Consolidated PR-3179-3191
May 1973

RESEARCH REPORTS

Sheep and Angora Goat, Wool and Mohair---1973

The Texas Agricultural Experiment Station
J. E. Miller, Director, College Station, Texas
Texas A&M University

Contents

5	PR-3179	Peanut Hulls and Cottonseed Hulls Compared With Alfalfa Hay as Roughage Sources in High Concentrate Lamb Rations
11	PR-3180	Influence of Ammonia Release Rate on Value of Urea in High Fiber Sheep Diets
13	PR-3181	Feeding Whole Sorghum Grain to Sheep
15	PR-3182	Evaluation of Reconstituted Sorghum Grain And Roughage for Adapting Lambs to High Concentrate Diets
17	PR-3183	Influence of Ration Pelleting on Angora Goat Performance
18	PR-3184	Effect of Diethylstilbestrol (DES), Anthelmintic Treatments and Fringed Tapeworm Infestation on Wether Lambs
22	PR-3185	Effect of Feeding Diethylstilbestrol (DES) And Implanting With DES or Zearalanol on Lamb Performance
24	PR-3186A	Influence of Type of Birth on Post Weaning Performance of Rambouillet Rams
26	PR-3186B	Influence of Season, Location and Source of Ewe on Estrus and Ovulation Rate of Rambouillet Ewes
28	PR-3187	Partitioning Losses in Reproductive Efficiency in Angora Goats
31	PR-3188	Mycoplasma Associated With Pneumonia in Sheep
33	PR-3189	Efficiency of Fiber Production of Various Types of Sheep and Goats
36	PR-3190	Fiber Traits of Primitive and Improved Sheep and Goats
37	PR-3191	Estimation of Clean Weights for Ram Performance Test Fleeces

Authors

J. W. Bassett, professor, The Texas Agricultural Experiment Station (Department of Animal Science)

R. W. Berry, former instructor, The Texas Agricultural Experiment Station (Department of Animal Science)

M. C. Calhoun, associate professor, The Texas Agricultural Experiment Station, San Angelo

G. R. Engdahl, former research associate, The Texas Agricultural Experiment Station (Department of Animal Science)

J. R. Gallagher, former research associate, The Texas Agricultural Experiment Station, McGregor

C. V. Hulet, physiologist, Agricultural Research Service, U.S. Department of Agriculture, U.S. Sheep Experiment Station, Dubois, Idaho

J. E. Huston, assistant professor, The Texas Agricultural Experiment Station, San Angelo

C. W. Livingston, associate professor, The Texas Agricultural Experiment Station, San Angelo

D. A. Price, director, Agricultural Research Service, U.S. Department of Agriculture, U.S. Sheep Experiment Station, Dubois, Idaho

Maurice Shelton, professor, The Texas Agricultural Experiment Station, San Angelo

J. R. Stewart, research associate, The Texas Agricultural Experiment Station, Sonora

M. D. Young, research associate, The Texas Agricultural Experiment Station (Department of Animal Science)

Foreword

Sheep and goats continue to be an important part of the Texas agricultural picture. Combination grazing of sheep, goats and cattle — and wildlife — will in general give more efficient and effective utilization of range resources than single species usage in those areas where sheep and goats are climatically adapted. Angora goat numbers increased during the past year, but sheep numbers showed a decrease. A strong increase in demand for wool and mohair fibers in early 1973 and the resulting increase in prices served to stimulate an interest in sheep and Angora goats that had been lacking for several years. However, improved management practices and adoption of new ideas and techniques will continue to be a major factor in determining the future of the sheep and goat industry in Texas.

Sheep and goat producers face most of the problems confronting the rest of agriculture plus some specific problems of their own, such as a decreasing number of sheep shearers and an increasing number of predators. The Texas Agricultural Experiment Station is dedicated to the task of developing and conducting effective research programs which will give solutions to the problems of the sheep and goat industry. This publication reports some of the research efforts in the field of animal science. Other research efforts which apply directly or indirectly to problems of the sheep and goat industry are conducted by the Departments of Range Science, Agricultural Economics, Entomology, Biochemistry and Biophysics, Soil and Crop Sciences, Agricultural Engineering and Wildlife and Fisheries Science and the College of Veterinary Medicine.

Mention of a trademark or a proprietary product does not constitute a recommendation or an endorsement of the product by The Texas Agricultural Experiment Station and does not imply its approval to the exclusion of other products that also may be suitable.

Sheep and Angora Goat, Wool and Mohair---1973

PR-3179

Peanut Hulls and Cottonseed Hulls Compared With Alfalfa Hay As Roughage Sources In High Concentrate Lamb Rations

M. C. Calhoun and Maurice Shelton

SUMMARY: About 10 percent roughage is necessary for best results with high concentrate lamb rations. At this level, cottonseed hulls, peanut hulls and alfalfa hay all appear to possess the necessary physical characteristics required to support normal rumen function and consequently give about the same performance with lambs. As the level of roughage increased above 10 percent, lambs were able to maintain equal digestible energy intakes until roughage bulk in the diet and rumen capacity began to limit feed intake. With increasing levels of roughage, quality becomes important because feed efficiency (expressed as pounds of feed per pound of gain) and more important, the efficiency with which digestible energy is utilized to produce live weight gains, decreases in proportion to the crude fiber content of the roughage.

Introduction

Roughage appears to be a necessary component of lamb rations. It supports normal rumen functions and helps prevent disturbances of the gastrointestinal tract, such as acidosis and off-feed—problems often encountered when lambs are fed all-concentrate rations. Shelton and Calhoun (1971) observed that about 10 percent roughage is required to obtain maximum performance of lambs fed high concentrate rations. At this level in the diet, the physical characteristic of the particular roughage used is probably more important than nutritional value.

Cottonseed hulls and alfalfa hay are extensively used as roughage sources in lamb rations in the southwestern United States. In some areas large quantities of peanut hulls are also available. Since the relative prices and availability of these feedstuffs vary considerably, the possibility of using peanut hulls to replace either cottonseed hulls or alfalfa hay was studied in two experiments.

Experimental Procedure

The source of lambs and experimental procedures used in experiment 1 were previously described (Shelton, Calhoun and Carpenter, 1972). However, a more complete description of the ingredient and chemical composition of the rations is given in Table 1. In experiment 1 the treatment comparisons were (1) all concentrate, (2) 10 percent alfalfa hay, (3) 10 percent cottonseed hulls, (4) 10 percent peanut hulls, (5) 20 percent peanut hulls and (6) 40 percent peanut hulls. Roughage replaced sorghum grain in the ration, and cottonseed meal levels were adjusted to provide equivalent calculated levels of crude protein in all rations.

To eliminate variation in performance related to adaptation to high concentrate rations, a second experiment was conducted in which lambs were first adapted to a 15-percent roughage ration (containing equal parts of alfalfa hay, cottonseed hulls and peanut hulls) and then fed a 10-percent level of one of three roughages (alfalfa hay, cottonseed hulls or peanut hulls) either with or without 3 percent dehydrated alfalfa meal.

The forty-eight lambs used in experiment 2 were obtained at auction in the Central Texas area. Seventy-five percent were Rambouillet wethers, and 25 percent were black-faced crossbred wethers.

The lambs were randomly assigned (two lambs per pen) to twenty-four 4- by 8-foot pens with raised expanded metal floors and fed in an enclosed building with forced ventilation. The ingredient and calculated chemical compositions of the rations used in experiment 2 are described in Table 2. All lambs were started on the 60-percent roughage ration and stepwise switched over a 14-day adaptation period to the 15 percent roughage ration. They were then maintained on the 15-percent roughage ration for an additional 7-day period. Subsequently, they were weighed and switched to their respective treatments. Four pens of lambs (eight lambs) received each of the six roughage treatments for a 28-day comparison period.

Results and Discussion

Results of experiment 1 are summarized in Table 3. One lamb fed the all-concentrate diet died suddenly during the last week of the experiment, apparently from enterotoxemia. Feed consumption data were adjusted to remove this lamb's contribution. Because of the large variation in rumen fill, as reflected by the observed reduction in dressing percent with increasing levels of roughage in the ration, final live weight and, consequently, live weight gain (pounds per day) were adjusted to remove this difference (Goodrich and Meiske, 1971). On this basis, the lambs receiving the all-concentrate ration had the greatest average daily gains. The live weight gains of lambs on either the 10-percent cottonseed hull or 10-percent peanut hull rations were greater than those obtained with 10-percent alfalfa hay rations. In two previous experiments (Shelton and Calhoun, 1971), gains of lambs were slightly greater with 10 percent alfalfa hay than with 10 percent cottonseed hulls.

Efficiency of live weight gain, expressed either as pounds of feed per pound of gain or megacalories digestible energy per pound of gain, was best for the all-concentrate ration. The 10-percent alfalfa hay and 10-percent peanut hull rations were about equal in efficiency and slightly better than the 10-percent cottonseed hull ration.

TABLE 1. INGREDIENT AND CHEMICAL COMPOSITION OF RATIONS (EXPERIMENT 1)

Ingredient, %	All concentrate	10% alfalfa	10% CSH	10% PH	20% PH	40% PH
Sorghum grain[1]	82.25	74.75	70.50	71.50	60.55	38.65
Alfalafa hay[2]		10.0				
Cottonseed hulls (CSH)			10.0			
Peanut hulls (PH)				10.0	20.0	40.0
Cottonseed meal	6.25	4.0	8.0	7.0	8.0	10.0
Dehydrated alfalfa meal, 17% C.P.	3.0	3.0	3.0	3.0	3.0	3.0
Urea, 281% C.P. equivalent	0.75	0.75	0.75	0.75	0.75	0.75
Calcium carbonate	1.75	1.5	1.75	1.75	1.70	1.60
Trace mineral salt	1.0	1.0	1.0	1.0	1.0	1.0
Molasses	5.0	5.0	5.0	5.0	5.0	5.0
Chlortetracycline	At a level to provide 15 mg/lb. of feed.					
Vitamin A palmitate	At a level to provide 1,000 IU/lb. of feed.					
Calculated Chemical Composition						
Crude protein (C.P.), %	13.4	13.4	13.3	13.3	13.3	13.4
Digestible protein, %	10.8	10.7	10.6	10.6	10.4	10.0
Digestible energy, Mcal/lb.	1.54	1.49	1.47	1.43	1.33	1.12
g. D.P./Mcal D.E.	31.8	32.5	32.8	33.5	35.5	40.5
Calcium, %	0.83	0.84	0.85	0.85	0.85	0.85
Phosphorus, %	0.33	0.31	0.32	0.31	0.30	0.27
Potassium, %	0.56	0.73	0.62	0.63	0.70	0.84

[1]Dry rolled.

[2]Alfalfa hay hammermill ground through a ½″ screen.

TABLE 2. INGREDIENT AND CHEMICAL COMPOSITION OF RATIONS (EXPERIMENT 2)

Ingredient, %	Adaptation diets: 60% roughage	Adaptation diets: 15% roughage	0% dehydrated alfalfa: Alf.[1]	0% dehydrated alfalfa: CSH[2]	0% dehydrated alfalfa: PH[3]	3% dehydrated alfalfa: Alf.[1]	3% dehydrated alfalfa: CSH[2]	3% dehydrated alfalfa: PH[3]
Sorghum grain[4]	27.0	72.5	79.4	75.1	76.1	77.5	73.2	74.0
Alfalfa hay	20.0	5.0	10.0			10.0		
Cottonseed hulls	20.0	5.0		10.0			10.0	
Peanut hulls	20.0	5.0			10.0			10.0
Cottonseed meal	5.0	4.0	3.0	7.0	6.0	2.0	6.0	5.2
Dehydrated alfalfa meal[5]						3.0	3.0	3.0
Urea, 281% C.P. equivalent	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Calcium carbonate	1.0	1.5	1.6	1.9	1.9	1.5	1.8	1.8
Molasses	5.0	5.0	4.0	4.0	4.0	4.0	4.0	4.0
Trace mineral salt[6]	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Vitamin A palmitate	Added at a level to provide 1,000 IU/lb. of diet.							
Chlortetracycline	Added at a level to provide 15 mg/lb. of diet.							
Calculated Chemical Composition[7]								
Crude protein, %			13.5	13.5	13.5	13.5	13.5	13.5
Digestible protein, %			11.1	10.9	10.9	11.0	10.8	10.9
Digestible energy, Mcal/lb.			1.52	1.49	1.46	1.50	1.48	1.44
g. D.P./Mcal D.E.			33.2	33.2	34.0	33.1	33.1	34.3
Calcium, %			0.84	0.85	0.86	0.83	0.85	0.86
Phosphorus, %			0.30	0.31	0.30	0.29	0.30	0.29
Potassium, %			0.64	0.53	0.54	0.69	0.58	0.59

[1]Alfalfa hay (No. 1 pea green, leafy, baled) hammermill ground through a ½" screen.

[2]Cottonseed hulls.

[3]Peanut hulls, ground.

[4]Dry rolled.

[5]17% crude protein.

[6]Guaranteed to contain between 91% and 95% salt (NaCl) and not less than the indicated percentages of each of the following elements: Mn, 0.30%; Zn, 0.25%; Fe, 0.15%; Cu, 0.015%; I, 0.01%; and Co, 0.01%.

[7]N.R.C., 1969.

TABLE 3. DRYLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS (EXPERIMENT 1)

Criterion	All concentrate	10% Alf.[1]	10% CSH[2]	10% PH[3]	20% PH	40% PH
Lambs, no.	21	11	11	11	11	11
Initial live wt, lb.	70.1	72.6	73.7	73.0	72.5	73.6
Live wt gain, lb./day	0.446	0.394	0.461	0.417	0.419	0.394
Feed intake, lb./day	3.4	3.4	3.9	3.5	4.0	4.7
Digestible energy intake, Mcal/day	5.3	5.0	5.8	5.0	5.3	5.2
Lb. feed/lb. gain	7.7	8.5	8.5	8.4	9.5	11.8
Dressing, %	54.0	53.2	52.6	53.4	50.9	50.1
Live wt gain, lb./day[4]	0.560	0.468	0.516	0.498	0.414	0.364
Lb. feed/lb. gain[4]	6.1	7.1	7.6	7.0	9.6	12.8
Mcal D.E./lb. gain[4]	9.4	10.6	11.1	10.1	12.8	14.3
Carcass Data						
USDA quality grade	11	11	11	11	11	10
Kidney and pelvic fat, estimated %	4.5	4.0	5.0	4.0	3.8	3.0
Fat thickness, *l. dorsi*, inches	0.19	0.19	0.20	0.16	0.18	0.19
USDA yield grade	3.4	3.3	3.6	3.1	3.2	3.1

[1]Alf. = Alfalfa hay, hammermill ground through a ½-inch screen.

[2]CSH = Cottonseed hulls.

[3]PH = Ground peanut hulls.

[4]Values have been adjusted to remove differences in dressing percent.

Average daily gain (Figure 1), feed consumption and calculated digestible energy (D.E.) intake (Figure 2) and Mcal D.E. per pound of adjusted live weight gain (Figure 3) obtained with 0, 10, 20 and 40 percent peanut hulls were compared with similar data calculated from values obtained with 0, 10, 20, 30 and 40 percent alfalfa hay and cottonseed hulls in a previous study (Shelton and Calhoun, 1971). Only the data from lambs in experiment 2 were used in this comparison because they were fed in the fall for a constant, 56-day period using essentially the same concentrate portion of the ration as in the present study. Although the level of performance (rate of live weight gain) was considerably different for the two studies, the pattern of response was similar for the three roughages. Unadjusted live weight gains remained fairly constant with increasing levels of roughage up to 40 percent. However, adjustment for differences in fill resulted in a decrease in live weight gains with increasing levels of roughage (Figure 1).

With the exception of the alfalfa hay ration, lambs appeared to compensate for the reduction in

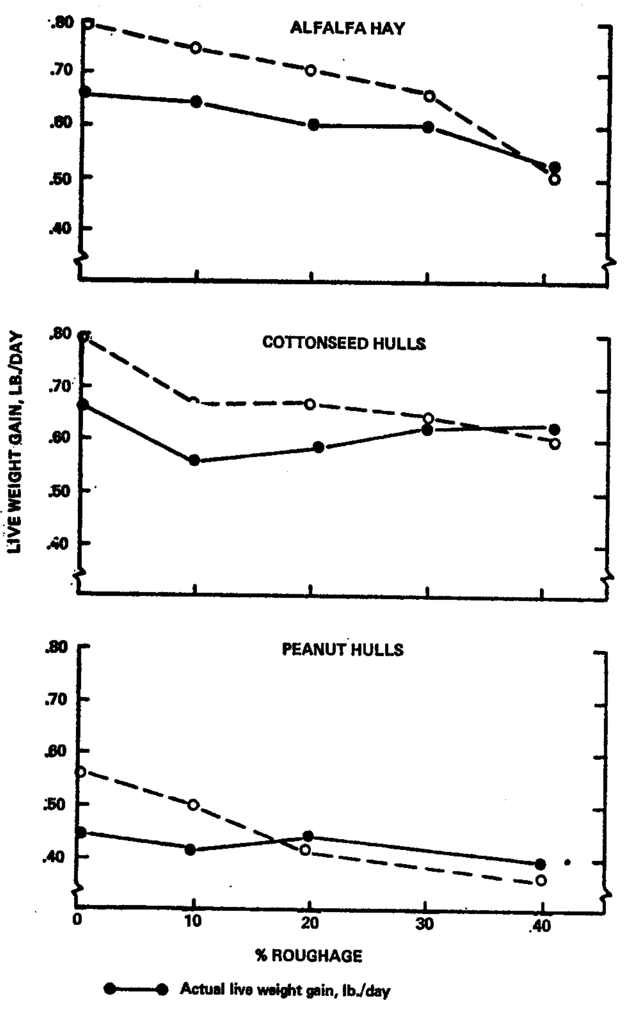


Figure 1. Effect of level of roughage on live weight gains of lambs.

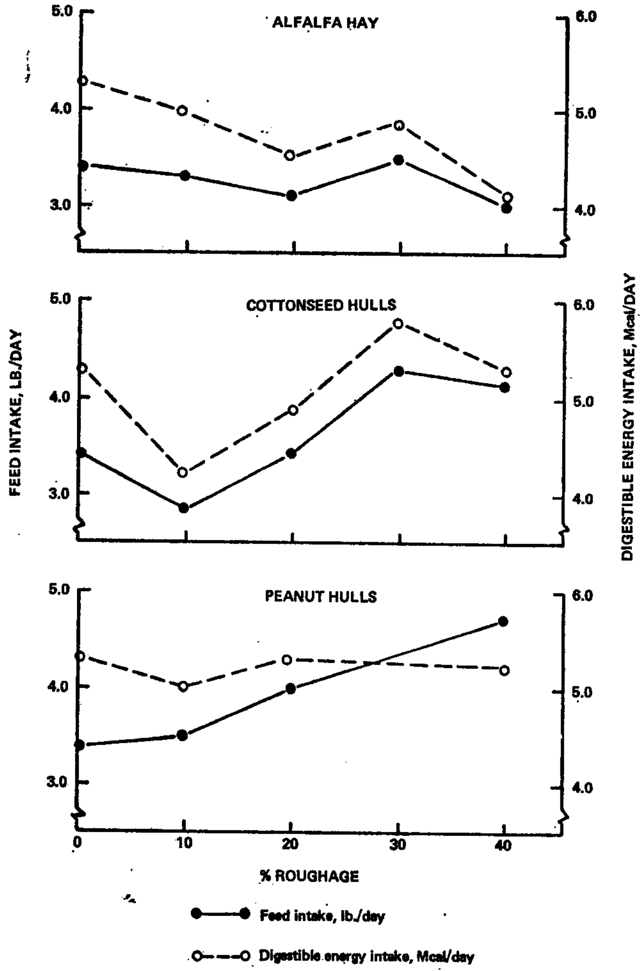


Figure 2. Effect of level of roughage on feed intake (pounds per day) and digestible energy intake (megacalories per day).

the energy density of the ration. With increasing levels of roughage (Figure 2), there was a trend toward increasing feed intake, whereas digestible energy intake possibly remained more constant. This is particularly apparent with peanut hull additions to the diet. The cottonseed hull data show a similar trend, even though the response is more variable. Failure of lambs fed alfalfa hay to demonstrate the same response may be explained by the fact that problems with dustiness and fines were encountered with increasing levels of hammermill ground alfalfa hay, particularly at the 40-percent level.

A comparison of the effect of roughage level on efficiency of live weight gains (Mcal D.E. per lb. adjusted gain) is presented in Figure 3 for the three roughages. The D.E.:gain ratio remained about constant over the range from 0 to 20 percent for alfalfa and increased slightly at higher levels. With cottonseed hull additions to the ration, the D.E.:gain ratio increased at levels above 10 percent. Peanut hulls increased the Mcal D.E. required per pound of gain over the entire range studied; however, the rate of increase was greater at levels above 10 percent peanut hulls. The effect of the three roughages on the rate

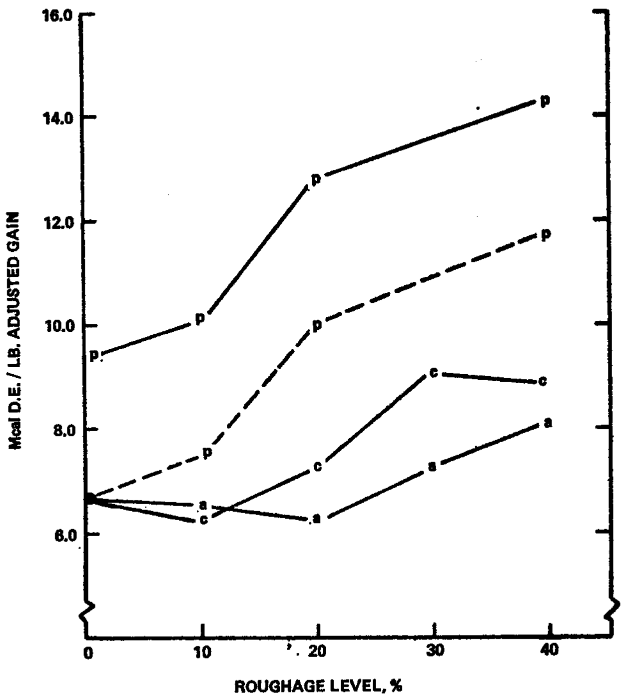


Figure 3. Effect of level and source of roughage on the efficiency of digested energy utilization (megacalories digestible energy per pound adjusted live weight gain).

of increase in the Mcal D.E. required per pound of gain was roughly proportional to their crude fiber content or digestibility.

The results of the second experiment are summarized in Table 4 for the main effects of alfalfa hay, cottonseed hulls and peanut hulls and in Table 5 for the main effects of adding dehydrated alfalfa meal to the diet. The results are presented separately because there did not appear to be an interaction between any of the three roughages and the inclusion of dehydrated alfalfa meal in the ration.

Peanut hulls and cottonseed hulls produced results similar to those of alfalfa hay when fed at a level of 10 percent to lambs previously adapted to a high concentrate diet (Table 4). The addition of 3 percent dehydrated alfalfa meal did not improve lamb performance (Table 5).

Lambs have been fed successfully to slaughter condition using rations which vary over a wide range of roughage concentrations. With all-concentrate rations, closer attention to management is required to minimize the stress of adaptation as the roughage content is reduced, as well as to offset the tendency for lambs to go off feed periodically as the length of the feeding period increases and they approach market condition. These problems generally result in slightly higher death losses and poorer overall performance of lambs fed all-concentrate rations.

When a small amount of roughage is provided (5 to 10 percent) in otherwise nutritionally adequate rations, the roughage factor results in improved live weight gains and feed efficiency. At these low levels, the physical characteristics of the roughage appear to be more important than its nutritional contribution to the diet. Addition of a small amount (10 percent) of roughage appears to slow the rate of passage of feed through the rumen, increase the digestibility of the grain portion of the ration and assist in maintaining normal rumen function and intake of feed while preventing abnormalities of the gastrointestinal tract (Dinus *et al.*, 1970).

Ruminants appear to maintain equal digestible energy intakes over a wide range of concentrate: roughage ratios; therefore, further increase in the percent roughage in the ration, to the point where the capacity of the rumen limits intake, results in little or no change in live weight gains (Montgomery and Baumgardt, 1965; Donefer, Lloyd and Crampton, 1963; Woods and Rhodes, 1962 and Brent *et al.*, 1961). However, feed efficiency, expressed as pounds of feed

TABLE 4. PERFORMANCE OF LAMBS FED ALFALFA HAY, COTTONSEED HULLS OR PEANUT HULLS AT A MINIMUM LEVEL IN A HIGH CONCENTRATE DIET (EXPERIMENT 2)

Criterion	Roughage: Alfalfa hay	Cottonseed hulls	Peanut hulls
Lambs, no.	16	16	16
Initial live wt, lb.	81.1	79.4	78.7
Live wt gain, lb./day	0.738	0.708	0.734
Feed consumption, lb./day	3.8	3.8	3.7
Digetible energy intake, Mcal/day	5.7	5.6	5.4
Feed efficiency			
Lb. feed/lb. gain	5.1	5.4	5.0
Mcal D.E./lb. gain	7.7	7.9	7.3

TABLE 5. EFFECT OF ADDING 3 PERCENT DEHYDRATED ALFALFA MEAL ON THE PERFORMANCE OF LAMBS FED HIGH CONCENTRATE DIETS CONTAINING 10 PERCENT ROUGHAGE (EXPERIMENT 2)

Criterion	Dehydrated alfalfa meal 0%	3%
Lambs, no.	24	24
Initial live wt, lb.	78.8	80.7
Live wt gain, lb./day	0.738	0.716
Feed consumption, lb./day	3.8	3.7
Digestible energy intake, Mcal/day	5.6	5.5
Feed efficiency		
Lb. feed/lb. gain	5.1	5.2
Mcal D.E./lb. gain	7.6	7.7

per pound of gain, and, more important, the efficiency with which digestible energy is utilized to produce live weight gains are decreased by the addition of roughage at levels much above 10 percent in high grain rations (Knox and Loosli, 1972; Vance *et al.*, 1972; Hironaka and Bailey, 1968; Kromann and Ray, 1967 and Woods and Rhodes, 1962).

Differences in the end products of digestion have been suggested as the reason for the decrease in the efficiency of digestible energy utilization as roughage levels are increased in high grain rations (Hironaka and Bailey, 1968; Potter, Purser and Cline, 1968; Weiss *et al.*, 1967). Increasing the level of concentrate alters the ratio of the rumenal concentrations of acetic and propionic acid. There appears to be an increase in the production of propionic acid with increasing levels of grain in the diet, and Weiss *et al.* (1967) reported that the acetate:propionate ratio was associated with 56 percent and 58 percent of the variation, respectively, in the amount of fat and protein deposited in the carcasses of steers fed diets varying in concentrate:roughage ratios.

The relative net energy for maintenance (NE_m) and for gain (NE_g) of roughages and concentrates may also be a factor in the efficiency of D.E. utilization in rations varying in concentrate and roughage as well as possible associative effects when these two sources of energy are combined in varying proportions in lamb diets. Fiber digestibility of roughages is reduced if it constitutes a small portion of a high-concentrate ration. This is probably due to the lowering of the rumen pH, thus changing it from the optimum for cellulytic activity. Also, there is probably competition between cellulytic and amylolytic bacteria for available nutrients.

Vance *et al.* (1972) found that the NE_g values for corn and corn silage were not constant in steer finishing rations. NE_g value of the corn grain decreased, and NE_g of the corn silage increased, respectively, as the increment of corn grain declined from 86 to 46 percent of the ration dry matter. The greatest change in NE_g of corn grain occurred in the range where corn made up 60 to 80 percent of the ration dry matter. Kromann and Ray (1967) reported similar associative effects when varying proportions of sorghum grain and alfalfa hay were fed to lambs. However, in a more recent study, Clemens, Kromann and Ray (1969) reported obtaining a linear relationship between energy (DE, ME and NE) and ration composition with varying ratios of dehydrated alfalfa meal and corn (0 to 100 percent in 5-percent increments for each ingredient) in a complete pelleted ration. This indicates that the energy values of corn and alfalfa were additive with no associative effects.

In the present study with lambs, net energy values were not obtained. It is apparent, however, that the addition of increasing levels of roughages in lamb rations interact with the grain portion of the ration in such a manner as to markedly decrease the efficiency of utilization of digestible energy as calculated from N.R.C. (1968). On the basis of available research results, apparently about 10 percent roughage is necessary for best results in lamb rations. At this level any number of roughages such as alfalfa hay, cottonseed hulls and peanut hulls, or even corn cobs, gin trash and hardwood sawdust will impart the desired physical characteristics and give about the same performance with lambs.

As the level of roughage increases above 10 percent in the diet, quality becomes an important consideration, and the negative effect of roughage on efficiency of energy utilization for growth appears to be in proportion to crude fiber content of the roughage.

Literature Cited

Brent, B. E., D. Richardson, W. S. Tsien and C. S. Menzies. 1961. Digestibility studies on levels of concentrates in complete pelleted rations for fattening lambs. J. Anim. Sci. 20:526.

Clemens, E. T., R. P. Kromann and E. E. Ray. 1969. Ration energy values as related to composition. J. Anim. Sci. 29:155 (Abstr.).

Dinus, D. A., A. D. Peterson, T. A. Long and B. R. Baumgardt. 1970. Intake and digestibility by sheep of rations containing various roughage substitutes. J. Anim. Sci. 30:309.

Donefer, E., L. E. Lloyd and E. W. Crampton. 1963. Effect of varying alfalfa:barley ratios on energy intake and volatile fatty acid production by sheep. J. Anim. Sci. 22:425.

Goodrich, R. D., and J. C. Meiske. 1971. Methods for improving the interpretation of experimental feedlot trials. J. Anim. Sci. 33:885.

Hironaka, R., and C. B. Bailey. 1968. Performance of steers receiving equal amounts of digestible energy from rations differing in proportions of hay and barley. Canadian J. Anim. Sci. 48:131.

Knox, K. L., and J. K. Loosli. 1972. Problems in the use of energy values in ration formulation. In Proc. Georgia Nutrition Conf., Atlanta. p. 59.

Kromann, R. P., and E. E. Ray. 1967. Energy metabolism in sheep as influenced by interactions among nutritional and genetic factors. J. Anim. Sci. 26:1379.

Montgomery, M. J., and B. R. Baumgardt. 1965. Regulation of food intake in ruminants. 1. Pelleted rations varying in energy concentration. J. Dairy Sci. 48:569.

N.R.C. 1968. Nutrient Requirements of Domestic Animals, No. 5. Nutrient Requirements of Sheep. National Academy of Sciences—National Research Council, Washington, D. C.

Potter, E. L., D. B. Purser and J. H. Cline. 1968. Effects of various energy sources upon plasma free amino acids in sheep. J. Nutr. 95:655.

Shelton, Maurice, and M. C. Calhoun. 1971. Influence of level and source of roughage in drylot rations for lambs. Texas Agr. Exp. Sta. PR-2915.

Shelton, Maurice, M. C. Calhoun and Z. L. Carpenter. 1972. The problem of soft, oily lamb carcasses. Texas Agr. Exp. Sta. PR-3025.

Vance, R. D., R. L. Preston, V. R. Cahill and E. W. Klosterman. 1972. Net energy evaluation of cattle-finishing rations containing varying proportions of corn grain and corn silage. J. Anim. Sci. 34:851.

Weiss, R. L., B. R. Baumgardt, G. R. Barr and V. H. Brungardt. 1967. Some influences of rumen volatile fatty acids upon carcass composition and performance in growing fattening steers. J. Anim. Sci. 26:389.

Woods, W., and R. W. Rhodes. 1962. Effect of varying roughage to concentrate ratios on the utilization by lambs of rations differing in physical form. J. Anim. Sci. 21:479.

PR-3180

Influence of Ammonia Release Rate On Value of Urea In High Fiber Sheep Diets

J. E. Huston

SUMMARY: Two trials were conducted to determine whether urea would be a more effective source of supplemental crude protein for high roughage diets than it is at present if its rate of ammonia release in the rumen was reduced. Rations containing no supplemental protein, urea, slow-release urea or cottonseed meal were fed to lambs in a growth trial. In a second trial, supplements consisting of sorghum grain alone, sorghum grain plus urea, sorghum grain plus slow-release urea or sorghum grain plus cottonseed meal were fed to ewes having free-choice access to cottonseed hulls. Results indicate that slow-release urea was more effective than urea and similarly effective as cottonseed meal as a source of supplemental crude protein.

Introduction

Urea has been included in sheep rations as a substitute for protein for more than 25 years. The enzyme *urease,* which is produced by the microorganisms located in the rumen (first stomach) of sheep, breaks down urea, thereby releasing ammonia which can be incorporated into available protein. A limitation to the use of urea is that under some conditions the rate of release of ammonia exceeds its rate of incorporation into protein, resulting in a reduced value of urea as a protein substitute and an ammonia toxicity hazard. While urea is relatively well utilized when included in high concentrate rations, it is poorly utilized as a protein substitute in high roughage rations and as a range supplement. Visible signs of poor utilization include reduced growth rate and feed conversion in growing lambs and reduced forage intake and increased weight loss in grazing ewes. Experiments were conducted to determine the effect of decreasing the rate of ammonia release in the rumen on the effectiveness of urea as a protein substitute.

Procedure

Two trials were conducted comparing control (low protein treatment), urea, slow-release urea and cottonseed meal treatments. The method for preparing the slow-release urea has been previously reported (Huston, Shelton and Breuer, 1969). In each trial the ingredients were mixed and pelleted to assure consumption of the feed as formulated.

TABLE 1. RATIONS FOR A LAMB GROWTH TRIAL TO EVALUATE SLOW-RELEASE UREA IN MIXED DIETS

	Ration			
Ingredients	1 Control	2 Urea	3 Slow-release urea	4 Cottonseed meal
	%			
Sorghum hay	50.0	49.7	49.7	50.0
Sorghum grain	43.0	37.7	37.7	24.0
Molasses	5.0	5.0	5.0	5.0
Urea premix[1]		5.0		
Slow-release urea[2]			5.0	
Cottonseed meal				19.0
Mineral premix	2.0[3]	2.6[4]	2.6[4]	2.0[5]
Total	100.0	100.0	100.0	100.0
Analyzed crude protein content	7.4	14.0	13.6	13.8

[1]Urea premix contained 50% urea (45%N) and 50% cornstarch.
[2]Slow-release urea contained 50% urea (45%N) and was prepared according to the method described by Huston, Shelton and Breuer (1969).
[3]Provided 1% dicalcium phosphate and 1% salt.
[4]Provided 1% dicalcium phosphate, 1% salt and 0.6% sodium sulphate.
[5]Provided 1% calcium carbonate and 1% salt.

Trial 1

Sixteen uniform lambs were assigned to four experimental groups of four lambs each and fed the rations presented in Table 1 in a 42-day growth trial. The level of feeding was controlled and increased at bi-weekly intervals. The control group refused to consume as much feed as the other three groups, so intake was allowed to increase more in groups 2, 3 and 4 but was held the same in respect to each group.

Trial 2

This trial was conducted to determine the effects of different supplements (Table 2) on weight change

TABLE 2. SUPPLEMENTS FOR EWES IN TRIALS TO EVALUATE SLOW-RELEASE UREA AS A SUPPLEMENT TO HIGH FIBER, LOW PROTEIN ROUGHAGE[1]

	Supplements			
Ingredients	1 Control	2 Urea	3 Slow-release urea	4 Cottonseed meal
	%			
Sorghum grain	100.0	85.3	85.3	49.0
Urea premix[2]		12.7		
Slow-release urea[3]			12.7	
Cottonseed meal				49.0
Dicalcium phosphate		2.0	2.0	2.0
Total	100.0	100.0	100.0	100.0
Calculated crude protein content	8.5	25.0	25.0	25.0

[1]Cottonseed hulls (approximately 3% crude protein) were fed free choice.
[2]Consisted of 50% urea (45%N) and 50% cornstarch.
[3]Consisted of 50% urea (45%N) and prepared according to the method described by Huston, Shelton and Breuer (1969).

TABLE 3. GROWTH PERFORMANCE OF LAMBS FED EITHER NO SUPPLEMENTAL PROTEIN OR UREA, SLOW-RELEASE UREA OR COTTONSEED MEAL AS A SUPPLEMENT IN 50% SORGHUM HAY RATIONS

Treatment	Ration number	Number of lambs	Weight gain Total lb.	Weight gain Daily lb.	Feed consumption Total lb.	Feed consumption Daily lb.	Feed conversion lb. feed/lb. gain
Control	1	4	10.6	.25	89.7	2.13	8.5
Urea	2	4	11.0	.26	104.5	2.49	9.5
Slow-release urea	3	4	14.3	.34	101.2	2.41	7.0
Cottonseed meal	4	4	15.3	.36	105.2	2.50	6.9

and feed intake of mature ewes offered cottonseed hulls free-choice. Twenty-four mature ewes were assigned to six treatment groups of four ewes each. Supplements 1, 2, 3 and 4 were fed daily at the level of 0.25 pound per ewe to groups 1, 4, 5 and 6, respectively. Ewes in groups 2 and 3 were fed supplements 2 and 3, respectively, at a level of 0.75 pound per ewe every third day. A preliminary period of 7 days, during which the ewes were fed cottonseed hulls without supplements, was followed by a test period lasting 21 days. Initial and final weights of ewes and the total consumption of cottonseed hulls were determined for each of the six groups of ewes.

Results and Discussion

Results of trials 1 and 2 are presented in Tables 3 and 4, respectively. In a previous report (Huston, Shelton and Breuer, 1969), slow-release urea was shown to be more effective than untreated urea in increasing nitrogen balance and rate of growth in lambs fed high concentrate rations. Similar results were obtained in these experiments when the primary energy source was roughage.

In trial 1 the lambs consuming the urea-containing diet (ration 2) had a growth rate similar to those fed a low protein diet (ration 1). This indicated that the urea was ineffective as a supplemental protein source. On the other hand, the lambs receiving the slow-release urea diet (ration 3) had a growth rate almost identical with those of lambs fed cottonseed meal (ration 4). Feed conversion values also indicated that the slow-release urea and cottonseed meal-containing rations were being utilized by the lambs with similar efficiency and more efficiently than the urea-containing and control rations.

Trial 2 was designed to test the relative value of slow-release urea when used as a supplement to a low protein, low energy diet. The weight losses of the control ewes indicated that they were under nutritional stress and in need of supplemental nutrients. Ewes receiving only grain sorghum (energy source) lost 5.0 pounds per head compared with only 1.3 pounds for those fed the cottonseed meal supplement. There was also a higher hull consumption by the group fed cottonseed meal. These differences indicated that a protein deficiency was at least partially alleviated by the cottonseed meal supplement. The urea and slow-release urea supplements produced intermediate results, with the slow-release urea supplement being more effective. Ewes supplemented every third day had the same relative order of response to the supplements but slightly greater weight losses than ewes supplemented daily. An attempt was made to recover all feed waste; however, some waste was not corrected for and was assigned a subjective estimate. Thus, the feed consumption values should be adjusted slightly, but the necessary adjustments would not change the relative order of feed consumption.

These trials are parts of a larger research project, and results should not be considered conclusive. The trends indicate that rapid ammonia production in the rumen contributes to reduced utilization of urea as a protein replacer and that substances which produce a slower rate of ammonia production (such as biuret or slow-release urea) may be more effective than urea as supplements to high fiber sheep diets.

Literature Cited

Huston, J. E., Maurice Shelton and L. H. Breuer. 1969. Utilization of urea in sustained-release pellets. Texas Agr. Exp. Sta. PR-2632.

TABLE 4. WEIGHT CHANGE AND HULL CONSUMPTION OF EWES FED COTTONSEED HULLS FREE-CHOICE AND SUPPLEMENTED WITH VARIOUS CONCENTRATES AT EITHER 1- OR 3-DAY INTERVALS

Group number	Number of ewes	Supplement fed	Feeding frequency	Weight change (21 days) lb./ewe	Hull consumption (21 days) lb./ewe	Waste estimate[1]
1	4	Control	Daily	−5.0	57.8	Moderate
2	4	Urea	3 days	−4.5	56.9	Moderate
3	4	Slow-release urea	3 days	−4.0	53.8	Light
4	4	Urea	Daily	−4.0	56.2	Light
5	4	Slow-release urea	Daily	−2.5	71.4	Heavy
6	4	Cottonseed meal	Daily	−1.3	69.2	Heavy

[1]A subjective estimate of the amount of waste by each group.

PR-3181

Feeding Whole Sorghum Grain to Sheep

Maurice Shelton and M. C. Calhoun

SUMMARY: A feeding trial was conducted with 100 head of old crop lambs to study the potential for feeding whole sorghum grain to lambs in drylot. Body weight gains (0.365 pound daily) and feed efficiency (7.8 pounds feed per pound gain) were somewhat unsatisfactory for lambs fed sorghum grain with a mineral mixture made up of equal parts salt and calcium carbonate with Vitamin A and aureomycin. The addition of biuret at the rate of one-third the mineral mixture improved both lamb gains (0.414 pound daily) and feed efficiency (6.51 pounds feed per pound gain). However, alfalfa hay fed one bale per week per 25 lambs resulted in the most satisfactory gains (0.464 pound daily) and feed efficiency (6.24 pounds feed per pound of gain). A mixed pelleted ration containing 10 percent peanut hulls as a roughage source supported good lamb gains (0.464 pound daily), but feed efficiency was unsatisfactory. Results indicate that whole grain can be satisfactorily fed to old crop lambs if appropriate supplements are provided.

Introduction

A number of factors suggest that it is more efficient for the original producer to feed lambs to market condition than to have them fed commercially. For the majority of the lambs produced in Texas, some time on concentrate feeds is required to reach market condition. One of the problems encountered is a source of feed at competitive prices. If a producer wishes to prepare his own ration, the equipment costs may be prohibitive for the small number of lambs involved. Sorghum grain constitutes the almost exclusive source of energy used in lamb feeding in Texas. Therefore, if sorghum grain could be fed as whole grain, the major equipment problems would be solved. This means that lambs would be given access to pure grain rations. The nutrient content of sorghum grain in comparison with the requirements for feedlot lambs is shown in Table 1. The nutrient requirements of lambs will vary according to age; the composition of sorghum grain also may vary widely. In practically all cases the grain will be deficient in calcium and Vitamin A and may be deficient in protein, potassium and certain other minerals (Table 1). Also, if roughage is considered as a requirement, then this ingredient is also deficient. Most feedlot rations contain at least 10 percent roughage. Thus, if whole grain is fed, a means must be developed to provide the lambs with those elements which are inadequate in sorghum grain to support good performance.

The performance of lambs provided various supplements to sorghum grain was studied.

TABLE 1. RELATIONSHIP OF COMPOSITION OF SORGHUM GRAIN TO NUTRIENT REQUIREMENTS OF FEEDLOT LAMBS

Ingredient	Content in sorghum grain, % (approximate)	Required by lambs, % (approximate)
Crude protein	7.0–12.0	11–16
TDN	82.0	60–80
Calcium	0.04	0.20
Phosphorus	0.33	0.18
Potassium	0.40	0.4–.5
Vitamin A	Nil	500 IU/lb. of wheat

Experimental Procedure

One hundred old crop Rambouillet wether lambs were divided into four lots. The treatments used and some of the results obtained are shown in Table 2. The lambs had been in drylot for approximately 2 weeks before this experiment was initiated. The lambs were shorn and vaccinated for enterotoxemia before being placed on the experiment. The feeding period continued for 53 days.

Lot 1 represents the minimal treatment in which the lambs received only sorghum grain along with a mineral supplement providing salt, calcium, Vitamin A and aureomycin (Table 2). The grain and mineral supplements were fed free choice in separate containers. The gain and feed efficiency of this lot would generally be considered unsatisfactory by most feeders. The feed efficiency was somewhat adversely affected by feed wastage, which did not occur in other lots. The calcium intake was approximately 3.6 grams (g) compared to a projected requirement of approximately 3 g per head per day. Vitamin A intake was substantially in excess of the requirement, but its availability when provided in this manner is not known.

Lot 2 represents essentially the same treatment as lot 1 except that biuret was added to the mineral supplement to provide an increase in the protein level in the ration. Biuret is a nonprotein nitrogen source which is better suited to use in this manner than urea. The increased gain and improved feed efficiency indicate that some advantage was realized from the increased nitrogen provided. The increased level of mineral intake by this group indicates that mineral supplements containing biuret are highly palatable to lambs. As in lot 1 the level of intake of calcium and Vitamin A was more than adequate to meet the needs of the lamb. The nitrogen intake from biuret was calculated to be 3.29 grams daily. Assuming a 100-percent efficiency of utilization, which is almost certainly not true, this would be equivalent to 20.5 grams of protein. Assuming a 10-percent protein content for the sorghum grain, the protein intake would appear to be inadequate for these lambs.

Lot 3 represents a duplicate of lot 1 except that one bale of alfalfa hay was provided per week (a single feeding) for the 25 lambs involved. The weight

TABLE 2. PERFORMANCE OF LAMBS FED VARIOUS SUPPLEMENTS TO WHOLE SORGHUM GRAIN

Lot no.	Number lambs	Treatment	Number death losses	Avg daily gain, lb.	Daily feed intake, lb. Sorghum grain	Alfalfa	Mineral supplement	Pelleted ration	Lb. feed per lb. gain	Feed cost, cents per lb. gain[2]
1	24	Whole sorghum grain plus mineral supplement #1[3]	0	.365	2.85[1]		.035		7.79	23.40
2	26	Whole sorghum grain plus mineral supplement #2[3]	0	.414	2.69		.059		6.51	20.24
3	25	Whole sorghum grain plus mineral supplement #1 plus alfalfa hay weekly[3]	0	.464	2.54	0.35	.037		6.24	18.96
4	25	Mixed pelleted ration[4]	0	.464				4.20	9.08	27.24

[1]Some feed wastage occurred in this lot.

[2]All feeds were charged to the lambs at 3 cents per pound except mineral supplement No. 2 containing biuret which was charged at 5 cents per pound.

[3]Mineral supplement composition:

No. 1—Equal parts of salt and calcium carbonate with 1000 I.U. Vitamin A and 15 mg aureomycin per 0.02 lb.

No. 2—Equal parts salt, calcium carbonate and biuret with 1000 I.U. Vitamin A and 15 mg aureomycin per 0.03 lb.

[4]Pelleted ration composition:

	%		%
Sorghum grain	— 76.0	Urea	— 0.5
Peanut hulls	— 10.0	Calcium carbonate	— 1.0
Dehydrated alfalfa	— 3.0	Salt	— 0.5
Cottonseed meal	— 5.0	Vitamin A — 1,000 I.U. per lb.	
Molasses	— 4.0	Aureomycin — 15 mg per lb.	

of the bales varied somewhat, but the intake averaged 0.35 pounds per lamb per day. No waste was involved as the lambs consumed the hay entirely. The alfalfa hay provided the lambs with increased protein, Vitamin A, and a wide variety of minerals, as well as fiber. Alfalfa hay contributed 12 percent of the ration, a level closely approximating that used in most feeding rations. The addition of alfalfa hay resulted in a marked improvement in gain, feed efficiency and cost of gain when compared to those in either lot 1 or lot 2. Alfalfa hay provided slightly more protein than the biuret in lot 2, but in addition the alfalfa provided bulk and perhaps mineral elements which potentially could be of importance in lamb rations. In any case the alfalfa contributed to improved lamb gains. Assuming sorghum grain to contain 10 percent or less protein, both rations should benefit from additional protein especially for younger lambs. Protein determinations were not made on the sorghum grain used because the grain was purchased on bids at approximately 2-week intervals, and several lots of grain were used during the 53-day period.

Lot 4 received a commercially prepared, mixed pelleted ration. The high daily intake and poor feed efficiency of this lot are unexplainable; they suggest the possibility of an error in ration formulation resulting in a higher roughage level or an error in recording feed intake.

Discussion

Results indicate the possibility of feeding whole grain sorghum to lambs. The most frequent problem from feeding whole grain sorghum to lambs is urinary calculi from mineral imbalances. Attempts were made to correct this through the minerals provided. During the 53-day test there were no losses of any kind. After termination of the trial, 25 lambs were continued on treatment number 3 for an additional 15 days with no calculi cases. One problem encountered was feed wastage. Whole grain feeds down very readily in self feeders, and waste can result. This occurred only in lot 1, and it is not known whether this was related to the treatment or was due to the feeding habits of certain lambs in this group. Near the termination of this study, birds became a problem since whole grain represents a good bird feed. Another problem which is to some degree characteristic of all high energy rations was the considerable variation in individual animal performance. Lamb gains varied from 0 to 42 pounds during the 53-day test period.

The feeding of whole sorghum grain rations appears to offer potential for producers not wishing to invest in extensive feed processing or mixing facilities. It is important that the nutrients which are deficient in the grain be provided in some other manner. Alfalfa hay, even in small quantities, provides many of these nutrients. Other types of hays could be used but generally would not contain the protein provided by the alfalfa. When alfalfa is used in small amounts, mineral supplements should be used to provide additional calcium. These can be mixed by the producer and provided free choice in salt mixes or can be purchased in specially formulated blocks to be made available to the animal in controlled amounts. The supplement of choice would vary depending on whether hay is used or the type of hay used. Some suggestions as to the mineral supplements which might be used with each type of ration can be obtained by contacting the authors.

PR-3182

Evaluation of Reconstituted Sorghum Grain and Roughage for Adapting Lambs To High Concentrate Diets

M. C. Calhoun and Maurice Shelton

SUMMARY: Live weight gains of lambs receiving grain sorghum, without added water, were 37.3 percent greater than for those lambs fed grain with 30 percent water content for the first 14 days. Feed efficiency, pounds feed per pound gain, was also adversely affected by adding water to the grain during the first 14 days on feed. A similar, though smaller, response was still apparent upon completion of the 56-day feeding period. Starting lambs on a 60-percent roughage ration and adapting them over a 12-day period to a 10-percent roughage, high-concentrate ration resulted in increased live weight gains and improved feed consumption after 14 days on feed; however, lambs placed directly on the 10-percent ration had slightly higher average daily gains and the best overall efficiency for the 56-day feeding period. Carcass measurements did not appear to be influenced by the water content of the sorghum grain, but lambs which were fed the 10-percent roughage ration for the entire 56-day period showed an increased fat thickness over the *l. dorsi* and a higher calculated USDA yield grade.

Introduction

The availability and prices of feedstuffs in the southwestern United States generally necessitates finishing lambs, in drylot, on rations containing a minimum level of roughage. The switch from a predominantly roughage diet to one containing as little as 5 to 10 percent roughage requires a period of adjustment during which the rumen microorganisms adapt to a high starch diet. To minimize the stress associated with this dietary change, the roughage portion of the diet is generally reduced gradually over about a 2-week period. Careful management of the lambs during this period is necessary to minimize digestive disturbances associated with overeating on a high-concentrate diet such as lactic acidosis, off-feed and, in some cases, enterotoxemia.

Water is a critical nutrient at this time. Lambs transported for considerable distances from range pastures, through auctions, to feedlots with little or no feed or water are usually in varying states of dehydration and often refuse to drink when water is provided at a new location in unfamiliar water facilities. This problem is further compounded by the adverse osmotic effects which occur when rations are consumed containing appreciable quantities of readily fermentable carbohydrates such as are present in the cereal grains (sorghum grain).

In previous experiments (Calhoun and Shelton, 1971a, b) in which lambs were switched directly from a 60-percent roughage ration to one containing 10 percent roughage, the use of reconstituted sorghum grain (30 percent water) resulted in a marked improvement in feed consumption and live weight gains during the initial 14-day period on feed. It was felt that the water added to reconstitute the grain reduced the stress of adaptation.

On this basis, it appears that water may be a satisfactory substitute for roughage during adaptation of lambs to high concentrate rations. An additional advantage would be obtained if the water added to the grain reduced the osmolality of the rumen contents and associated fluid shifts in the body during this period.

The mechanics of adding water to the grain portion of the ration is relatively simple, and the cost of water is minimal when compared to the cost of generally available roughage materials, such as alfalfa hay, cottonseed hulls and peanut hulls.

The possibility was examined that water added to the sorghum grain to dilute the energy content might be a suitable alternative to the use of roughage for adapting lambs to a high concentrate diet.

Experimental Procedure

Seventy-two Texas feeder lambs of mixed sex, purchased at auction, were used in this study. They received a 60-percent roughage ration, *ad libitum,* for a 14-day pretrial, standardization period during which the lambs were ear tagged for identification, sheared and weighed. Upon completion of the pretrial period, all lambs were reweighed after a 24-hour period without feed and 12 hours without water and assigned to pens at random (12 pens, six lambs per pen) but balanced with respect to sex (three ewes and three wethers in each pen).

Two pens of lambs were then started on each of the following treatments:

1. Sorghum grain (13 percent water); stepwise decrease in roughage.[1]
2. Sorghum grain (13 percent water); 10 percent roughage.
3. Sorghum grain (30 percent water);[2] stepwise decrease in roughage.

[1]Lambs were started on the 60-percent roughage ration (Table 1). This was stepwise reduced over a 12-day period to the 10-percent roughage ration.

[2]Sufficient water was added to the dry rolled sorghum grain to bring the water content to 30 percent. This was accomplished by adding the water to the grain in the mixer prior to adding other ration ingredients.

4. Sorghum grain (30 percent water); 10 percent roughage.

5. Sorghum grain (30 to 13 percent water);[3] stepwise decrease in roughage.

6. Sorghum grain (30 to 13 percent water); 10 percent roughage.

The percent ingredient and chemical composition of the experimental rations is given in Table 1. In practice, all ingredients except the grain sorghum and, in the case of the 10-percent roughage ration, a portion of the molasses were put together in a premix. This was then mixed together with the grain portion of the ration at 1- to 2-day intervals to insure comparable freshness of the feeds and prevent spoilage of the high-moisture diet.

The relative amounts of premix and sorghum grain required to formulate 100 pounds of the experimental rations on an equivalent 87-percent dry matter basis are shown in Table 2.

Live weights of lambs were obtained (unshrunk) at 2-week intervals during the 56-day experiment. A representative of the Meats Investigations Section of the Animal Science Department at Texas A&M University assisted in obtaining carcass data on the lambs when they were slaughtered.

[3]Thirty percent water sorghum grain was switched to 13 percent grain on the 14th day.

TABLE 1. INGREDIENT AND CHEMICAL COMPOSITION OF EXPERIMENTAL RATIONS

Ingredient	60% roughage	10% roughage	Premix 60% roughage	Premix 10% roughage
	– – – – –	– % –	– – – – –	
Sorghum grain[1]	27.5	77.5		
Alfalfa hay, ground[2]	30.0	10.0	41.38	54.05
Cottonseed hulls	30.0		41.38	
Cottonseed meal	4.0	4.0	5.52	21.62
Urea, 281% protein equivalent	1.0	1.0	1.38	5.40
Calcium carbonate	1.5	1.5	2.07	8.11
Molasses	5.0	5.0	6.90	5.40
Plain salt	0.25	0.25	0.34	1.35
Trace mineral and vitamin mixture[3]	0.75	0.75	1.03	4.05
Chlortetracycline[4]	+	+	+	+
Stilbestrol[5]	+	+	+	+
Chemical composition:				
Crude protein, %	13.5	13.8		
Calcium, %	1.08	0.81		
Phosphorus, %	0.24	0.30		
Potassium, %	1.18	0.67		

[1]Dry rolled through a Davis Krimper-Kracker® mill.

[2]Hammermill ground through a ½-inch screen.

[3]Guaranteed to contain between 62 and 66% NaCl, 10 to 12% calcium and not less than the following percentages of mineral elements: P, 6.0; Zn, 0.32; Mn, 0.256; Fe, 0.16; Ca, 0.032; I, 0.0064 and Co, 0.0064. Vitamin A palmitate 204,800 USP units per pound and Vitamin D 40,960 USP units per pound.

[4]Chlortetracycline: American Cynamid Co. Aureofac 50, 50 g chlortetracycline per pound added at a level to provide 15 mg of chlortetracycline per pound of mixed feed.

[5]Stilbestrol (DES)—Elanco Products Co. Stilbosol—2, added at a level to provide 2 mg DES per lamb per day.

TABLE 2. AMOUNTS (POUNDS) OF PREMIX AND SORGHUM GRAIN REQUIRED TO FORMULATE 100 POUNDS OF THE EXPERIMENTAL RATIONS ON AN EQUIVALENT 87-PERCENT DRY MATTER BASIS

Ration	% H_2O in grain	Sorghum grain	Premix	Molasses
		– – –	(lb.)	– – –
60% roughage	13	27.5	72.5	
	30	34.2	72.5	
10% roughage	13	77.5	18.5	4.0
	30	96.3	18.5	4.0

Results and Discussion

There was no significant interaction between the two factors examined; that is, the response to the roughage level of the starting ration was not significantly changed by the water content of the sorghum grain. Therefore, the information obtained from this factorial experiment was combined to show the overall response to either the roughage level of the starting ration (Table 3) or the water content of the sorghum grain (Table 4).

TABLE 3. EFFECT OF ROUGHAGE LEVEL OF STARTING RATION ON DRYLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS

Criterion	Roughage level of starting ration 60%	10%
14-day summary		
Lambs, number	36	36
Initial live wt, lb.	60.7	64.2
Live wt gain, lb/day	0.380	0.330
Feed consumption, lb./day	2.6	2.3
Lb. feed/lb. gain	6.8	6.8
56-day summary		
Live wt gain, lb./day	0.418	0.447
Feed consumption, lb./day	2.5	2.5
Lb. feed/lb. gain	6.0	5.6
Carcass data		
USDA quality grade	44.7	47.8
USDA quality grade	10.8	11.2
Fat thickness, *l. dorsi*, inches	0.18	0.22
Kidney and pelvic fat, estimated %	3.6	4.0
USDA yield grade	3.2	3.5
Fat color score[1]	3.0	3.2
Fat firmness score[2]	3.6	3.8

[1]Fat color score: 4 = White, 3 = Creamy white, 2 = Slightly yellow, 1 = Yellow.

[2]Fat firmness score: 6 = Firm and dry, 5 = Moderately firm and moderately dry, 4 = Slightly firm and slightly dry, 3 = Slightly soft and slightly oily, 2 = Moderately soft and moderately oily, 1 = Soft and oily.

After 14 days on feed, the live weight gains and feed consumption of those lambs started on a 60-percent roughage ration and stepwise adapted over a 12-day period to the 10-percent ration were 0.05 and 0.3 pound per day greater, respectively, than the average values for those lambs placed directly on the 10-percent roughage ration. Feed efficiency was the same for both groups of lambs at 14 days.

However, upon completion of the 56-day feeding period, the lambs started directly on the 10-percent ration had the better gains and feed efficiency, and feed consumption was the same for both groups. In this experiment, two pens of lambs were fed each of the treatments, and the average differences in response (variation) between pens receiving the same treatments were used as a guide to determine whether the observed differences between treatments were great enough to be considered real treatment effects. On this basis, the difference in feed consumption at 14 days was the only response large enough to be considered significant ($P<.05$).

Carcass data, examined on the same basis, showed a significant increase in fat thickness over the *l. dorsi*, as measured with a fat probe ($P<.05$) and also reflected in a higher calculated USDA yield grade ($P<.05$). None of the other carcass data were significantly affected by the roughage level of the starting ration. The differences in warm carcass weight at slaughter are merely a reflection of the differences in the live weight of the lambs at the start of the experiment. These small differences in initial weight would not be expected to alter the response to treatments or the results of this experiment.

The effects of the water content of the sorghum grain on the drylot performance of lambs during the first 14 days on feed are different in this experiment from those obtained in two previous experiments in which the grain, after reconstitution with water, was placed in airtight storage for greater than 10 days before feeding. The reason is not immediately apparent since reconstitution does not appear to change either the digestibility or palatability of sorghum grain for lambs. However, grain that has been reconstituted for a long enough period to go through an anaerobic fermentation process may be less likely to spoil in the feeder than high moisture grain which has not been fermented. If this is true, then chemical reconstitution using either acetic or propionic acid as preservatives for the high moisture grain might be a practical solution.

The live weight gains and feed efficiency of lambs receiving grain sorghum without added water were considerably better than for those fed the 30-percent water grain for the first 14 days.

A similar, though smaller, response was still apparent upon completion of the 56-day feeding period. Carcass measurements obtained at slaughter did not appear to be influenced by the water content of the sorghum grain.

TABLE 4. EFFECT OF WATER CONTENT OF SORGHUM GRAIN ON DRYLOT PERFORMANCE AND CARCASS CHARACTERISTICS OF LAMBS

Criterion	Water, %		
	13	30	30 to 13[1]
14-day summary			
Lambs, number	24	24	24
Initial live wt, lb.	63.0	63.8	60.5
Live weight gain, lb./day	0.434	0.353	0.279
Feed consumption, lb./day	2.4	2.5	2.3
Lb. feed/lb. gain	5.6	7.1	8.3
56-day summary			
Live wt gain, lb./day	0.459	0.427	0.411
Feed consumption, lb./day	2.6	2.6	2.4
Lb. feed/lb. gain	5.6	6.0	5.8
Carcass data			
Warm carcass wt, lb.	47.2	46.8	44.7
USDA quality grade	11.1	10.9	10.9
Fat thickness, *l. dorsi*, inches	0.20	0.21	0.19
Kidney and pelvic fat, estimated %	3.7	4.0	3.8
USDA yield grade	3.4	3.4	3.3
Fat color score[2]	3.2	2.9	3.2
Fat firmness score[3]	3.7	3.5	3.8

[1]The water content of sorghum grain was reduced from 30 to 13% on the 14th day.
[2]See footnote 1, Table 3.
[3]See footnote 2, Table 3.

Literature Cited

Calhoun, M. C., and Maurice Shelton. 1971a. Comparison of reconstituted and dry rolled sorghum grain in high concentrate rations for lambs. Texas Agr. Exp. Sta. PR-2909.

Calhoun, M. C., and Maurice Shelton. 1971b. Processing sorghum grain for feeder lambs: Comparison of dry rolled, reconstituted, popped and steam-flaked grain. Texas Agr. Exp. Sta. PR-2910.

PR-3183

Influence of Ration Pelleting On Angora Goat Performance

J. R. Stewart and Maurice Shelton

SUMMARY: Pelleted and unpelleted feeds were compared in a ration for Angora mutton kids. The ration utilized was made up of 60 percent roughage. The kids on pelleted feeds gained 32 percent faster and produced 29 percent more grease mohair and 25 percent more clean mohair than those on unpelleted feeds. It is suggested that pelleting of the ration for Angora goats provides a performance response equal to or greater than that obtained with other ruminant species.

TABLE 1. INFLUENCE OF RATION PELLETING ON ANGORA KID PERFORMANCE

Treatment	No. kids	Body wt, lb.		Avg. daily gain, lb.	Fleece wt, lb.		Lock length, inches	Lb. feed per lb.	
		Initial	Final		Grease	Clean		Gain	Clean fiber
Pelleted	11	40.1	74.5	0.304	5.87	4.44	6.1	9.13	112.4
Nonpelleted	10	39.7	65.8	0.231	4.55	3.55	5.7	13.21	154.6

Introduction

Numerous studies have shown an advantage from pelleting of rations fed cattle and sheep, but to date no data have been reported from studies with Angora goats. Because Angora goats are often finicky eaters, declining to consume soiled or leftover feed, pelleting may well provide an even greater response with this species.

Procedure

A feeding trial was conducted with Angora mutton kids for the 113-day period, March 8 to June 29, 1972. They were fed a commercially prepared ration with the following composition:

Ingredient	%
Cottonseed hulls	17.50
Alfalfa hay (ground)	42.50
Barley	10.00
Molasses	6.10
Ground steamed sorghum grain	20.50
Cottonseed meal	1.00
Salt	1.00
Mineral premix	1.30
Aureomycin	0.10
	(10 milligrams per pound)

Two lots of kids were fed — one received the ration in pelleted form (3/8-inch pellets), and the other received the same ration nonpelleted. Data collected included rate of gain, lock length and grease and clean mohair production. All fleece data were converted to a 180-day equivalent.

Results and Discussion

Results of the feeding trial are shown in Table 1.

There were large differences between the performances of the two lots. The kids on the pelleted feed gained 32 percent faster and produced 25 (clean) and 29 (grease) percent more fiber than those on nonpelleted. Similar differences are found in the efficiency of body weight gains and fiber production. Although the number of animals involved is small, these differences are rather marked and appear to be important. In studies with other species, pelleting is a major aid to animal performance in the case of roughage ration but usually does not provide a marked improvement in high energy rations. In the latter case pelleting tends to be important only to eliminate fines, reduce waste and to facilitate self feeding. Some of these factors may be even more important with the Angora goat.

PR-3184

Effect of Diethylstilbestrol (DES), Anthelmintic Treatments And Fringed Tapeworm Infestation On Wether Lambs

M. C. Calhoun, Maurice Shelton and B. W. Berry

SUMMARY: Diethylstilbestrol (DES) increased live weight gains of wether lambs 30.9 percent and decreased feed requirements 22.3 percent. Feed consumption was not affected by DES treatments. A 3-milligram (mg) DES implant was more effective in increasing gains and improving feed efficiency than DES in the feed. Intermittent feeding of DES was as effective as continuous use of DES in the diet (2 milligrams per lamb per day). USDA quality grade and yield grade were not significantly affected by any of the DES treatments employed. However, DES significantly altered the composition of gains as estimated by specific gravity measurements of the carcass — increasing the formation of muscle tissue and protein and decreasing fat deposition. The use of thiabendazole and *l*-tetramisole hydrochloride at recommended levels did not adversely affect live weight gains of lambs with an initial low level of gastrointestinal nematodes. At slaughter, 45.8 percent of the lambs were infested with fringed tapeworms *(Thysanosoma actinioides)*. The average live weight gain of lambs with worms was 0.048 pound per day less than that of lambs in which no worms were observed.

Introduction

Diethylstilbestrol (DES) has been extensively used with both cattle and sheep for more than a decade to stimulate rate of gain and improve feed efficiency (Hafs, Purchas and Pearson, 1971; Ott, 1968). Until recently,[1] DES was approved for use with feeder lambs as either a 3-milligram implant or an addition to the diet to provide 2 milligrams per lamb per day. Studies by Davis and Garrigus (1971) with lambs and by Hankes *et al.* (1972) with steers have demonstrated that intermittent feeding of DES can be as effective in promoting growth as continuous DES supplementation. On the basis of these findings and the possibility that approval for use of DES as a feed additive

[1]The Food and Drug Administration has recently issued regulations prohibiting all use of diethylstilbestrol (DES) in livestock feeding—whether used as a feed additive or as an implant.

in the future will require a withdrawal period, the relative response of feeder lambs to intermittent and continuous DES supplementation was studied. The effect of anthelmintics on lambs with a low level of gastrointestinal nematodes was determined.

Experimental Procedure

Ninety wether lambs were purchased and transported via truck to the Texas A&M University Agricultural Research Center at McGregor. Fifteen lambs selected at random were slaughtered in the Meats Laboratory at Texas A&M University to provide information on the carcass characteristics of the lambs at the beginning of the experiment. The remaining lambs were placed into pens and fed a 60-percent roughage diet (Table 1) for an 18-day preliminary adjustment period during which they were sheared, ear tagged and weighed. Subsequently, 72 of the lambs were assigned at random to pens (12 pens with six lambs per pen) and treatments and switched stepwise over an 8-day period from the 60-percent to the 10-percent roughage diet (Table 1).

The treatments were (1) control; (2) continuous feeding of 2 milligrams of DES[2] per lamb per day for 49 days followed by a 7-day withdrawal period; (3) intermittent DES (21 days DES at 2 milligrams per head per day followed by 7 days without DES in the feed. This cycle was repeated to complete the 56-day feeding period); and (4) 3-milligram DES implant.[3] Each treatment was imposed on three pens of six lambs each (three replicates).

[2]Diethylstilbestrol: Elanco Products Company, Stilbosol-2® containing 2 grams of DES per pound was added at a level calculated to provide 0.66 milligram DES per pound of the complete ration, as fed. This material was provided through the courtesy of Gene Yeager and Nolie Elliston.

TABLE 1. INGREDIENT AND CHEMICAL COMPOSITION OF EXPERIMENTAL DIETS

	Roughage, %	
Ingredient	60	10
Grain sorghum, dry rolled	24.0	73.2
Alfalfa hay, ground, ½-inch screen	30.0	
Cottonseed hulls	30.0	10.0
Cottonseed meal	8.0	6.0
Dehydrated alfalfa meal, 17% C.P.[1]		3.0
Urea, 281% crude protein equivalent		1.0
Calcium carbonate, Carbotex	1.0	1.8
Molasses	6.0	4.0
Plain salt	1.0	
Trace mineralized salt		1.0
Chlortetracycline	To provide 15 mg/lb. of diet	
Vitamin A palmitate	To provide 1,000 IU/lb. of diet	
Chemical composition[2]		
Dry matter, %	87.4	87.6
Crude protein, %	14.5	14.6
Digestible protein, %		*10.8*[3]
Digestible energy, k cal/lb.		*1477*
Ratio: g D.P./Mcal D.E.		*33.1*
Calcium, %	1.22	1.09
Phosphorus, %	.31	.30
Potassium, %	1.73	.82

[1]Crude protein.
[2]All values are reported on an as-fed basis.
[3]Numbers in italics are calculated values.

Fecal samples were obtained from 12 lambs, randomly selected, at the beginning of the experiment and examined for worm eggs to provide an estimate of gastrointestinal nematode load. The average fecal egg count was 150 with a range of 0 to 650, thus indicating a very low level of gastrointestinal nematodes. Three anthelmintic treatments were imposed in a split-plot arrangement on the lambs within each pen to provide information on the effect of anthelmintics on live weight gains of lambs with a low level of gastrointestinal nematodes. The anthelmintic treatments were (1) control, no anthelmintic; (2) thiabendazole,[4] 2 grams (g) per lamb; (3) *l*-tetramisole hydrochloride,[5] 0.27 gram per lamb. Each treatment was administered to two lambs in each pen.

Upon completion of the 56-day feeding period, all lambs were slaughtered in the Meats Laboratory at Texas A&M University to provide detailed carcass information. In addition, since upon examination a number of the lambs slaughtered initially revealed infestation with fringed tapeworm *(Thysanosoma actiniodes)*, an attempt was made to quantitate the number of tapeworms present at time of slaughter.

The statistical analysis of the data followed that for a randomized complete-block design essentially as outlined by Steel and Torrie (1960). The treatment comparisons tested were control versus all DES treatments, DES in the feed versus DES implant and continuous DES versus intermittent DES.

A separate analysis tested the effect of anthelmintic treatments. Within treatment regressions of fringed tapeworm scores, X, on live weight gains, Y, were calculated to ascertain the association between these criteria.

Results and Discussion

The analyses of the chemical composition of the diets used are presented in Table 1.

A summary of initial live weight, pounds; live weight gains, pounds per day; feed consumption, pounds per day; and feed efficiency, pounds feed per pound gain, is presented in Table 2. Initial live weights were not significantly different among treatment groups.

[3]3-milligram DES implant: Pfizer Agricultural Division, Chas. Pfizer & Co., Stimplants®; provided through the courtesy of R. C. Crum, Jr.

[4]Thiabendazole: Merck Chemical Division, Merck and Co., Inc., Rahway, New Jersey; Thibenzole®; 1 ounce of a suspension containing 2 grams per ounce was administered orally.

[5]*l*-tetramisole hydrochloride: American Cyanamid Co., Princeton, New Jersey; Tramisol®; ⅔ ounce of solution containing 0.41 gram per ounce was administered orally.

TABLE 2. EFFECT OF DIETHYLSTILBESTROL (DES) TREATMENTS ON DRYLOT PERFORMANCE OF WETHER LAMBS

Criterion	DES treatments			
	Control	C-DES[1]	I-DES[2]	Implant
Lambs, number	18	18	18	18
Feeding period, days	56	56	56	56
Initial live wt, lb.	72.1	71.4	72.3	70.1
Live wt gain, lb./day	0.307	0.374	0.390	0.441
Feed consumption, lb./day	3.43	3.46	3.41	3.50
Efficiency, lb. feed/lb. gain	11.2	9.3	8.8	7.9

[1]C-DES: 2 mg/lamb/day in the feed for 49 days followed by a 7-day withdrawal period.

[2]I-DES: Intermittent DES, 2 mg/day for 21 days followed by 7 days without DES in the feed. This cycle was repeated to complete the 56-day feeding priod.

Comparison of the control group with the average for all the DES treatments indicated that DES increased live weight gains by 0.095 pound per day or 30.9 percent ($P<.005$) and implanting the lambs with 3 milligrams of DES significantly increased live weight gains over that obtained with DES in the feed ($P<.05$). The difference in live weight gains between the groups fed DES either continuously (C-DES) or intermittently (I-DES) was not significant.

Feed consumption was not significantly affected by the DES treatments. The effect of DES treatments on feed efficiency, pounds feed per pound gain, was similar to that reported for live weight gain. The feed required per pound of gain for all DES treatments averaged 2.5 pounds less than for the control group or a 22.3 percent reduction in feed requirements ($P<.005$). The 3-mg DES implant decreased feed requirements by 1.1 pound or 12.2 percent below the average of the two treatments with DES added to the feed ($P<.05$). The difference between C-DES and I-DES was not significant.

A summary of the slaughter and carcass data of lambs fed the various DES treatments is given in Table 3. There were no significant treatment effects for warm carcass weight, maturity score, USDA quality grade and yield grade. On the average, the DES treatments decreased the dressing percent by 1.0 percent ($P<.05$) when compared with the control. The differences in dressing percent among DES treatments were not significant.

For fat thickness (over *l. dorsi,* inches) and loin eye area, the only treatments significantly different were C-DES and I-DES ($P<.05$ in both cases).

The estimated percent kidney and pelvic fat was decreased 0.6 percent by the DES treatments ($P<.05$). This represents an average change relative to the control of −15.8 percent. The 3-milligram DES implant was more effective in reducing the percent of kidney and pelvic fat than DES in the feed ($P<.10$); the difference between C-DES and I-DES was not significant.

TABLE 3. EFFECT OF DES TREATMENTS ON CARCASS CHARACTERISTICS OF WETHER LAMBS

Criterion	DES treatments			
	Control	C-DES[1]	I-DES[2]	Implant
Warm carcass, wt, lb.	47.2	47.8	49.1	49.1
Dressing %	52.9	51.6	52.3	51.9
Maturity score[3]	1.9	1.8	1.8	1.9
USDA quality grade	10.9	11.2	11.0	11.1
Fat thickness over *l. dorsi*, inches	0.16	0.18	0.15	0.18
Kidney and pelvic fat, estimated %	3.8	3.2	3.4	2.9
USDA yield grade	3.1	3.0	2.9	3.0
Loin eye area, sq inches	1.91	1.88	2.11	1.95
Estimated boneless cuts, %	45.2	45.4	45.6	45.5
Specific gravity	1.0426	1.0480	1.0461	1.0521

[1]See footnote 1, Table 2.

[2]See footnote 2, Table 2.

[3]Official USDA lamb carcass maturity classifications are A = Young lamb; B = Mature lamb; Y = Yearling mutton. In this study each of these classifications was split into thirds and given a numerical equivalent; that is, A− = 1, A = 2, A+ = 3, B− = 4, B = 5 and B+ = 6.

DES treatments significantly increased the estimated percent of boneless retail cuts ($P<.05$) when compared with the control group. However, the differences between the various DES treatments were not significant.

The specific gravity of the chilled carcass was increased by the DES treatments ($P<.025$) with the 3-milligram implant more effective than DES in the feed ($P<.05$). The difference between C-DES and I-DES was not significant.

Specific gravity was used to estimate the fat (Garrett, 1968), muscle (Adams, Carpenter and Spaeth, 1970), protein and energy (Meyer, 1962) content of the carcass to allow comparison of the effects of the various DES treatments on the composition of carcass gains (Table 4).

DES decreased the rate of fat deposition in the carcass and increased the formation of muscle tissue and protein. Because of this alteration in the ratio of fat to protein in the carcass, the total gain in carcass energy tended to be less for the DES treatments than for the control. This situation existed even though the increase in carcass weight was greater for the DES treated lambs. The 3-milligram DES implant was more effective in altering the composition of carcass gains than were the oral DES treatments, which were about equal in effectiveness.

Live weight gains were not significantly affected by anthelmintic treatments.

TABLE 4. EFFECT OF DES TREATMENTS ON COMPOSITION OF CARCASS GAINS OF WETHER LAMBS FED A HIGH CONCENTRATE DIET

Criterion	Initial data	Control	DES treatments C-DES[1]	I-DES[2]	Implant
Lambs, no.	15	18	18	18	18
Warm carcass wt, lb.					
Initial	35.8	34.3	34.0	34.0	33.3
Final		47.2	47.8	49.1	49.1
Gain		12.9	13.8	15.1	15.8
Specific gravity	1.0567	1.0426	1.0480	1.0461	1.0521
Carcass fat[3]					
Percent	23.0	30.5	27.7	28.7	25.5
Gain, lb.		6.51	5.39	6.25	4.84
Carcass muscle[4]					
Percent	59.1	53.4	55.6	54.8	57.2
Gain, lb.		4.93	6.47	6.83	8.42
Carcass protein[5]					
Percent	15.2	13.8	14.3	14.1	14.8
Gain, lb.		1.27	1.66	1.75	2.17
Carcass energy[5]					
Mcal/lb.	1.36	1.64	1.53	1.57	1.45
Gain, Mcal		30.8	27.1	30.9	26.0

[1]See footnote 1, Table 2.
[2]See footnote 2, Table 2.
[3]Garrett, 1968.
[4]Adams *et al.*, 1970.
[5]Meyer, 1962.

TABLE 5. ASSOCIATION BETWEEN FRINGED TAPEWORM (*THYSANOSOMA ACTINIOIDES*) SCORES AND LIVE WEIGHT GAINS OF WETHER LAMBS

DES treatment	Fringed tapeworm score[1] 0	1	2	3	4	b	Sy·x	P
	Live wt gain, lb./day							
Control	.322 (9)[5]	.292 (5)	.217 (3)	(0)	.286 (1)	−.024	.092	N.S.[4]
C-DES[2]	.354 (11)	.316 (3)	.409 (2)	.333 (1)	.429 (1)	+.014	.085	N.S.
I-DES[3]	.382 (10)	.348 (6)	.397 (1)	.286 (1)	(0)	−.025	.068	N.S.
Implant	.467 (9)	.363 (5)	.353 (3)	.393 (1)	(0)	−.046	.088	P<.10
Overall average	.380 (39)	.332 (19)	.325 (9)	.337 (3)	.358 (2)	−.017	.094	N.S.

[1]The number of fringed tapeworms was counted and scored as follows: No worms observed, 0; 1 to 5 worms, 1; 6 to 10, 2; 11 to 15, 3; and greater than 15, 4.
[2]See footnote 1, Table 2.
[3]See footnote 2, Table 2.
[4]N.S., the slope (b) of the regression of fringed tapeworm scores on live weight gains of lambs was not significant.
[5]Number of lambs on which average is based.

A summary of fringed tapeworm scores and live weight gains of lambs is given in Table 5. Only one of the within-treatment regressions of fringed tapeworm scores (X) on live weight gains in pounds per day (Y) approached significance. This was for the implanted lambs where P<.10. However, three of the four regressions had a negative slope, and the average daily gains of all lambs with fringed tapeworms was 0.048 pound less than of lambs in which no worms were observed. Fringed tapeworms were observed in 33 of the 72 lambs, an incidence of 45.8 percent.

Literature Cited

Adams, N. J., Z. L. Carpenter and C. W. Spaeth. 1970. Estimation of lamb carcass composition by use of specific gravity measurements. J. Anim. Sci. 31:1081.

Davis, S. L., and U. S. Garrigus. 1971. Intermittent versus continuous Diethylstilbestrol in lambs: Effects on plasma urea nitrogen and nitrogen retention. J. Anim. Sci. 32:107.

Garrett, W. N. 1968. Experiences in the use of body density as an estimator of body composition of animals. In body composition in animals and man. National Academy of Sciences Publ. 1598. p. 170. Washington, D.C.

Hafs, H. D., R. W. Purchas and A. M. Pearson. 1971. A review: Relationships of some hormones to growth and carcass quality of ruminants. J. Anim. Sci. 33:64.

Hankes, R. N., C. F. Cmarik, F. C. Hinds and U. S. Garrigus. 1972. Intermittent administration of DES to steers. J. Anim. Sci. 35:1128 (Abst.).

Meyer, J. H. 1962. Removing sources of error in lamb feeding experiments. J. Anim. Sci. 21:127.

Ott, E. A. 1968. Use of feed additives for lambs. Proc. Sym. Sheep Nutrition and Feeding. p. 206. Iowa State Univ., Ames, Iowa.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York.

PR-3185

Effect of Feeding Diethylstilbestrol (DES) And Implanting With DES or Zearalanol On Lamb Performance

M. C. Calhoun, Maurice Shelton and B. W. Berry

SUMMARY: Implanting lambs with either 3 milligrams diethylstilbestrol (DES) or 12 milligrams zearalanol increased live weight gains by 23.3 percent and decreased the feed required per pound of gain by 14.6 percent. However, both USDA quality grade and dressing percent were slightly reduced by the use of implants as compared to those of the controls. The response to 3 mg of DES was about equal to that obtained with 12 mg zearalanol. DES in the feed (2 milligrams per lamb per day) was relatively ineffective in improving lamb performance; the use of DES in the feed in combination with either the DES or zearalanol implants did not improve performance over that obtained with the use of either implant by itself.

Introduction

Two hormonal growth stimulants, diethylstilbestrol (DES)[1] and zearalanol, have been used with lambs. DES has been used as a single 3-milligram (mg) implant or in the feed at a level of 2 milligrams per head per day, whereas zearalanol is available only as a 12-milligram implant. Both of these compounds have been demonstrated to increase the rate of live weight gain and decrease the feed required per pound of gain with ewe and wether lambs (Ott, 1968; Jordan and Hanke, 1969; Brown, 1970; Shelton and Calhoun, 1971; Hohenboken and Landers, 1971; Sharp and Dyer, 1971).

Because of a lack of reported research describing the relative response to DES and zearalanol, this experiment was initiated to examine the effect of feeding DES and implanting with DES or zearalanol on live weight gain, feed consumption, feed efficiency and carcass characteristics of ewe and wether lambs.

Experimental Procedure

Ninety black-faced, crossbred feeder lambs of mixed sex (approximately equal numbers of ewe and wether lambs), purchased at auction (San Angelo), were placed on pasture with access to water for a 5-day period. Subsequently, they were ear tagged, weighed and distributed at random throughout a set of 24 pens (4 by 8 feet with raised expanded metal floors) and fed a 60-percent roughage ration (Table 1) for a 7-day standardization period.

Upon completion of the standardization period, the lambs were reweighed after a period of 48 hours without feed and 24 hours without water. This procedure was followed in an attempt to minimize errors associated with variable gut fill (Meyer, 1962). Seventy-two of the lambs were then split into sex groups (ewe and wether) and assigned at random to pens. This provided 12 pens with three ewe lambs each and a similar set of wether lambs.

Experimental treatments were assigned to pens at random. The treatments were a factorial arrangement of sex (ewe or wether lambs), DES in the feed (none or 2 milligrams DES per head per day; that is, 0.666 milligram DES per pound of feed based on an estimated daily feed intake of 3 pounds) and hormone implants (none, 3 milligrams DES and 12 milligrams zearalanol). Thus, the complete experiment consisted of 24 pens (three lambs per pen) in a 3 x 2 x 2 factorial arrangement, replicated two times.

Initially, the lambs were started on the 60-percent roughage ration. They were then changed, in a stepwise manner, over an 8-day period, onto the 10-percent roughage, high-concentrate ration (Table 1).

During the course of the experiment, feed and water were provided *ad libitum*. Feed was weighed out daily, and feed refusals were weighed back at 7-day intervals or sufficiently often so that feed residues would not adversely affect feed consumption.

The feeding period was 56 days. Lambs were weighed off the experiment using the same weighing conditions as were used initially.

Upon completion of the feeding period, two lambs from each pen were selected at random and slaughtered at a commercial meat packing plant. The remaining 24 lambs were slaughtered at the Meats

[1]The Food and Drug Administration has recently issued regulations prohibiting all use of diethylstilbestrol (DES) in livestock feeding—whether used as a feed additive or as an implant.

TABLE 1. PERCENT COMPOSITION OF EXPERIMENTAL RATIONS

Ingredient	60% roughage	10% roughage
	%	%
Sorghum grain[1]	24.0	76.5
Alfalfa hay, ground[2]	30.0	10.0
Cottonseed hulls	30.0	
Cottonseed meal	8.0	4.0
Carbotex ($CaCO_3$)	1.0	1.5
Urea (281% crude protein equivalent)		1.0
Plain salt, NaCl	1.0	0.25
Trace mineral and vitamin mixture[3]		0.75
Molasses	6.0	6.0
Chlortetracycline[4]	+	+

[1]Dry-rolled through a Davis Krimper Kracker® Mill.
[2]Hammermill ground through a ½-inch screen.
[3]Guaranteed to contatin between 62 and 66% NaCl, 10 to 12% calcium and not less than the following percentages of mineral elements: P, 6.0; Zn, 0.32; Mn, 0.256; Fe, 0.16; Ca, 0.032; I, 0.0064 and Co, 0.0064. Vitamin A, 204,800 USP units per pounds and Vitamin D, 40,960 USP units per pound.
[4]Chlortetracycline—American Cyanamid Co. Aureofac 50, 50 g chlortetracycline per pound added at a level to provide 15 mg of chlortetracycline per pound of mixed feed.

Laboratory at Texas A&M University so that an estimate of the relative pelting difficulty could be obtained. Carcass data were collected from the lambs at both locations.

Results and Discussion

Since the interactions among the various factors studied were not significant, the data were pooled to show the average effect of sex (Table 2), implant (Table 3) and DES in the feed (Table 4).

The average daily gain of wether lambs was 0.067 pound greater than for ewes, a difference of +12.4 percent ($P<.05$). Feed consumption and efficiency of gains were not significantly influenced by sex of lamb. On the average ewe lambs were fatter at slaughter than wether lambs as evidenced by the difference in fat thickness over the *l. dorsi* ($P<.05$) and estimated percent of kidney and pelvic fat ($P<.01$). This resulted in a more desirable USDA yield grade for wether lambs, 3.4 versus 4.0 for the ewe lambs ($P<.01$). Fat color scores were not significantly different between ewe and wether lambs, but fat firmness scores were significantly less ($P<.01$) for the wether lambs, indicating a tendency for wethers to have a softer subcutaneous fat. This observation may be related to the fact that wether lambs generally have less fat cover than ewes at comparable carcass weights.

The use of implants significantly ($P<.01$) increased live weight gains compared to those of the nonimplanted control lambs (Table 3). On the average, gains were increased by 0.116 pound per day or an advantage of +23.3 percent in the rate of live weight gain for the implanted lambs. The difference in live weight gains between the lambs implanted with 3 milligrams of DES and 12 milligrams of zearalanol was not significant. Although the implanted lambs consumed slightly more feed per day than the controls, this difference was not significant. Feed efficiency (pounds of feed per pound of gain), however, was significantly improved by the use of implants ($P<.01$) as implanted lambs required 1.0 pound less feed per pound of live weight gain. The difference between DES and zearalanol implanted lambs was not significant.

Dressing percent ($P<.05$) and USDA quality grade ($P<.05$) were significantly decreased by the use of implants as compared to the values obtained for the control lambs. The differences in these criteria between DES and zearalanol implanted lambs, however, were not significant.

TABLE 2. EFFECT OF SEX OF LAMB ON PERFORMANCE AND CARCASS CHARACTERISTICS

Criterion	Sex of lambs	
	Ewe	Wether
Lambs, number	36	36
Initial live wt, lb.	62.2	62.5
Live wt gain, lb.	0.538	0.605
Feed consumption, lb./day	3.5	3.6
Feed conversion, lb. feed/lb. gain	6.4	6.1
Carcass weight, lb.	52.0	53.8
Dressing %	53.0	52.4
USDA quality grade	11.0	11.0
Fat thickness, *l. dorsi*, inches	0.74	0.64
Kidney and pelvic fat, estimated %	3.7	2.6
USDA yield grade	4.0	3.4
Fat color[1]	3.1	3.1
Fat firmness[2]	4.5	3.8

[1]Fat color score: 4 = White, 3 = Creamy white, 2 = Slightly yellow, 1 = Yellow.
[2]Fat firmness score: 6 = Firm and dry, 5 = Moderately firm and moderately dry, 4 = Slightly firm and slightly dry, 3 = Slightly soft and slightly oily, 2 = Moderately soft and moderately oily, 1 = Soft and oily.

TABLE 3. EFFECT OF DES AND ZEARALANOL IMPLANTS ON PERFORMANCE AND CARCASS TRAITS OF LAMBS

Criterion	Implant		
	Control	3 mg DES	12 mg Zearalanol
Lambs, number	24	24	24
Initial live wt, lb.	62.6	62.2	62.6
Live wt gain, lb.	0.496	0.591	0.632
Feed consumption, lb./day	3.4	3.6	3.6
Feed conversion, lb. feed/lb. gain	6.9	6.1	5.7
Carcass wt, lb.	51.6	52.9	54.4
Dressing %	53.8	52.0	52.4
USDA quality grade	11.2	10.7	11.1
Fat thickness, *l. dorsi*, inches	0.28	0.26	0.27
Kidney and pelvic fat, estimated %	3.4	2.9	3.1
USDA yield grade	3.8	3.6	3.7
Fat color[1]	3.2	3.2	3.0
Fat firmness[2]	4.4	4.2	4.0
Pelting difficulty[3]	2.6	2.8	2.6

[1]See footnote 1, Table 2.
[2]See footnote 2, Table 2.
[3]Degree of difficulty in pelting was scored as follows: 1 = Very easy, 2 = Easy, 3 = Normal, 4 = Hard, 5 = Very hard.

TABLE 4. EFFECT OF DES ADDED TO THE DIET ON PERFORMANCE AND CARCASS TRAITS OF LAMBS

Criterion	Control	2 mg DES
Lambs, number	36	36
Initial live wt, lb.	61.9	62.7
Live wt gain, lb.	0.562	0.585
Feed consumption, lb./day	3.5	3.6
Feed conversion, lb. feed/lb. gain	6.4	5.7
Carcass wt, lb.	52.5	53.4
Dressing %	53.1	52.4
USDA quality grade	11.1	10.9
Fat thickness, *l. dorsi*, inches	0.26	0.28
Kidney and pelvic fat, estimated %	3.4	2.9
USDA yield grade	3.7	3.7
Fat color[1]	3.0	3.2
Fat firmness[2]	4.1	4.3

[1]See footnote 1, Table 2.
[2]See footnote 2, Table 2.

Although the reported values for fat thickness, measured over the *l. dorsi,* estimated percent of kidney and pelvic fat, USDA yield grade, and fat color and fat firmness scores are slightly less for the implanted lambs than for the controls, none of the differences were statistically significant. The relative difficulty in pelting the lambs was not increased by the implants at the levels used.

The growth response to 2 milligrams of DES per lamb per day added to the feed was less than that obtained when either 3 milligrams of DES or 12 milligrams of zearalanol was implanted. Also, the use of DES in the feed in combination with either DES or zearalanol implants did not appear to improve performance of the lambs over that obtained with either implant alone.

A summary of the responses obtained from the use of DES in the feed is given in Table 4.

Acknowledgment

Appreciation is expressed to Swift and Company, Brownwood, Texas, for their cooperation in making it possible to obtain carcass information.

Literature Cited

Brown, R. G. 1970. An anabolic agent for ruminants. J. Amer. Vet. Med. Ass. 157:1537.

Hohenboken, W. D., and J. H. Landers. 1971. Effect of stilbestrol and zeranol on lamb gains. J. Anim. Sci. 33:286 (Abst.).

Jordan, R. M., and H. E. Hanke. 1970. The effect of "Ralgro" and DES implants on lamb performance. 43rd Ann. Sheep and Lamb Feeders Day Report S-113. Univ. of Minnesota, Morris.

Meyer, J. H. 1962. Removing sources of error in lamb feeding experiments. J. Anim. Sci. 21:127.

Ott, E. A. 1968. Use of feed additives for lambs. Proc. Sym. Sheep Nutrition and Feeding. p. 206. Iowa State Univ., Ames, Iowa.

Sharp, G. D., and I. A. Dyer. 1971. Effect of zearalanol on the performance and carcass composition of growing-finishing ruminants. J. Anim. Sci. 33:865.

Shelton, Maurice, and M. C. Calhoun. 1971. Influence of hormone treatments on performance and carcass traits of lambs. Texas Agr. Exp. Sta. PR-2917.

PR-3186A

Influence of Type of Birth On Post Weaning Performance Of Rambouillet Rams

J. R. Stewart and Maurice Shelton

SUMMARY: The extent to which twin-born lambs were discriminated against in the ram performance tests conducted at the Sonora Research Station was determined. Type-of-birth data were available on only station-raised lambs between 1951 and 1972. The major effect of type of birth was in initial weight of the lambs going on test. This indicates that in order not to discriminate against twin-born lambs, size should not be the primary determinant in selecting lambs to be tested. Type of birth appeared to be a factor in test performance only in clean wool production; this can largely be corrected for by adjusting clean fleece production for differences in initial body weight. Decreasing the length of the test period adds importance to making this adjustment.

Introduction

Improved lamb production provides the primary opportunity for improving the competitive position of the sheep industry. Fertility, or number of lambs raised, and growth rate are the primary factors contributing to improved lamb production. Thus, these factors should receive emphasis in selection programs. Performance testing of rams as an aid in sheep improvement programs has been conducted at the Sonora Research Station for the past 23 years. The selection-index values based on the performance test data include rate of growth, clean wool production, staple length, face cover and skin folds. Other traits such as soundness and wool quality, are considered in the form of independent culling levels at the time ram selections are made. Lamb meat production is emphasized in the selection program through the inclusion of rate of growth in the index; no means have been developed to permit selection for carcass value independent of the effect of rate of growth. However, the greatest deficiency in the program is the absence of any emphasis on fertility. Effective selection for fertility is difficult under range conditions due to the difficulty of obtaining the necessary records. A major requirement for effective selection is to insure that twins are not discriminated against in sire selection. Discrimination has resulted for many years from visual selection under range conditions. This study was undertaken to determine to what extent type of birth was a factor in the performance of rams on test.

Results

The comparative test performance of single versus twin-born lambs, available only on station-owned rams for the years 1951 through 1972, was analyzed (Table 1). The data generally confirm that type of birth is largely without effect on staple length, face cover and skin folds since these traits are highly heritable and are little affected by environment. Type of birth significantly affected initial weight of rams going on test — this is perhaps the most important observation from this study. Since these rams went on test shortly after weaning at approximately 7 months of age, the initial weight closely approximates weaning weight.

TABLE 1. PERFORMANCE OF SINGLE VERSUS TWIN-BORN LAMBS WHEN FED UNDER POSTWEANING PERFORMANCE TEST CONDITIONS

Year	Initial wt, lb.		Rate of gain, lb.		Clean fleece, lb., 12-month basis		Staple length, inches		Face cover score		Skin folds[2]	
	Twin	Single	Twin	Single	Twin	Single	Twin	Single	Twin	Single	Twin	Single
1972	78.8 (8)[1]	94.3 (18)	.70	.74	8.60	8.87	5.22	5.00	2.0	2.0	1.6	1.5
1971	91.0 (4)	96.1 (18)	.60	.67	8.37	9.68	4.53	4.56	2.0	2.2	1.8	1.8
1970	71.0 (2)	63.8 (21)	.70	.69	8.49	7.95	4.39	4.29	1.0	1.8	1.3	1.7
1969	48.0 (1)	56.3 (24)	.47	.56	5.47	7.80	3.88	4.59	2.8	2.3	2.3	1.7
1968	52.6 (5)	73.8 (17)	.53	.55	6.46	8.56	3.79	4.01	2.4	2.4	2.7	2.8
1967	61.7 (3)	80.2 (20)	.49	.50	8.62	8.37	4.33	4.36	2.8	2.3	2.2	1.9
1966	71.0 (7)	72.6 (5)	.55	.56	8.39	9.43	4.53	4.62	1.6	1.9	1.7	2.3
1965	62.8 (4)	82.0 (19)	.53	.53	7.29	8.44	4.08	3.98	2.3	2.3	1.2	2.0
1964	71.3 (11)	66.9 (16)	.57	.58	8.40	8.48	4.66	4.50	2.1	2.7	2.0	2.3
1963	62.9 (13)	75.2 (21)	.60	.62	7.76	8.45	3.92	3.93	2.5	2.2	1.9	1.9
1962	78.4 (5)	82.9 (18)	.59	.56	9.80	8.91	4.38	4.26	2.0	2.8	32	33
1961	86.9 (7)	90.4 (17)	.53	.51	8.80	8.21	4.19	4.23	2.3	2.3	32	26
1960	77.2 (19)	85.9 (11)	.52	.48	8.58	8.85	4.44	4.39	2.8	2.6	29	37
1959	75.7 (11)	83.8 (20)	.52	.52	7.91	7.51	4.12	4.21	3.3	3.0	37	26
1958	80.8 (4)	83.6 (15)	.64	.64	8.55	9.18	4.09	4.38	2.1	2.1	31	44
1957	80.0 (22)	79.5 (8)	.50	.49	8.22	8.04	3.94	4.03	2.4	2.6	26	25
1956	84.8 (5)	88.9 (13)	.51	.52	9.20	9.07	3.95	3.87	2.0	2.6	40	36
1955	79.6 (11)	84.6 (7)	.50	.50	7.59	7.64	4.38	3.99	2.6	2.3	32	43
1954	64.1 (11)	61.7 (9)	.54	.55	8.60	8.89	3.73	3.81	2.6	2.7	38	41
1953	61.7 (6)	67.2 (22)	.48	.51	7.62	8.03	3.25	3.37	3.1	3.2	70	53
1952	69.5 (8)	71.8 (27)	.40	.45	6.76	7.53	3.04	3.37	3.1	2.9	39	35
1951	76.4 (12)	77.9 (16)	.53	.53	8.33	7.94	3.40	3.09	2.9	2.9	63	59
Avg	72.1 (179)	78.2 (362)	.545	.557	8.08	8.45	4.10	4.13	2.40	2.46	1.87 39	1.99 38

[1]Numbers in parentheses represent the number of animals in each type of birth group.

[2]The method of appraisal of skin folds changed in 1962. Previous to this date a count of the folds was used. After 1962 this trait was scored on a 1–4 basis.

Earlier studies established that type of birth significantly affects weaning weight. The values in Table 1 somewhat understate the effect of type of birth because of the small numbers of lambs involved and because some selection was practiced in putting lambs on test. Also, in some years twin-born lambs were given preferential treatment. The primary conclusion is that if type-of-birth data are not available, to prevent discrimination against twin born lambs, selection at weaning or selection of rams to be tested should not be made primarily on size.

The influence of type of birth on rate of gain and wool production on test is less clear. The data (Table 1) indicate no real difference in rate of gain as related to type of birth; however, single-born lambs produced approximately 0.4 pound more clean wool than twin-born. This difference in production is not statistically significant in this analysis, but statistical interpretation of these data is difficult — large year to year differences make pooling the data for analysis of variance of questionable value, whereas the small numbers make within-year analysis largely meaningless. Under routine conditions twin-born lambs will go on test at lighter weights unless the twins had received favored treatment in the management program or unless the light-weight twin lambs are culled before the test starts.

Thus the pertinent question is how low initial weights affect test performance. The relationship between initial weight and rate of gain has been essentially zero. The heavier lambs tend to make faster initial gains, but compensatory gains at the end of the feeding period tend to equalize performance. This may not be true as the length of the test period is reduced. Initial weight does have a highly significant effect on wool production with larger lambs having an advantage, and this advantage increases as the length of the test period decreases. The length of the test period has decreased from more than 300 days initially to 140 days in 1972. The advantage for the larger sheep is evident (Table 1). In those years in which single-born lambs outweighed the twins by as much as 10 pounds, the single-born lambs had an advantage of 1.05 pounds clean fleece weight, and this difference disappeared as the twin-born lambs approached the weight of the single lambs. These data indicate that fleece weights should be adjusted for initial body weight by appropriate statistical procedures in order to prevent discrimination against twin-born lambs. If this is done, the differences favoring single-born lambs will largely disappear. Adjustment for the average difference in fleece weights between single and twin-born lambs provides an alternative, but it would appear to be less desirable than correcting for initial body weight.

PR-3186B

Influence of Season, Location And Source of Ewe on Estrus And Ovulation Rate of Rambouillet Ewes

Maurice Shelton, C. V. Hulet, J. R. Gallagher and D. A. Price

SUMMARY: The effect of location (Dubois, Idaho, and McGregor, Texas) and source of ewe (Texas versus Northwest) on various reproductive phenomena of Rambouillet sheep was studied for 2 years. Considerable seasonal variation in level of reproductive activity (percent of ewes in estrus and ovulation rate) was observed at both locations. However, this variation was considerably greater in Idaho. The ewes in Idaho had a significantly higher ovulation rate in fall and winter and a lower rate in spring and summer than those in Texas. These data suggest that, if bred at the most optimum period, flocks in the Northwest could be expected to have a higher level of reproduction than those in Texas. However, flocks at the more southerly locations should adapt better to out-of-season or accelerated lambing. These data seem to suggest that the number of hours of darkness is the primary factor controlling estrus and ovulation rate in ewes, but this conclusion is not clearcut, as some observations remain unexplained.

Introduction

Interest in accelerated lambing suggests a need to re-evaluate the influence of season and related variables on the occurrence of estrus, ovulation and lambing rate. Observations suggest that geographic location may be a factor in control of the breeding season in sheep, but this has not been well documented.

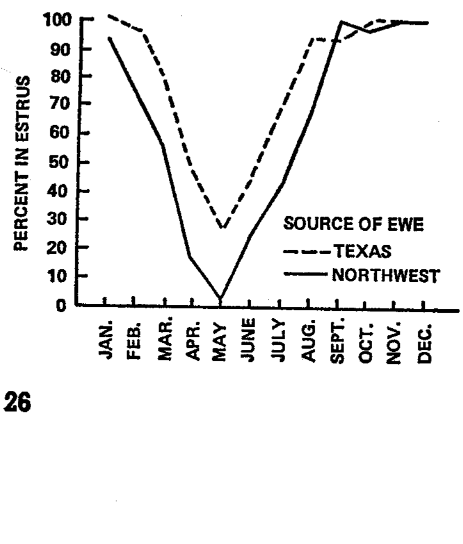
Experimental Procedure

From October 1969 to October 1971 the Texas Agricultural Experiment Station and the U.S. Department of Agriculture, U.S. Sheep Experiment Station, Dubois, Idaho, cooperatively studied the interaction of season, source of ewe and location on various reproductive phenomena in Rambouillet ewes. Approximately 170 head of 5-year-old Rambouillet ewes were purchased in Texas and an equal number in the Northwest (Montana and Wyoming). None of the ewes from either source had a history of out-of-season lambing.

One-half of the ewes from each source were placed at each location. All ewes at both locations were fed for maintenance on alfalfa pellets purchased from the same source. Forty-eight ewes at each location (composed of 24 from each source) were held open. One-third of these were checked for estrus and were laporatomized to record ovulation rate each month. This report is concerned with the occurrence of estrus and ovulation of these open ewes.

Results and Discussion

Ewes of Texas origin appeared to be somewhat less restricted than ewes originating in the Northwest (Figure 1). However, the difference is modest, as ewes of Texas origin showed a greater tendency to go into anestrus than indicated by earlier studies (Shelton and Morrow, 1965). The effect of location on various reproductive phenomena is shown in Figure 2. The ewes located in Texas appeared to be less restricted, but again the difference was modest. It has been observed repeatedly that sheep can be bred earlier in Texas than at more northerly points in the United States. These data suggest that the cause is that the ewes in Texas happened to go into anestrus earlier and



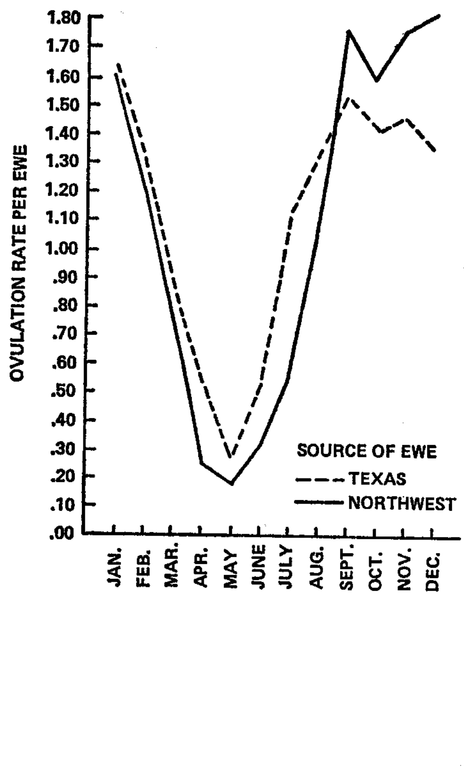


Figure 1. Influence of source of ewe on various reproductive phenomena.

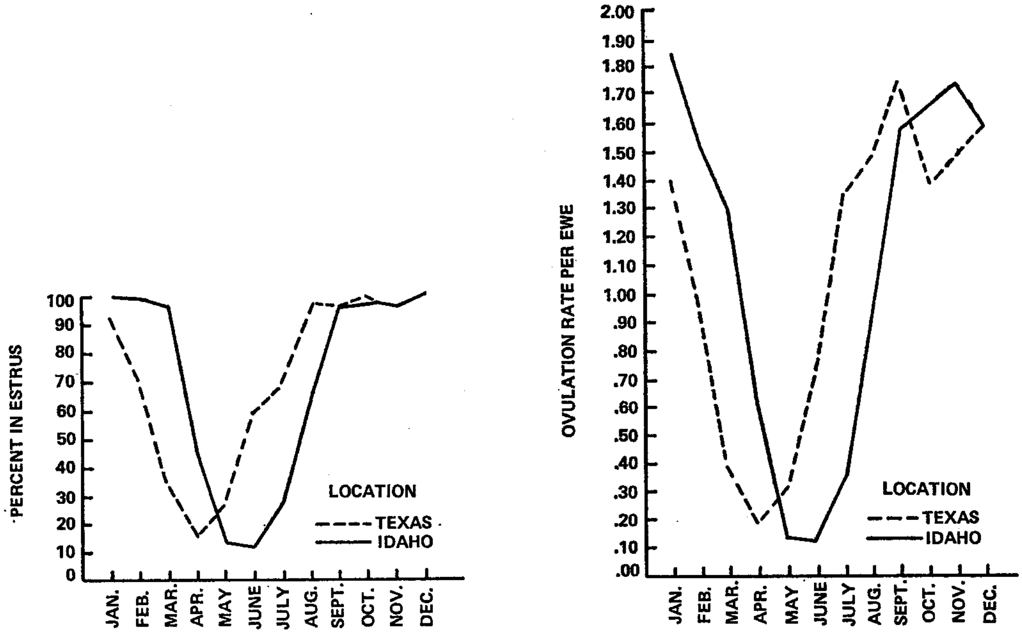


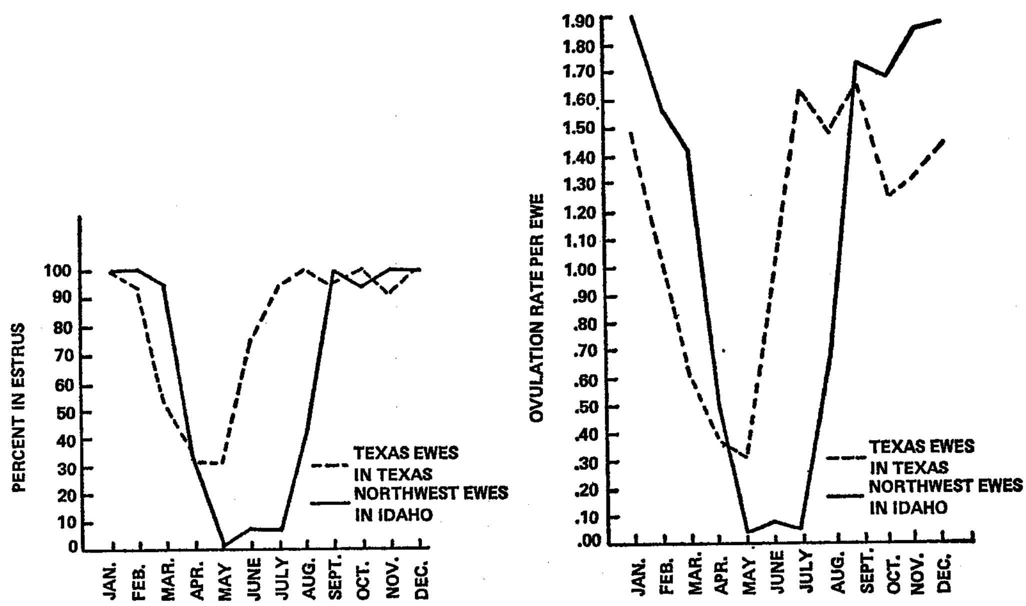
Figure 2. Effect of location on percent ewes showing estrus and ovulation rate.

also to come out earlier. The apparent tendency for ewes in Texas to go into anestrus earlier may be largely an artifact (Figure 3). If not, this observation is difficult to explain. The downturn in ovulation rate tends to start at approximately the same time (January) for both groups, but since the Texas sheep start from a lower rate, this gives the impression of a shift to an earlier anestrul season. The difference between the two groups in the time of a return to cycling approaches 60 days. This would be a substantial factor in the ability to breed for early lambs.

A comparison of Texas ewes in Texas and Northwest ewes in Idaho is presented in Figure 3. Since both source and location significantly influenced the degree of anestrus, the combination of both factors accounts for a marked difference between the two groups in the number of ewes in anestrus in April, May and June.

This study appears to corroborate earlier studies suggesting the length of the photo period as the primary mechanism influencing the breeding season. These data suggest a high relationship between the total hours of darkness and the level of ovulation. The total hours of darkness (sundown to sunup) are plotted for the Texas and Idaho locations in Figure 4. The Idaho location has over 2 hours more darkness per day at the time of the winter equinox, whereas the Texas location has over 2 hours more darkness at the time of the June equinox. The level of reproductive activity (percent showing estrus and ovulation rate)

Figure 3. Influence of source and location on number of ewes showing estrus and on ovulation rate.



in both groups follows a similar pattern, with the ewes in the Northwest having a higher peak in the fall and a lower trough in the spring. These data suggest that total hours of darkness is the primary controlling factor. The mean correlation coefficient of number of hours of darkness with the ovulation rate is 0.878. As might be expected from the greater extremes in day length, this value is somewhat higher at the Idaho location than at Texas.

Location and year	Correlation of number of hours of darkness and ovulation rate
Texas 1969-70	0.829
Texas 1970-71	0.845
Idaho 1969-70	0.928
Idaho 1970-71	0.911

The mean ovulation rates by 6-month periods as related to the total hours of darkness for each location and for combined locations are shown in Figure 5. These data indicate that when the number of hours of darkness favored the Idaho sheep, they had a higher ovulation rate (1.72 compared to 1.50) but the reverse is true when the number of hours of darkness favored the Texas sheep (0.72 compared to 0.51). It might be concluded from these data that number of hours of darkness alone controls the level of reproductive activity. However, the observation that the ovulation rate of the sheep in Texas tends to turn upward in April when the number of hours of darkness is still decreasing distracts from this simple conclusion.

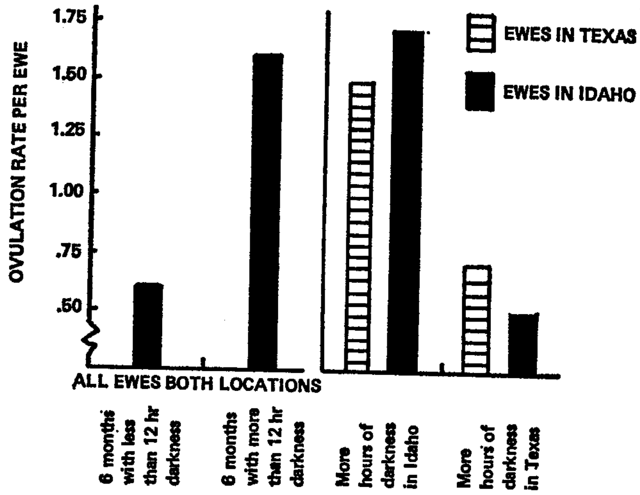


Figure 5. Relationship of hours of darkness and ovulation rate at the two locations.

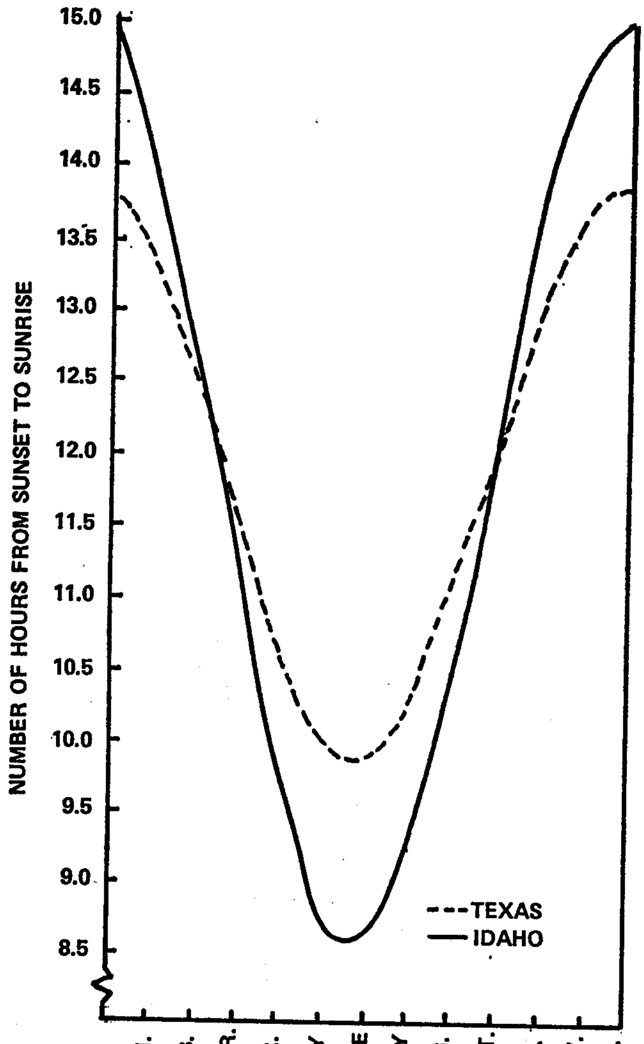


Figure 4. Number of hours of darkness at the two experimental locations.

At both locations the ewes were more restricted in the second year than in the first year. The ewes were 1 year older in the second year, but age alone is generally considered to have the opposite effect. It seems likely that confinement is a causative factor—this has been suggested by other workers. If later studies substantiate this, it can have important consequences for the conduct of confinement sheep operations.

Literature Cited

Shelton, Maurice, and J. T. Morrow. 1965. Effect of season on reproduction of Rambouillet ewes. J. Anim. Sci. 24:795.

PR-3187

Partitioning Losses in Reproductive Efficiency in Angora Goats

Maurice Shelton and J. R. Stewart

SUMMARY: An attempt was made to estimate the loss in reproductive efficiency of Angora goats through failure to ovulate, failure of conception, embryo loss prior to kidding or death loss of kids produced. Some losses occurred at each stage of reproduction, and identification of any single step as the major point of

loss was not possible. However, the data were obtained from five different samples of does, and in various groups of does identification of certain problem areas was possible. By analogy, it may be assumed that for the industry as a whole no single cause may be identified as the major source of trouble but it may be possible to do so for individual flocks. Failure of ovulation is a problem in many flocks which is largely explained by lack of size and development of the does. Assuming that an adequate number of good healthy males are used, failure to conceive should not be a problem, or if it is, this study does not reveal the reason for failure at this point. Abortion storms were not observed, but it is obvious that several does, including some of the larger ones, were losing the embryos prior to kidding. It would appear advisable to identify and remove such does from the flock. High death loss of kids dropped is obviously a problem. Predators and inclement weather appeared to be the major causes. Kidding in confinement would provide some protection from both, but for most ranchers this will not be considered a solution.

Introduction

Poor reproductive efficiency continues to be a problem with Angora goats. A logical first step in the study of this problem is to attempt to identify the stage or phase in the reproductive processes in which failure is occurring. Although excellent techniques are available to accomplish this, the sacrifice of a substantial number of animals usually is required. Previously it has not been possible or appeared desirable to do this. However, in recent years research flocks were reduced or liquidated at both the McGregor and Sonora stations at a time when limited demand existed for surplus breeding stock. Therefore, a portion of the does in these flocks were used in a study attempting to partition the losses in reproduction efficiency.

Methods

Successful reproduction requires the exhibition of estrus or estrual cycling, ovulation, conception, embryo survival, delivery of a live fetus and survival of the kid to weaning. Although the opportunities for failure are numerous, the primary points of failure appear to be lack of ovulation, failure of conception, loss of fetus at or prior to term and death of kid prior to weaning. Through slaughter or laporatomy at the end of the breeding season, it is possible to accurately record the ovulation rate. Approximately 25 days are required for the fetus to be readily observable. Slaughter of does and removal and dissection of the uterus at this time permits determination of the conception rate. Thus, observation of the reproductive tract at these critical times along with a sample of the does being carried to kidding permits an evaluation of losses at each stage in the reproductive process. Data of this nature were collected on five small groups of Angora does from various sources and reproductive histories. In the groups 1, 2 and 3, approximately one-third were killed at the termination of the breeding season (30-day breeding period in September or October) and another third approximately 25 days later. In groups 4 and 5 only a single sample was slaughtered approximately 25 days after the males were removed. This latter procedure permits the collection of the same data with the reservation that ovulation data for does which do not conceive represent a later estrual cycle than that which occurred during the mating phase. This is in error only to the extent that the level of ovarian activity has changed during this time lapse.

Results and Discussion

Results are shown in Table 1. An overall kid crop of 78.6 percent was dropped and 56.4 percent raised. These values should be somewhat below that typical of good Angora flocks since three of the five groups utilized in this study represented problem flocks due to being young (group 2), culls from ranch flocks (group 1) or does with a special abortion history (group 5). Only groups 3 and 4 were the type from which good reproductive performance could be expected, and these were generally above average in size and condition. Unfortunately, kid crops as low as 56 percent are not unusual in the industry, and the does in this study represented many of the extremes in types of does found in range flocks.

These data fail to identify any single phase in the reproductive process in which the major loss is occurring. Some loss is occurring with each phase. However, by considering each group individually, it is possible to identify major causes of loss in certain of the groups involved. By analogy it may be assumed that in the industry as a whole no single factor may be identified as the source of the problem, but in individual flocks it may be possible to do so. As a whole only 10.7 percent of the does failed to cycle within the 30-day breeding season as indicated by ovulation sites on the ovaries. However, in the experimental groups this ranged from a low of 0 to a high of 42.8 percent.

In summary, 23.2 percent of the does failed to conceive or failed to maintain a viable embryo to slaughter. Does with degenerating embryos were classified as having conceived. Since this value of 23.2 percent includes the 10.7 percent which did not cycle, theoretically 12.5 percent which did ovulate failed to conceive. This value is variable among the groups, with a low of 5.9 percent for group 4 with a high level of reproductive activity and a high of 21.4 percent for the group with an abortion history. Although the numbers involved are small, the high value of 21.4 percent suggests that in the group with a history of reproductive difficulties, some losses were occurring shortly after conception. Open does were smaller than pregnant does, but this can largely be

TABLE 1. REPRODUCTIVE PHENOMENA OF FIVE SAMPLE GROUPS OF ANGORA DOES

Criterion	Group 1[1]	Group 2	Group 3	Group 4[2]	Group 5[2]	Summary
Ovulation data						
No. observed	43	7	54	17	28	149
No. ovulating	37	5	52	17	88	133
No. multiple ovulations	2	0	18	9	3	32
Total ovulations	39	5	70	26	25	165
Wt of does not ovulating	53.8 (6)	42.5 (2)	57.5 (2)	(0)	57.7 (6)	52.9
Wt of does with one *corpus luteum*	59.0 (35)	48.6 (5)	69.4 (34)	69.9 (8)	66.7 (19)	62.7
wt of does with two *corpora lutea*	73.5 (2)	(0)	85.7 (18)	82.8 (9)	69.7 (3)	77.9
Conception data						
No. observed	43	8	46	17	28	142
No. pregnant	31	4	41	16	17	109
No. multiple embryos	2	0	11	6	1	20
Total no. embryos	33	4	52	22	18	129
Wt of open does	61.8 (12)	46.8 (4)	72.0 (5)	54.0 (1)	62.6 (11)	59.4
Wt of does with single fetus	64.1 (29)	54.3 (4)	73.8 (3)	72.7 (10)	65.7 (16)	66.1
Wt of does carrying twins	76.0 (2)	(0)	86.9 (11)	87.2 (6)	82.0 (1)	83.0
Kidding data						
No. does	42	9	45	14	30	140
No. kidding	26	3	40	11	15[3]	95
No. kids dropped	27	3	49	14	17	110
No. surviving	26	1	31	12	9	79
Wt of dry does	64.8 (16)	48.0 (5)	77.4 (5)	60.7 (3)		62.7
Wt of does with single kid	62.8 (25)	52.7 (3)	74.6 (31)	77.1 (8)		66.8
Wt of does wtih multiple birth	78.0 (1)	(0)	83.0 (9)	91.3 (3)		84.1
Mean initial body weight	62.3	49.5	75.8	76.7	65.1	65.9
% kid crop dropped	64.3	33.3	108.9	100.0	56.7	78.6
% kid crop weaned	61.9	12.5	68.9[4]	85.7	30.0	56.4
% does not ovulating	14.0	42.8	3.7	0.0	17.9	10.7
Cumulative loss (%) due to failure of ovulation and failure of conception	27.9	50.0	10.9	5.9	39.3	23.2
Cumulative loss (%) due to failure of ovulation, failure of conception and failure of embryo survival	38.1	66.7	11.1	21.4	50.0[3]	32.1
% death loss of kids born	3.7	66.7	36.7[4]	14.3	47.1	28.2

[1]Description of the experimental groups:
1—Aged does purchased in the Sonora area and kidded at the Sonora station.
2—Two-year old does from the Sonora flock and kidded at Sonora station.
3—Mixed aged does from McGregor flock and kidded at McGregor in 1970–71.
4—Mixed aged does from McGregor flock and kidded at San Angelo 1971–72.
5—Aged (senile) does which had a special abortion history. These were kidded at San Angelo 1971–72.

[2]In these two groups ovulation and conception data were taken from the same group of slaughter does and would be in error to the extent that the ovaries of nonpregnant does were observed at a cycle subsequent to the one in which mating occurred.

[3]Three does are known to have aborted in this group.

[4]Predators were a factor in the heavy kid losses in this group.

explained by the fact that the former group contains the nonovulators. When the nonovulators are removed from this group, much of the difference in weight disappears. These data provide no clear insight as to the reason why 12.5 percent of the does which ovulated failed to be pregnant at slaughter.

In this study 32.1 percent of the does failed to kid. This value includes both those which failed to ovulate and those which failed to conceive. If these two factors (as previously estimated) are removed, the residual value of 8.9 percent theoretically represents the level of abortion or embryo loss *in situ*. Since abortion is considered to be one of the major sources of loss in reproductive efficiency in Angora goats, this value is surprisingly low. However, it is known that abortion tends to occur as "abortion storms" or outbreaks of sporadic nature; since none of these occurred among the experimental groups involved, the value of 8.9 percent loss may be low as applied to the industry as a whole.

From all groups, 28.2 percent of the live kids dropped failed to survive to weaning, but in the individual groups this varied from 3.7 to 66.7 percent, Death losses of kids can usually be explained, but not always prevented. Group 2 showed a death loss of 66.7 percent. However, since only three kids were dropped in this group, this value can be disregarded. The heavy death losses in group 3 can be largely explained by predators. The heavy losses in group 5 (47.1 percent) can be explained by aged does, many of which had large teats or damaged udders. These two causes represent important sources of loss in kid goats, but in commercial practice cold stress must be added as another major cause of loss. In these studies losses

TABLE 2. RELATION OF SIZE (BREEDING WEIGHT) OF DOE TO VARIOUS ASPECTS OF REPRODUCTION IN ANGORA GOATS

Body wt (lb.)	Ovulation rate				Conception data		No. embryos		Kidding data[1]		No. kids	
	No.	% does ovulating	For does ovulating	% of all does	No.	% pregnant	Per 100 pregnant does	% all does	No.	% kidding	% of does kidding	% of total
Less 50 lb.	17	41.2	100.0	41.2	9	44.4	100.0	44.4	8	50.0	100.0	50.0
50–60 lb.	54	77.8	100.0	77.8	27	51.9	100.0	51.9	19	68.4	107.7	73.7
60–70 lb.	56	92.9	109.6	101.8	41	82.9	100.0	82.9	28	67.9	100.0	67.9
70–80 lb.	69	95.7	122.7	117.4	53	81.1	120.9	98.1	27	85.2	108.7	92.6
80–90 lb.	35	97.1	147.1	142.9	21	95.2	155.0	147.6	21	81.0	122.7	104.8
90–100 lb.	11	100.0	181.8	181.8	5	100.0	180.0	180.0	6	100.0	166.7	166.7
100+ lb.	4	100.0	200.0	200.0	3	100.0	200.0	200.0				
Σ	246	87.8	122.7	107.7	159	77.4	122.0	94.3	109	75.2	113.4	85.3
Correlation coefficient, size and indicated variable				.581				.578				.410
Regression on weight				.024				.024				.018

[1]Body weights at breeding wre not available on group 5, and thus data in this table are not completely comparable to that of Table 1. Slaughter weight on this group was used in tabulations relating to ovulation and conception, but this value was not available on the does caarried to kidding.

due to cold stress were not a factor as the does kidded in confinement or under close observation.

Previous studies have shown a high relationship between body size and fertility in Angora goats (Menzies, 1968; Shelton, 1961; Shelton, 1965). The relation of breeding weight of the doe to various reproductive phenomenon as observed in this study is shown in Table 2. There is a strong relationship between size and certain aspects of reproduction. The major influence of breeding weight seems to be expressed through its influence on the number of does cycling and the ovulation rate. On the basis of the regression of ovulation rate on body weight (regression coefficient of .024), it can be estimated that a flock of 100 does would have 24 more ovulations for each 10-pound increase in body weight. The similar value for the number of embryos at slaughter is 29; and since this relationship includes the effect of weight on ovulation, it may be concluded that the primary contribution of body weight is through its effect on ovulation rate. The relation of size to the number of kids dropped is lower than for ovulation or conception data. The sample size is small for this latter statistic; but to the extent that it is reliable, these data indicate that it is some of the larger does which are losing the fetus prior to parturition.

Literature Cited

Menzies, J. W. 1968. Effect of Angora doe size on kid and mohair production. Texas Agr. Exp. Sta. PR-2524.

Shelton, Maurice. 1961. Factors affecting kid production of Angora does. Texas Agr. Exp. Sta. MP-496.

Shelton, Maurice. 1965. The relation of size to breeding performance of Angora does. Texas Agr. Exp. Sta. PR-2339.

PR-3188

Mycoplasma Associated With Pneumonia in Sheep

C. W. Livingston, Jr.

SUMMARY: Mycoplasma were isolated from pneumonic lesions in 39 of 40 lamb lungs obtained at slaughter plants in San Angelo. Mycoplasma producing two distinct colonial types were observed. Bacteria including pasteurella, staphylococci and streptococci were isolated frequently from the same lung specimens. Pathogenicity studies using these agents to inoculate lambs are in progress.

Introduction

Pneumonia is an important disease problem of Texas sheep. Epizootics usually occur in feedlot lambs during the summer months. Although the death loss usually is negligible, the morbidity is high, often with as many as 30 percent of the lambs in a group affected. As a result, more feed is required to fatten the lambs, and occasionally a carcass may be condemned. The relationship of mycoplasma to ovine pneumonia is not clear.

In 1955, Grieg reported the isolation of mycoplasma from pneumonic lesions obtained from sheep with respiratory infections. These isolates produced colonies with dense centers on a solid medium. Sugars were not fermented, and the isolates were nonpathogenic.

Boidin, Cordy and Adler (1958) isolated a mycoplasma from a pneumonic lesion. This isolate produced colonies with a dense center and did not ferment carbohydrates. Arthritis was produced in several lambs upon parental inoculation, but the pneumonic lesions were not reproduced.

Hamby, Pounden and Ferguson (1959) isolated mycoplasmas from the respiratory tract of lambs with pneumonia. All isolates were nonpathogenic, and the researchers concluded that these mycoplasma were secondary invaders.

Barber and Fabricant (1962) obtained seven mycoplasmal isolates from pneumonic lesions in sheep. No attempt was made to classify or to determine the pathogenicity of these isolates.

Mycoplasma occurring in sheep and goats in Turkey have been classified by Cottew *et al.* (1968) as Type A, *M. agalactiae;* Type N, nonpathogenic species isolated from the eyes and nose of healthy sheep and goats; and Type C, a pathogenic mycoplasma producing an edematous swelling in sheep and goats but differing from the cellutitis produced by *M. mycoides var capri.*

Kraus and Wandera (1970) cultured 16 mycoplasmal isolates from the respiratory tracts of sheep showing clinical signs of Jaagsikte in Kenya. The isolates were classified into serological groups. Group I contained the fast-growing, nonfermenting organisms. Group II contained the fastidious organisms that partially fermented glucose and other sugars. Group III contained the Laidlaw type of mycoplasma. The pathogenicity of the isolates was not determined.

Barile, Del Giudice and Tulley (1968) isolated a new species *Mycoplasma arginini* from sheep brain and exudates from the knee joint of a goat with arthritis. Leach (1970) reported the isolation of this species from bovine, ovine, chamois species. The pathogenicity of these isolates was not determined. Al-Aubaidi *et al.* (1972) identified *M. arginini* isolated from pneumonic lesions of domestic goats and wild bighorn sheep.

Mycoplasma associated with ovine pink-eye were isolated by Langford (1971); one isolate fermented glucose, reduced tetazolium, but did not hydrolyze urea or arginine. The other isolate did not ferment glucose, hydrolyze urea or reduce tetazolium but did hydrolyze arginine.

In Australia, Cottew (1971) obtained 59 strains of mycoplasma from the respiratory tract of sheep with pneumonia. All isolates were included in two groups, those producing colonies with well-defined nipples — type 1, and those producing colonies without the central nipple — type 2. Type 1 was similar to type N strain isolated in Turkey. Type 2 appears to be unique but morphologically was similar to *M. dispar,* a cattle isolate described by Gourlay and Leach (1970). Barile *et al.* (1972) isolated *M. conjunctivae* sp. nov. from sheep and goats. This mycoplasma was associated with keratoconjunctivitis. Pathogenicity was not determined.

A study was initiated to determine the relationship of mycoplasma to ovine pneumonia.

Materials and Methods

Cultural Methods: During August 1971 and May 1972 an increase in the incidence of pneumonic lesions was observed in lambs being slaughtered at abattoirs in San Angelo, Texas. Forty lung specimens were obtained from selected individuals for cultural purposes. In both instances approximately 35 percent of the lambs slaughtered had gross pneumonic lesions. Lung specimens weighing approximately 1 gram (g) were added to 9 milliliters (ml) of sterile soy trypticase broth (BBL) and homogenized in a large Ten Broeck tissue grinder. The homogenate (0.5 ml) was inoculated into 4.5 ml of media containing inhibitors. Hayflick's medium with added thallium acetate and penicillin, Whittlestone medium (Whittlestone, 1967) with added penicillin and modified Hayflick's medium containing 1 percent urea and penicillin 1,000μ per ml were inoculated routinely. Serial passages were performed by transferring 0.5 ml of culture fluid to 4.5 ml of medium in seven capped tubes. One drop of fluid from the homogenate and each ensuing subpassage was streaked on solid medium without added inhibitors. Liquid cultures were incubated aerobically at 36° C. Cultures streaked on solid medium were incubated under high humidity at 36° C in the presence of flowing 10 percent carbon dioxide.

Biochemical Characteristics: The methods employed were as described by Al-Aubaidi and Fabricant (1971).

Results

Mycoplasma were isolated from 39 of 40 lung specimens cultured. Bacteria including pasteurella, staphylococci and streptococci were isolated from many of the lung specimens.

Two mycoplasmal colony types were observed. One mycoplasma produced colonies without well-defined nipples. The other mycoplasmal type formed colonies with well-defined nipples. The mycoplasmas forming colonies without nipples fermented glucose, mannose, levulose; reduced tetrazolium chloride; did not hydrolyze urea or arginine; and did not form film and spots. The mycoplasma grew in a medium adjusted to pH 9.5 and in medium containing 0.02 percent methylene blue but did not grow in medium adjusted to pH 5.5. Growth was inhibited in medium containing 3 percent sodium chloride.

At least two different species of mycoplasma were included in the group forming colonies with well-defined nipples. One mycoplasmal isolate did not reduce tetrazolium chloride, but did hydrolyze arginine. Growth occurred in medium adjusted to pH 5.5 to pH 9.5 and in medium containing 3 percent sodium chloride. Dr. Barile at the National Institutes of Health identified this isolate as *M. arginini.*[1]

[1]Personal communication.

The other mycoplasma species forming colonies with well-defined nipples fermented glucose, mannose and levulose; did not hydrolyze urea or arginine; and did not grow in medium adjusted to pH 5.5 or to pH 9.5. Methylene blue was reduced. Film and spots were not produced. Growth occurred on medium containing 3 percent sodium chloride.

Discussion

By use of colonial morphology as a means of differentiation, at least two different species of mycoplasma were isolated from the pneumonic lung specimens.

The mycoplasma forming colonies without well-defined nipples morphologically are similar to type 2 mycoplasma isolated by Cottew from sheep in Australia. These mycoplasma were present in very large numbers in nearly all of the lung specimens cultured. Cottew did not determine the pathogenicity of his isolates. The type 2 mycoplasma fermented glucose but did not hydrolyze arginine.

Mycoplasma arginini apparently is distributed over a wide geographic area in the United States. *Mycoplasma arginini* was isolated from lungs collected from each flock involved in this study. Al-Aubaidi *et al.* (1972) isolated *M. arginini* from pneumonic lungs of bighorn sheep and from the arthritic joints of goats. The type 1 mycoplasma isolated by Cottew (1971) hydrolyzed arginine and had similar cultural characteristics. The Texas goat isolate identified as *M. arginini* by Al-Aubaidi was isolated from lung lesions in the lungs of goats and sheep in arthritic joints of goats. The pathogenicity of this species has not been determined.

Literature Cited

Al-Aubaidi, J. M. 1970. Bovine Mycoplasma: Purification, Characterization, Classification and Pathogenicity. PhD Dissertation. Cornell University, Ithaca, New York.

Al-Aubaidi, J. M., and J. Fabricant. 1971. Methods for the purification of mixed cultures of mycoplasma. Cornell Vet. 61:559.

Al-Aubaidi, J. M., W. D. Taylor, G. R. Bubash and A. H. Dardiri. 1972. Identification and characterization of *Mycoplasma arginini* from Bighorn sheep *(Ovis canadensis)* and goats. Am. J. Vet. Res. 33:87.

Barber, T. L., and J. Fabricant. 1962. Primary isolation of mycoplasma organisms (PPLO) from mammalian sources. J. Bact. 83:1268.

Barile, M. F., R. A. Del Giudice, T. R. Carski, C. F. Gibb, and J. A. Morris. 1968. Isolation and characterization of *Mycoplasma arginini.* Spec. Nov. Proc. Soc. Exp. Biol. and Med. 129:491.

Barile, M. F., R. A. Del Giudice and J. G. Tulley. 1972. Isolation and characterization of *Mycoplasma conjunctivae* sp. n. from sheep and goats with keratoconjunctivitis. Infect. Immunity 5:70.

Boidin, H. G., D. R. Cordy and H. E. Adler. 1958. A pleuropneumonia-like organism and a virus in ovine pneumonia in California. Cornell Vet. 48:410.

Cottew, G. S. 1971. Characterization of mycoplasmas isolated from sheep with pneumonia. Aust. Vet. J. 47:591.

Cottew, G. S., W. H. Watson, F. Arisoy, O. E. Erday and L. S. Buckley. 1968. Differentiation of *Mycoplasma agalactiae* from other mycoplasmas of sheep and goats. J. Comp. Path. 78:275.

Gourlay, R. N., and R. H. Leach. 1970. A new mycoplasma species isolated from pneumonic lungs of calves *(Mycoplasma dispar* sp. Nov.). J. Med. Microbiol. 3:111.

Grieg, A. S. 1955. The isolation of pleuropneumonia-like organisms from the respiratory tracts of sheep. Canad. J. Comp. Med. 19:265.

Hamby, A. H., W. D. Pounden and L. G. Ferguson. 1959. Microbial agents associated with pneumonia in slaughtered lambs. Am. J. Vet. Res. 20:87.

Kraus, H., and J. G. Wandera. 1970. Isolation and properties of mycoplasma from the respiratory tract of sheep with Jaagsiekte in Kenya. J. Comp. Path. 80:389.

Langford, E. V. 1971. Mycoplasma and associated bacteria isolated from ovine pink-eye. Canad. J. Comp. Med. 35:18.

Leach, R. H. 1970. The occurrence of *Mycoplasma arginini* in several animal hosts. Vet. Rec. 87:319.

Whittlestone, P. 1967. Mycoplasma in enzootic pneumonia of pigs. Ann. N. Y. Acad. of Sci. 143:271.

PR-3189

Efficiency of Fiber Production Of Various Types of Sheep and Goats

Maurice Shelton, J. E. Huston,
J. R. Gallagher and M. C. Calhoun

SUMMARY: Mature females (sheep and goats) of various breeds were fed in individual stalls to determine the nutritional efficiency of fiber production. Large differences were observed in maintenance requirements and level of fiber production. Disregarding Barbado sheep and Spanish goats, the higher fiber producing types tended to have a higher maintenance requirement. When interpreted in a direct manner, on the order of 1 percent of the energy consumed was stored as energy in the form of clean fiber. However, this value does not represent net efficiency of fiber production as the maintenance requirement is included. No firm conclusions have been reached as to efficiency of fiber production independent of maintenance.

Introduction

A knowledge of the nutritional efficiency of various functions or production processes is important for intelligent decisionmaking in animal breeding. Logically primary emphasis in selection should be placed on those traits which provide the greatest economic return per unit of feed energy consumed. With a dual or multipurpose animal such as the sheep, the question of the nutritional efficiency with which various products are produced is pertinent. In the case of wool this question is extremely difficult to answer because the nutrients utilized for wool production cannot be separated from those expended for maintenance.

An earlier report (Gallagher, 1971) comparing the efficiency of fiber production of Rambouillet sheep and Angora goats showed Angora goats to be markedly more efficient as fiber producers than Rambouillet sheep. However, young as well as mature animals were involved in this study, and they were allowed to gain weight during the period of fiber growth. Feeding young animals, especially Angora goats, for maintenance is unrealistic because the metabolic priority for fiber production is sufficiently high that they will sacrifice weight or condition for fiber production.

Two subsequent studies were conducted in an attempt to further investigate the question of the nutritional efficiency of fiber production.

First Experiment

Animals of each species with different inherent levels of fiber production were utilized. Mature females of three types of sheep (Rambouillet, Southeastern Native and Barbado) and two types of goats (Spanish and Angora) representing high, medium or low levels of fiber production were fed for maintenance on the following ration:

Ingredient	%
Cottonseed hulls	29
Ground alfalfa hay	25
Ground sorghum grain	40
Hydrolized feather meal	4
Trace mineral salt	1
Bone meal	1
Vitamin A—1000 I.U. per lb. feed	

During the study period the animals were housed in individual 4- by 4-foot cages. Initially, four animals were included in each group, and feed intake (feed required for maintenance) and fiber production were measured over two periods of 62 and 69 days each. Two Rambouillet ewes proved to be pregnant, and it was necessary to discard data on these, resulting in only two animals in this group in one period. The results are shown in Table 1. Although the experimental plan called for feeding these animals for maintenance, this was not completely accomplished. The weight gains are modest and are of the same general magnitude for the various groups. Feeding the animals for maintenance was difficult as the energy required to maintain the animals decreased as the feeding period advanced. Thus, changes in amount of feed supplied tended to lag behind body weight changes. An attempt was made to determine the thyroid status of each animal in the study by obtaining T-3 and T-4 values. Also each animal was put through a digestion trial during one of the periods. These data are summarized by groups in Table 2 along with data relating maintenance requirements to body weight and level of clean fiber production.

Second Experiment

The Barbado sheep and Spanish goat were unsatisfactory for the intended use of comparing the maintenance requirement of a low as compared to a high producing strain (Table 2). Thus, a second trial was conducted in which Suffolk ewes were used as a low fiber producing strain, and medium-wool

TABLE 1. COMPARISON OF MAINTENANCE REQUIREMENT AND FIBER PRODUCTION OF VARIOUS TYPES OF SHEEP AND GOATS

Breeding	Initial wt	Body wt gain[1]	Avg daily feed, lb.	Daily fleece production, g		Lb. of feed per lb. fleece	
				Grease	Clean	Grease	Clean
Period 1							
Barbado	63.5	0.2	1.66	2.99	2.39	252.5	316.0
Native	94.3	3.5	1.55	6.46	4.82	108.9	146.0
Rambouillet	88.0	8.3	1.85	11.94	5.61	70.3	149.7
Angora	94.2	−0.6	1.72	10.87	8.67	71.6	89.8
Spanish	69.8	0.5	1.54	1.63	1.45	428.9	482.2
Period 2							
Barbado	59.3	9.0	1.56	1.58	1.16	448.1	610.3
Native	93.0	7.0	1.55	5.66	4.18	124.3	168.3
Rambouillet	96.3	3.7	1.90	9.47	5.10	91.1	169.1
Angora	91.7	7.1	1.82	11.43	9.56	72.3	86.4
Spanish	68.0	8.4	1.47	1.40	1.25	476.7	533.9
Summary							
Barbado	61.4	4.6	1.610	2.285	1.775	350.3	463.2
Native	93.7	5.2	1.550	6.065	4.500	116.6	157.2
Rambouillet	92.2	6.0	1.875	10.705	5.355	80.7	159.4
Angora	93.0	3.2	1.770	11.150	9.115	72.0	88.2
Spanish	68.9	4.5	1.510	1.515	1.350	452.8	508.1

[1]Adjusted for fleece weight.

TABLE 2. INFLUENCE OF BREED AND SPECIES ON RATION DIGESTIBILITY AND THYROID STATUS

Group	Digestibility in %			Maintenance requirements		Lb. TDN per lb. clean fiber	Thyroid status[1]	
	Dry matter	Protein	Energy	Total TDN in lb.	TDN in lb. per lb. body wt		T-3	T-4
Barbado	71.5	61.4	69.8	1.003	.0163	256	19.9	10.49
Native	74.4	65.6	73.0	0.966	.0103	97	26.5	8.38
Rambouillet	70.4	59.0	68.6	1.166	.0126	99	26.1	10.64
Angora	71.2	60.0	69.8	1.102	.0118	54	24.4	7.29
Spanish	71.8	56.0	69.8	0.939	.0136	316	22.1	8.78

[1]The authors wish to thank Dan Hightower, Department of Veterinary Physiology and Pharmacology, College of Veterinary Medicine, Texas A&M University, for providing the T-3 and T-4 values.

crossbred ewes (Dorset, Columbia or Leicester X Rambouillet) were used as an intermediate fiber producer. In some cases the crossbred ewes equalled the Rambouillet in level of clean fiber production, but they did provide a difference in fleece yield and presumably oil content. A total of 14 animals was fed for 110 days on the following ration:

Ingredient	%
Cottonseed hulls	45
Sorghum grain	38
Dehydrated alfalfa	4
Cottonseed meal	12
Salt	1

Cyclophosphamide was used as a defleecing agent in order that the growth period could be controlled. Data from the second trial are shown in Table 3.

Discussion

Barbado sheep and Spanish goat were unsuitable for use as a low fiber producing strain for the purpose intended. When expressed as a function of body size, maintenance requirements for both were higher than for fiber producing types. Both types were extremely nervous and active. The thyroid studies do not suggest that they were hyperthyroid.

In conformity with earlier studies, the Angora goat was markedly more efficient in fiber production than the other types. The difference between Angora goat and Rambouillet sheep is small when applied to grease weight, but the difference is marked when expressed as a function of clean weight. With the two low producing groups removed, only the Rambouillet and Native sheep remained for comparison as originally planned. Rambouillet sheep were substantially more efficient than the Natives in the production of grease wool, but not of clean wool. This finding was somewhat surprising and may well be due in part to chance variation in sampling. However, the Native appears to have a lower maintenance requirement and possibly to have a greater capability to digest ration constituents. When comparing these two types, it should be noted that the higher fiber producer does not have a higher maintenance requirement. When interpreted in a direct manner, on the order of 1 percent of the digestible energy intake is stored as energy in clean fiber; this value was similar for both the Rambouillet and Native.

In the second experiment the maintenance requirement again closely paralleled the level of wool production. Again only on the order of 1 percent of the energy consumed was deposited in the form of wool energy. A direct comparison between the two types was difficult due to differences in size or body weight gains. As an alternative both maintenance requirements and clean fiber production were expressed as a function of body weight. Thus, theoretically any increased maintenance requirement of the higher fiber producing types might be attributed to nutrients expended in fiber production. Although theoretically the maintenance requirement is removed when this procedure is employed, the resulting value is still on the order of 1 percent of the digestible energy that ends up being stored as wool energy. A somewhat similar value was obtained from the first experiment. This value is disappointingly low, and, at this point, it does not seem desirable to accept it as a legitimate estimate of nutritional efficiency of fiber production. Derivation of a more plausible value will be attempted by statistical treatment of individual animal data from this and other experiments.

Literature Cited

Gallagher, J. R. 1971. Relative efficiencies of conversion of feed to fiber of the Angora goat and Rambouillet sheep. Texas Agr. Exp. Sta. PR-2932.

TABLE 3. MAINTENANCE REQUIREMENTS AND FIBER PRODUCTION FROM SECOND EXPERIMENT

Breeding	No. ewes	Mean wt, lb.	Body wt gain, lb.	Avg daily feed intake total, lb.	Lb. TDN per lb. body wt	Daily fleece production, g		Lb. feed per lb. wool		Lb. TDN per lb. clean fiber
						Grease	Clean	Grease	Clean	
Whiteface cross	5	119.4	4.9	2.12	.0113	8.54	4.50	112.8	214.1	135.7
Rambouillet	5	109.4	13.4	2.25	.0131	10.32	4.92	99.2	208.2	131.9
Suffolk	4	164.6	3.8	2.75	.0083	7.30	3.92	134.0	249.5	157.9

PR-3190

Fiber Traits of Primitive And Improved Sheep and Goats

J. R. Gallagher and Maurice Shelton

SUMMARY: Fiber diameters were measured from Rambouillet and Barbado sheep and from Angora and meat-type goats. Means and standard deviations in microns for the four groups were Rambouillet 17.4 ± 4.8, Barbado 49.0 ± 55.1, Angora 35.3 ± 9.4 and meat type goat 32.4 ± 29.3. The percentages of fibers exceeding an arbitrary limit of fiber fineness of 30 microns were Rambouillet 1.9 percent, Barbado 31.6 percent, Angora 70.7 percent and meat-type goat 31.8 percent. These results seem to be related to characteristics of follicle populations.

Introduction

Large areas of rangeland in the Southwest are utilized by Rambouillet sheep and Angora goats for fiber and meat production. Also present are Black-bellied Barbado sheep which are utilized as game animals and for meat production. These are hair-type sheep which do not produce merchantable fiber. A non-Angora goat, often referred to as the Spanish or meat-type goat, is kept for meat production and brush control. Within species these animals are often knowingly or unintentionally crossed, resulting in a decline in the fleece quality of the improved breeds. Some mixing or contamination of fibers can also result from running these animals on the same range or utilizing the same handling facilities.

As part of a study on level of fiber production, fiber diameters of these breeds or types were characterized.

Experimental Procedure

Eight mature female animals—two Barbado and two Rambouillet sheep and two Angora and two Spanish goats—were shorn and held in individual metabolism cages. They were fed daily for maintenance with a 54 percent roughage, 46 percent concentrate ration previously described by Gallagher and Shelton (1972).

Sixty-two days after the first shearing, fleece samples were clipped from the midside of each animal and scoured according to the procedure of Turner *et al.* (1953). One hundred fiber diameter measurements were made from each fleece sample with a projection microscope and the data pooled for each group of animals.

Results and Discussion

Fiber diameter distributions with means and standard deviations for Barbado and Rambouillet sheep and for Angora and Spanish goats are presented in Figure 1. The fiber diameter range in microns was about 10 to 40 in the Rambouillet and 5 to 210 in the Barbado fleece samples. If 30 microns are considered an arbitrary limit of fiber fineness, then 1.9 percent of the Rambouillet and 31.6 percent of the Barbado fibers exceeded this limit. The ranges of fiber diameters of Angora and Spanish goats were 20 to 90 and 8 to 140 microns, respectively, with 70.7

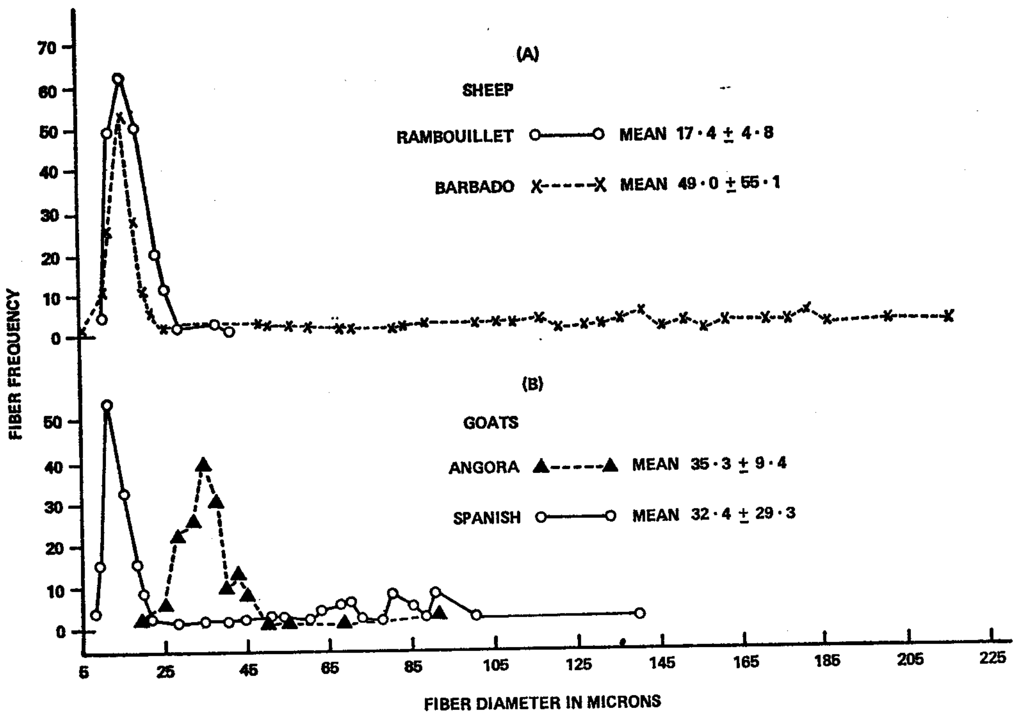


Figure 1. The fiber diameter distribution of Rambouillet and Barbado sheep are shown in (A) and of Angora and Spanish goats in (B).

percent of the Angora fibers and 31.8 percent of the Spanish exceeding 30 microns.

Traditional selection aims in fiber production are for both fineness and uniformity of fleece. Fiber diameter is generally considered the most important characteristic influencing spinning limit, yarn texture and value (McMahon and Whiteley, 1965), while variation in fiber diameter affects yarn regularity (Martindale, 1969).

In comparison with the primitive fleece type of the Barbado which shows an abnormal extension to the coarse fiber range, the Rambouillet fiber distribution demonstrates the fineness and uniformity of the improved fleece type. It is for these qualities that the Rambouillet occupies a unique position in the United States in producing fiber for apparel purposes.

The fiber diameter distribution of the Angora goat indicates uniformity of fiber diameter. However, the Angora goat has fewer fibers finer than 30 microns than the Spanish goat which displays a very fine inner and coarse outer coat. The large mean fiber diameter of 35.3 microns in the mature Angora goat and the high incidence of fibers exceeding 30 microns (70 percent) indicate the problem of fiber coarseness in the Angora fleece. Davis and Bassett (1965) showed that this coarseness increases from the kid to the adult fleece.

Studies of fleece structure by Gallagher (1971) indicated secondary/primary follicle (S/P) ratios of 21.7-22.8/1 in two Australian Merino flocks. The Australian Merino is an improved fleece type which, like the Rambouillet, was developed from the Spanish Merino. By contrast, Ryder and Stephenson (1968) reported S/P ratios of the order 1.8-5.3/1 for a wide range of double-coated sheep breeds. No S/P ratio data are available for the Spanish goat, but it is assumed that the ratio is within the range of 3.0-4.0/1 quoted by Margolena (1959) for U.S. dairy and Toggenburg goats. A later study (Margolena, 1966) reported S/P ratios of 6.7-8.6/1 for the improved fleece type of the Texas Angora goat. Since the majority of coarse fibers are from primary follicles (Gallagher, 1971), it would appear that in double-coated fleece types like the Barbado and Spanish goat, primary follicles have a much greater influence on variability of fleece structure than they do in the more uniform, single-coated Rambouillet sheep and Angora goat.

Although the Barbado sheep and Spanish goat have a definite role in meat production and brush control, the seasonal shedding of their colored and variable fibers should not be allowed to contaminate wool and mohair clips. In addition, within species, crossing needs to be avoided if high standards of wool and mohair are to be maintained.

Acknowledgment

Thanks are due to J. W. Bassett and G. R. Engdahl for facilities and technical assistance.

Literature Cited

Davis, S. P., and J. W. Bassett. 1965. The influence of age on fiber diameter, staple length and yield of mohair. Texas Agr. Exp. Sta. PR-2344.

Gallagher, J. R. 1971. The classification of fibers according to follicle type. J. Agr. Res. 76:373.

Gallagher, J. R., and Maurice Shelton. 1972. Efficiencies of conversion of feed to fiber of Angora goats and Rambouillet sheep. J. Anim. Sci. 34:319.

Margolena, L. A. 1959. Skin and hair follicle development in dairy goats. Virginia J. Sci. 10:33.

Margolena, L. A. 1966. Lock type, follicular characteristics and medullation in Texas and South African Angora does. Virginia J. Sci. 17:32.

McMahon, P. R., and K. J. Whiteley. 1965. The establishment of objective fineness grades for Australian wool. III. Congres International de la Recherche Textile Lainiere, Paris, 661.

Martindale, J. G. 1969. The effect of variability of fiber diameter on worsted processing. J. Text. Inst. 60:81.

Ryder, M. L., and S. K. Stephenson. 1968. Wool Growth, Academic Press, New York.

Turner, H. N., R. H. Hayman, J. H. Riches, N. F. Roberts and L. T. Wilson. 1953. Dep. Div. Anim. Health Prod. C.S.I.R.O. Australia No. 4 (Ser. S.W., 2).

PR-3191

Estimation of Clean Weights For Ram Performance Test Fleeces

J. W. Bassett, G. R. Engdahl,
M. D. Young and J. R. Stewart

SUMMARY: An alternative method for determining clean fleece weights for performance tested rams was considered. The use of a multiple regression equation which included grease fleece weight, staple length measurement and squeeze machine reading was developed from fleece data from 709 rams over a 6-year period. The equation used was

clean fleece weight = 9.245 + 0.9 staple length + 0.248 grease fleece weight − 0.108 squeeze machine reading.

The correlation of predicted clean fleece weight with actual clean fleece weight was 0.882. This generally would be sufficient accuracy for ram test information. Costs and time involved would be greatly reduced by use of the regression equation.

Use of the regression equation in the ram certification program of the American Rambouillet Sheep Breeders Association was also considered. Its use would create a shifting of relative rank and some changes in individual ram certifications.

Introduction

A ram performance test was initiated at the Texas A&M University Agricultural Research Station at

Sonora in 1948. One of the several traits measured over the succeeding years is clean fleece weight. This trait is one of significant economic importance and is high in heritability (Scott, 1970).

During the years of the ram performance test, average clean fleece weight has increased from 6.6 pounds in 1948-49 to 9.8 pounds in 1971-72.

The method used in determining clean fleece weight has been to scour the entire fleece produced while the ram was on test. Scouring was done at the Wool and Mohair Laboratory at Texas A&M University using a four-bowl, 24-inch C. G. Sargent's & Sons commercial scouring train. This process has produced accurate results even though the equipment was not designed for this type of scouring. Because it requires a considerable expenditure for labor and is slow, alternative methods of determining clean fleece weights have been considered.

Price, Ercanbrack and Wilson (1960) reported a method for estimating clean weight of fine wool fleeces using a regression equation combining grease fleece weight, "squeeze machine" reading and staple length. Predictive value was 0.918 using these three traits and increased to 0.919 when body weight, fiber diameter and crimps per inch were added. Sidwell *et al.* (1958) reported a correlation of 0.87 using only the squeeze machine to predict clean fleece weights, but Spurlock, Davis and Bradford (1962) failed to achieve this accuracy.

Data were available from 709 fine wool rams on test from 1967 to 1972 at Sonora. These data were analyzed to determine the potential for an alternative method of determining clean fleece weights which would provide acceptable accuracy at a lower cost and in a shorter time.

Experimental Procedure

Rams entered in the performance test were taken to the research station in September each year, and all were sheared just prior to being weighed onto the test. A standard ration was self fed for a 168-day period from 1966 to 1971, but the time was shortened to 140 days in 1971-72. The rams were weighed off of the test at the completion of the feeding period and shorn. Prior to shearing, staple length was measured on the side of each ram by two different individuals. Face cover score, belly wool score and visual appraisal were assigned by a three-man committee. After shearing, a skin-fold score was assigned.

Each fleece was weighed immediately after shearing and put in an individual sack for sending to the Wool and Mohair Laboratory. A squeeze machine reading was obtained for each fleece prior to scouring. After scouring, each fleece was left in a large barrel for 12 to 24 hours to equalize moisture content. The fleece was then weighed and a sample taken for moisture determination. Clean fleece weights were adjusted to a standard 12 percent moisture. Staple length, grease fleece weight and clean fleece weights were all corrected to a 365-day basis on a straight arithmetic basis.

Correlations were calculated for all combinations of body weight, staple length, fiber diameter, grease fleece weight, clean fleece weight and squeeze reading. A regression equation was derived to predict clean fleece weight.

Results and Discussion

Correlations between body weight, staple length, fiber diameter, grease fleece weight, squeeze reading and clean fleece weight are shown in Table 1. Clean fleece weight was more highly correlated with grease fleece weight than with any other trait, but this was closely followed in magnitude by the negative correlation between clean fleece weight and squeeze reading. Body weight, staple length and fiber diameter followed in order of decreasing magnitude. The squeeze machine reading showed a slightly higher correlation with grease fleece weight than with clean fleece weight.

A multiple regression equation was developed to predict clean fleece weights. Fiber diameter and body weight contributed very little to the predictive value of equations 1 and 2 as indicated in Table 2 and were dropped. The remaining three traits made significant contributions and were combined into the following equation:

$$Y = 9.245 + 0.9\,X_1 + 0.248\,X_2 - 0.108\,X_3$$

where Y = estimated clean fleece weight

X_1 = staple length

X_2 = grease fleece weight

X_3 = squeeze machine reading

Fiber diameter was not a significant predictive factor, probably because these data were from only Rambouillet rams, and little variation existed. It was anticipated that body weight would be of greater importance than shown, particularly in view of the fact that there were differences in age of 5 to 6 months among the rams on test.

The correlation of predicted clean fleece weight with actual clean fleece weight was 0.882, which is lower than the figure of 0.918 reported by Price *et al.* (1960) for fine wool ewe fleeces.

TABLE 1. CORRELATIONS OF BODY AND FLEECE MEASUREMENTS[1]

Trait	Staple length	Fiber diameter	Grease fleece wt	Squeeze reading	Clean fleece wt
Body wt	0.19	0.27	0.67	−.64	0.57
Staple length		−.59	0.33	−.16	0.47
Fiber diameter			0.27	−.45	0.28
Grease fleece wt				−.79	0.83
Squeeze reading					−.77

[1]All correlations reported are significant at P<.01 level.

TABLE 2. REGRESSION COEFFICIENTS FOR PREDICTING CLEAN FLEECE WEIGHTS

Equation	Fiber diameter	Body wt	Grease fleece wt	Squeeze reading	Staple length	R^2
1	0.0082	−.0027	0.259	−.111	0.903	0.7797
2		−.0027	0.258	−.112	0.900	0.7797
3			0.248	−.108	0.900	0.7787

The accuracy of the regression equation is great enough to permit its use for normal performance test procedures. Of more critical concern possibly is in the use of the Sonora ram performance test by the American Rambouillet Sheep Breeders Association for their ram certification program. Only the top 40 percent of the nominated rams based on selection index values are eligible for certification. The index used is as follows:

Index = 60 X daily gain + 4 X staple length + 4 X clean fleece weight − 3 X face cover score − 4 X skin fold score.

Changes in clean fleece weight thus influence selection index values. In addition to selection index values, a minimum of 9.0 pounds of clean wool is required for certification purposes. Selection index values were calculated for all rams in the 1971-72 performance test, and these values were considered along with the 9.0-pound clean wool requirement.

The fall born rams are considered separately from the spring born rams for certification purposes. Within the fall born group relative positions changed when estimated clean fleece weights were substituted for actual weights. One ram would have been displaced by a ram with a higher selection index value. In this instance, both rams involved belonged to the same breeder. The 9.0-pound limitation for clean wool did not figure in any changes within the fall certified group as generally those rams within that group having close to the minimum fleece weight did not score sufficiently high on index values to be considered.

There was a slightly different situation in the spring born group. Again there was some shifting of position within the 21 rams which certified. Two rams which did certify would have been eliminated by the 9.0-pound requirement, and four rams which had originally failed to meet the requirement would have been eligible for certification. These changes

TABLE 3. CHANGES IN RAM CERTIFICATION

Fall rams				Spring rams			
Actual clean fleece wt		Calculated clean fleece wt		Actual clean fleece wt		Calculated clean fleece wt	
Index value	Rank	Index value	Rank	Index value	Rank	Index value	Rank
109.10	1	105.71	2	110.02	1	108.61	3
108.96	2	107.07	1	108.66	2	108.25	4
105.32	3	102.30	5	106.66	3	107.24	5
104.84	4	99.99	8	105.34	4	109.43	1
104.40	5	101.06	7	105.08	5	106.72	6
103.28	6	103.39	3	100.56	6	96.89	13
103.24	7	101.56	6	100.24	7	101.47	8
101.94	8	99.98	9	99.56	8	108.69	2
101.76	9	97.75	13	98.52	9	101.16	9
100.88	10	99.48	10	95.30	10	97.03	12
100.72	11	98.17	12	94.00	11	88.59	[1]
99.98	12	99.14	11	93.74	12	94.96	15
99.08	13	103.33	4	92.88	13	89.25	[2]
97.96	14	94.67	17	92.66	14	97.63	11
97.62	15	95.90	15	92.58	15	91.69	17
97.12	16	94.46	[1]	92.40	16	91.41	19
95.64	17	95.48	16	92.28	17	95.31	14
94.32	[1]	96.84	14	91.76	18	90.89	[2]
				91.60	19	89.39	[1]
				89.84	20	89.53	21
				89.74	21	90.22	20
				100.92	[2]	104.44	7
				95.32	[2]	98.85	10
				87.52	[1,2]	91.67	18
				86.94	[1,2]	93.09	16

[1]Index value not in top 40%.
[2]Clean fleeece weight <9.0 lb.

would have occurred primarily within the 25- to 40-percent range of index values rather than in the top 25 percent. Table 3 shows the changes which would have occurred had calculated clean fleece values been used.

The accuracy of the regression equation is biased in this report in that it was tested on the 1971-72 test fleeces which were a portion of the data used to develop the equation. It will be used on the 1972-73 test fleeces to more fully determine the feasibility of its use to predict clean fleece weight.

Literature Cited

Price, D. A., S. K. Ercanbrack and L. O. Wilson. 1960. An evaluation of the "squeeze machine" and other methods of estimating clean fleece weight. Proc., West. Sect., Am. Soc. Anim. Sci. Vol. 11:XIV-1.

Scott, G. C. 1970. The Sheepman's Production Handbook, p. 19. Sheep Industry Development Program, Inc., Denver, Colorado.

Sidwell, G. M., P. E. Neale and G. L. Jessup, Jr. 1958. A comparison of five methods of estimating clean fleece weight. J. Anim. Sci. 15:593.

Spurlock, G. M., S. P. Davis and G. E. Bradford. 1962. Methods of estimating clean-fleece production. Hilgardia 32:267.