: 2-6.
- Donald, C. M., and Allden, W. G. (1959). The summer nutrition of weaner sheep: The deficiencies of the mature herbage of sown pasture as a feed for young sheep. *Australian Journal of Agricultural Research*, **10**: 199-218.
- McGregor, B. A. and McLaughlin, J. W. (1980). The influence of dietary protein and energy concentration on the growth of Merino weaner sheep. *Australian Journal of Experimental Agriculture and Animal Husbandry*, **20**: 308-315.
- McLaughlin, J. W. (1973). Management of weaner sheep in Western Victoria. 2. The effects of supplements of oat grain or pasture hay or the periodic grazing of a green fodder crop upon current and subsequent production. *Australian Journal of Experimental Agriculture and Animal Husbandry*, **13**: 637-642.
- Marshall, T. (1980). Drought feeding sheep. Western Australian Department of Agriculture Farmnote No. 14/80.
- Mulhearn, C. J. (1958). Unthriftiness of weaner sheep in South Australia. *Australian Veterinary Journal* **34**: 383-390.
- Pritchard, R. K., Hall, C. A., Kelly, J. D., Martin, L. C. A. and Donald, A. D. (1980). The problem of anthelmintic resistance in nematodes. *Australian Veterinary Journal* **56**: 239.

Weston, R. H. (1971). Factors limiting the intake of feed by sheep. V. Feed intake and the productive performance of the ruminant lamb in relation to the quantity of crude protein digested in the intestines. *Australian Journal of Agricultural Research*, **22**: 307-320.

Weston, R. H. (1974). Factors limiting the intake of feed by sheep. VIII. The roughage requirement of the ruminant lamb fed on concentrate diets based on wheat. *Australian Journal of Agricultural Research*, **25**: 349-362.

Appendices

Appendix 1. Flock history

Appendix 2. Monthly management data collection

Appendix 3. Summary of recommendations
for the management of young sheep.
Katanning Advisory District—1978/79

Appendix 1-Flock history

A. Animals

- (i) Type of sheep—breed _____
strain _____
- (ii) Mating dates—rams in _____
rams out _____
- (iii) Weaning date _____
- (iv) Treatments, preventatives and vaccines used on lambs.

Treatment	Preparation	Dose	Date	How many treated?
Vaccination				
Drenching				
Dipping				
Jetting				
Minerals				
Licks				
Others				

Mulesed	Yes/No
Degree	Mules
	Mules and tail strip
	Radical

Appendix 2—Monthly management data collection

Farmer assessment

A. Feed value—if not hand feeding

How long will this paddock support this group of sheep? . . . weeks.

B. Animals

(i) What per cent of the mob is showing ill-thrift?

0% 5% 10% 15% 20% 25%

(ii) What is the average condition of the mob?

Emaciated

Backward store

Store

Forward store

Prime

(iii) What is the condition of the sheep with ill-thrift?

Emaciated

Backward store

Store

Foward store

Prime

(iv) How many have died during the last month?

(a) Tagged weaners (collect tags)

(b) Whole mob

(v) Have there been any signs of ill-health in the mob?

Details _____

Management data

(i) No. weaners in the mob _____

(ii) Size of paddock(s) _____

(iii) Date of paddock shift _____

(iv) Supplementary feeding Yes/No

Date commenced _____

Type fed	Quantity	How often?
Oats		
Barley		
Wheat		
Lupins		
Others		

(v) Treatments administered

Treatment	Preparation	Dose	Date	How many treated?
Vaccination				
Drenching				
Jetting				
Minerals				
Licks				
Rainfall				
mm/pts		Date		

Appendix 3—

Summary of recommendations for the management of young sheep. Katanning Advisory District—1978/79.

Time of lambing

Lambing should be completed by the end of August. This allows lambs to achieve maximum body weight and condition before pastures mature in October.

Lamb marking

Usually, lambs are ear marked at 4 to 6 weeks of age and tails removed. Mulesing is done at this time. Individual farmers may choose to vaccinate against clostridial diseases such as enterotoxaemia or tetanus. This decision will be affected by the disease history of the property, the availability of green pasture and whether cereal grain will be available over the coming summer. The first vaccination should be given followed by another dose 4 to 6 weeks later to obtain maximum immunity.

Shearing

Lambs should be shorn between September and November to prevent flystrike, to minimise the contamination of wool with vegetable matter and to avoid intradermal penetration by grass seeds. Unless external parasites are present in the flock, spraying or plunge dipping is not recommended. Such treatment could aggravate diseases such as dermatophilosis and caseous lymphademitis.

Internal parasite control

An anthelmintic should be given at weaning with a similar first 'summer' drench being given some 3 to 4 weeks after the pastures dry-off (usually November). Additional drenches may be necessary depending upon rainfall area and previous history of parasites on the property (appendix 3, table 1). 'Summer' drenches are given until the end of March.

Appendix 3, Table 1

Drenching programme for weaner flocks in different rainfall zones.

Rainfall zone mm	Weaning drench	First 'summer' drench	Second 'summer' drench	Additional drenches
<375	Yes	Yes	No	No
375-500	Yes	Yes	Yes	No
>500	Yes	Yes	Yes	Optional

Supplementary feeding

Seasonal and market factors determine producer's decisions if or when to begin supplementary feeding for growth or the maintenance of body weight. It is usually uneconomic to feed sheep except when they are being prepared for special markets. Minimal amounts of supplements should be fed to prevent or minimise weight loss during summer and autumn. High energy cereal grain such as wheat, barley and oats are preferred. (During the study, lupin seed, which has a high energy and protein content, was expensive and

in short supply). Low energy and protein feed, such as cereal hay, are not advocated except where paddock roughage is unavailable. Quantity of grain fed depends upon availability; price; condition of sheep and seasonal conditions.

The amounts of grain and hay for the maintenance of liveweight in weaner sheep is shown in appendix 3, table 2.

Appendix 3, Table 2

Weekly grain and/or hay ration for weaner sheep to maintain liveweight kg/head

Weaners	Ration†	Half† ration††
14 kg or more and/or older than 6 months	2.5 kg grain plus 1.0 kg roughage (hay)	1.5 kg grain

† = where no paddock feed available.

†† = some paddock feed available.

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