Summary of Reports...  

1971 Sheep and Wool Days

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Cover: Sheepshearing Festival of the Southern Nebraska Wool Growers Association at Beatrice, Nebraska, 1877. Illustration courtesy of The Wool Bureau, Inc., United States branch of The International Wool Secretariat.
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Effects of Sex, Diethylstilbestrol, and Zeranol on Gains of Feeder Lambs on Pasture

W. D. Hohenboken and John H. Landers, Jr.

The growth-promoting effect of diethylstilbestrol in ruminants has long been recognized. Recently, a compound isolated from molded corn by Purdue University scientists was demonstrated to be a growth-promoting agent. The compound, christened zeranol, is not closely related to diethylstilbestrol chemically. It has been cleared by the Food and Drug Administration and is recommended by its manufacturer for use on suckling beef calves, growing beef cattle, feedlot steers and heifers, and feedlot lambs.

In the winter of 1970, two field trials were conducted by Oregon State University to evaluate diethylstilbestrol (DES) and zeranol (Zer) as growth stimulants for lambs on grass. The objectives of the experiment were: (1) to determine the response of feeder lambs on pasture to DES and to Zer, (2) to determine whether ewes and wethers respond differently to either chemical, and (3) to determine the response to both chemicals compared to either or to none.

Procedure

The experimental design for each trial can be visualized best as a cube sliced in half through all three dimensions—height, width, and depth (see Figure 1). This would result in eight smaller cubes—a stack two cubes high, two cubes wide, and two cubes deep. The entire block represents one trial of 200 lambs. Each smaller cube represents 25 individuals. The four upper cubes represent lambs receiving DES while the four lower cubes are lambs not DES implanted. The four cubes to the left receive Zer, the four to the right do not. Finally, the four cubes farther forward are wethers, while the four farther back are ewe lambs.

In Trial 1, 100 wether and 100 ewe feeder lambs were assigned at random to receive a single 3 mg ear implant of DES, a single 12 mg ear implant of Zer, single implants of both DES and Zer, or no implant. Prior to treatment, the lambs had been held in drylot for three days while they were treated with a combination sulfonamide, intestinal roundworm drench, vaccinated for shipping fever, and shorn. Initial weight averaged 82 and 79 pounds for wethers and ewes, respectively. On November 5, 1970, they were turned onto a 60-acre...
rape and common ryegrass pasture with 600 other feeder lambs of approximately the same weight and condition. Following individual weighing 28 days later, the experimental lambs were transferred to a fresh 30-acre rape and common ryegrass pasture. Final weights and grades were recorded 42 days post-treatment.

Trial II was identical in number and design to Trial I. Wethers and ewes averaged 85 and 82 pounds, respectively. Prior to implantation, the lambs had been shorn and treated with a combination sulfonamide, roundworm drench. On November 12, 1970, they were turned onto a 180-acre fawn fescue and perennial ryegrass pasture. Poor climatic conditions for pasture growth necessitated sorting the lambs to three locations after weights were taken 27 days later. One hundred and six lambs remained on the original pasture, while 59 went onto 80 acres of fresh bluegrass and 29 were placed on 40 acres of ungrazed tetraploid ryegrass. Terminal weights and grades were recorded 54 days post-treatment.

Results and discussion

Results of the two trials are summarized in Table 1. In Trial I, gains were poor the first period, averaging only 0.9 found for the entire 28 days.

A severe ice storm preceded weighing by two days. As lambs had no cover during the storm and as they were sorted and trucked two miles to be weighed, shrinkage influenced the initial period gain. Competition among lambs at the stocking rate of 13 per acre may also have been a factor. With the low average and high variability in performance, it could not be established that differences between treatments were real and not merely due to chance.

Average daily gain for the second period was 0.67 pound. This abnormally large gain probably reflects the shrunken condition of lambs at the beginning of the period and subsequent fill. Wethers gained 18% more than ewes while lambs implanted with Zer gained 16% more than lambs not Zer implanted. Though not statistically significant, DES lambs gained 6% more than those not DES implanted.

Total gain for Trial I averaged 10.3 pounds or 0.24-pound average daily gain. Wethers gained 21% more than ewes. Lambs implanted with DES gained 10% more than those not receiving DES. Likewise, gains of Zer implanted lambs were 10% greater than gains of lambs not receiving Zer. The second objective of the experiment was to determine whether sexes responded differently to either chemical. Wethers

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Table 1. Effects of Sex, DES and Zer on Lamb Gains (lbs.)

<table>
<thead>
<tr>
<th></th>
<th>First period</th>
<th>Second period</th>
<th>Total</th>
<th>First period</th>
<th>Second period</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>.9</td>
<td>9.4</td>
<td>10.3</td>
<td>6.2</td>
<td>5.6</td>
<td>11.8</td>
</tr>
<tr>
<td>Wethers</td>
<td>1.1</td>
<td>10.2</td>
<td>11.3</td>
<td>6.9</td>
<td>6.2</td>
<td>13.1</td>
</tr>
<tr>
<td>Ewes</td>
<td>.7</td>
<td>8.6</td>
<td>9.3</td>
<td>5.5</td>
<td>4.9</td>
<td>10.4</td>
</tr>
<tr>
<td>DES</td>
<td>1.1</td>
<td>9.7</td>
<td>10.8</td>
<td>6.8</td>
<td>6.2</td>
<td>13.0</td>
</tr>
<tr>
<td>No DES</td>
<td>.7</td>
<td>9.1</td>
<td>9.8</td>
<td>5.7</td>
<td>4.9</td>
<td>10.6</td>
</tr>
<tr>
<td>Zer</td>
<td>.7</td>
<td>10.1</td>
<td>10.8</td>
<td>6.8</td>
<td>6.1</td>
<td>12.9</td>
</tr>
<tr>
<td>No Zer</td>
<td>1.1</td>
<td>8.7</td>
<td>9.8</td>
<td>5.7</td>
<td>5.0</td>
<td>10.7</td>
</tr>
</tbody>
</table>
and ewes responded similarly to DES but not to Zer. Zer in ewes netted a response of 3.3 pounds, while Zer in wethers resulted in a –1.3-pound response.

In Trial II, first-period average daily gain was 0.23 pound. Wethers gained 25% more than ewes. DES implantation added 20% to gains, as did implantation with Zer.

During the second period, average daily gain was 0.21 pound. Wethers gained 27% more than ewes. DES implanted lambs gained 27% more than lambs not receiving DES implants. Zer added 23% to gains.

Total gain and average daily gain for Trial II equalled 11.8 and 0.21 pounds respectively. Wethers outgained ewes by 22%. Total gain of DES implanted lambs was 23% greater than lambs not implanted with DES, and Zer implanted lambs exceeded those not Zer implanted by 21%. Zer implants in wethers resulted in a 1.1-pound response, while Zer in ewes resulted in a 3.3-pound response. As in Trial I, there was a greater response to Zer in ewes than in wethers. Also as in Trial I, both sexes responded similarly to DES.

The third objective of the study was to determine the response of lambs to a single implant of both chemicals compared to either by itself or to no implant. In both trials, there was a positive response to DES and a similar positive response to Zer, when compared to no implant. Lambs with both implants, however, performed no better than lambs with either DES or Zer.

In both trials, there was no measurable effect of chemical implantation, either DES or Zer, on USDA quality grade at the termination of the test.

**Summary**

Two 200-lamb trials were conducted to determine the effects of sex, diethylstilbestrol (DES), and zeranol (Zer) on gains of feeder lambs on pasture. In Trial I, wethers gained 21% more than ewes. Implantation with either DES or Zer was associated with 10% greater gains than unimplanted lambs. The response to Zer implantation was 3.3 pounds in ewes and –1.3-pound in wethers. In Trial II, wethers gained 27% more than ewes, DES implanted lambs gained 23% more than those without DES. Zer implanted lambs gained 21% more than those without Zer. Response of ewes to Zer was 3.3 pounds, response of wethers, 1.1 pounds. In both trials, there was a greater response to Zer in ewes than in wethers. Also in both trials, the combination of both DES and Zer was no better than either implant by itself.
Freezing and Preservation of Ram Semen—
A Progress Report
H. Ray Burkhart

Artificial insemination could make the sheep business more profitable by allowing better management, reduced operating costs, and increased profits per ewe. Before A. I. is practicable, however, agricultural scientists must accomplish effective semen preservation. This means, essentially, long-term storage in the frozen state and acceptable fertilizing capacity upon thawing.

Several distinct advantages would accrue to the industry from the use of frozen semen. Two of the most important of these are the long-distance shipping of frozen semen (within and between countries) and the greatly extended use of superior sires—possibly years after their death.

In the dairy industry, the use of frozen semen has stimulated the keeping of records to locate sires prepotent for economically important traits. Its use in sheep would encourage sheepmen to extend and increase the keeping of meat and wool production records necessary to locate the truly outstanding rams. Acceptable fertility from frozen ram semen would also increase the potential number of offspring from individual sires, thus making progeny tests more meaningful and precise.

Although there has been much research conducted on the freezing of ram sperm, there has been little success in preserving fertilizing capacity. A Russian worker (Pokatilova, 1960) reported a lambing percentage of 46% from ewes inseminated with frozen semen. Another European (Lopatko, 1962) reported that 91% of 126 ejaculates diluted in a glucose-yolk-citrate-glycerol medium showed no less than 40% motility after storage for three to five months at –196° C. He inseminated approximately 100 ewes in each of three trials with this semen with 44 to 67% of the ewes lambing. Work in the United States and elsewhere has been much less successful.

A study on ram semen preservation was initiated at Oregon State University in September, 1969. Ram lambs were trained to the use of the artificial vagina. Those that showed good sex drive and that produced semen of high motility were selected for frozen semen investigations.

More than 400 collections of semen have been made from these rams to find the best extender, sperm life protector, and techniques of freezing and thawing.

Among the various media tested, an extender consisting of sodium citrate, lactose, egg yolk, glycerol, and a broad-spectrum antibiotic has given the best survival. Using this extender, ram semen has been frozen in ampules in a controlled-rate freezing chamber, in pellets on dry ice, and in glass capillary tubes on dry ice. The freezing in ampules and in pellets on dry ice has given better results than the freezing in glass capillary tubes. The best of these samples have exhibited sufficient motility upon thawing to warrant the testing of fertilizing capacity. A limited number of ewes have been inseminated with semen frozen as long as six months. The breeding results and findings of other studies in progress will be reported elsewhere.

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Hormone-Induced Ovulation in Anestrous Ewes—
A Progress Report

FRED STORMSHAK

Recent research indicates that shortening the time interval between consecutive lambings holds real promise for increasing efficiency of lamb production. Treatment of anestrous (non-cycling) ewes—outside the normal breeding season—with hormones (progestogens and gonadotropin) can cause ovulation; and the ova, if fertilized, will develop into viable lambs. Unfortunately, response of anestrous ewes to hormonal treatment has been quite variable. This variability may be due in part to the nature of the hormonal treatments.

A study to compare the effects of various hormonal treatments on inducing ovulation in the anestrous ewe was conducted in cooperation with Dr. Clarence V. Hulet, U. S. Sheep Experiment Station, Dubois, Idaho, and a local producer, Mr. Don Gnos, Albany, Oregon.

Twenty yearling crossbred Romney ewes were assigned at random to each of four groups. The groups and the treatments the ewes received were: Group 1, controls (no hormone administered); Group 2, implant + 750 International Units (IU) pregnant mare serum (PMS); Group 3, 2 mg estrogen + implant + 750 IU PMS; and Group 4, 2 mg estrogen + implant + two injections of 750 IU PMS. The implant (silicone rubber containing 375 mg of progesterone) was inserted under the skin of the brisket on May 2, 1970. Estrogen (2 mg 17β-estradiol) was injected intramuscularly into ewes of Groups 3 and 4 at the time of implantation. Implants were removed 16 days later and ewes in Groups 2, 3, and 4 were injected intramuscularly with 750 IU PMS. Rams were turned in with all ewes on the day of implant removal (May 18, 1970). Ewes in Group 4 were injected a second time with 750 IU PMS 16 days following the first injection (June 3, 1970). Rams were removed June 10 after remaining with ewes 23 days. Response to treatment was based on the number of ewes lambing and the number of lambs born.

The effect of treatment on number of ewes lambing and number of ewes having multiple births is presented in Table 1. All treatments (Groups 2, 3, 4, vs. Group 1) were effective in inducing ovulation, but some hormonal

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment</th>
<th>No of ewes</th>
<th>Ewes lambing</th>
<th>Live lambs born</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Controls</td>
<td>20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Implant + PMS</td>
<td>20</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>E + Implant + PMS</td>
<td>20</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>E + Implant + PMS + PMS</td>
<td>20</td>
<td>11</td>
<td>55</td>
</tr>
</tbody>
</table>

*Implant = Silicone rubber implant containing 375 mg progesterone.
E = 2 mg 17β-estradiol in corn oil injected intramuscularly.
PMS = 750 IU pregnant mare serum injected intramuscularly.
combinations were more effective than others. Injection of estrogen at the time of progestogen implantation resulted in a slight but nonsignificant improvement in fertility (Group 3 vs. Group 2). The data strongly suggest that the second injection of PMS had a highly beneficial effect on number of ewes lambing and number of ewes having multiple births (Group 4 vs. Group 3).

Role of Hypothalamic Biogenic Amines in Ovulation of the Ewe—A Progress Report

JON WHEATON, SUSAN K. MARTIN and FRED STORMSHAK

Efficiency of sheep production could be increased if it were possible to ensure an increased number of lambs per ewe at lambing as well as to induce multiple lamb crops each year. Attempts to control ovulation by use of hormone treatments have met with varied success. Increasing the number of ovulations in ewes by use of exogenous treatments would be dependent in part on the ability of the treatments to permit release of sufficient ovulatory hormone. Ovulatory hormone is responsible for causing rupture of the ova bearing ovarian follicles. The anterior pituitary gland, located at the base of the brain, releases ovulating hormone in response to an ovulatory hormone releasing factor secreted by neurosecretory cells in another region of the brain called the hypothalamus. The ovulating hormone releasing factor is transported to the anterior pituitary by way of short blood vessels (Figure 1).

Recent experimental evidence suggests that biogenic amines, nitrogen-containing compounds originating in the nervous system, can stimulate or inhibit the secretion of ovulating hormone releasing factor from hypothalamic neurosecretory cells.

Little is known of the nature and quantity of hypothalamic biogenic amines in estrous and anestrous ewes. Experiments were conducted to determine the hypothalamic biogenic amine content of estrous ewes, particularly at the time of ovulation. The levels of three biogenic amines were measured—serotonin, dopamine, and norepinephrine. Of the three hypothalamic bio-
genic amines measured, only the levels of serotonin were found to differ with stage of the estrous cycle studied. It was found that ewes in early estrus contained significantly less hypothalamic serotonin than ewes in the middle of the estrous cycle. Subsequent work will be performed to determine hypothalamic biogenic amine levels in anestrous ewes and whether ovulation can be induced by modifying the hypothalamic biogenic amine content of anestrous ewes to mimic concentrations detected in estrous ewes.

Mineral Requirements of Sheep—
A Review of Research and Recommendations

A. L. Pope

It is not the objective of this presentation to dwell on the voluminous research data that indicate the rather precise requirements, metabolic functions, and classical deficiency symptoms of sheep mineral nutrition. Rather, the objectives are to review only the most recent literature; to fully discuss three mineral problems involving copper and molybdenum, selenium, and the calcium-phosphorus ratio; and to summarize what is most needed to improve the mineral nutrition of sheep. Few references published more than five years ago are used. Every sheep producer would find the mineral section in the Sheepman’s Production Handbook, published by SID, Inc., Denver, very valuable reading for further information.

Although the sheep’s body contains a large number of mineral elements, evidence to date indicates that only 15 can be considered essential. These are sodium, chlorine, iodine, manganese, iron, copper, cobalt, and zinc, contained in trace mineralized salt, and calcium, phosphorus, potassium, magnesium, sulfur, molybdenum, and selenium.

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Detection of mineral deficiencies or excesses

The majority of mineral needs of sheep are met through the consumption of home-grown feed and pasture. Many factors can influence the mineral content of plants beginning with the soil texture, pH, and fertility. Liming can reduce the cobalt, copper, zinc, and particularly, molybdenum and manganese content of plants. Nitrogen fertilization can reduce cobalt, copper, molybdenum, and manganese level in plants, but much of this effect may be due to changing the botanical composition of the pasture.

The species of plants and stage of growth can affect the mineral content. Usually there is more variation in the vegetative parts of plants than in the seeds. However, even if the mineral content of the soil and feeds is known, it provides no information of the availability of these minerals to the animals. Minerals in feeds occur in the complex carbohydrate structure of plants and are not as available as mineral supplements including trace mineralized salt.

How then can one be sure that sheep are receiving the correct amount of minerals? It is not easy, and to be certain would require soil, feed, liver, and blood analyses. Some symptoms of deficiency
are helpful, but many of these are similar. Fortunately, if most minerals are fed in moderate excess there is little harm done.

Salt. There is very little data available on the salt (NaCl) requirements of sheep and none to indicate the precise requirements for Na and Cl. Consumption has often been confused with requirement (Denton, 1969). Salt is normally supplied free choice, and the practice in recent years has been to lower the amount added to the complete diet from 1.0 to 0.5% with no other salt offered. Some drylot tests show that lambs consume about 9 grams or ½-ounce daily.

Salt may be used safely to limit the intake of supplemental feeds if adequate water is available. Such mixtures contain 10 to 50% salt. Salt containing other elements should not be used for this purpose.

Iodine. There are regions such as the Midwestern area of the United States that are iodine deficient. Salt containing iodine should therefore be fed at all times. This is a much more satisfactory method of providing iodine than by dosing or injection.

Manganese. Manganese (Mn) deficiency had not been produced in sheep or goats prior to 1968. Lassiter and Morton (1968), at the Georgia Station, showed that early weaned lambs receiving a purified diet containing less than 1 ppm Mn over a five-month period exhibited bone changes similar to other Mn-deficient animals. Wool Mn levels appeared to be quite sensitive to changes in the Mn status of the lambs. They conclude that the abundant evidence of the need for Mn in skeletal development in various other species probably applies to sheep.

Iron. There is no evidence of normally occurring iron (Fe) deficiency in adult sheep or lambs. However, under the slotted platform method of production, lambs can be raised free of gastrointestinal nematodes (Silverman et al., 1970). These lambs grow very rapidly and can develop moderately severe anemia on a diet of hay, corn, soybean meal fortified with steamed bone meal, limestone, trace minerals, and vitamins. This is believed to be a result of Fe deficiency caused by the rapid growth of the lambs under these favorable environmental conditions requiring a corresponding increase in blood volume, thus, imposing a heavy demand on the blood-forming cells in the ribs and long bones.

Prevention of this anemia can be successful with this system of management by intramuscular injection with 150 mg of elemental Fe and repeated three weeks later or by offering a commercial oral Fe compound free choice in the creep area according to Mansfield et al. (1967).

Zinc. One of the most striking clinical signs of zinc (Zn) deficiency in ram lambs is impaired testicular growth and complete cessation of spermatogenesis (Underwood and Somers, 1969). This dramatic testicular atrophy occurred within 20-24 weeks when a diet containing 2.4 ppm of Zn was fed. When these same males were fed 32.4 ppm of Zn, there was complete recovery as measured by size and sperm production. Since adequate body growth was obtained with a diet level of 17.4 ppm, but optimum testes growth only at 32.4 ppm of Zn, it would appear that the requirement for male reproduction is greater than for growth. These workers (Somers and Underwood, 1969) provide evidence that protein utilization is impaired in Zn deficient sheep.

Cobalt. There are numerous methods of supplying Co to sheep including its
addition to salt which is highly effective in the United States. Much of the research conducted throughout the world the past several years has added credence to the fact that Co ingestion should be very frequent—even daily—because of its use in the synthesis of ruminal vitamin B<sub>12</sub>. Thus methods such as adding it to the soil, the induction of Co pellets or bullets with abrasive steel grinders into the rumen, adding Co to salt, or even daily dosing, have all proved superior to intermittent dosing or feeding (Marston, 1970; Griffiths et al., 1970).

**Calcium and Phosphorus.** McDonald (1968) concludes, following an extensive review of the literature, “that there is no authentic record of a calcium (Ca) deficiency in grazing cattle or sheep. When pasture forage has a low calcium content it is likely to be low in phosphorus and protein and to have a low digestibility; these nutritional defects would overshadow any inadequacy in calcium intake.”

It is of interest that McDonald reaches the same conclusion regarding phosphorus (P) and grazing sheep. He points out that there is a great difference between cattle and sheep in their response to P deficiency. Soils and plants throughout many grazing areas of the world have a low P content, and the response of cattle to P supplementation has been pronounced and has been repeated many times. This is in marked contrast to the response of grazing sheep where there has been no clear demonstration of a primary P deficiency. Likewise, there is no evidence of infertility in grazing sheep induced by P deficiency. McDonald presents several hypotheses to explain this difference in P requirement of grazing sheep and emphasizes the need for research to explain the difference.

The work of Tomas et al. (1967) shows the sheep to be a most efficient animal in the use of P. While the inorganic P content in rumen fluid, serum, and the parotid saliva were related to P intake, the correlation between inorganic P concentration in rumen fluid and parotid saliva was 0.91 (P < .001). The parotid salivary P secreted was 4.5 g/sheep daily which is more than sheep require in feed aside from the lactating ewe. Salivary glands other than the parotid secrete P. This salivary P can buffer rumen P variations due to diet, particularly at lower P intakes.

**Potassium.** There are few data in the literature to indicate the potassium (K) requirement of sheep. Recent research has not confirmed that a high dietary ratio of K to Na, often occurring in grass, depletes the body of Na and Cl. K can substitute for Na in the ruminant parotid saliva. Potash fertilization of pastures on sandy soils low in Na and Mg can lower the level of these elements in herbage (Underwood, 1966).

**Magnesium.** Very little is known about the magnesium (Mg) requirement of sheep. A deficiency is associated with grass tetany of lactating and grazing ewes. It is not as common in the United States as it is in Europe. Blood serum normally contains about 2.5 mg per 100 ml, and rations containing 0.06% or about 1.52 g per day are considered adequate.

McDonald (1968) points out the need for a continuous supply of Mg to ruminants, and Egan in Ireland (1969) found Mg alloy “bullets” weighing 30 g to be very effective in preventing hypomagnesemic tetany in nursing ewes.

**Sulfur.** Wool is high in sulfur (S) and since this element is closely related to wool production, it is of particular interest in the mineral nutrition of
sheep. The metabolism of S and N is closely integrated in ruminants and this relationship is commonly expressed as N to S ratios (N:S). This ratio varies widely in feedstuffs and is dependent on many factors. Much has been learned in recent years regarding ruminal sulfur metabolism, losses that occur, requirements of the microorganisms, and the recycling of both N and S. All this supports a dietary N:S ratio of close to 10:1, narrower than formerly believed (Garrigus, 1970; Moir, 1970).

**Copper and Molybdenum (Cu and Mo).** McDonald (1968) summarizes the present nutritional knowledge of these elements as follows:

"Evidence from both field and laboratory work shows that dietary intakes of copper, molybdenum, and sulphate form a most complex set of interactions with profound effects on the animal, but the mechanisms are still obscure. The main features are as follows: A high molybdenum intake can induce copper deficiency even when the copper content of the pasture is quite high; the effect can be prevented by providing an increased copper intake . . . When pastures provide the animals with low intakes of molybdenum, excess of copper tends to accumulate in the tissues, especially the liver, even when the copper intake is moderate. The liver concentrations may become very high and under certain stress conditions, copper can be mobilized rapidly from the liver, increasing the copper in the blood and thus precipitate a hemolytic crisis with consequent fatal jaundice. The disease can be prevented by increasing the molybdenum intake of the animals. These two contrasting situations make it very difficult to define nutrient requirements of copper and molybdenum and to predict the reaction of animals in any given situation. There are marked differences in the responses shown by cattle and sheep . . . Sheep are very much more susceptible to copper poisoning than cattle; but cattle are very much more severely affected than sheep by high molybdenum intakes. The physiological factors that determine these differences are by no means evident."

While McDonald is confining the above to a pastoral situation, the increased incidence of Cu toxicity in recent years seems to be associated more with drylot feeding in New Zealand (Hogan et al., 1968), Great Britain (Bracewell, 1968), Canada, and the United States.

In Wisconsin, Kowalczyk et al. (1962, 1964) found that increased consumption of trace mineralized salt (TMS) of sheep on pasture or confined sheep with free access to TMS caused Cu poisoning.

Table 1 summarizes some of the treatments used for the prevention and cure of Cu toxicity.

**Selenium.** Kubota et al. (1967) presented a map showing the regional distribution of selenium (Se) concentration in crops in the United States. The two areas where forages were most deficient in Se were the Pacific Northwest and the extreme southeastern United States. The Pacific Northwest area has as its southern boundary a line from Carson River Valley of Nevada northwest across the Sierras and the Sacramento River Valley to the Pacific Ocean near Eureka, California. From the Carson Valley, the eastern boundary extends almost due north to Lakeview, Oregon, and then to the east of the Deschutes River Valley. From Central Oregon northward, the eastern boundary tends to parallel the eastern foothills of the Cascades. More than 80% of the forage samples from this area contained less than 0.05 ppm Se with a mean concentration of 0.03 ppm. A level of 0.1 ppm is considered necessary for maximum production of sheep. Another deficient area includes the region east of the Mississippi and north of the Ohio River.

Se deficiency presents a serious problem in the production of lambs in these
Table 1. Methods of Treating or Preventing Copper Toxicity in Sheep

<table>
<thead>
<tr>
<th>Treatment or Prevention</th>
<th>Time Period</th>
<th>References</th>
</tr>
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<tbody>
<tr>
<td><strong>Drenching:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 mg ammonium molybdate + 1 g Na sulfate in 20 ml water daily per lamb</td>
<td>13 weeks</td>
<td>Ross (1970), ENGLAND</td>
</tr>
<tr>
<td>50 to 500 mg ammonium molybdate + 0.3 to 1 g thiosulphate daily per sheep</td>
<td>3 weeks</td>
<td>Buck (1969), IOWA</td>
</tr>
<tr>
<td><strong>Fertilizing:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molybdenum + superphosphate (4 oz. Mo/A)</td>
<td>187 days</td>
<td>Cole (1966), AUSTRALIA</td>
</tr>
<tr>
<td><strong>In Salt:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>187 lbs salt + 140 lbs finely ground gypsum + 1 lb Na molybdate (dissolved in 2 gal water and sprayed on salt-gypsum mixture)</td>
<td>free choice</td>
<td>Investigation Committee (1956), AUSTRALIA</td>
</tr>
<tr>
<td><strong>Feeding:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1500 ewes:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150 g ammonium molybdate (100 mg/head) + 5 lb Na sulphate (approximately 15 g/head) + 5 gal water and sprayed on hay</td>
<td>3 weeks</td>
<td>Pierson and Aanes (1958), COLORADO</td>
</tr>
<tr>
<td>100 mg ammonium molybdate + 1 g Na sulphate/lb of pellets/lamb/day (9.3 ppm Cu and 1.3 ppm Mo diet fed thereafter)</td>
<td>21 days</td>
<td>Bourassa (1970), CANADA</td>
</tr>
<tr>
<td>38 mg Mo + 5.2 g sulfate ion/day incorporated into pellets = no deaths, very high liver Cu content in controls</td>
<td>15 months</td>
<td>Hogan <em>et al</em> (1968), NEW ZEALAND</td>
</tr>
</tbody>
</table>

**CONCLUSION:** IN TREATING TOXICITY, TREATMENT MUST BE DAILY FOR THREE WEEKS OR LONGER AND BOTH Mo AND SO₄ MUST BE USED.

deficient regions. This is manifest in cases of white muscle disease in lambs two to eight weeks of age and in reduced growth. It has been estimated by Muth (1967) that the discovery of the response of livestock to Se could add $10,000,000 to the income of livestock producers in the Northwest region previously described. A deleterious effect of a deficiency on fertility has not been demonstrated in the United States.

The addition of inorganic Se as sodium selenate to trace mineralized salt offered free choice to ewes has been found effective in the prevention of white muscle disease (WMD) in their lambs as evidenced by gross observations, examination of the muscle, and serum lactic acid dehydrogenase levels (Rotruck *et al*., 1969). Levels of 26 and 132 ppm of Se in the salt supplied, respectively, about 0.15 and 0.90 ppm as added Se to the total diet of the ewes which contained approximately 0.03 ppm while they were in drylot. These levels of supplementation to the ewes provided for maximal protection against occurrence of WMD and also promoted growth of their lambs as compared to an unsupplemented group. Supplementation of Se at these levels on a continuous basis for four years did not result in an abnormal appearance, deaths, or excessive accumulation of Se in the tissues of the ewes or their lambs. Paulson *et al* (1968) found that these levels of supplementation for one year did not result in accumulation of Se.
in excess of Se contents of tissues of lambs receiving no supplemental Se and raised under practical conditions in various parts of the United States. However, supplementation of a higher level of 264 ppm Se in the salt, which supplied approximately 2 ppm Se to the diet of the ewe, did cause a depressed weight gain of the lambs in two of four years of experimentation (Rotruck et al., 1969).

The situation as of this date is that a request has been made to the Food and Drug Administration for permission to add 0.1 ppm Se to complete rations of livestock and chickens. This request was denied last fall, and it will be necessary to provide more data to show that the Se concentration in meat will not be greater as a result of this supplementation than it would be in natural diets high in Se.

The most recent method reported, of providing Se, comes from Australia and is to incorporate Se in a pellet similar to those used for Co and Mg. A single pellet in the rumen has enhanced blood and tissue Se levels for up to 12 months and the components of the pellet are finally divided metallic Fe and elemental Se in proportion of 20:1 (Handreck and Godwin, 1970).

The only method of supplying Se to young lambs and calves in deficient areas at the present time in this country is to use a commercial injectable product. According to the manufacturers, 0.25 mg of Se as sodium selenite and 68 IU of vitamin E as d-alpha tocopherol should be injected intramuscularly at birth. The lambs should be injected again at two weeks of age with a dosage containing 1.0 mg Se and the same amount and form of vitamin E as given at birth. This product containing both Se and vitamin E should be superior to either separately according to the work of Ewan, Baumann, and Pope (1968) using a torula yeast diet. The combination of these two nutrients had an additive effect on reduction of blood levels of enzymes released when muscle is damaged and in increasing survival time. Vitamin E reduced enzyme levels more than did Se. Se increased growth rate in one of two experiments while vitamin E had no effect in either experiment. While natural feedstuffs would contain more vitamin E than torula yeast, it would still seem advisable to inject this above combination.

**Ca:P Ratio in Lamb Nutrition.** Urinary calculi formed when lambs are fed dry diets are of the phosphatic type composed principally of calcium, magnesium, and ammonium phosphates. A number of experiments have been conducted at the South Dakota Agricultural Experiment Station to determine the extent that phosphorus and other causative factors may be involved in phosphatic calculogenesis and to establish methods for calculi prevention (Emrick and Embry, 1963). Table 2 shows that P levels of 0.62 or 0.81%, representing nearly a two or threefold increase above requirement level, can cause a high incidence of urinary calculi. Of many other factors tested, none was found to be, singularly, of comparable significance.

Of the various methods used successfully for urinary calculi prevention under experimental conditions, strict control of P levels and Ca:P ratios appear to be most applicable to practical drylot lamb production. The use of ground limestone to provide a ratio of 2:2.5 parts Ca to 1 part P in high-concentrate lamb rations has proved effective in lowering blood and urinary P levels and has yielded a high degree of protection against urinary calculi.
Table 2. Effect of various calcium and phosphorus levels on the incidence of urinary calculi in lambs

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Urinary calculi incidence</th>
<th>Serum phosphorus mg/100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca %</td>
<td>Phosphorus %</td>
<td></td>
</tr>
<tr>
<td>0.44</td>
<td>0.33</td>
<td>0</td>
</tr>
<tr>
<td>0.71</td>
<td>0.33</td>
<td>0</td>
</tr>
<tr>
<td>0.96</td>
<td>0.33</td>
<td>0</td>
</tr>
<tr>
<td>0.44</td>
<td>0.62</td>
<td>31</td>
</tr>
<tr>
<td>0.71</td>
<td>0.62</td>
<td>7</td>
</tr>
<tr>
<td>0.96</td>
<td>0.62</td>
<td>12</td>
</tr>
<tr>
<td>0.44</td>
<td>0.81</td>
<td>73</td>
</tr>
<tr>
<td>0.71</td>
<td>0.81</td>
<td>33</td>
</tr>
<tr>
<td>0.96</td>
<td>0.81</td>
<td>25</td>
</tr>
</tbody>
</table>

From data reported by Emerick and Embry (1963).

Suggestions and comments

1. Recommendations for field application involving Ca, P, Fe, Cu, Mo, and Se have already been made as each was discussed individually.

2. A complete publication on feed composition as well as a revision of N.R.C. Nutrient Requirements of Sheep should be published in 1971. If a diet of alfalfa hay alone, alfalfa-brome pasture, or half alfalfa hay and half grain is fed, there seems little possibility of a deficiency of Ca, Fe, Mg, K, S, or Cu. There is a possibility of deficiencies of P, Co, Mn, Zn plus I, Se, and Mo. With the possible exception of P, Zn seems most likely to be deficient of the four.

3. Approval is urgently needed to permit the addition of Se to salt or mineral mixtures or complete feeds in the areas of the United States containing less than 0.1 ppm in forage.

4. Approval is even more urgently needed to permit the addition of Mo to salt or mineral mixtures or complete feed whenever Cu is added. The suggested ratio is 1:5 (Mo:Cu). Until this is possible, Cu should be eliminated from the above materials for sheep.

5. The practice of adding Fe to salt or mineral mixtures, with the exception of lambs raised on slotted floors, is not warranted from a nutritional standpoint.

6. Zinc now appears to be incorporated in salt and mineral mixtures and that practice has merit.

Summary

It is most difficult in a review of this nature to summarize and compare nutritive requirements of sheep based on research in many areas of the world and to make the results applicable to a particular region. Sheep raising in much of the United States, for example, is based primarily on lambs per ewe, rapid growth of lambs to heavy weights or, in other words, on meat produced per day of age or ewe units. This is not typical sheep husbandry throughout the world.

With the help of the feed industry, a reasonable job of supplementing minerals to sheep is being accomplished. Some minerals are "over-supplemented," and some that should be added to the diet are not. However, one can-
not leave this subject of minerals for sheep without the feeling that too often minerals carry the blame for inadequacies of energy or management.

References


Cyclophosphamide as a Chemical Defleecing Agent

W. D. Hohenboken

In the World Review of Animal Production, Hank Stoddard of the University of Minnesota records that Bolivian peasants have only recently substituted hand-operated metal shears for tin can lids or bits of broken glass for shearing sheep. In a way, this modest technological advance is symbolic of the “too little, too late” plight of the entire sheep and wool industry. We are among the last of agricultural enterprises to enthusiastically embrace mechanization and intensification for cost-cutting purposes. The industry today needs all the profitable technology it can get and it needs it immediately.

A potentially valuable management technique currently under investigation at Oregon State University and other stations is defleecing with the chemical compound cyclophosphamide. This article reviews the development and method of action of cyclophosphamide (hereafter abbreviated CPA) and will discuss possible advantages and disadvantages of “chemical shearing.” Finally, experimental evaluation of CPA will be reviewed.

Development and mode of action

Cancer is uncontrolled cell division. Thus many experimental cancer drugs are designed to interrupt or halt cellular division. In 1960, medical scientists at the National Cancer Institute reported a surprising side effect of some drugs being tested to stop tumor growth. Several days after drug administration, patients lost their hair! One of these drugs was cyclophosphamide. Cell division in the hair follicle had been interrupted. This caused a weak point which led to hair loss as that point reached the skin surface. In 1968, other National Cancer Institute scientists induced wool loss in two Suffolk sheep and hair loss in dogs and Angora rabbits from the intravenous injection of CPA.

CPA acts in sheep by temporarily halting division of pre-wool cells in the
wool follicle. Within 24 hours, wool growth resumes but there is a constriction in the fiber where growth was interrupted. New growth pushes the construction to the skin surface. The fiber can then be easily pulled off—or will “break” by itself in time. The cause and effect is the same as natural fleece breaks resulting from severe illness or parasitism. Unlike natural breaks, however, the timing is directed by man and (ideally) the fleece is removed manually before it is strung across fence rows, hay bunks, and berry vines.

**Advantages and disadvantages**

Conventional shearing is costly. It demands highly skilled workers and expensive equipment. The greatest potential benefit of chemical shearing is the possibility of making shearing an unskilled job which could be accomplished with cheaper labor. Additional benefits could accrue from slightly higher-quality fleeces. Chemical shearing eliminates second cuts and reduces the proportion of short fibers which must be removed from the “top” or longer fibers in the manufacturing operation. Skirting, or separating lower quality head, belly, and britch wool from the rest of the fleece, could be accomplished more easily with chemical defleecing. Finally, body cuts and bruises from mechanical clippers could be prevented.

Like most innovative techniques, there are potential disadvantages as well. Part of the saving in labor cost would be offset by the cost of treatment. CPA is not yet commercially available pending Food and Drug Administration approval. It’s probable cost is not known. There are major problems in determining optimum dose rates. A high dose will allow defleecing in 7 to 10 days without premature wool loss. At this stage, however, the sheep is completely naked and poorly equipped to withstand sun, rain, or cold. Lower doses allow fleece removal after regrowth has cleared the skin surface. Under these conditions, however, premature wool loss could be a problem. There is variation from sheep to sheep in the time from dosing until wool can be easily removed. Thus a flock dosed at the same rate may require handling several times. Finally, there is variation in ease of wool removal between different parts of the body. Head, belly, and britch wool are the last to be ready to pull. This could also involve additional handling.

**Experimental evaluation**

USDA scientists at Beltsville, Maryland, began experiments with CPA in June, 1968. In 1969, they reported results of an experiment utilizing 14 wether and 14 ewe crossbreds each with 15 months of wool growth. Dose rates (from 2 mg to 41 mg per pound of body weight) and methods of administration (oral drench vs. intravenous injection) were tested. No differences were associated with method of administration. The highest dose was toxic and fatal. A dose of 27 mg per pound caused the sheep to go off feed from one to two weeks but was not fatal. Doses from 5 mg to 14 mg per pound produced the desired result—a constriction in the wool fiber that allowed easy hand removal of the fleece 7 to 10 days after treatment. The USDA scientists reported that sheep defleeced at seven days were completely bare and were poorly equipped to face environmental stress, either cold or sunshine. (Based on preliminary results at OSU, we certainly can’t argue with that conclusion.) They noted that manipulation of dose rates might allow defleecing without wool loss some three weeks after treat-
ment. By that time, there would be a short protective regrowth.

Based on these results, chemical shearing looked promising enough to warrant further investigation. USDA workers reported additional studies during 1970. In the first study, four ewes treated in the latter third of pregnancy lambed without complication. Lambs were of normal size and vigor at birth. Likewise both prenatal and postnatal wool development of the lambs were normal.

In an experiment to determine when natural wool loss without defleecing would occur, 17 crossbred wethers were treated with 12 mg of CPA per pound of body weight and run in an open shed and exercise lot. Wool loss began within two weeks and was extensive by 17 days. Beginning on day seven, sheep were sampled periodically for ease of wool removal at side, shoulder, thigh, head, and belly sites. Wool from the shoulder, side, and thigh could be removed easily before wool on the head and belly.

In another trial 20 crossbred wethers were given 11 mg of CPA per pound body weight and defleeced eight days later. No undesirable side effects were noted. There was some variability in ease of wool removal: 3 fleeces were removed very easily, 14 easily, and 3 with some difficulty. There was no wool loss prior to defleecing. At the same time, 20 control wethers were shorn conventionally. Fleeces from these 40 wethers were evaluated for wool quality. Stable length was longer on CPA fleeces, since wool was removed at the skin surface. Fiber diameter of treated vs. controls was not different. The percentage of noils (short fibers) from treated fleeces was 12.8% while from controls it was 15%. CPA fleeces lacked the second cuts found in conventionally shorn fleeces. One year later, all 40 wethers were re-evaluated. There were no differences in treated vs. controls for weight gain, stable length, or fineness grade.

Work currently in progress at Oregon State University is designed to determine dosing conditions which will provide ideal constriction of the wool fiber and to identify additional operational problems and side effects which might be encountered. Our trials are being conducted on 130 sheep. Six ewe lambs were treated in early March as a pilot study. On March 26, 18 lactating ewes were treated with a low dose (6.8 mg/lb) designed to allow defleecing after 30 days. Twenty-one mature, dry ewes and 85 ewe lambs were divided at random into two groups. Half were treated on March 26 with an intermediate dose (9 mg/lb) and half were treated on April 2 with a high dose (11.4 mg/lb). As the Sheep Day bulletin goes to press, results of these trials are not in. Hopefully, we will be able to contribute information leading to early commercial availability of a cheap, effective, practical, and money-saving management technique — chemical defleecing.
Strategic Management of Sheep

D. T. Torell

Introduction

The word “strategy” is defined as “a plan of action based on the science, art, and management of combining and employing forces into the most advantageous position prior to actual engagement with the enemy.” This usually applies to warfare. And who is to say that the sheepman of today is not engaged in war against the many forces that are reducing his standard of living as costs rise and his income either decreases or remains the same.

To be effective in strategy, one must be well-informed and then sit down with pencil and paper and list the various alternatives. With the various plans before him, he can then determine costs and calculate returns.

The remainder of this paper will describe various practices, some fairly recent, which should be considered when the various alternatives are determined.

Wool

The sheepman has up to the present time produced two principal products from his sheep, meat and wool. As long as there is an incentive payment, wool continues to be of value as a crop but, if this program should be discontinued, the value of wool would drop to a very small portion of the total income. This possibility indicates to me that we cannot afford to select for the wool. Helen Newton Turner (1969) of Australia states, “In our Merino flocks, without selection for reproduction rate, the genetic correlation between wool weight and number of lambs born or weaned over the first three lambings is negligible. Further selection for wool weight has caused no serious fall so far in number of lambs weaned, while selection for twinning rate has produced no appreciable change in wool weight.”

This would indicate that if our principal thrust were for increased lamb production, the amount of wool produced would not change appreciably.

Increased lamb production

To increase lamb production many alternatives must be considered. One of the first steps is to eliminate breeds which are not suited to our particular climate and feed conditions. When these are eliminated from our list, we must consider the advantages and disadvantages of each remaining available breed.

Items to consider for each breed might be: number of lambs born to ewes lambing, length of anestrous (non-breeding) period, and size of lamb at weaning. Even though a particular breed may have an average of perhaps 120 to 140 lambs per 100 ewes, this does not mean that the number cannot be increased by selection. Dr. Eric Bradford has shown in our flock at Hopland that by selecting for multiple ovulation we can increase by approximately 2% per year. And in like manner he has shown that the 120-day weights can be increased by 1.5 pounds per year. This is with a Corriedale-Columbia-Targhee-Merino flock of ewes. Ram lambs are used to achieve one generation per year on the male side. This experiment is being con-
continued to see if a plateau will be reached.

If lambing before January 1 is planned, the anestrous period is very important. Some breeds such as Rambouillet and Dorset Horn have very short anestrous periods, whereas the mutton breeds such as Suffolk, Hampshire, and Shropshire have long anestrous periods. Very little selection has been practiced for this trait and, as a consequence, in California where replacement ewes are imported from most of the western states, there are a few ewes that will not lamb until the last of February even though they were bred to start lambing in October.

Figure 1 shows the ovarian activity of slaughtered Merino ewes during a 12-month period (Dun, Ahmed, and Morrant, 1960).

Using this figure, you can see that if you want to lamb comparable ewes early — November to December — you can expect only 70% of the ewes to ovulate, with about 30% having twins, whereas if you lamb in January or February, approximately 100% of the ewes will lamb, with 60% producing twins.

The breed of the sire is also very important. R. V. Large (1970) in England has computed the biological efficiency of meat production (E) and concludes, “The highest values for E will be obtained from small breeds of ewes producing large litters and crossed with a large breed of ram, leading to a high growth rate and final size in the lamb.”

Nutrition

If a ewe received all the feed recommended by the National Research Council, we would have few problems. However, under range conditions, though not impossible, it is impractical. There are times during the year when the nutritive requirement should be met, however, for instance at breeding and during lactation.

Blood Urea Nitrogen. The range manager must determine the nutrients supplied by the range. Recently we (Torell and Weir, 1970) have shown that there is a good correlation \( r = .94 \) between the urea nitrogen (BUN) content of the blood at breeding and the number of lambs born per ewe lambing. Blood samples from 20 ewes (0.5 ml of serum from each ewe combined into one sample) analyzed for blood urea nitrogen will provide an estimate of the amount of protein the ewes are receiving from the pasture. This is a simple analysis which can be done in any hospital laboratory. Generally if the serum contains less than 10 mg % of BUN, the ewe is receiving only a maintenance diet and will have a low ovulation rate. Additional protein as a supplement to the pasture or feedlot feeding of the ewes will greatly increase the ovulation rate. If the serum value is between 10 and 17 mg %, the pasture is fairly good (dry subclover plus grass is usually 17 to 22 mg %) and supplementation on the pasture is of variable value. However, feedlot feeding of a balanced diet will still increase the ovulation rate. From 17 to 22 mg % indicates a good pas-
ture, and above 22 mg % indicates an excellent pasture with BUN values similar to those from ewes being fed alfalfa hay in a feedlot. Caution must be taken, however, as a ewe on a very poor pasture will be starving and thus catabolizing her own body. Consequently, her blood will show a high BUN value.

**Flushing.** Flushing has been used for years to increase the number of ova shed at each estrous period. Work at New Zealand by L. R. Wallace at Ruakura and I. E. Coop at Lincoln College indicates that liveweight or condition may have as much effect on the ovulation rate as does “flushing.” Coop (1964) found that “As the liveweight of the ewe increases, twinning rate increases at a consistent rate of about 6% per 10 pounds liveweight.” He also found that nutrition during the three weeks immediately prior to breeding was more important than it is during the first three weeks of breeding.

Under California range conditions lambs are weaned as range forage dries. The ewes are then left on the dry feed until, and often through, breeding. This dry forage will usually provide only a maintenance ration for the ewes. This is the situation in which flushing seems to have the greatest effect.

In 1963-64 a group of 241 ewes were placed in drylot and fed a full ration of alfalfa hay beginning August 8. At that time rams were put with the ewes. Figure 2 shows that during the first 12 days of lambing this group had a lambing percentage of approximately 115. During the next 12 days the percentage jumped to over 145, with an overall average of 131. This would indicate that approximately 12 days were required for the flushing to have an effect. Another group of 274 ewes were bred on the range and their lambing varied from 112 to 126% during four-day periods, with an average of 119%. An increase from 115 to 145% in such a short time would indicate an effect of flushing rather than of liveweight change.

A group of similar ewes breeding on irrigated pasture at Davis produced a 165% lamb crop.

**Breeding in Dry Lot.** Since we found such a great improvement in the ovulation rate when we fed in a dry lot, the next step was to determine the effects of protein and energy on multiple ovulations. In 1968 (Torell et al., 1971) 408 ewes grazing dry annual range pasture were fed in dry lot 2.0, 2.8, 3.6, or 4.4 pound/day alfalfa wafers and, except for the 4.4 pounds, either 0, 0.5, or 1.0 pound barley/day for 20 days prior to and 20 days during breeding. In 1969, 306 similar ewes were fed 2 pounds pelleted oat hay supplemented with 0, 0.5, or 1.0 pound cottonseed meal and/or 0, 0.5, or 1.0 pound barley per day. Nitrogen intake varied from 33 to 72 g/day in 1968 and 10 to 46 g/day in 1969. Digestible energy intake varied from 2.0 to 4.4 Mcal/day in 1968 and 1.9 to 4.6 Mcal/day in 1969. Lambing % (lambs born per ewes
present at lambing) increased from 108% to 167% and 127% to 159% in 1968 and 1969, respectively, as both nitrogen and digestible energy intakes were improved.

It appears that up to a certain level, protein is the limiting nutrient but then above this amount, both protein and energy will increase the number of lambs born per ewe present at lambing. Our spread in levels fed was not great enough to show the effect of higher levels, especially if they are unbalanced.

Breeding in a dry lot has other advantages besides increasing the number of lambs born. Fewer rams will be needed, one per 100 ewes, or a minimum of 2 rams per group, instead of the 3 to 4 rams normally used on the range. Higher quality rams can be used, especially for the replacement ewes, so there is a more rapid flock improvement.

The time spent in the dry lot reduces the grazing pressure on the range, so theoretically more ewes could be run on the ranch.

By-product Feeds. Many by-products of both agriculture and industry are now being used by the livestock industry; however, there are many more that may have feed value. One of these is chicken manure or broiler litter.

During a major drought in Chile, ewes were fed for six to eight months on a ration consisting of 98% broiler litter plus 2% salt. In several experiments conducted by the University of Chile (Galmez et al., 1970) the group of ewes fed a ration containing 63% broiler litter plus 35% beet pulp and 2% salt did just as well as another group fed 87% alfalfa, 11% beet pulp, and 2% salt during pregnancy and lactation.

In a lamb-fattening trial, four groups were fed fattening rations containing 68, 58, 48, and 38% broiler litter (rice-hull base with 27.4% crude protein, 12.7% ash, and 4.146 kcal/g energy). The remainder of the ration was 1/2 beet pulp and 1/2 ground oats + 2% salt. Another group was fed baled alfalfa hay. All rations were fed ad libitum. Average daily gains (lb) were .374, .383, .410, .458, and .185, respectively, while efficiencies (feed/gain) were 5.4, 5.3, 4.5, 4.3, and 25.0.

Warning: “The U. S. Food and Drug Administration has not approved and prohibits the use of poultry litter as animal feed, for the following reasons: ‘Drugs in litter, and diseases in litter.’ However, ‘If the poultry litter is being used in animal food, and human food products, produced therefrom, were not being transported across state lines, the Federal Food and Drug Administration would not be involved in the control of the use of the waste products.’” (Kerr, 1970.)

Other by-products—straw, garbage, sawdust, newsprint, etc.—are being investigated as feed sources.

Sometimes range is excellent feed, but at other times it doesn’t meet the nutritive requirement of the animal, so if less costly by-products can be substituted for high-cost feedstuffs at these times, then over-all efficiency should be increased.

References
Comparison and Evaluation of Hampshire, Suffolk, and Willamette Sheep Under Differing Environmental Conditions

RALPH BOGART

In 1955, development of the Willamette sheep was begun by crossing Cheviot and Dorset Horn rams with Columbia ewes. Reciprocal crosses among crossbred progeny from these matings were made. The resulting offspring became a gene pool for establishment of the Willamette sheep. A population of approximately 100 ewes and 6 rams has been maintained. Selection of replacements from within the population has been based on 120-day weight and scores for conformation and condition.

At the same time the Willamette sheep were being developed, purebred Suffolk sheep were selected on the same basis as the Willamettes. The Suffolks were bred as three one-sire lines of 15 ewes each and one three-sire line of 45 ewes. Later, the three one-sire lines were crossed using a diallel mating scheme.

A Hampshire flock was originally divided into an open population in which rams from outside the flock were used and a closed population in which ram and ewe replacements were selected from within the population. Later, these sheep were assigned to a selection study in which selection was based on pounds of lamb produced per ewe or pounds of lamb produced per unit of ewe metabolic weight.

In a study initiated in the fall of 1969, the Willamette, Suffolk, and Hampshire sheep have been crossed using a diallel mating scheme as a means of comparing and evaluating each of the three breeds both as straightbreds and as crossbreds. A total of 288 ewes, 96 of each breed, were used. Half the sheep of each breed were bred and maintained under intensive (irrigated pasture) conditions while the other half were maintained under “hill pasture” conditions. The mating plan is shown below for each of the pasture conditions.

<table>
<thead>
<tr>
<th>Breed of ram*</th>
<th>Hamp-</th>
<th>Suf-</th>
<th>Wil-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breed of ewe</td>
<td>shire</td>
<td>folk</td>
<td>lamette</td>
</tr>
<tr>
<td>Hampshire ...</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Suffolk ......</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Willamette ....</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

* Two rams of each breed were used.

Only one lamb crop has been produced; consequently, the results to be reported are in the form of a progress report only.

There are several criteria that could be used for evaluating and comparing
the three breeds of sheep. Each criterion will be presented after which generalized statements relative to overall evaluation and comparison of the breeds will be made.

**Body Weight of Ewes.** The weight of the Willamette ewes at breeding time was lower than the weights of the other two breeds. The weight of the Suffolks assigned to the intensive location was higher than the weight of Suffolks assigned to the hill pasture area. There was no difference between the Hampshires or Willamettes assigned to the two locations.

**Number of Days from time Ram Was Put with Ewes to Lambing.** The number of days from the start of the breeding season to lambing was approximately the same at the two locations. The Hampshires had lambs the earliest under intensive management, while the Willamettes lambed earlier at the hill pasture location. Ewes producing straightbred lambs did not differ from ewes producing crossbred lambs in date of lambing.

**Total Number of Lambs Born per Ewe Lambing.** The Suffolk ewes produced more total lambs per ewe lambing than the Hampshire and Willamette ewes, which were equal. There were more lambs produced per ewe lambing when the lambs were crossbreds than when they were straightbreds. The ewes under the intensive regime had more lambs per ewe lambing than ewes under the hill pasture conditions. There did not appear to be an effect of breed of sire on number of lambs born per ewe lambing.

**Lambs Born Alive per Ewe Lambing.** The number of lambs born alive per ewe was lower for the Willamette ewes than for ewes of the other two breeds which were about equal. Ewes having crossbreds lambs under the intensive area had more live lambs per ewe lambing, but this difference did not exist with ewes under the hill pasture conditions. Suffolk sires produced more lambs per ewe lambing than rams of the other two breeds under the intensive area, but not under the hill pasture conditions.

**Birth Weight of Lambs.** There were no differences in size of lambs at birth due to breed of ewe or breed of sire. Lambs at the hill pasture were larger than lambs at the sheep barn, probably due to fewer twins. Crossbred lambs were heavier than straightbred lambs at birth.

**Number of Lambs Weaned per Ewe Bred.** There were fewer lambs weaned per ewe bred by the Willamette ewes under the intensive area than for ewes of the other two breeds. The Hampshire sires had fewer lambs weaned per ewe bred than rams of the other breeds under the intensive area. There were more crossbred than straightbred lambs weaned per ewe bred.

**Weaning Weights of Lambs.** Lambs produced by Willamette and Suffolk ewes were heavier than those produced by Hampshire ewes at the hill pasture, but there was no difference among the breeds of ewes in weaning weights of lambs under the intensive area.

**Weaning Age of Lambs.** The lambs produced by Hampshire ewes were older than lambs produced by ewes of the other two breeds under both environments. Hampshire-sired lambs were older at weaning under the intensive area than lambs sired by rams of the other breeds.

**Slaughter Weights of Lambs.** There were no differences among lambs for slaughter weights.
Slaughter Age of Lambs. The lambs produced by Hampshire ewes were older at slaughter than lambs produced by ewes of the other two breeds at the hill pasture. Also, lambs sired by Hampshire rams were older at slaughter than lambs sired by rams of the other breeds at the hill pasture. Lambs sired by Suffolk rams were older at slaughter than lambs sired by rams of the other breeds under the intensive area. Straightbred lambs were older at slaughter than crossbred lambs.

Cold Carcass Weight of Lambs. There were no apparent differences among the groups in cold carcass weights.

Carcass Cutability. The small numbers in some of the group makes it hazardous to draw conclusions from average figures. There appeared to be a lower cutability of carcasses of lambs produced by Suffolk ewes; however, lambs sired by Suffolk rams had higher carcass cutabilities than lambs sired by rams of the other breeds.

General Evaluations and Comparisons. It appeared that fertility was higher when the ewes were bred on irrigated pastures. The higher twinning resulted in smaller birth weights of lambs.

Crossbred lambs were slightly superior to straightbred lambs in survival and growth, but the differences were not marked.

The Hampshire ewes performed better relative to the other breeds under intensive management, while the Willamette ewes performed better relative to the other breeds under the hill pasture conditions.

Since the first lambs to reach marketable size were weaned on a weight basis (100 pounds), there was little difference between groups in weaning weights, slaughter weights, and carcass weights. The ages at weaning and at slaughter are more meaningful criteria for comparisons than weights. Slaughter age was higher for straight bred than for crossbred lambs. Slaughter age was greater for lambs sired by Hampshire rams or produced by Hampshire ewes on the hill pastures, but was lowest for lambs sired by Hampshire rams or produced by Hampshire ewes under the intense regime.

The lambs that were raised on the hill pastures did as well as lambs on irrigated pastures during the early part of the summer. Lambs that had not reached market weight prior to the drying of the forage however, did poorly on the hill pasture.

No one breed was decidedly superior or inferior for overall productivity considering the criteria used in this report. Perhaps differences between breeds or breed crosses will become apparent when more data are obtained.