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RESEARCH REPORTS

Sheep and Angora Goat, Wool and Mohair

TEXAS A&M UNIVERSITY
Texas Agricultural Experiment Station
H. O. Kunkel, Acting Director, College Station, Texas

Contents

Authors

SALAH AYACHI, former graduate student, Department of Animal Science

J. W. BASSETT, associate professor, Department of Animal Science

GARY D. BORING, formerly with Merck, Sharp and Dohme Research Laboratories, Rahway, New Jersey

H. R. CROOKSHANK, animal nutritionist, Agricultural Research Service, U. S. Department of Agriculture

G. R. ENGDAHL, wool and mohair technician, Department of Animal Science

J. E. HUSTON, technician II, Livestock and Forage Research Center, McGregor

J. W. MENZIES, research associate, Ranch Experiment Station, Sonora

MAURICE SHELTON, animal geneticist, Livestock and Forage Research Center, McGregor

A. M. SORENSEN, JR., professor, Department of Animal Science

RESEARCH REPORTS

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Performance of Feeder Lambs Fed Rations Containing Various Protein Concentrates

J. E. Huston and Maurice Shelton

Prices of feed ingredients usually are determined by a supply and demand relationship based on tradition rather than actual nutritive value. Although nutritive value of a feed ingredient is not constant (due to its relationship with associated feeds), it seems possible to more accurately define a feedstuff's value using performance data. The most expensive nutrient in most livestock rations, therefore the first one which should be given price consideration, is protein. In the past, cottonseed meal has been in abundant supply in Texas at a competitive price level as a source of protein for livestock feed. A combination of circumstances, including decreases in cotton acreages and the probable future increase in human consumption of vegetable protein, indicates a need for more performance information on alternative protein sources for livestock feeds. A series of studies was conducted at the Livestock and Forage Research Center, McGregor, to obtain comparative information on various protein sources for feeder lamb rations.

Experimental Procedure

Experiment 1

Seven experimental rations were formulated and mixed in such proportions that at a determined level of feeding for each ration, the lamb receiving the feed was consuming 800 grams of basal ration ingredients plus enough of a protein concentrate to furnish approximately 43 grams crude protein daily. The seven rations and levels of feeding follow: basal, 800 grams; cottonseed meal, 905 grams; soybean meal, 899 grams; guar meal, 912 grams; blood meal, 854 grams; feather meal, 851 grams; and urea, 819 grams. The basal ration was composed of 10 percent alfalfa hay, 78 percent sorghum grain, 10 percent oats, 1 percent ground oyster shells and 1 percent trace mineralized salt. These rations and levels were fed to lambs (approximately 70 pounds) in metabolism stalls where total fecal and urine collections could be made. Treatments were rotated among individual animals until collection data were obtained from four lambs on each treatment (urine data collected on only two lambs) except the urea treatment on which only two collections were obtained. Crude protein utilization was determined for each protein concentrate by using average increases in intake, fecal and urinary crude protein over basal levels.

TABLE 1. PROTEIN UTILIZATION EFFICIENCIES OF VARIOUS PROTEIN CONCENTRATES BY LAMBS

Protein concentrate	Apparent C.O.D.,[1] percent	Efficiency of utilization of digested protein,[2] percent	Estimated relative value,[3] percent
Guar meal	84.4	54.9	46.3
Soybean meal	77.5	52.6	40.8
Blood meal	76.2	52.2	39.8
Feather meal	74.8	40.4	30.2
Urea	110.0	39.0	42.9
Cottonseed meal	70.3	63.8	44.9

[1]Apparent coefficient of digestibility.

Calculation:

$$\text{Apparent C.O.D.} = \frac{\text{Crude protein intake} - \text{Fecal crude protein} \times 100}{\text{Crude protein intake}}$$

[2]Calculation:

$$100 \times \frac{(\text{Crude protein intake} \times \text{Apparent C.O.D.}) - \text{Urinary crude protein}}{\text{Crude protein intake} \times \text{Apparent C.O.D.}}$$

[3]Calculation:

$$\frac{1 \times 2}{100}$$

The average protein digestibilities and levels of utilization of digested protein for the protein concentrates were calculated and are given in Table 1.

Experiment 2

Seventy-two crossbred lambs were weaned at an early age and randomly divided into six lots of 12 lambs each. Each group was immediately placed on one of the rations listed in Table 2 and self-fed for 58 days. Weights were taken at the beginning and end of the feeding period, and the performance results are given in Table 3.

Experiment 3

Seventy-five light weight crossbred lambs were randomly divided into six groups and placed directly on experimental rations, Table 2, for 71 days. Performance data are given in Table 3.

Discussion

All the protein concentrates considered in these experiments are available commercially. Cottonseed meal, the most widely accepted protein concentrate in the Southwest, was used as a standard in these studies. The remaining high protein concentrates were selected because of their availability and possible price advantage over cottonseed meal. Guar meal is a by-product of the guar seed crushing process and analyzes 35-40 percent crude protein. Soybean meal (44 percent crude protein) is a by-product from a similar process. Blood meal (80 percent) and feather meal (80 percent) are both animal by-products, and urea (281 percent crude protein equivalent) is a synthetic protein replacer which furnishes nitrogen for the conversion into protein inside the animal. A general conclusion resulting from these studies is that all can be considered of value for feeding sheep.

The value of any given protein supplement is determined by (1) level of consumption by animal, (2) digestibility of consumed protein and (3) level of utilization of digested protein. All three determinates were considered in this study. Protein digestibilities (Table 1) were similar for all of the natural proteins fed, with guar meal having the highest and cottonseed meal the lowest. The greater than 100 percent digestibility in the case of urea can be explained by its effect on protein digestibility of associated feed ingredients. Levels of utilization of digested protein were somewhat inverse when compared with the coefficients of digestibility. As a

TABLE 2. RATIONS FOR FEEDLOT STUDIES

	Experiment 2						Experiment 3					
Pen	1	2	3	4	5	6	1	2	3	4	5	6
Ingredients	Percent						Percent					
Alfalfa hay	10	10	10	10	10	10	15	15	15	15	15	15
Sorghum grain	60	60	60	60	74.2	60	66	68	75	75	80.2	67
Oats	5.0	8.6	18.2	18.5	10.0	6.5						
Guar meal	21.5						16					
Soybean meal		17.9						14				
Blood meal			8.3						7			
Feather meal				8.0						7		
Urea					2.3						1.8	
Cottonseed meal						20.0						15
Calcium carbonate	1.5	1.5	1.5	1.5	1.5	1.5	2	2	2	2	2	2
Trace mineral salt	2.0	2.0	2.0	2.0	2.0	2.0	1	1	1	1	1	1
Aureomycin (15 mg./pound)	+	+	+	+	+	+	+	+	+	+	+	+
Vitamin A (2500 I.U./pound)	+	+	+	+	+	+	+	+	+	+	+	+
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

TABLE 3. PERFORMANCE OF LAMBS FED VARIOUS PROTEIN SOURCES

	Experimental group					
	1	2	3	4	5	6
Experiment 2 (58-day totals)						
Initial weight, pounds	48.5	47.1	48.4	47.2	47.7	47.5
Final weight, pounds	69.3	81.8	80.7	78.0	79.2	84.8
Gain, pounds	20.8	34.7	32.3	30.8	31.5	37.3
Average daily gain, pounds	.36	.60	.56	.53	.54	.64
Daily feed intake, pounds	1.91	2.30	2.60	2.58	2.61	2.71
Feed conversion, pounds feed per pound gain	5.31	3.83	4.64	4.87	4.83	4.23
Experiment 3 (71-day totals)						
Initial weight, pounds	56.6	57.6	56.8	56.6	56.9	56.8
Final weight, pounds	89.0	94.6	89.5	91.7	90.1	93.6
Gain, pounds	32.4	37.0	32.7	35.1	33.2	36.8
Average daily gain, pounds	.46	.52	.46	.49	.47	.52
Daily feed intake, pounds	2.64	2.92	2.79	2.75	2.70	2.91
Feed conversion, pounds feed per pound gain	5.74	5.62	6.07	5.61	5.74	5.60
Average of two trials						
Average daily gain, pounds	.41	.56	.51	.51	.50	.58
Daily feed intake, pounds	2.3	2.6	2.7	2.7	2.7	2.8
Feed conversion, pounds feed per pound gain	5.6	4.6	5.3	5.3	5.4	4.8

result, the final estimated values of the various proteins (percent of consumed protein retained by the animal) are similar, Table 1.

These estimated values are of little consequence unless they are valid under the same conditions as they are to be used. A most important determinate of animal performance is an animal's state of adjustment to ration and feedlot, affecting among other things level of feed consumption. Experiments 2 and 3 were conducted to determine the relative animal performance on rations containing the various protein concentrates as the only supplemental sources of protein. Results of experiment 2, Table 3, generally follow what would be expected from estimated values from experiment 1 except that differences were not as great.

Notable exceptions to this generalization are the poor performance of the group fed guar meal and the excellent feed conversion obtained from the soybean meal ration. Raw guar meal has an objectionable "beany" odor and apparently reduced level of intake to such a level that performance suffered. For many years, soybean meal has been considered a superior protein source and gave an excellent performance in this trial. Older lambs were fed in experiment 3, and, although results were not completely dissimilar, performances of lambs on the various protein sources were much more alike than in the previous trial. Feed intake and rate of gain were somewhat higher for lambs receiving the rations containing either cottonseed meal or soybean meal than for those receiving the other rations tested, but all groups had satisfactory performance. Average performance data for the two feeding trials indicate that cottonseed meal and soybean meal supplements result in similar gains. Blood meal, feather meal and urea supplements resulted in slightly lower gains and less favorable feed conversions. The low level of feed consumption by the guar meal group in the first trial resulted in a reduced average rate of gain and higher requirement for feed per pound of gain.

Collectively these studies indicate that all of the protein concentrates tested can be used in feedlot rations although not necessarily with equal results. Performance by animals on the various protein supplements does suggest that true values are not always reflected by prices placed on each. Indications are that such animal by-product proteins as blood meal and feather meal approach in value the oil seed meal proteins provided feed intake is not considered. This immediately suggests their use in range supplements in which case low intake is desirable. Studies at the Livestock and Forage Research Center will continue in this area.

Some disadvantages of certain concentrates are probably reduced or eliminated when they are included in protein blends. During experiment 1, an additional group of lambs was fed a ration containing all of the protein concentrates (except soybean meal), each contributing equal amounts of crude protein to the ration. Average daily gain, daily feed intake and feed conversion were .60, 2.8 and 4.7, respectively. These results were not as good as those with cottonseed meal but somewhat better than the pooled average (.53, 2.5 and 4.8).

PR-2513

Effects of Ration Protein Level And Parasite Load on Performance Of Summer-fed Lambs

J. E. Huston and Maurice Shelton

Poor performance of late born lambs during the hot summer months is an annual problem facing Texas sheep producers. As an alternative, many ranchers use an early breeding season in order to get lambs to slaughter as milk lambs or after a short stay in the feedlot or in winter grain pasture. Nevertheless, a large number of feeder lambs become available during June and July and must be either fed in dry lot or held on grass until cool weather and then fattened in the feedlot.

It would be to the producer's advantage to feed the animals, get them to market as quickly as possible and not use valuable summer grass or run the risk involved in holding the lambs. However, feeder lambs perform poorly in Texas feedlots because of

TABLE 4. RATIONS FOR SUMMER-FED LAMBS

Ingredient	Ration protein level Low	Medium	High
	— — — Percent	— — —	
Alfalfa hay	5	5	5
Cottonseed hulls	20	20	20
Sorghum grain	73	63	57
Cottonseed meal		10	15
Urea			0.5
Calcium carbonate	1	1	1.5
Trace mineralized salt	1	1	1
Aureomycin (15 mg./pound)	+	+	+
Vitamin A (2500 I.U./pound)	+	+	+
Total	100	100	100
Calculated crude protein	9.0	12.1	16.3

the high temperature stress and also due to the fact that a large proportion of these lambs are "doggied" by near starvation and/or a heavy infestation of internal parasites. A feeding study was conducted at the Livestock and Forage Research Center, McGregor, to determine the effects of level of protein in the ration and parasite load on the performance of summer-fed lambs.

Experimental Procedure

Ninety-six uniform ewe and wether lambs were purchased from a commercial source and placed on a heavily grazed pasture for 2 weeks to assure a heavy infestation of parasites. Then they were gathered, shorn and weighed into the feedlot. Two lots of 16 lambs per lot were self-fed each of the experimental rations, Table 4. Eight lambs from each lot were randomly selected and each drenched with 1 ounce Thiabenzole. Fecal samples were taken from six lambs from each lot at initiation of the trial. Included in these were three lambs which were drenched at the time of sampling and three left nondrenched. Sampling was repeated 2 weeks later and at the end of the feeding trial. Initial infestation of gastrointestinal nematodes was uniform among the groups and averaged 2,105 parasite eggs per gram of feces. Blood samples were taken from the same six lambs in each lot near the mid-point of the experiment, and packed blood cell volume was determined on each as a measure of anemia. Tables 4, 5 and 6 contain the experimental rations, 80-day performance records and the effects of protein level and drenching on average daily gain, parasite load and packed cell volume, respectively. Replicated lots within each protein level were pooled for construction of tables.

TABLE 5. PERFORMANCE OF SUMMER-FED LAMBS AT THREE PROTEIN LEVELS

	Ration protein level Low	Medium	High
Number of lambs	29	32	31
Average daily gain, pounds	.29	.40	.43
Daily feed intake, pounds	2.59	2.76	2.94
Feed conversion, pounds feed per pound gain	8.9	6.9	6.8

TABLE 6. EFFECTS OF DRENCHING ON AVERAGE DAILY GAIN AND PARASITISM OF SUMMER-FED LAMBS

	Ration protein level Low	Medium	High	Average
Drenched				
Average daily gain, pounds	.33	.41	.45	.40
Parasite eggs per gram feces	150	523	563	412
Packed cell volume, percent	30.0	33.8	32.8	32.2
Not drenched				
Average daily gain, pounds	.24	.38	.41	.34
Parasite eggs per gram feces	9,462	3,105	1,957	4,841
Packed cell volume, percent	22.3	27.2	31.0	26.8

Discussion

A previous report from this station discussed results of studies to determine the most optimum protein level for high concentrate lamb rations. Those results indicated that no response could be expected from feeding typical feeder lambs rations containing higher protein levels than the lowest fed in those studies (12 percent). However, a lower range of ration protein was studied in the present experiment, and it is evident from the performance data, Table 5, that the low protein ration was not adequate for satisfactory performance. Again, the differences between the higher levels (12.1 vs. 16.3) were small and not significant.

Table 6 shows the effect of parasite load on lamb performance and the significant interaction between parasite load and ration protein level. Both the drenched and nondrenched groups responded to increased ration protein level, but the nondrenched group, although having a lower average performance, had a substantially greater response when the higher levels of protein were fed. Differences in fecal parasite eggs and blood cell volume within the drenched group were small, whereas those within the nondrenched group were large with the level of parasitism and corresponding anemic condition increasing as ration protein level became lower. Three of the nondrenched, low protein group were observed to have "bottle jaw" during the experiment. One of the three died; the other two were removed from the experiment and given a higher level of nutrition to prevent death.

These results indicate that the performance of summer-fed lambs increases slightly when ration protein level is increased from 12 to 16 percent and decreases substantially when reduced from 12 to 9 percent. This decrease in performance when ration protein level is reduced, is much more drastic when lambs are heavily infested with internal parasites. The number of intestinal parasites increased in the nondrenched group as the protein level decreased. This possibly can be explained in part by increased manure consumption by the protein deficient lambs. However, since this increased level of parasitism was not noted in the drenched group, it appears that increasing the protein consumption of lambs not only partially alleviates the effects of parasitism (increased daily gain and higher packed cell volume) but also increases an animal's resistance to internal parasite survival.

PR-2514

Night Lighting as an Aid To Feedlot Production Of Market Lambs

J. W. Menzies

Various physical improvements have been made in lamb feedlots to determine their effect on market lamb performance. This report is a summary of 3 years' work with the effect of night lighting during fall, shorter-day months on market lamb production.

Experimental Procedure

Each trial was conducted starting the last week in October and continuing through the latter part of December (45-60 days), during the shorter days of the year. Each year the lambs were divided into three groups as follows: Group 1—Control, normal feedlot treatment; Group 2—all-night lighting in the form of a 100-watt bulb over the feeder (sufficient to light the entire pen); Group 3—4 hours of light from 10 p.m. to 2 a.m. each night.

A different ration was fed each year; however, all of the rations were of a high concentrate nature consisting (in each case) of over 50 percent milo. Within each year all of the lambs received the same ration, self-fed.

Results

Table 7 gives results of 3 years of study. A total of 84 lambs showed an increase in average daily gain due to the partial (4 hours) night-lighting technique. This apparently was due to an increase in feed consumption of 3.67 pounds per day for the partially lighted group as compared to 3.07 pounds per day for the controls. The continuously lighted group consumed 3.57 pounds feed per day.

Feed efficiency was more desirable for the partially lighted group: 7.95 pounds of feed per pound of gain as compared with 8.76 pounds for the controls. The feed efficiency was about the same between the continuously lighted and the control groups.

Summary

Three different trials on a total of 84 lambs have shown a small but consistent improvement in feedlot performance of lambs due to a night-lighting system. Partial lighting (10 p.m. to 2 a.m.) was found to be more desirable than was all-night lighting.

PR-2515

Influence of Melengestrol Acetate (MGA) on Performance Of Ewe Lambs in Feedlot

Maurice Shelton and J. E. Huston

Several reports have shown that the use of orally active progestogens offer promise of improvement in gain performance of feedlot heifers. Therefore, it seemed advisable to investigate the possibility of utilizing this drug to advantage with ewe lambs in the feedlot. One of these orally active progestogens (Melengestrol Acetate or MGA[1]) was used in a single feeding trial starting November 4, 1966. The results are shown in Table 8. The MGA was fed at the rate of .03 milligrams per pound of feed for an anticipated daily intake in the range of .10 milligrams per head. However, since the animals were self-fed, the daily intake was somewhat higher than expected with a resulting drug intake of .13 milligrams per head per day. The ration fed was as follows: 25 percent sorghum hay, 10 percent alfalfa hay, 38 percent sorghum grain, 15 percent oats, 10 percent cottonseed meal, 1 percent trace mineral salt, 1 percent bone

[1]Supplied by TUCO Products Company, Division of the UpJohn Company, Kalamazoo, Michigan.

TABLE 7. EFFECT OF NIGHT LIGHTING SYSTEMS ON LAMB PERFORMANCE IN THE FEEDLOT DURING THE FALL MONTHS

	Average daily gain, pounds				Pounds feed per pound gain				Daily feed consumption, pounds			
	1964	1965	1966	Average	1964	1965	1966	Average	1964	1965	1966	Average
Control, no light	.34	.36	.35	.35	8.79	8.60	8.89	8.76	3.0	3.1	3.1	3.07
Continuous light	.45	.39	.33	.39	9.04	8.65	9.42	9.04	4.0	3.4	3.3	3.57
Partial light, 10 p.m.–2 a.m.	.41	.45	.41	.42	7.72	7.80	8.29	7.95	4.1	3.5	3.4	3.67

TABLE 8. EFFECT OF MGA ON PERFORMANCE OF EWE LAMBS IN FEEDLOT

Treat-ment	Daily intake MGA, mg.	Number lambs	Initial weight, pounds 11/4/66	Final weight, pounds 1/5/67	Average daily gain, pounds	Daily feed consumption, pounds	Pounds feed per pound gain
Control	0	12	62.3	98.0	.567	4.36	7.7
MGA	.13	12	62.8	98.3	.563	4.35	7.7

meal and Aureomycin at the rate of 15 milligrams per pound of feed.

The data in Table 8 show that in this trial no response was obtained from the addition of MGA to the ration for ewe lambs. Normally, more than one feeding trial utilizing a range in drug levels would be required to properly evaluate the addition of a progestogen to sheep rations. However, since this trial was initiated, other workers have failed to show a response to its use with ewe lambs. Thus, it appears that further work on such material at this location is not justified now. This failure to show a response with sheep similar to that reported with cattle requires explanation. Progestogens of this type are known to prevent ovulation but not follicular development. Thus, animals receiving this drug would tend to be in a hyperestrogenic state. However, if the animal in question had not reached sexual maturity, no significant response to this drug would be expected. Ewe lambs of the type used in this experiment and those generally going into feedlots would not be expected to have reached sexual maturity within the weight range of most commercial feedlot programs. Thus, this would offer a potential explanation for their failure to show a response to this drug.

PR-2516

Effect of Fluorogestone Acetate Pessaries On Reproduction in Ewes

SALAH AYACHI, MAURICE SHELTON AND A. M. SORENSEN, JR.

Synchronizing hormones and a program of increased lamb crop remain primary topics of research in sheep reproduction. The use of progestational compounds has taken precedence over other compounds and hormones for synchronization. The method of administering these compounds changed from injection to feeding, and now to the use of tampons in the vagina of the female. The purpose of this project was to determine the effect of a progestational compound, fluorogestone acetate, and pregnant mare serum on the reproductive performance of ewes as measured by ovulation and fertilization.

Experimental Procedure

A total of 139 fine-wool ewes were assigned to treatments shown in Table 9. Pessaries[2] containing 20 milligrams of fluorogestone acetate were inserted into the anterior vagina of the ewes and left 16-18 days. They were then removed, and the various combinations of (injected) pregnant mare serum were made. Marked rams bred the ewes as they showed signs of estrus. On the second day following breeding, the ewes were salpingectomized on the side of the active ovary, and the ova were flushed from the oviducts for further study.

Estrus synchronization was good over the 5-day period following removal of the pessaries, Table 9. By the second day, 43.9 percent (61/139) of the ewes came in estrus, 83.5 percent (116/139) by the third day and 95.0 percent (132/139) by the fifth day. Most of the groups and especially those on the lower levels of 0, 250 and 500 International Units of PMS regardless of day of injection showed 100 percent in estrus by the third day.

The effect of different PMS dose levels injected on day 0 is given in Table 10. Table 11 gives the fertilization percentages of ova recovered. Although the ovulation rate was greatest for the 1,000 IU dose level, Table 11 indicates that this was the lowest

[2]Supplied by G. D. Searle and Company.

TABLE 9. EFFICIENCY OF FLUOROGESTONE ACETATE IN THE CONTROL OF ESTRUS AND OVULATION

PMS dose	Injection day	Number ewes involved	Estrus exhibited by day 2	3	5	Total percent in estrus
0		13	2	13		100
250	0	8	4	8		100
500	−3	6	5	6		100
	−2	5	5			100
	−1	6	2	6		100
	0	25	13	25		100
	+1	20	4	13	19	95.0[1]
750	−3	4	2			50[1]
	−2	4	3	4		100
	−1	4	2	3		75[1]
	0	22	10	19		86.4[1]
	+1	9	1	6	9	100
1,000	0	13	8	13		100
Total		139	61	116	132	95

[1]One or more ewes did not come in estrus (did not breed).

TABLE 10. EFFECT OF DIFFERENT PMS DOSES INJECTED ON DAY 0 ON OVULATION

PMS dose	Number ewes treated	Number ewes ovulated	Total ovulations	Ovulation rate
0	13	12	20	1.54[1]
250	8	7	11	1.38[1]
500	25	25	49	1.96
750	22	22[2]	47	2.13
1,000	13	13	62	4.77

[1]One ewe at each level did not show ovulation points when laparotomized.

[2]Three ewes were not recorded in estrus but showed recent ovulation points upon laparotomy.

percent fertilization group. Table 12 is an attempt to project the data so that fertilization rate can be determined. In this table the number of ovulation points multiplied times the percent fertilization of those ova that were recovered is extended to give the number of ova fertilized. Although this is theoretical, it is based upon the fertilization rate of those that were recovered and can be used in calculating the fertilization rate based on ovulations. According to this extrapolation, the 1,000 IU of PMS given on day 0 would return approximately 30 percent more lambs than any other level of injection or control.

Several aspects must be considered in evaluating the fertilization rate. With the increased number of ova produced as a result of PMS injections, the passage of the ova through the oviduct is expected to be increased. Some of the ova that supposedly would be in the oviduct at this time were flushed from the uterus when none could be found in the oviduct. The lower percent fertilization at the higher levels sustantiates this belief. Although 30 percent more lambs is a substantial increase, the cost of bringing about the increase is such that it cancels the benefits of it.

TABLE 11. FERTILIZATION PERCENTAGES OF OVA RECOVERED FROM EWES PRETREATED WITH FLUOROGESTONE ACETATE AND INJECTED WITH DIFFERENT PMS DOSES ON DAY 0

PMS dose, IU	Number ewes ovulated	Number ovulation points	Number ova recovered	Percent recovered	Number ova fertilized	Percent fertilization
0	12	20	14[1]	70.0	10	71.4
250	7	11	7[2]	63.7	3	42.9
500	25	49	37	75.5	20	54.0
750	22	47	35	74.5	14	40.0
1,000	13	62	19	30.6	6	31.6
Total	79	189	112	59.2	53	48.0

[1]Eleven ova plus three embryos.

[2]Two ewes with 2 *corpora lutea* each were later found open.

TABLE 12. FERTILIZATION RATES RECORDED FOR EWES INJECTED WITH DIFFERENT PMS DOSES ON DAY 0

PMS dose, IU	Number ewes	Number ovulation points	Percent fertilization of ova recovered	Number ova fertilized (theoretical)	Fertilization rate
0	12	20	71.4	14.3	1.19
250	7	11	42.9	4.7	.67
500	25	49	54.0	26.5	1.06
750	22	47	40.0	17.6	.80
1,000	13	62	31.6	19.6	1.51
Total	79	189	48.0	89.0	1.13

PR-2517

A Method of Pregnancy Diagnosis in Sheep

MAURICE SHELTON

A method of diagnosing pregnancy and of identification of ewes bearing twins would contribute greatly to efficiency in the sheep industry. The primary advantage would be to permit earlier culling of dry ewes or improved feeding and management according to needs of the ewe. Many procedures have been suggested and tested, but to date all lack accuracy or are impractical because of time or cost involved. For instance, x-ray provides a highly accurate means to accomplish both of these objectives, but it is not suggested for widespread use.

Experimental Procedure

Recently an instrument was developed and used for pregnancy determination and for monitoring fetal or placental circulation in humans. A number of investigators are interested in adapting this technique to pregnancy diagnosis in sheep. During the past year, one instrument[3] was tested extensively at the Livestock and Forage Research Center, McGregor, to evaluate its utility for pregnancy diagnosis in sheep and goats. This paper contains a preliminary report on its use in sheep. The goats tested have not yet kidded; thus no data are available on this species.

The instrument uses the Doppler shift principle. An ultrasonic beam is directed through maternal tissue by a probe placed on the anterior portion of the udder tissue which is devoid of wool follicles. For this purpose the ewes are placed in reverse direction on a Lammond laparotomy cradle. The significance of position of ewe during testing is not fully known. Any tissue movement in this area reflects a portion of the sound waves which are picked up by the instrument and converted into audible sounds. Although any movement of the musculature or intestines can create static in the instrument, a positive

[3]The instrument used is the MD500 Ultrasonic Doppler Instrument manufactured by Magnaflux Corporation, Chicago, Ill.

diagnosis of pregnancy is based on a pulsating sound created by arterial blood flow. In the nonpregnant ewes, no arterial flow is detectable in this region. In the pregnant animal, either or both fetal or maternal flow may be detected, and the presence of either is a positive indication of pregnancy. The source of the signals can be determined relatively accurately by pulse rate. The instrument is completely directional and must be kept in direct contact with the skin. The area is searched by change in direction or by movement of skin over underlying tissue.

Results

In one of the first tests of this instrument, 10 ewes were checked October 6, 1967. These ewes were purchased at auction and were of unknown history. Two of these were classified pregnant and eight as open. Those showing to be negative were slaughtered. Three of these were found pregnant, but based on crown-rump length, the fetuses were 70 days or less in age. This indicates that the technique cannot be used satisfactorily when 70 days or less of the gestation period has elapsed. Use of this machine involves an element of search. Thus, the ability to detect pregnancy is to some extent a function of time expended and perhaps sensitivity of equipment.

Several groups of ewes have been tested with this machine and have completed their lambing performance, and the results are summarized in Table 13. The ewes in group 1 were yearling ewes which had been exposed to rams during May and which were checked in early September. The second group of ewes were exposed to rams in June and were checked in early October. The number of ewes in this flock was much larger than the numbers indicated here. Prior to checking with the machine, they were run through a cutting chute, and those obviously pregnant based on udder development were pulled out. Thus, only questionable ewes were checked by the machine. The ewes in both these groups were subsequently exposed to rams in September. Thus, most of the ewes classified as open at the time of checking were pregnant, but of less than 30 days duration, and are considered open for the sake of this test. The ewes in group 3 were continuously exposed to rams after June. They were checked in October. Thus, those classified as open could have been pregnant, but of short duration, as they showed no evidence of lambing as of December 15, 1967.

The summary column in Table 13 shows that 96 of 98 ewes classified as pregnant lambed. One of these can be accounted for by confusion in proper identification of ewes lambing. Only 3 of 79 ewes classified as open lambed. Other tests on which lambing records are not complete indicate that this degree of accuracy cannot be expected when dealing with larger numbers.

In practice, the operator will soon develop a high degree of confidence in positive diagnosis in that a distinct pulse beat leaves little room for doubt. However, in rapidly testing large numbers, some error will be encountered due to rapid classification based on preliminary signals. By contrast, the operator will lack confidence in negative classification. As indicated, some element of search is involved, and the operator can say only that in a reasonable testing time (2-5 minutes per ewe) no positive evidence was obtained. Test conditions seem to affect the degree of accuracy or at least ease of testing. It is more difficult to obtain positive readings on fat ewes than on thin ones. Readings are more easily obtained in the later stages of gestation, except for the last few days or 2 weeks before parturition. In the latter case, the fetuses often appear to be displaced anteriorly to the extent that a reading from the position described is difficult to obtain. The test location can be moved forward on the ewe's abdomen, but this requires shearing the test area and adds considerably to the test time. This was not done in any of these tests.

These data provide limited insight into how early this test can be utilized. The youngest fetus among the ewes included in Table 13 was 84 days. The two embryos missed in group 3 were 82 and 84 days at testing. This indicates that the test could be used routinely after approximately 90 days of gestation have elapsed. Positive readings have been obtained in individual ewes as early as 60 days, but in early

TABLE 13. RESULTS OF PREGNANCY DIAGNOSIS IN SHEEP UTILIZING THE DOPPLER SHIFT PRINCIPLE

	Group 1		Group 2		Group 3		Summary	
Classification	Number in classification	Number lambing	Number in classification	Number lambing	Number in classification	Number lambing	Number in classification	Number lambing
Pregnant	36	36	21	19[1]	41	41	98	96
Open	21	0	51	1[2]	7	2	79	3
Range in fetal age at checking[3]	(105-130)		(115-147)		(84-118)		(84-147)	

[1]One ewe on this list was shown to be open and one shows to have lambed twice, suggesting the discrepancy to be a case of erroneous matching of ewes and lambs.

[2]This ewe was sick at the time of checking and lambed 2 days after checking.

[3]Calculating from lambing date based on a 149-day gestation period.

attempts to use this instrument, embryos of this age were missed. Thus, the relatively accuracy of the method between 60 and 90 days requires further testing.

Recommendations

This is the most promising technique yet proposed for pregnancy diagnosis in sheep. This technique should find immediate application as a research tool and should see limited producer use in the near future. Improvements in equipment and techniques also should extend the utility of this procedure and possibly enable identification of twin-bearing ewes.

Most producers could easily pick up the techniques required. However, the initial cost of the instrument (approximately $800) probably will restrict its use to veterinarians and public service personnel. More economical instruments may be available in the future. There is little indication that this instrument can be used early in gestation such as near the end of the breeding season. This restricts its use to culling open ewes in advance of the lambing season or before the stage of gestation at which improved nutrition is required by pregnant ewes. The instrument was used routinely at Livestock and Forage Research Center in the fall of 1967 to pull open ewes in advance of the initiation of lambing. To save labor, the ewes were put through a cutting chute, and those determined pregnant by udder palpation were pulled out. The remaining ewes were then tested with the Doppler instrument. Used in this manner, the machine proved to be more accurate than udder palpation. The two methods can be combined into a fairly rapid and accurate means of pulling out open ewes several weeks before the lambing season. This technique should be suitable for use 30-45 days before initiation of the lambing. At this stage, it is necessary to test practically all the ewes. However, when the ewes are placed in an inverted position on the laparotomy cradle, udder development, which can be more readily observed in this position, or fetal activity as observed or palpated through the lower abdominal region can be used to speed up readings.

PR-2518

Comparison of Various Types Of Ewes for Slaughter Lamb Production in Central Texas

MAURICE SHELTON AND J. W. BASSETT

Many scientists think that the phenomenon of hybrid vigor is the major contribution of animal breeding research to animal production systems. A two-stage crossbreeding program in which the final market product is a three-breed cross is among the most efficient programs. In the case of fertility traits, the greater response is obtained by using crossbred females as the breeding unit. Texas producers have long used first-stage crossing in which the market lamb is sired by black-face rams of the Suffolk or Hampshire breeds. However, little use has been made of the more advanced crossbreeding systems in the state. This is largely due to a lack of breeds sufficiently well adapted to the environmental and economic situations involved. However, a major goal of research programs should be location or development of breeds or strains that can be satisfactorily used for this purpose.

This report contains a preliminary comparison of certain types of ewes tested at the Livestock and Forage Research Center, McGregor. The breeds involved are Rambouillet, Merino and crosses between these two as well as Dorset x Rambouillet and Columbia x Rambouillet crosses. These two breeds of non fine-wool types were chosen because they are the white-fleeced breeds more readily available in this area. This flock is on a fall and winter lambing program and during this study was not given an opportunity to lamb after February 1.

Because of generally good grazing conditions, the ewes are well developed and over-fatness is a problem at times, at least with crossbred ewes. No attempt has been made to artificially rear the lambs, with the result that lamb mortality tends to be high from lambing at this time of year. Performance data of these crosses are shown in Table 14. The values for 120-day weights were obtained from a least

TABLE 14. PRELIMINARY RESULTS OF COMPARISON OF VARIOUS TYPES OF EWES FOR FALL AND WINTER LAMB PRODUCTION

Type of ewe	Number ewes	Body weight, pounds		Percent ewes lambing		Lambing rate, percent (Mature)	120-day lamb weight, pounds	Pounds lamb at 120 day per ewe bred	Fleece weight, pounds	Approximate gross per ewe[1]
		Yearling	Mature	Yearling	Mature					
Rambouillet	234	114.4	133.2	80.8	90.3	135.1	65.1	63.7	10.4	$21.15
Delaine Merino	57	101.1	118.4	73.7	86.8	126.6	62.1	51.5	10.7	18.53
Dorset x Rambouillet	44	118.2	134.0	79.2	81.8	144.4	68.4	64.3	9.8	20.91
Columbia x Rambouillet	47	121.1	143.0	73.8	83.0	133.3	67.6	55.4	10.4	19.24
Rambouillet x Merino	108	111.7	129.4	86.2	87.0	147.9	65.2	64.2	11.0	21.64

[1]Based on an assumed price of 23¢ per pound for lamb and 62.5¢ per pound for wool.

squares analyses in which adjustments were made for such factors as age of the ewe, type of birth of lamb and breed of sire. Ewe body weights, fertility and fleece weight data are based on hand tabulations and include all records on each ewe up to the time these analyses were initiated.

Pounds of lamb per ewe bred is a calculated value combining fertility data and a least squares estimate of growth data. No detailed statistical treatment of these data seemed to be indicated. The goal was to find a ewe that is superior in performance to the basic fine-wool type. These limited data indicate that neither of the two medium-wool crosses have proved superior under these conditions. The numbers of the two crosses involved in this comparison are less than would be desired, but data available from additional numbers were not comparable in management or contemporary in the sense that they could be included in these tabulations. However, results from these tend to support the conclusions drawn from data reported in this study.

Columbia x Rambouillet ewes were the largest with a 10-pound weight advantage at maturity over any of the other types studied. However, they were below all the fine-wool types in percent ewes lambing and surpassed only the Delaine Merino in lambing rate. They did not surpass any of the fine-wool types in grease fleece weight. These results do not encourage the use of this breed in crossbreeding programs. This breed contains, in part, the genes of fine-wool sheep and would not be expected to yield maximum hybrid vigor in crossing. As a breed, they do not excel in fertility and are subject to a more restricted breeding season than fine-wool types. As suggested by the weight advantage for the Columbia cross ewes, Columbia rams perform satisfactorily as sires of market lambs and are recommended for this purpose (see TAES PR-2442).

The Dorset x Rambouillet are approximately comparable to Rambouillet in body weight but are below the latter in fleece weight. They are below all fine-wool types in percent ewes lambing. They exceed both Rambouillet and Delaine in lambing rate and 120-day weight of lambs raised. These factors combine to make this cross comparable to any of the fine-wool types in pounds of lamb weaned per ewe bred. However, again they do not exceed the Rambouillet in either lamb or wool production or estimated gross income. This type of ewe has a shorter productive life under Texas conditions. Also the first cross lambs sired by Dorset rams are at least 6 pounds lighter at weaning than most other types (TAES PR-2442). Since all the male lambs would be marketed at this stage, this represents a financial sacrifice from this cross. Much of the difficulty with this cross is due to the tendency to early maturity and excessive fat deposition. A major increase in body size in this breed might go a long way to making it more suitable in a crossbreeding program, since it does appear to have some advantage in level of twinning, lamb growth rate and lack of seasonal restriction to breeding.

Merino ewes do not equal any of the other types tested in lamb production, but they were surpassed by only the Rambouillet x Merino crossbred ewe in wool production. Merino ewes approach, but do not equal, the Rambouillet as an income producer when this is expressed as a function of body size. This is logical only if it is assumed that feed consumption is a direct linear function of body size. However, it is generally considered that metabolic activity and feed intake increases only at approximately three-fourths power of body size. This would indicate that Merino ewes are slightly less efficient. This is probably due to the higher level of fiber production per unit of body weight. The TDN required for wool production is considerably higher than that required for meat production. Therefore, keeping Delaine Merinos is justified only in case they are better adapted to the breeding and environmental conditions.

In this study Rambouillet x Merino crossbred ewes at least equal and, in some respects, exceed the pure Rambouillet in reproductive and fleece performance indicating some degree of hybrid vigor associated with this cross. However, advantage of this hybrid vigor could be realized largely through the cross of Rambouillet rams on Merino ewes. If followed, this course would result in a transition from Merino to Rambouillet breed which must be justified based on a comparison of the two breeds. The reciprocal cross would result in some immediate sacrifice in market weight of market lambs sired by Merino rams.

PR-2519

Heritability Estimates of Some Performance Characteristics Of Range Fine-wool Sheep

Maurice Shelton and J. W. Menzies

Fertility, longevity and wool production of the ewe flock and growth rate of the lambs produced contribute directly to income. These traits are encompassed in such measures as total lifetime lamb and wool production. Relatively few attempts have been made to study the genetic parameters relating to such total production traits. The possibility of improving these traits through genetic means warrants thorough investigation. Two potential schemes exist for improvement of ewe performance through genetic means. These are by exploiting the phenomenon of hybrid vigor through appropriate crossbreeding programs or by selection within the breed or population concerned. Of the two schemes, crossbreeding offers potential for a more immediate response, but no crossbred ewe has been identified

TABLE 15. THE RELATION OF AGE OF EWE TO BODY WEIGHT AND LAMB AND WOOL PRODUCTION

Age	Number	Average ewe weight pounds	Percent of ewes lambing	Percent lambs born of ewes lambing	Lambs raised, percent of lambs born	Average weaning weight, pounds		Average fleece weight, pounds
						Singles	Twins	
2	1,330	96.8	64.4	108.1	85.3	61.8	56.1	9.6
3	1,111	101.2	81.5	118.9	88.9	70.0	60.9	9.9
4	924	113.7	80.6	127.0	89.2	70.4	60.1	9.8
5	747	117.0	82.1	128.7	86.3	70.8	61.2	9.7
6	568	118.6	82.2	128.5	86.3	70.8	58.5	9.4
7	364	117.9	77.5	129.8	88.3	62.7	58.3	8.9
8	200	117.5	70.0	127.9	82.1	64.7	56.3	8.7
9	84	112.4	76.2	123.4	88.6	60.7	55.2	8.0
10	23	106.0	73.9	141.2	79.2	52.8	56.5	7.2

which is entirely satisfactory for the environmental and economic conditions of the area.

Materials and Methods

This report concerns an analysis of data collected on the Rambouillet flock at the Ranch Experiment Station, Sonora, 1930-1966, inclusive. The only animals included are those ewes which were born on the station and added to the breeding flock in the years 1930-1960, inclusive, and which had completed their lifetime performance by the summer of 1966. The data studied include actual weaning weight, taken in August; actual yearling weight, taken at time of spring shearing; mature body weight, taken at the time the rams were placed with the ewes in late September; and complete lamb and wool production throughout the productive life of the ewe. Mature body weights were taken in only some of the years included in the study, and the volume of data on this variable is limited. A function for breeding efficiency was calculated by dividing the number of lambs born or raised by the number of years in the breeding flock. The resulting value expressed as a ratio or percent does not show a normal distribution but exhibits two peaks at zero and around the mean.

Results

The first analysis undertaken was that of the effect of age of the ewe on her performance. The results are shown in Table 15 and agree closely with a similar analysis on the same flock (1). It will be noted that fleece weight decreases with advancing age after the third year. It will also be noted that lamb production is poor for two-year olds but thereafter is relatively stable through the age of 7. In certain genetic analyses, performance for ages 3 through 7 were considered separate as well as that for total lifetime production.

Phenotype Correlations

Simple correlation coefficients between some of the variables studied are shown in Table 16. None

TABLE 16. SIMPLE CORRELATIONS AMONG TRAITS MEASURED

	Yearling breeding weight	Mature weight	Years in breeding flock	Number lambs born	Number lambs raised	Number dry seasons	Number multiple births	Average fleece weight	Total wool production	Total lamb production	Lambs born / Times bred	Lambs raised / Times bred
Weaning weight	.660**	.418**	.039	.101**	.088**	—.049	.126**	.059	.063	.102**	.130**	.125**
Yearling weight		.621**	.069*	.131**	.124**	—.039	.151**	.147**	.105**	.148**	.166**	.154**
Mature weight			.269**	.203**	.159**	.228**	.221**	.295**	.349**	.207**	.012	—.017
Years in flock				.853**	.826**	.409**	.477**	.017	.949**	.821**	.220**	.222**
Number lambs born					.954**	—.011	.757**	—.059	.793**	.936**	.604**	.542**
Number lambs raised						—.016	.696**	—.083**	.764**	.980**	.565**	.634**
Number dry seasons							.022	.209**	.438**	—.020	—.480**	—.417**
Number multiple births								.021	.456**	.651**	.597**	.498**
Average fleece weight									.295**	—.101**	—.135**	—.169**
Total wool production										.576**	.188**	.190**
Total lamb production											.532**	.600**
Lambs born / Times bred												.856**

*P<.05.
**P<.01.

of these are particularly revealing, since they are of relatively low magnitude except in those cases in which they represent an alternative measurement of the same function. As would be expected, there is a low but significant negative relationship between average wool production and the various measures of reproductive efficiency. Both weaning weight and yearling weight are positively related to various performance traits. However, these relationships are of low magnitude, and, of the two, yearling weight is of more value in predicting subsequent performance. Mature body weight was not significantly related to reproductive efficiency when the latter was expressed in percent but was significantly related to the various measures of total performance.

Heritability Estimates

Efforts were made to estimate the heritability of the traits studied by both the paternal half-sib and parent-offspring regression procedures (intra-sire regression of offspring on dam). The results are shown in Table 17. The two procedures disagree markedly on the heritability of the various measures of body weight. These estimates are somewhat biased, since these data include only a selected population consisting of those animals actually entering the breeding flock. Other more extensive analyses (2) indicate the true heritability of weaning weight to be in the range of 14-30 percent depending on the extent of environmental corrections or adjustments of the data.

TABLE 17. HERITABILITY ESTIMATES OBTAINED BY THE PATERNAL HALF-SIB AND INTRA-SIRE REGRESSION OF OFFSPRING ON DAM PROCEDURES

Trait	Number	Half-sib method, percent	Number	Intra-sire regression method, percent
Actual weaning weight	1,165	37.41**	737	3.32
Actual yearling weight	1,165	78.55**	556	7.24
Mature weight	386	15.24	112	44.50
Mean fleece weight	1,039	58.39**	552	52.26**
Total wool production	1,252	26.12**	733	22.58**
Number lambs born	1,270	26.03**	738	18.08*
Number lambs raised	1,269	27.57**	736	25.18**
Total lamb production	1,267	29.29**	735	26.38**
Number lambs born / Years in flock	1.038	20.74*	564	27.59*
Number lambs raised / Years in flock	1,308	22.31*	734	26.48*

*P<.05 — Tests of significance are based on the F test in the case of sire.

**P<.01 — component and significance of correlation coefficient in case of parent-offspring relationship.

This study, plus other analyses, seem to confirm that heritability of yearling weight is substantially higher than weaning weight. Increases in body size, if this is desired, can be brought about more rapidly by selecting for yearling weight instead of weaning weight. Mature body weight of ewes seems to be somewhat lower in heritability than yearling weight, perhaps because it is influenced by differential levels of lamb production by breeding ewes. The heritability of average fleece weight seems to be uniformly high with estimates of 52.3 and 58.4 in this study. The estimate for total wool production was somewhat lower, since it includes the additional variable length of time in the breeding flock.

The heritability estimates for the various measures of lamb production or reproductive efficiency ranged from 18.1 to 29.3, all of which are significant positive values. However, by comparison with other traits of fine-wool sheep, they would be considered to be low to moderate values. Because of the difficulties involved, there would appear to be little opportunity to select for lamb production or reproductive efficiency in a range flock of fine-wool sheep. However, it should be practical to do this in stud flocks where it is possible to keep some type of performance records on the ewe flock. This would probably take the form of selecting for high performance sire lines by selecting rams out of ewes with good performance records. However, this would require some sacrifice in the emphasis on the phenotypic characters of the ram itself.

Genetic Correlations

Genetic correlations were calculated between growth rate, fleece weight and the various measures of ewe performance by the covariance procedure. The results are shown in Table 18. The majority of these values are of low magnitude, but a few observations appear to be of interest. There appears to be a slight negative relationship between weaning weight and the variables which reflect longevity in the breeding flock. The physiological explanation for this negative relationship is not clear, but it is probably related to an adverse effect of rapid early growth on longevity of the ewe or to the obvious fact that this represents a higher level of milk production on the part of the ewe. The latter might be expected to reduce longevity of the ewe. By contrast, yearling weight is positively related to all measures of ewe productivity. These observations tend to support selling milk-fat ewe lambs and keeping replacements from those that develop more slowly, but which have the potential to reach adequate development as yearlings.

There is a consistent negative genetic relationship between average fleece weight and all measures of reproductive efficiency or lamb production. This appears logical because energy expenditure for wool production is not available for lamb production. If a major interest in increasing fertility of range

TABLE 18. GENETIC CORRELATIONS BETWEEN WEANING WEIGHT, YEARLING WEIGHT, MEAN FLEECE WEIGHT AND OTHER VARIABLES STUDIED CALCULATED BY COVARIANCE ANALYSES FROM HALF-SIB DATA

	Weaning weight	Yearling weight	Average fleece weight
Yearling weight	.6354		
Mature weight	[1]	.4671	.2235
Mean fleece weight	.3577	.2557	
Number lambs born	—.0337	.1828	—.1382
Number lambs raised	—.1137	.1122	—.0972
Total lamb production	—.1118	.1254	—.1664
Total wool production	—.0822	.0739	.4656
Lambs born			
Times bred 3-7 years	.0586	.5745	—.2493
Lambs raised			
Times bred 3-7 years	.0387	.4426	—.3713
Lambs born			
Times bred lifetime	—.1104	.2371	—.1349
Lambs raised			
Times bred lifetime	.0258	.3511	—.2450

[1]The calculated value for the genetic correlation between weaning weight and mature weight was in excess of 1.0 and has been deleted from this tabulation.

sheep through breeding develops, these data would suggest that it may be both desirable and necessary to relax somewhat the emphasis on fleece weight in selection programs.

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PR-2520

Repeatability and Heritability Of Certain Components Of Reproduction Efficiency In Fine-wool Sheep

Maurice Shelton and J. W. Menzies

The previous report (TAES PR-2519) suggested a significant genetic influence on reproductive efficiency or total lamb production. However, total reproductive efficiency on a flock basis is a function of number of dry ewes, frequency of multiple births and survival rate of the lambs dropped. The purpose of this report is to look in more detail at these individual components of reproductive efficiency.

Data are included from the flocks of both the Ranch Experiment Station, Sonora, and the Livestock and Forage Research Center, McGregor. The data from the Sonora Station were essentially those utilized in the previous report (TAES PR-2519) and included 5,182 matings of 1,329 registered Rambouillet ewes between 1930 and 1966. The data from the McGregor Center included only Rambouillet ewes born on the station between 1953 and 1963. A total of 1,301 matings were involved. The two flocks differed markedly in environmental conditions and management practices, and the possible influence of these on the genotypic parameters involved provided one of the reasons for making these analyses.

The Sonora flock has been run on the range for most of the year with a somewhat suboptimum nutritional level. The ewes, throughout most of their lifetime, have been below the body weight range (120-125 pounds) considered optimum for maximum performance. They have been on a spring lambing program and during this study have been managed intensively during the lambing period. In this flock, 80.4 percent of the ewes lambed (excluding yearlings), and the lambing rate was 122.8 lambs born per 100 ewes lambing, and the percent lambs raised of lambs born was 87.2 percent.

By contrast, the flock at the McGregor Center has been on a much higher nutritional level, resulting in approximately 20 pounds weight advantage at any given age. This flock is on a fall and winter lambing program. During this study, 86 percent of the ewes lambed with a lambing rate of 135.7 percent (including yearlings), and 87 percent of the lambs dropped were raised.

Methods of Analysis

The three traits related to successful reproduction were all expressed on an all or none basis and analysed according to the procedure employed by Davenport *et al.* (1). All analyses were on a within age-of-ewe and year-of-birth basis. This would automatically make the analyses on a within year-of-record basis. The three traits involved were (a) the tendency for a given ewe to be fertile or infertile in a given year and hereafter referred to as fertility, (b) the tendency for a given parturition to involve a single or multple birth and hereafter referred to as prolificacy and (c) the tendency for a given lamb to survive to weaning and hereafter referred to as liveability. Repeatability estimates were calculated by the procedure presented by Lush (2). The ewes were classified into one of two groups based on their performance at a given age (shown first in heading) and their performance tabulated for the following year. Plus values indicate a tendency to repeat with similar performance. Negative values indicate the reverse to be true.

Results and Discussion

The repeatability values for the two flocks are shown in Table 19. This tabulation shows prolificacy, or a tendency for mulptle births, to be more highly

TABLE 19. REPEATABILITY OF THREE COMPONENTS OF SUCCESSFUL REPRODUCTION IN TWO FLOCKS OF FINE-WOOL EWES

Trait	Sonora data		McGregor data		
	Number	Repeat-ability	Number	Repeat-ability	Average
Fertility	4,004	—0.56	1,071	9.43	4.44
Prolificacy	2,820	11.66	877	14.73	13.20
Liveability	2,514	6.05	801	10.48	8.27

repeatable than the other variables studied, although culling practices may have biased this comparison slightly. It is evident that no culling was practiced in either flock based on the number of lambs born. It is probable that some selective culling was practiced in both flocks based on a failure to lamb or failure to raise lambs which were dropped. However, the general practice in both flocks was to cull only after two consecutive failures to raise a lamb, and this is not likely to have biased the above results greatly.

These data actually show a negative repeatability for fertility on the Sonora Station, but the analyses for this station are much more meaningful if expressed based on age of the ewe. This is shown in Table 20. This shows a negative repeatability for the first 2 years followed by positive values later in life. As pointed out earlier, ewe weights were low in this flock and especially during their first 2 years in the breeding flock. Under these conditions, production of a lamb early in life adversely affects the ewe's performance the following year and results in a slight tendency for alternate year lambing. This would strongly indicate that in many range flocks, culling of young, dry ewes would not be necessary. However, any decision in this respect should take into consideration the size and condition of the ewes involved.

In the McGregor flock, where the ewes were well developed, the repeatability was higher with no such age trend evident. The repeatability of prolificacy also shows an age trend but in the exact opposite direction to that of fertility, indicating that classification of ewes based on twinning potential can be more accurately done early in life. Heritability values were calculated according to paternal half-sib analyses. The results are shown in Table 21.

The magnitudes of these estimates are somewhat erratic, but it is important that positive values were obtained for each trait in each flock. However, it is evident from this and other reports, that heritability of these three traits must be classified as low. It will be noted that these heritability estimates tend to be higher than the repeatability. Theoretically, repeatability sets the upper limit for heritability since the genotype is the same from year to year, but it is becoming evident that this does not apply to fertility data (3, 7). This is apparently explained by a carry through effect of each of these variables in which performance in a given year affects that of the subsequent year. This would tend to lower repeatability.

These data are also unusual in that most workers have found prolificacy to be the more highly inherited of the three variables. These data also were calculated by age of ewe, but in general, year-to-year estimates were erratic and difficult to interpret. The one exception to this is that in the Sonora data there appeared to be a distinct tendency for both the heritability and repeatability of prolificacy to be higher for the young ewe. This can be rationalized, as a ewe which drops twins under less favorable conditions is more likely to have superior genotype for this trait than others in the same flock.

TABLE 20. REPEATABILITY OF VARIOUS TRAITS ASSOCIATED WITH SUCCESSFUL REPRODUCTION BY AGE OF EWE (SONORA DATA ONLY)

Trait studied	Ages of ewe[1] 2 - 3	3 - 4	4 - 5	5 - 6	6 - 7
Fertility (wet vs. dry)	—3.32 (1116)[2]	—0.05 (910)	0.42 (751)	4.47 (560)	6.21 (368)
Prolificacy (multiple vs. single births)	14.15 (425)[3]	14.59 (766)	13.36 (606)	9.21 (482)	7.77 (308)
Liveability (Live vs. dead lambs)	4.75 (568)	5.79 (630)	13.08 (512)	8.82 (399)	—2.30 (241)

[1]The first numeral represents age of the ewe when classification was made and the second, year of record. Repeatability values simply represent a difference between the two classes.

[2]The values in parentheses represent the numbers on which each statistic is based.

[3]Including only data from those years in which twin births occurred among the 2-year old ewes.

Recommendation

Selection for two of the three traits mentioned here (fertility and liveability) is automatic in nature. Because of this natural selection, extensive programs selecting specifically for these traits probably are not justified. Any improvement on natural selection for these traits would, of necessity, be based on performance over a period of years requiring extensive record keeping along with considerable time delay.

TABLE 21. HERITABILITY OF THREE COMPONENTS OF SUCCESSFUL REPRODUCTION IN TWO FLOCKS OF FINE-WOOL EWES

Trait	Sonora data		McGregor data		
	Number	Herita-bility, percent	Number	Herita-bility, percent	Average, percent
Fertility	5,182	26.81	1,301	6.73	16.77
Prolificacy	3,988	13.88	1,000	10.19	12.03
Liveability	4,926	13.12	1,371	19.03	16.08

Selection for twinning can be automatic in nature, but under range conditions the opposite is more likely to be true due to unknowingly favoring single-born males in selecting replacement sires. For this reason, it appears selection for multiple births in registered or stud flocks should be considered. Based on a heritability estimate of 12 percent as found in this study, theoretically 17 generations of using only twin-born offspring on one side of the pedigree would be required to convert a flock to one in which multiple, as contrasted to single births are typical. The expected improvement was investigated by comparing the performance of twin-born versus single-born lambs in both flocks. The results were erratic and difficult to interpret.

In the Sonora flock, the results closely approached that predicted from the heritability estimate; in the McGregor flock, with the more limited numbers involved, there was no evidence of a response. However, these calculations presuppose that all selections will be based simply on the animals own type of birth. In this case, most twin-born individuals would be out of old ewes, and it has been suggested earlier that both repeatability and heritability were lower for type of birth in the older ewes. This suggests that in selection of this character, twin-born lambs out of young ewes or those under less favorable conditions should be favored. Better still, would be lambs out of ewes which dropped twins early in life and which had a high proportion of multiple births throughout their lifetime. It is not possible to evaluate the potential for this in either of the two flocks concerned since these selections were not made, but one would predict a response several times greater than that suggested by this heritability estimate reported here. There is some suggestion of a much greater response in recent reports (5, 6). This possibility is being investigated in a flock of registered Rambouillets recently established at the McGregor Center.

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Effect of Horn Gene On Performance Of Fine-wool Sheep

MAURICE SHELTON

Polled strains of fine-wool sheep have been available in Texas for several decades, but no data have been reported comparing their performance with the horned types. A research project studying polled Rambouillet sheep has been in effect at the Texas Agricultural Experiment Station for a number of years. Early work in this connection was concerned with inheritance of the horned characteristic in sheep. Warwick and Dunkle (4) were the first workers to propose the currently accepted triple allelic series as an explanation for inheritance of this trait. However, one of these alleles is that found in the Dorset breed where both sexes are horned. This condition is not generally found in fine-wool sheep in this state, and thus only two of the three alleles are segregating in this population. Other workers (3) called attention to the problem of cryptorchids in the polled sheep and suggested that this may be a pleiotropic effect of the polled gene as contrasted to the previously suggested theory of an independent gene closely linked to the gene for the absence of horns.

This report is concerned with the performance of sheep of polled versus horned breeding. Three different genotypes are possible in a Di-allelic Series as in Table 22.

From data in Table 22 it can be seen that it is not possible to distinguish the two polled genotypes, although it is possible to make some inference about this in the case of the male. The data reported in this study were taken from the flock at the Livestock and Forage Research Center, McGregor. Estimates of the gene frequency in this flock indicate that between 85 and 90 percent of the polled animals are heterozygotes. Thus, the data reported herein are essentially a comparison of animals of horned versus heterozygous polled breeding.

TABLE 22. GENOTYPES POSSIBLE IN A DI-ALLELIC SERIES

Genotype		Phenotype	
		Visual appearance	
Gene compliment	Symbol	Male	Female
Homozygous polled	PP	Without horn or scur development	Depressions
Heterozygous polled	P_p	Without horns, but may or may not have horn stubs or scurs	Depressions
Homozygous horned	pp	Horns	Knobs

TABLE 23. A COMPARISON OF THE PERFORMANCE OF KNOBBED AND DEPRESSION EWES IN THE McGREGOR FLOCK

Type of ewe	Geno-type	Number ewes	Number matings	Ewes lambing, percent	Lambs born of ewes lambing, percent	Lambs raised of lambs born, percent	Average ewe weight, pounds	Average 120-day weight of lamb, pounds	Grease fleece, pounds
Knobbed	pp	151	570	84.6	134.0	78.7	136.4	72.2	10.2
Depressions	$PP+P_p$	273	1,070	82.9	135.7	78.4	139.6	72.8	10.4

Ewe Performance

The most important animal in a sheep flock is the breeding ewe, and the ewe performance traits which make the major contribution to income are fertility, lamb growth rate and fleece weight. A comparison of these important characters in the two types of ewes is shown in Table 23. These data include only those ewes born at the McGregor Center and added to the flock between 1949 and 1963. Many of the ewes included in these tabulations have not completed their lifetime records. Thus, these data are based on somewhat younger than average ewes. These data have not been subjected to statistical analyses, but the differences observed are considered to be within the range of normal variation. There is no consistent trend indicating a superiority of either type. However, in this case, the homozygous and heterozygous polled animals are grouped together out of necessity. If it were possible to separate these two genotypes, a different picture might be evident.

Ram Performance

A ram performance testing program has been in effect at the McGregor Center since 1958. In the first 3 years, the rams were placed on test in early summer at approximately 6 months of age and continued for 168 days. Since 1961 they have been placed on test in early fall and continued for a comparable period. These data have been analysed to compare the performance of horned and polled rams. One group of cooperator owned rams were included for the 1965 season, but except for this, all animals were raised on the station and were, in general, the offspring of the same sires. The segregation for head type was based on head type of ewes to which they were mated. All data were summarized within year of record. The results are shown in Table 24.

These data show the polled rams to exceed the horned rams in all performance traits. However, these differences were statistically significant only in the case of fleece traits (grease wool, clean wool and staple length). The mean squares for several characteristics are shown in Table 25. The consistency of the difference in grease fleece weight by years is shown in Figure 1. It would appear that the lines in this figure should balance above and below the average for the population. However, they do not do so because of disproportionate numbers in the two groups.

These data show that the polled rams produced more wool than the horned individuals, but there is no indication of a superiority in any of the other traits on which data were collected. These conclusions are supported, in part, by a study reported from Australia (1) and by similar analyses of data collected in performance tests at the Sonora Station. The magnitude of the difference in fleece weight in this study, Table 24 and Figure 1, is somewhat greater than that of the other studies, and thus may be a somewhat exaggerated expression of the effect of the polled gene.

If one accepts the assertion that polled rams produce more wool than horned rams, then some explanation is required in order to evaluate the significance of this observation to sheep breeding programs. It is believed that the advantage for the polled ram is explained by a lack of necessity for diversion of nutrients for horn growth. No studies on the chemical content of horns or the nutrients required to produce them are known. Both wool, as a specialized form of hair, and horn tissue are largely keratinized protein. It is generally believed that phylogenetically horn growth originated as a coalesced body of hair tissue. Thus, the two are of similar composition and origin, and horn growth could only occur at the expense of the nutrients available for wool growth.

If this is the case, castrate animals sired by the two types of rams should not differ. No data on fleece production of castrate animals are available

TABLE 24. THE RELATION OF HEAD TYPE TO PERFORMANCE OF RAMS TESTED, McGREGOR

Head type	Number rams	Total gain, pounds	Final weight, pounds	Grease weight, pounds	Clean weight, pounds	Staple length, inches	Fiber diameter, microns	Index value
Horned	94	74.3	169	17.5	8.5	4.21	21.7	65.3
Polled	128	75.3	171	19.1	9.2	4.30	21.9	68.5

TABLE 25. MEAN SQUARES FOR THE INFLUENCE OF HEAD TYPE ON PERFORMANCE CHARACTERISTICS OF RAMS

Source of variance	Degrees of freedom	Mean squares				
		Final body weight	Grease wool	Clean wool	Staple length	Fiber diameter
Head type (within year of record)	11	292.7	11.90**	2.80*	0.325*	5.10
Error	198	804.2	4.97	1.29	0.163	3.52

*Indicates the probability of chance occurrence is less than 5 percent.
**Indicates the probability of chance occurrence is less than 1 percent.

from this station, but in one study reported from Australia (2) this proved to be the result. Should this theory be acceptable as an explanation for the difference in wool production, then this observation would have little significance to sheep breeding programs. The wool-producing superiority of the polled types would exist only in the rams, and more especially in young rams, during the period when rapid horn growth is occurring. Thus, a decision relative to which of the two types to breeds should be based on factors other than the small difference in wool production as reported in this study.

These data are essentially a comparison of the heterozygous polled with the homozygous horned. The performance of the homozygous polled animals remains to be investigated, but this is difficult because of the small number produced in most flocks, the difficulty of their identification and the fact that a high proportion of those which are produced are cryptorchids. Of the 128 polled rams included in the above analyses, 11 were thought to be homozygous polled by virtue of pedigree or test matings. Mean values for the performance data on these few rams indicated that they may be markedly inferior to either of the other types.

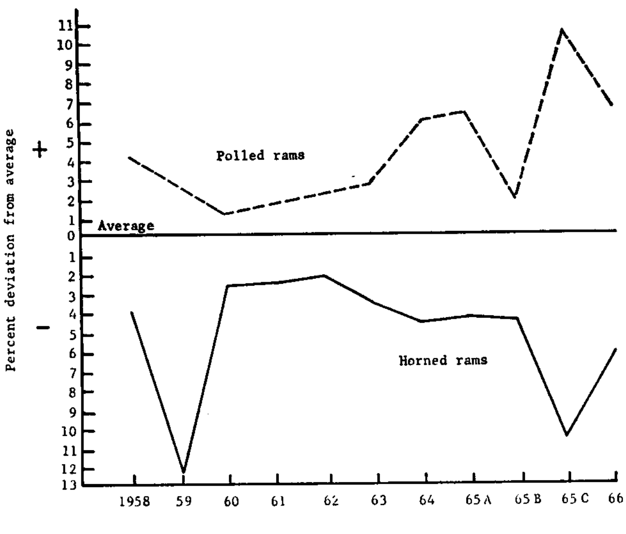

Figure 1. Comparison of grease wool production of polled and horned rams performance tested at the Livestock and Forage Research Center, McGregor, 1958-1966. Each type is expressed as a deviation from the average in percent.

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PR-2522

Evaluation of Some Newer Drugs For Control of Internal Parasites of Sheep and Goats

Maurice Shelton, Gary D. Boring[4] and J. E. Huston

Procedures for the control of internal parasites of sheep and goats are among the most frequent inquiries received from producers. The continual development of new drugs requires a continuous reassessment of drenches when treatment becomes necessary. Several trials have been conducted at the Livestock and Forage Research Center, McGregor, in recent years to provide comparative data on the effectiveness of some of these. Results of earlier trials involving some old established drug preparations were reported in an earlier publication (1). This report is primarily concerned with some of the newer preparations.

Trial 1

The first trial involved 60 ewe lambs averaging 63 pounds which were drenched with Rulex, Thia-

[4]This work was partially supported in funds and materials provided by Merck, Sharp and Dohme Research Laboratory, Rahway, New Jersey.

TABLE 26. INFLUENCE OF DRENCHING WITH VARIOUS ANTHELMINTIC PREPARATIONS ON NEMATODE EGGS PER GRAM (EPG) OF EWE LAMBS

Treatment				EPG		Final EPG	
Drug	Level, ounces	Number animals	Average weight, pounds	Initial	Final	As percent of initial	As percent of controls
Control		15	64.2	4,413	6,092	138.00	100.00
Rulex[1]	½	15	58.7	3,960	32	0.81	0.53
Thiabenzole[2]	1	15	62.9	4,973	339	6.82	5.57
Loxon[3]	½	15	66.5	4,098	23	0.57	3.38

[1]Rulex is a trade name for a formulation marketed by Starbar, Inc., and contains ruelene as the active ingredient (21 percent).
[2]Thiabenzole is a product manufactured by Merck and Company and contains approximately 2 grams of ingredient per fluid ounce.
[3]Loxon is a product of Cooper, McDougall & Robertson, Ltd. of England and contains Haloxon as the active ingredient.

benzole and Loxon along with a control group. Tests of effectiveness were based on fecal egg counts (EPG) taken before treatment and 1 week later. The treatments employed and results are shown in Table 26. These data indicate that both Rulex and Loxon were highly effective in removing parasite load. Thiabenzole at the level used was slightly less effective, but this treatment resulted in a 93.2 percent reduction in egg counts. No animals were lost and no adverse effects were noted as a result of these treatments.

Trial 2

The second trial with Angora doe kids was conducted similar to the first, except that phenothiazine was used instead of Rulex. Many of the goats used in this study were below the weights at which the use of Rulex is recommended. Experience had indicated that it is hazardous to use this drug with light-weight, unthrifty animals. The level of parasite infestation in these goats was low as indicated by the initial egg counts shown in Table 27. However, if EPG at the second observation expressed as a percent of either the initial or control values can be taken as an indication of drug effectiveness, both Thiabenzole and Loxon were highly effective in this case. However, by contrast phenathiazine did not remove all the parasite load. It should be noted that, with the light weight animals employed in this trial, Thiabenzole was administered at a higher than recommended dose level based on manufacturers label.

Trial 3

Fecal egg counts cannot be considered as an exact measure of parasite load, and they provide essentially no information on the species of parasites present. For this reason, two critical trials were conducted. In the first of these, identified here as trial 3, only mature *Haemonchus contortus* in the abomasum were counted. The drugs employed and the results are shown in Table 28. The three products employed, Thiabenzole, Rulex and Loxon, were each used according to directions on the label. Each animal was weighed and dosage calculated separately for each individual animal. These data show both Rulex and Loxon to be essentially 100 percent effective in removing *H. contortus*.

By contrast, Thiabenzole failed to remove all of the parasites of this species. These data indicate that 83.6 percent of the total *H. contortus* was removed by this treatment. The seriousness of this residual parasite population would depend somewhat on the conditions involved. If the animals were being moved to clean pastures, this level of infestation could prove to be an important source of reinfestation. It should be noted that two of the four animals originally treated with Rulex died as a result of this treatment. One of these was below the weight range (30 pounds) in which this drug is recommended, but the other was a 70-pound lamb. These animals were replaced in this study, but this experience indicates that toxicity of this drug represents a hazard to widespread

TABLE 27. THE INFLUENCE OF DRENCHING WITH VARIOUS ANTHELMINTIC PREPARATIONS ON NEMATODE EGG COUNT (EPG) OF ANGORA KID GOATS

Treatment		Animals		EPG		Final EPG	
Drug	Level, ounces	Number	Weight	Initial	Final	As percent of initial	As percent of controls
Control		15	39	507	608	119.9	100.0
Phenothiazine	1	12	36	305	177	58.0	29.1
Thiabenzole	1	14	37	408	12	2.9	2.0
Loxon	½	13	37	431	17	3.9	2.8

TABLE 28. CRITICAL TRIAL ON EFFICACY OF THREE ANTHELMINTICS IN THE CONTROL OF *H. CONTORTUS*

Animal number	Treatment	Pre-treatment EPG	Number *H. contortus* in abomasum at slaughter
262	Control	8,200	3,930
6344	Control	6,400	2,280
6360	Control	16,200	7,450
224	Control	1,400	415
Average		8,050	3,519
202	Thiabenzole—1 ounce	4,650	33
6349	Thiabenzole—½ ounce	17,800	1,550
269	Thiabenzole—1 ounce	1,800	150
6314	Thiabenzone—½ ounce	8,000	580
Average		8,062	578
Percent controls			16.4
Percent efficacy			83.6
242	Rulex—¾ ounce	7,800	0
No tag	Rulex—½ ounce	6,100	0
273	Rulex—¾ ounce	1,500	0
6304	Rulex—¼ ounce	13,000	0
Average		7,100	0
Percent controls			0
Percent efficacy			100
241	Loxon—½ ounce	4,200	0
274	Loxon—½ ounce	3,750	0
6385	Loxon—¼ ounce	27,300	0
6333	Loxon—¼ ounce	12,200	0
Average		11,863	0
Percent controls			0
Percent efficacy			100

use since many of the animals requiring treatment for internal parasites are lightweight or unthrifty.

Trial 4

In the previous trial only mature form *H. contortus* were counted. Although this is the most prevalent and frequently the most damaging of the gastro-intestinal nematodes, it is not the only species causing trouble with sheep and goats. Therefore, a second critical trial was conducted in which other species in both the abomasum and small intestines were determined. In this trial, 24 lightweight, heavily parasitized, late spring lambs averaging 38 pounds were used. Rulex, Thiabenzole, Loxon and combinations of the last two were employed. Each drug was employed according to directions on the label, and where used in combination, Loxon was used at one-fourth or one-half recommended dose as indicated. The lambs involved were sacrificed for total parasite counts 5 days after drenching. The treatments employed and results obtained are shown in Table 29. These data are organized as *Haemonchus contortus,* including larval forms which could be identified as belonging to this species, unidentified larval forms and smaller gastro-intestinal nematodes identified as *trichostrongylus sp., cooperia sp., strongyloides sp.* and all others.

Again the most striking result of this study was the failure of Thiabenzole to remove the total load of *H. contortus.* All the drugs tested seem reasonably effective in removing other types of gastro-intestinal nematodes. There is no indication that Thiabenzole is lacking in efficacy against any other than *H. contortus.* There is some indication that a combination of Thiabenzole with low level use of one of the organo-phosphates, in this case Loxon, will effectively remove all of the *H. contortus.* This observation should be investigated further before it is recommended for routine use.

Discussion

Throughout these studies there is close agreement between the evaluations using fecal egg counts and the critical trials in which the animals were sacrificed and worm counts made. This indicates that fecal egg counts can be used satisfactorily in routine appraisal of the relative effectiveness of anthelmintics. However, these trials dealing primarily with *H. contortus* infestations, and the results may have differed somewhat in cases where one of the other species predominated. A second indication from these data is that both the organo-phosphates (Rulex or Loxon) were highly effective against a wide range of parasites. Each has some limitation: Rulex has a limited safety margin and Loxon is not yet available on the American market.

Neither phenothiazine nor Thiabenzole, used according to label, are completely effective in removing the parasite load. Of the two, Thiabenzole appears to be more effective and is apparently highly effective when the dose level is increased to at least double that recommended, Table 27 and (1). Apparently the difficulties with both these drugs are due to the development of resistance on the part of the organisms involved. Thus, the effectiveness of these two drugs may vary over a period of time and with the past history of their use on a given property. The work in trial 4 suggests that mixing an organophosphate at a low level with one of the other drenches holds promise. This possibility should be further investigated before its use is generally recommended.

The almost complete removal of the parasite load by the two organo-phosphates used in this study suggest that it might be possible by use of these preparations to clean up animals being moved to new pasture and eliminate the need for repeat treatments. This could prove important with the recent trends toward intensification and heavy stocking in the sheep industry.

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TABLE 29. COMPARATIVE EFFICACY OF THREE NEWER ANTHELMINTICS FOR PARASITE CONTROL IN LAMBS

Lamb number	Treatment	Pre-treatment EPG		Worm counts at slaughter: *Haemonchus contortus*	Unidentified larval forms	*Trichostrongylus* sp.	*Cooperia* sp.	*Strongyloides* sp.	All others
6296	Control	1,700		3,100	350	Species undetermined 150 total			
6330	Control	7,100		3,025	525	50	375	0	0
6359	Control	35,500		died					
6381	Control	5,000		3,425	1,250	150	75	125	0
			Average	3,183	708		308		
6329	Thiabenzole	17,500		300	200	0	0	0	0
6406	Thiabenzole	12,250		175	0	0	0	0	0
6401	Thiabenzole	1,950		0	75	0	0	0	0
6335	Thiabenzole	17,400		1,350	75	0	0	0	0
			Average	456	88		0.0		
			Percent controls	14.3	12.4		100.0		
			Percent efficacy	83.7	87.6		100.0		
6389	Rulex	7,800		0	175	25	0	0	0
6313	Rulex	4,750		25	0	0	0	125	25
6386	Rulex	23,900		0	25	0	0	0	0
6379	Rulex	14,200		75	0	0	0	0	0
			Average	25	50		44		
			Percent control	0.8	7.1		14.3		
			Percent efficacy	98.2	92.9		89.7		
6443	Loxon	6,050		0	0	0	0	0	0
6303	Loxon	16,950		50	450	0	75	100	0
6354	Loxon	20,400		0	0	0	0	0	0
6419	Loxon	2,600		0	25	0	0	0	0
			Average	13.0	119		44		
			Percent controls	0.4	16.8		14.3		
			Percent efficacy	99.6	83.2		85.7		
6402	Thiabenzole + ¼ Loxon	8,950		0	25	0	0	0	0
6398	Thiabenzole + ¼ Loxon	21,450		0	175	0	0	0	0
6361	Thiabenzole + ¼ Loxon	18,700		50	25	0	0	0	0
6277	Thiabenzole + ¼ Loxon	2,300		0	225	0	150	0	0
			Average	13	113		38		
			Percent controls	0.4	16.0		12.3		
			Percent efficacy	99.6	84.0		87.7		
6413	Thiabenzole + ½ Loxon	11,250		0	25	0	0	0	0
6394	Thiabenzole + ½ Loxon	3,900		0	0	0	0	0	0
6336	Thiabenzole + ½ Loxon	11,800		0	125	0	0	0	0
6321	Thiabenzole + ½ Loxon	15,250		0	0	0	0	0	0
			Average	0.0	38		0.0		
			Percent controls	0.0	5.3		0.0		
			Percent efficacy	100.0	94.7		100.0		

PR-2523

Protein Supplementation Of Angora Goats

J. E. Huston and Maurice Shelton

There is always a need for the Angora goat or mohair producer to improve the efficiency of production, and this is especially true during the present period of low mohair prices. Increased fleece weights or reduced production costs are the two primary possibilities insofar as the producer is concerned. High mortality has always been a problem in this industry, but this problem has intensified in recent years. This is probably the result of continuous development of flocks with a higher genetic potential for mohair production along with a coincident requirement for a higher level of nutrition and improved management. It seems that with the present low mohair prices, the animals are not receiving this high level of care and management, resulting in many of the animals being poorly adapted to their environment.

The Angora goat has a high level of fiber production per unit of body weight. Since this fiber is almost pure protein, it follows that protein nutrition is critical with this species at certain seasons of the year. Energy supplementation is generally required by dry does or muttons only at the more extreme periods, but may be needed routinely by kids or by breeding does in late gestation or during lactation.

A series of experiments was conducted at the Livestock and Forage Research Center to evaluate the response to various protein sources used as a supplement to range forage or poor quality roughage. More specifically, these studies were initiated to determine to what extent urea could be used for this purpose and to determine if feather meal, because of its similarity in composition to hair, would stimulate hair production. Cottonseed meal was used as a control or standard.

Experimental Procedure

Experiment 1

Twenty-four yearling billies were shorn and assigned to four treatment groups of six each in dry lot. The group averages were approximately equal with respect to body weight and previous mohair production. Each experimental group was fed 10 pounds (1⅔ pounds per head) of the basal ration daily, in addition, groups 2, 3 and 4 were given 2 pounds daily (⅓ pound per head) of the appropriate supplement shown in Table 30. This basal ration was chosen to simulate average quality dormant winter range forage. The groups were maintained on the described nutritional level for 122 days. Then, they were weighed, measured for staple growth and immediately shorn. The results are given in Table 31.

TABLE 30. RATIONS USED IN EXPERIMENTS 1, 2 AND 3

Experiments 1 and 2			
Basal ration			
			Percent of total
Sorghum hay			50
Alfalfa hay			25
Sorghum grain			25
			100
Analyzed crude protein, percent			9.8
Supplements			
	Supplement 1	Supplement 2	Supplement 3
	— — — —	Percent	— — — —
Cottonseed meal	100	50	
Sorghum grain		44	54
Feather meal			46
Urea		6	
	100	100	100
Calculated crude protein	41.0	41.0	41.0
Experiment 3			
	Supplement 1	Supplement 2	Supplement 3
	— — — —	Percent	— — — —
Cottonseed meal	85	39	
Sorghum grain		40	46
Feather meal			39
Urea		6	
Minerals	15	15	15
	100	100	100
Calculated crude protein	35	35	35

TABLE 31. RESULTS OF FEEDLOT STUDY WITH ANGORA BILLIES

	Treatment groups			
	Control	Supplement 1	Supplement 2	Supplement 3
Weights, shorn basis				
Initial, pounds	73.2	64.8	72.2	69.2
Final, pounds	64.4	66.2	74.9	72.0
Change, pounds	–8.8	+1.4	+2.7	+2.8
Fleece data, 6-month basis				
Grease fleece weight, pounds	4.80	6.78	7.19	6.96
Staple length, inches	5.71	6.14	6.44	6.33
Increase due to treatment				
Grease fleece weight, percent		41.3	49.8	45.0
Staple length, percent		7.5	12.8	10.9

Experiment 2

This experiment was conducted concurrent with experiment 1, and the treatment rations were the same. Four Angora muttons of similar weights and age were placed in metabolism stalls to facilitate total collection of urine and feces. Each goat was fed 500 grams daily of the basal ration, and three of the four were given a 100-gram portion of one of the supplements. Following the data collection period, the treatments were rotated until data had been collected from each goat while receiving each treatment. Preliminary feeding periods were at least 8 days and data collection periods at least 5 days. Daily excreted feces were collected, dried, weighed and analysed for total nitrogen. Urine was collected daily from each, diluted to the next highest liter volume, sampled and analysed for total nitrogen. Results are presented in Table 32 as crude protein (N X 6.25).

TABLE 32. RESULTS OF METABOLISM STUDY WITH ANGORA MUTTONS

	Control	Supplement 1	Supplement 2	Supplement 3
Digestibility, percent				
Dry matter	65.1	66.3	67.9	69.1
Protein	60.0	68.1	74.1	70.5
Net retained protein, grams/day	9.13	17.75	25.44	27.31
Percent increase over control		94.4	178.6	199.1

TABLE 33. PERFORMANCE OF ANGORA BILLIES ON WINTER RANGE

	Control	Cottonseed meal	Cottonseed meal - urea	Feather meal
Weights, shorn basis				
Initial, pounds	86.3	71.3	71.8	70.8
Final, pounds	68.9	66.1	64.6	65.8
Weight change, pounds	—17.4	—5.2	—7.2	—5.0
Fleece data, 6-month basis				
Grease weight, pounds	5.46	6.54	5.56	6.90
Clean weight, pounds	3.94	4.91	4.36	5.24
Yield, percent	72.1	75.1	78.5	76.0
Length of staple, inches	3.44	4.60	4.60	4.54
Percent increase over control				
Grease fleece weight		19.8	1.8	26.4
Clean fleece weight		24.6	10.7	33.0
Staple length		33.7	33.7	32.0

Experiment 3

Thirty-six recently shorn yearling billies were equally divided according to weight and past mohair production into four experimental groups. These goats were grazed together in a mixed native grass and bermuda pasture, penned three times weekly and divided into their assigned groups. The control group was held overnight without feed. Groups 2, 3 and 4 were fed 10 pounds each (approximately 0.48 pounds per goat per day) of supplements 1, 2 and 3, respectively, Table 30. This amount was chosen to meet approximately one-half the animals protein requirement under the assumption that the remainder would be obtained from range forage. After a treatment period of 122 days, staple measurements were taken on the goats, and they were weighed and shorn. The body weights, grease fleece weights and clean fleece weights are shown in Table 33.

Discussion

This series of experiments was a collective effort to determine the effect of increasing protein intake on mohair production and body weight maintenance and to compare responses due to protein supplements comprised of differing protein sources. The protein sources selected for comparison differ in that cottonseed meal is a plant source of protein, feather meal a low priced animal by-product, and urea a synthetic source commonly used in feedlot rations. It is generally recognized that urea is a poor source of supplemental protein in cases where it is not consumed in combination with a ration high in concentrates. In these experiments, the urea-containing supplements were comprised of cottonseed meal and a sorghum grain-urea mixture each contributing about one-half of the protein of the supplement. This combination of ingredients is cheaper than straight cottonseed meal, furnishes more energy per pound and would be a more economical supplement if the responses of the two were equal. The feather meal supplement also costs less than cottonseed meal but was studied mainly to determine whether this protein source, being similar to mohair in composition, would have an extra advantage in promoting mohair growth. The minerals which were added to the supplements in experiment 3 provided a generous amount of all minerals which were thought to be marginal or limited in supply under the described conditions (P, Mg, Fe, Cu, Mn, Zn, Co, Se and salt).

Experiment 1 was conducted in dry lot where level of feed consumption was controlled at a level which was thought to simulate conditions of dormant range. The results, Table 31, show that the basal ration failed to maintain the body weight of the control group which lost an average of 8.8 pounds per goat over the 122-day treatment period. Weight changes of all animals receiving a protein supplement were similar and slightly postive. The fleece data show that all supplements resulted in large responses in fleece weight and substantial responses in staple length. These responses were similar, and the differences between individual treatments were not significant.

The same treatments were used in a concurrent study conducted in metabolism stalls in an attempt to determine how the supplemental protein was affecting the animals metabolism. Addition of protein to a protein deficient diet increases the digestibility of the consumed feed. Table 32 shows that such an effect was apparent in this study, with the feather meal supplement resulting in the greatest increase. Such an increase would be expected to affect body weight maintenance favorably by increasing the efficiency of feed utilization and, under range conditions, voluntary intake. Protein digestibility was similar for all three supplements, with the urea mix slightly the highest. Retained protein was about the same for the urea-containing and feather meal supplements. Less protein was retained from the cottonseed meal supplement due primarily to the poor grade of cottonseed meal used in this trial. Analysis revealed that the protein content of the meal was low, and, therefore, less protein was consumed. It is apparent that all the response in protein retention due to these protein supplements was not manifested in increased mohair growth (199.1 percent versus 45 percent for feather meal supplement) but produced combined responses in mohair and body weight growth in these developing billies.

Experiment 3 was conducted to determine the effects of the various supplements on performance of Angora goats under poor winter range conditions. The nutritional stress was greater under these conditions as indicated by the average weight loss of the control group and the fact that two goats died during the study apparently from malnutrition (Table 33). Those groups receiving supplemental protein also lost weight, but they maintained vigor and appeared healthy.

Higher fleece weights were evident for the cottonseed meal and feather meal groups, but the urea supplement failed to increase fleece weights above that of the control group. Scouring the fleeces revealed that the control group had high shrinking fleeces, whereas, the fleeces from the urea-fed group were high yielding. Clean fleece weights were much more alike between the treated groups, yet those from the urea-fed group were still substantially lighter than would be expected after considering results of experiments 1 and 2. A possible explanation for this reduced efficiency of utilization of the urea as a protein supplement is that it was fed less frequently in this study than in the previous two. It is well recognized in feedlot studies that frequency of consumption is important in urea utilization. The total allowance was fed daily in experiments 1 and 2, whereas, in this study the supplement was fed three times weekly. The response in fleece weight was again slightly in favor of the feather meal supplement over cottonseed meal. There was almost identical responses in staple length to all three supplements.

These studies indicate that supplemental feeding Angora goats is beneficial to the animal at times when available forage is not adequate to maintain body weight and/or a desired level of mohair production. However, the response may not always be an economic one. In this study, the costs of the supplements cannot be justified by the increase in mohair weight alone. In experiment 3, two of nine goats died of malnutrition, and in each study, the nonsupplemented animals lost weight. This would presumably affect mortality and mohair production in the following seasons. When these factors are considered, supplemental feeding can be justified, but the exact level which would give the most economic response would vary with conditions from year to year. Providing protein when available forage is deficient in protein results in range forage being more efficiently utilized and provides additional protein for body maintenance and increased mohair production.

An anaysis of the fleece data from these studies shows that the grease fleece weight and staple length in experiment 1, net retained protein in experiment 2 and clean fleece weight and staple length in experiment 3 were significantly different (.05 level) between all treatment groups. Differences between individual protein sources were not significant. This suggests that alternative protein sources for supplemental feeding should be investigated. The observed increase in response by feather meal over cottonseed meal and the apparent difference in response by the urea-containing supplement, fed at different frequencies, merit additional study. Based on results to date, it appears that feather meal can be used as a substitute for cottonseed meal in range supplements on an equal protein basis and might possibly have some advantage in stimulating greater fiber production. At the present it appears that urea should be used only to a very limited extent in infrequently fed range supplements.

PR-2524

Effect of Angora Doe Size On Kid and Mohair Production

J. W. Menzies

Angora goats in Texas have a low reproductive rate, the usual being in the range of 50-85 percent. The potential reproduction rate is over 150 percent which indicates that there is a large percentage of unexpressed kidding potential in goats. The information in this study is being collected to determine what factors are contributing to this low kidding rate and what can be done to improve it.

The information from this report is from 1 year's breeding and kidding field notes on the Ranch Experiment Station's flock. This information has been divided into two categories: yearling doe reproduction and aged doe reproduction.

Results

The results in Table 34 reveal that there is a positive relationship between doe size (yearling and mature) and kidding percent.

Yearling doe weights ranged from 40 to 70 pounds in the Ranch Station's flock. Forty to fifty-pound yearling does had a 16 percent kidding rate, while over 60-pound yearling does had a 92 percent kidding rate. This represents an increase in kidding rate of 73 percent. Based on these data, yearlings should weigh over 60 pounds when bred the first time at approximately 18 months of age.

As aged doe breeding weights increased to over 80 pounds (a high of 90 pounds), there was a corresponding increase in both kidding percent and mohair production. There was a 56 percent increase in kid production from the 49-pound and under group to the 60-69-pound breeding weight. After reaching a 70-pound breeding weight there was an approximate 12 percent increase in kid production for each 10-pound increase through 90 pounds.

TABLE 34. EFFECT OF ANGORA DOE SIZE ON KID AND MOHAIR PRODUCTION

	Doe weight class, pounds				
	49 and under	50 - 59	60 - 69	70 - 79	80 and over
Yearling does, kidding percent	16	35	92		
Aged does, kidding percent	11	25	67	78	91
Mohair weight, pounds (year's total, all ages)	8.17	9.07	9.55	10.45	10.43

Mohair production, as measured by total grease fleece weight for the year, shows a direct positive relationship with size up to 70-79 pounds body weight, Table 34. No consideration has been given in these fleece data for possible age differences.

Summary

Field notes on the Ranch Station's grade Angora goat flock (semi-arid range conditions) have revealed that for every 10 pounds increase in doe breeding weight there was a corresponding increase in kid and mohair production. Using this information, breeders in this area should strive for minimum 60-pound yearling doe to assure early kid production and proper sized aged does.

PR-2525

First-year Angora Goat Performance Testing

J. W. Menzies and J. W. Bassett

Performance testing is defined as the placing of a group of animals under uniform environmental conditions and measuring differences (economic traits in this case) which occur among them.

Performance testing of animals is not a new procedure. This method of determining genetically superior animals was first used extensively with cattle in the late 1930's and early 1940's. The Texas Agricultural Experiment Station initiated the first annual sheep performance test at the Ranch Experiment Station, Sonora, in 1948. This test has been in continuous existence since that time and has contributed between 3,000 and 4,000 performance-tested rams to the sheep industry.

Angora goat performance testing was initiated at the station in the spring of 1966, through the cooperation of the Texas Angora Goat Raisers Association, the Texas Agricultural Extension Service and the Texas Agricultural Experiment Station.

Experimental Procedure

On February 1, 1966, 45 head of Angora yearling males (grade and registered) were brought to the station by nine cooperating breeders. The goats were

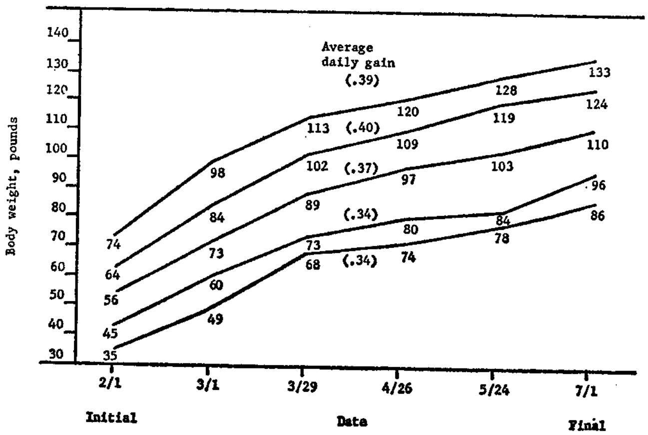

Figure 2. Effect of initial weight upon rate of growth during 150-day performance test.

sheared, weighed and placed on a self-fed 16 percent protein pelleted ration. The ration contained alfalfa hay, 55 percent; sorghum grain, 15 percent; ground oats, 12 percent; cottonseed meal, 12 percent; molasses, 3.5 percent, trace mineral salt, 1.0 percent; bone meal, .5 percent; ammonium chloride, .5 percent; and urea, .5 percent.

The goats were fed for 150 days, until July 1, at which time they were weighed and sheared off of test. The fleeces were sacked individually and individual fleece data obtained at the Animal Science Department Wool and Mohair Laboratory, Texas A&M University.

Data Obtained

1. Body weights and gains
2. Fleece weights, grease and clean
3. Percent yield of fleece
4. Staple length and fiber diameter (back, side, neck and belly)
5. Percent medullated fibers
6. Committee scores: face cover, neck cover, belly cover, britch cover, kemp, lock type, luster, character, handle

Results

A total of 42 goats from nine different breeders completed the 1967 Angora goat performance test. A review of the data in Table 35 reveals that yearling

TABLE 35. 1967 TEST DATA

	Body weight, pounds			Fleece data, 6-month basis			Committee scores 0—desirable, 5—undesirable				Pounds feed per pound gain
				Lock length, inches	Fleece weight, pounds						
	Initial	Final	Daily gain		Grease	Clean	Face cover	Neck cover	Belly cover	Britch cover	
Average all goats	53.5	108.4	0.366	5.31	14.7	9.95	2.06	2.37	2.36	2.77	8.35
Range, low	31	57	0.11	3.7	5.7	5.7	0	0.5	0.8	1.0	7.6
high	80	125	0.60	6.2	22.3	14.1	5.0	4.0	4.0	4.0	10.6

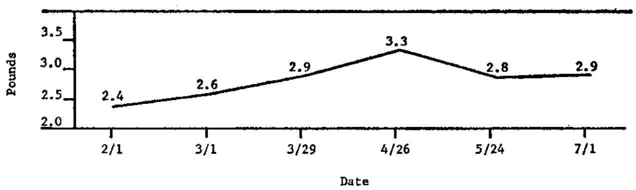

Figure 3. Daily feed consumption.

billies should weigh at least 55 pounds at the beginning of the test to assure good performance. In general, the larger billies were healthier and adapted more readily to test conditions, and, as a result, they performed more desirably.

Figure 2 shows the growth rate and average daily gain for each 10-pounds increase in starting weight. Figure 3 charts the daily feed consumption for the goats on the 150-day test. Daily feed consumption increased through the first part of May, then fell off from 3.3 to 2.9 pounds per daily. This was attributed to heat stress due to increased environmental temperature and mohair growth.

In general, the test demonstrated that goats can be successfully performance-tested. The test averages and ranges in Table 35 reveal that the goats performed very well. Male yearling goats (between second and third shearing) are capable of gaining over .5 pound per day, producing over 12 pounds of clean mohair in 6 months and over a 6-inch staple. The wide variation in individual performance, body and mohair type and phenotype characteristics indicate that more uniform selection procedures are needed in the industry to standardize the product (mohair).

PR-2526

Seasonal Influence On Mohair Production

J. W. Bassett and G. R. Engdahl

The practice of shearing Angora goats twice a year at approximately 6-month intervals has led to some recent criticism from the mohair processing industry because of the variation in fiber length which may result. The shearing season is generally divided into spring and fall seasons, with the spring mohair being sheared from January through March and the fall hair shorn July through September. Individual producers generally arrange their shearing dates to approximate 6-month intervals within these months. There has been little indication that a producer could benefit financially from managing shearing dates to increase staple length or decrease variability between seasonal clips so there has been no incentive for other than the traditional way of doing things. Some of the seasonal variations which are to be found are available from data collected over a 3-year period by personnel of the Animal Science Department Wool and Mohair Laboratory.

Experimental Procedure

Angora does were selected within four age groups from the flocks of five cooperating producers. The age groups, designated as 1, 2, 3 and 4 were 6 months, 1½, 2½ and 3½ years of age, respectively, at the start of the trial in 1964.

These goats were individually identified and were maintained within each producer's flock for six consecutive shearings, three each of spring and fall clips. Some of the animals died or lost their identification so that the total number of animals decreased with each shearing. The grease fleece weight and shorn body weight were obtained at shearing times which approximated the customary 6-month interval. The fleeces were then returned to the Wool and Mohair Laboratory for measurement of lock length, clean yield and fiber diameter.

Results

Season influences on body weight, grease and clean fleece weights, yield, staple length and fiber diameter are given in Table 36. Age of the goats is a confounding element in these data since each shearing period represents a 6-month increase in age. Yearly differences as a result of nutritional or other environmental influences may also be involved. In

TABLE 36. SEASONAL INFLUENCE ON BODY WEIGHT AND MOHAIR FLEECE CHARACTERISTICS

Season and year	Body weight, pounds	Grease fleece weight, pounds	Clean fleece weight, pounds	Clean yield, percent	Staple length, inches	Fiber diameter, microns
Fall 1964	50.8	5.25	4.09	77.90	5.40	30.60
Spring 1965	58.2	5.51	4.22	76.59	4.28	33.22
Fall 1965	58.2	5.44	4.25	78.12	4.71	36.84
Spring 1966	62.2	4.94	3.86	78.14	4.15	36.13
Fall 1966	61.7	5.53	4.36	78.84	4.54	37.78
Spring, 1967	62.4	5.27	4.00	75.90	3.74	36.92
Fall, average	55.8	5.39	4.22	78.29	4.94	34.50
Spring, average	60.2	5.27	4.05	76.85	4.11	34.88

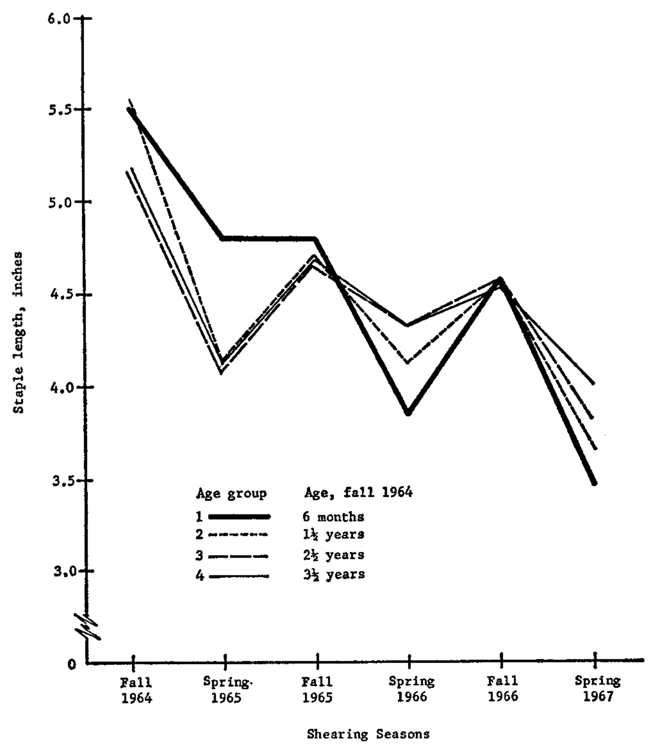

Figure 4. Season and age influence on staple length.

spite of any age or year effect, the influence of season on staple length is apparent. Staple length, in general, is decreasing as the goats get older, but the spring clip is over 0.8 inches shorter on the average than the fall clip. The seasonal response of staple length is similar for all age groups as shown in Figure 4. The desired goal of 1-inch growth of staple length each month is not reached in these goats even at the more desirable fall shearing dates.

Seasonal influences on grease and clean fleece weights, as shown in Table 35 are not too distinct. This is due in part to the large increase in both grease and clean fleece weights for the age group 1 does who were only 6 months old at the initiation of the trial. This is brought out in Figure 5 which shows fleece weights by the respective age groups. A possible year and age effect is shown in group 3 and 4 does, as they show a decrease in fleece weights from the spring, 1965 shearing to the fall, 1965 shearing. This differs from the fleece weight changes of the two younger groups at those shearings. Another indication of possible differences due to year is the increased fleece weights in all groups in the spring of 1967 as compared to the spring of 1966.

Fiber diameter is one trait closely associated with age and less responsive to seasonal influence. All age groups show increasing fiber diameter for the first three shearings which overall gave a larger average fiber diameter for the spring shearing season. Figure 6, however, indicates a fairly distinct seasonal pattern after the first two shearings. The overall influence of age on fiber diameter is shown in Figure 7. The even-year ages represent spring shearings in every case, and thus the seasonal response is again evident.

Body weight changes in which the spring weights average heavier than fall weights may be a reflection of an increase in body weight due to gestation. This increase in body weight, for the most part, is associated with a decrease in mohair production.

Discussion

The specific reasons for season influence on mohair production are not determined from these data, although undoubtedly nutrition is a major factor. Research relating to wool fibers has shown a seasonal reduction in diameter and length of the wool fiber which is not related to nutritional levels, and it is quite possible that these influences also apply to mohair fiber production. The influence of late pregnancy and lactation are not readily apparent, since these conditions exist during the period of time in which the longer staple fall mohair is being grown by the animal.

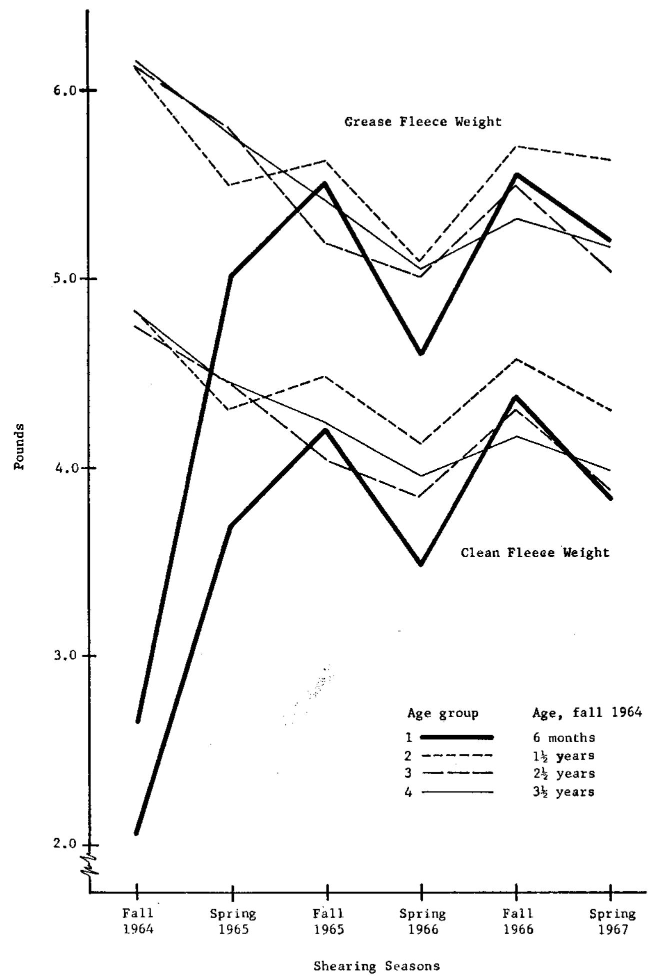

Figure 5. Season and age influence on fleece weights.

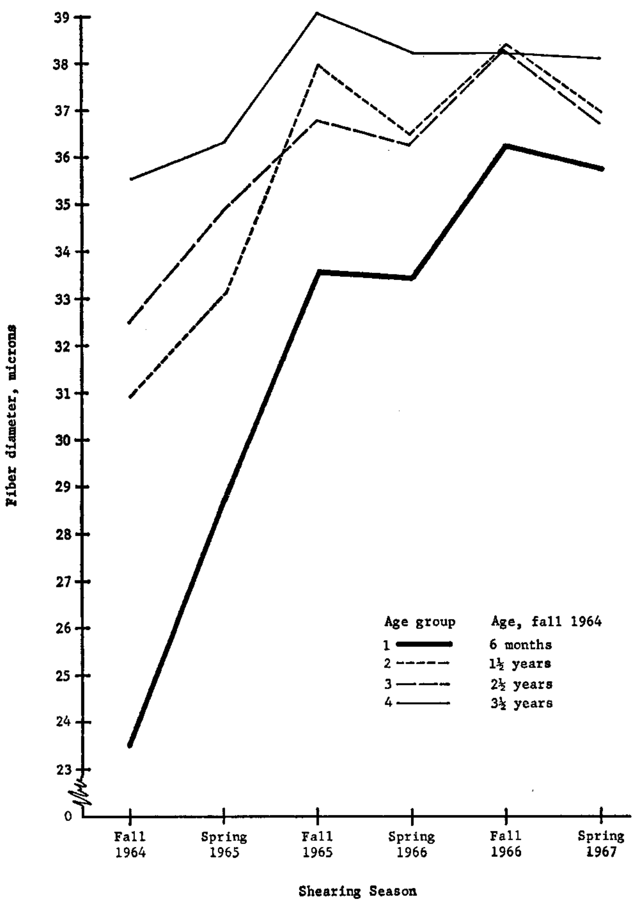

Figure 6. Season and age influence on fiber diameter.

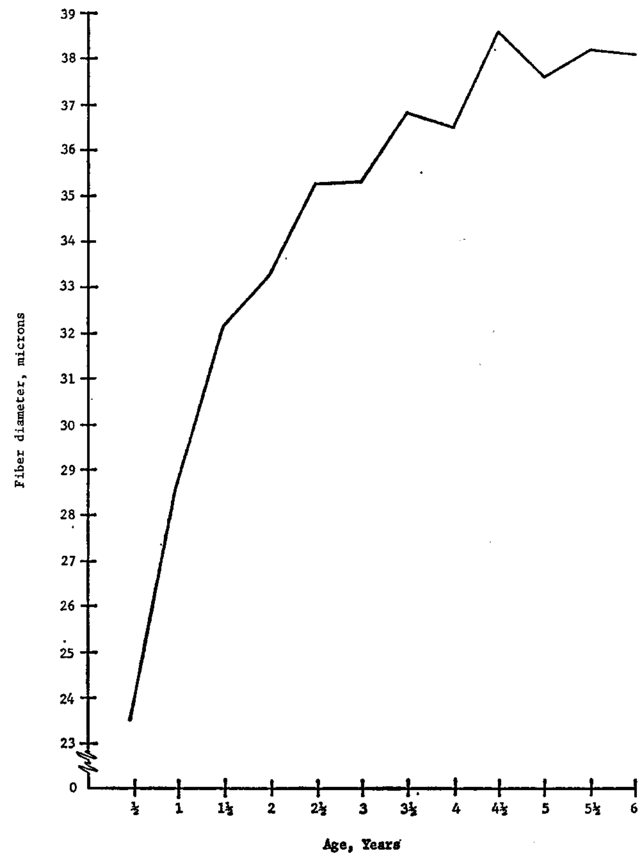

Figure 7. Age influence on fiber diameter.

Regardless of the specific reasons for seasonal influences, the fact that they exist under normal range conditions may make it desirable to develop management practices to compensate for seasonal influence. Staple length is the major mohair fiber character which appears susceptible to modification by management practices. The length of staple might be used to determine shearing dates rather than the interval of time since the previous shearing. If length of fiber is of importance to the mohair processing industry, then consideration should be given to compensating those producers who effectively produce fibers of the desired length.

Fiber diameter is a trait which has been shown to increase with age and improved nutrition. However, fiber diameter varies considerably between individuals, and it is reasonable to assume that this trait is one which is inherited to a high degree and thus can be improved through selection and breeding.

It may be difficult and undesirable to completely or partially offset seasonal variation in fiber diameter, since the finer fiber associated with the lower producing spring clip is more desirable.

Clean yield is a trait which can be improved through both management and selection and is probably influenced least by seasonal effects.

PR-2527

Urinary Calculi in Sheep

H. R. CROOKSHANK

Urolithiasis, urinary calculi or the more common term water belly has been recognized in many species of domestic animals. In 1965, it was estimated that in excess of 16 million pounds of beef were lost because of urinary calculi, with a proportionate loss of mutton from the same cause. While urinary calculi was considered primarily a problem west of the Mississippi River, reports have been received of appreciable amounts developing in livestock in the southeastern area of the United States.

The nature and composition of calculi vary widely. While there may be one or more factors common and fundamental to all cases of urolithiasis, there apparently is a wide diversity of factors and combination of factors which predispose or contribute to the condition. Cattle, sheep and rats fed sorghum and cotton products generally develop uroliths which are largely magnesium phosphate mixed with varying amounts of silicates. Excess vitamin D usually produces calcium carbonate stones. Silicate stones are prevalent in portions of the Northwest. Depending upon conditions, the uroliths may contain salts of iron, aluminum or organic compounds such as uric acid, urates, oxalates, cholesterol or protein. Most of the calculi examined in the Southwest have been magnesium phosphates, with a few of calcium carbonate.

What can be done to control or prevent the formation of calculi? Should the use of sorghum and cotton by-products be curtailed? If so, what should be used in their place? Are they in as plentiful supply, and how do they compare in price with the sorghum and cotton by-products?

The sorghum grains have been blamed by many as the primary causative agent of stones in the rations used in this area. Under rather carefully controlled conditions in our experiments, it has not been possible to show any one particular dietary component of the more commonly used items in the Southwest to be the primary agent. The contribution made by each item will vary as its composition varies. Calculi formation or prevention is the net result of the combination of the dietary components. For the past several years, the same basic diet formulation in terms of grain, protein meal, roughage and other rations has been used in the sheep studies. However, there has been considerable variation in mineral composition and the number of calculi cases from year to year, Table 37.

Since 1955, a rather wide series of diets has been tested. It appears that diets which may be calculi-forming for the wether may not be for the steer and vice versa. One chemical has been tested which has worked well as a control measure for both the wether lamb and the steer under a variety of ration formulations, environmental conditions and ranges. The addition of ammonium chloride to the ration for feedlot use or to the protein supplement for livestock on winter range has afforded almost complete control of calculi without any alteration in management or handling practices. It has been indicated that FDA will approve it for commercial use in the near future. Ammonium chloride is a white crystalline material easily handled by mechanical or automatic mixing devices. In experiments and in field tests, excellent control has been obtained by the addition of approximately 1.25 ounces technical grade ammonium chloride per head daily to the mixed ration for steers and ¼ ounce or about 0.5 percent of the total ration for wethers in the feed lot. This level is used regardless of the size of the animal or composition of the ration. For range animals, it is believed the level may be reduced somewhat and still maintain effective control.

TABLE 37. VARIATION IN MINERAL CONTENT OF RATION[1]

Year	Calcium	Phosphorus	Magnesium	Potassium	Calculi
			Percent		
1958	0.17	0.35	0.20	0.27	62
1959	0.33	0.28	0.23	1.14	21
1960	0.47	0.20	0.23	0.99	36
1961	0.42	0.25	0.31	1.03	40
1962	0.67	0.21	0.39	0.98	43
1963	0.22	0.22	0.42	1.20	65
1964[2]	0.29	0.19	0.41	0.66	45
1965	0.24	0.21	0.17	0.80	55
1966	0.19	0.24	0.20	0.81	55
Calculated[3]	0.19	0.30	0.22	0.85	

[1]Ration composition: 40 percent sorghum grain, 40 percent cottonseed hulls, 10 percent cottonseed meal and 10 percent molasses.

[2]Soymeal substituted for cottonseed meal.

[3]NRC – NAS 449 and 585.

While control has been reported using ammonium chloride only after an outbreak was noted and discontinuing its use as soon as the condition was under control, best results have been obtained in experiments using ammonium chloride continuously while the animals are in the feed lot and from about October to April for range animals depending somewhat upon climatic conditions. It should be used during the period when a protein supplement normally is used. The Fort Hays, Kansas, Branch Experiment Station working with steers has shown that ammonium chloride can replace some of the protein in the diet.

What about the form of the ration? Apparently it does not matter if the diet does not tend to be calculi-forming. However, if the ration composition is such that the formations of stones is favored, pelleting such a ration resulted in a definite increase in both the number of animals involved and the quantity of stones produced.

Sodium chloride has been suggested and used in some areas as a control measure. The addition of 1 percent of sodium chloride to a ration known to produce calculi did not result in any effective control. However, when sodium chloride was replaced with potassium chloride, a much greater degree of control was obtained. It requires more time for the cases to develop with the potassium compound, Table 38. Sodium and potassium carbonate, potassium bicarbonate and potassium chloride all reduced the incidence of calculi while sodium chloride, sodium bicarbonate and dipotassium or disodium phosphate either did not affect or else increased the incidence. Potassium bicarbonate afforded the best protection, while potassium or sodium carbonates and potassium chloride were about equally effective in reducing calculi formation.

The addition of calcium carbonate in the form of ground limestone or oyster shell to the diet of sheep will provide some protection while dicalcium phosphate will afford little protection. When calcium carbonate was added to this same type of rations for steers, it tended to increase rather than decrease calculi formation. Substituting sorghum silage for

TABLE 38. RATE OF DEVELOPMENT OF CALCULI

Treatment	28 days	56 days	84 days	112 days	140 days	Uroliths at slaughter	Total	Percent
Experiment I								
Basal	0	1	2	4		1	8	38
$Na_2HPO_4 \cdot 7H_2O$[1]	0	6	7	1		2	16	80
K_2HPO_4[1]	0	1	3	3		3	10	50
Experiment II								
Basal	1	2	2	4	0	3	8	38
NaCl[1]	2	0	0	0	1	2	5	25
KCl[1]	1	1	0	0	0	0	2	10
Experiment III								
Basal	0	0	4	1		4	9	50
NaCl[1]	0	4	0	2		5	11	61
$NaHCO_3$[2]	0	3	2	3		2	10	53
Na_2CO_3[2]	0	0	0	1		5	6	32
Na_2HPO_4[2]	0	4	5	2		3	14	74
Total fed Na	0	11	7	8		5	41	56
KCl[3]	0	0	0	3		2	5	26
$KHCO_3$[3]	0	0	0	0		0	0	0
K_2CO_3[3]	0	0	1	3		2	6	32
K_2HPO_4[3]	0	0	2	4		7	13	68
Total fed K	0	0	3	10		1	24	32

[1]1 percent of the diet.
[2]Na content equivalent to Na content of 1 percent NaCl.
[3]K content equivalent to Na content of 1 percent NaCl.

the cottonseed hulls and molasses in the rations did not affect the results. Also, substituting soybean meal for cottonseed meal did not affect the formation of calculi.

Based on the reduction in calculi gain and feed efficiency, the various chemical compounds tested during the past several years with the sorghum grain, cottonseed hulls and meal and molasses type ration, may be ranked in overall effectiveness as follows: ammonium chloride, 100; potassium bicarbonate and calcium carbonate, 75; diammonium phosphate, sodium carbonate and potassium chloride, 50; phytic acid 25; and calcium phosphate sodium chloride and magnesium oxide, 0. Both disodium and dispotassium phosphates tended to increase calculi formation. In the process of being tested are ammonium sulfate, potassium citrate and an ammoniated phosphoric acid compound used in liquid feeds.

PR-2528

Influence of Treatment For Tapeworms on Performance Of Lambs in Feedlot

Maurice Shelton and J. E. Huston

Most lambs, at least during their first year of life, are infested with tapeworms. The commonly observed species are *Moniezia expansa* or *Moniezia benedeni.* In some areas infestation with the fringed tapeworm (*Thysanosoma actinioides*) is considered widespread. Producers have not routinely treated for either of these types of tapeworms, due either to lack of an effective drug or to lack of a demonstrated benefit from their removal. The drug Di-Phenthane—70[5] is generally recognized as being effective in removal of the Moniezia species, but its effect on the fringed tapeworm remains controversial.

Two groups of lambs were treated with this drug at the Livestock and Forage Research Center, McGregor, in the summer and fall of 1967. The first group of lambs, Table 39, were born at the center in late spring and were weaned, treated with 1 ounce Teniatol and put on feed August 23. These lambs were known to be infested with Moniezia sp. tapeworms from experience and from a preliminary autopsy of three lambs out of the group. The second group of lambs were feeder lambs purchased on local auction markets. No specific information is available concerning the tapeworm infestation of these lambs, but from previous knowledge it seems safe to assume that they also harbored tapeworms of the Moniezia species. No specific information is available concerning the fringed tapeworm infestation in either group, but this type of parasite is not generally

[5]This drug is marketed by Pitman Moore Company under the trade name Teniatol which contains 15 percent Di-Phenthane —70 (2,2' Methylene bis (4-Chloraphenal). This product was used in these studies at the rate of 1 ounce per lamb (4.5 grams of active ingredient).

TABLE 39. INFLUENCE OF TREATMENT FOR TAPEWORMS ON DRY LOT PERFORMANCE OF EARLY WEANED SUMMER LAMBS

	Replicate 1		Replicate 2		Replicate 3		Replicate 4		Summary	
	Number lambs	Average daily gain	Number lambs	Average daily gain	Number lambs	Average daily gain	Number lambs	Average daily gain	Number lambs	Average daily gain
Control	6	.466	5	.400	6	.522	6	.441	23	.457
Treated[1]	5	.456	5	.395	5	.532	5	.478	20	.465

[1]Each animal was treated with 1 ounce of Teniatol, a product containing 15 percent of Di-Phenthane-70.

considered to be as prevalent in this area as further west. The results from this second group of lambs are shown in Table 40.

In each case the results are reported by replicates since the parasite treatments were imposed as a split block design on other feeding studies (urea versus cottonseed meal and stilbesterol implants versus no implants). Three death losses occurred during these studies. All of these were in the Teniatol groups, but appeared to be unrelated to treatment with this drug. Five lambs were autopsied, either at death or at termination of the studies, and examined for the presence of Moniezia sp. tapes. Results with these limited numbers seem to confirm the effectiveness of this drug in removal of this parasite. However, the data do not show much evidence of a response in gain as a result of the treatment. Using the summary figures and rounding off to the second decimal place, the treated groups gained .01 pound faster during the test. This is not statisically significant, and even on an extended feeding period would not repay the cost of treatment.

TABLE 40. INFLUENCE OF TREATMENT FOR TAPEWORMS ON DRY LOT PERFORMANCE OF FEEDER LAMBS

	Replicate 1		Replicate 2		Summary	
	Number lambs	Average daily gain	Number lambs	Average daily gain	Number lambs	Average daily gain
Control	13	.516	13	.370	26	.443
Treated[1]	12	.525	14	.366	26	.446

[1]Each animal was treated with 1 ounce of Teniatol, a product containing 15 percent of Di-Phenthane-70.

These data seem to confirm the opinion that treatment for tapeworms of this type does not yield an economic response, but this deserves further investigation under varying conditions. These studies provide no meaningful data on the more important question of the effect of fringed tapeworms. There is a widespread belief that the presence of tapeworms contributes to losses from enterotoxemia. No losses from enterotoxemia occurred in these studies, and thus no data are provided on this aspect. Since losses due to enterotoxemia occur sporadically, extremely large numbers would be required to adequately test the relationship between these and tapeworm infestation.