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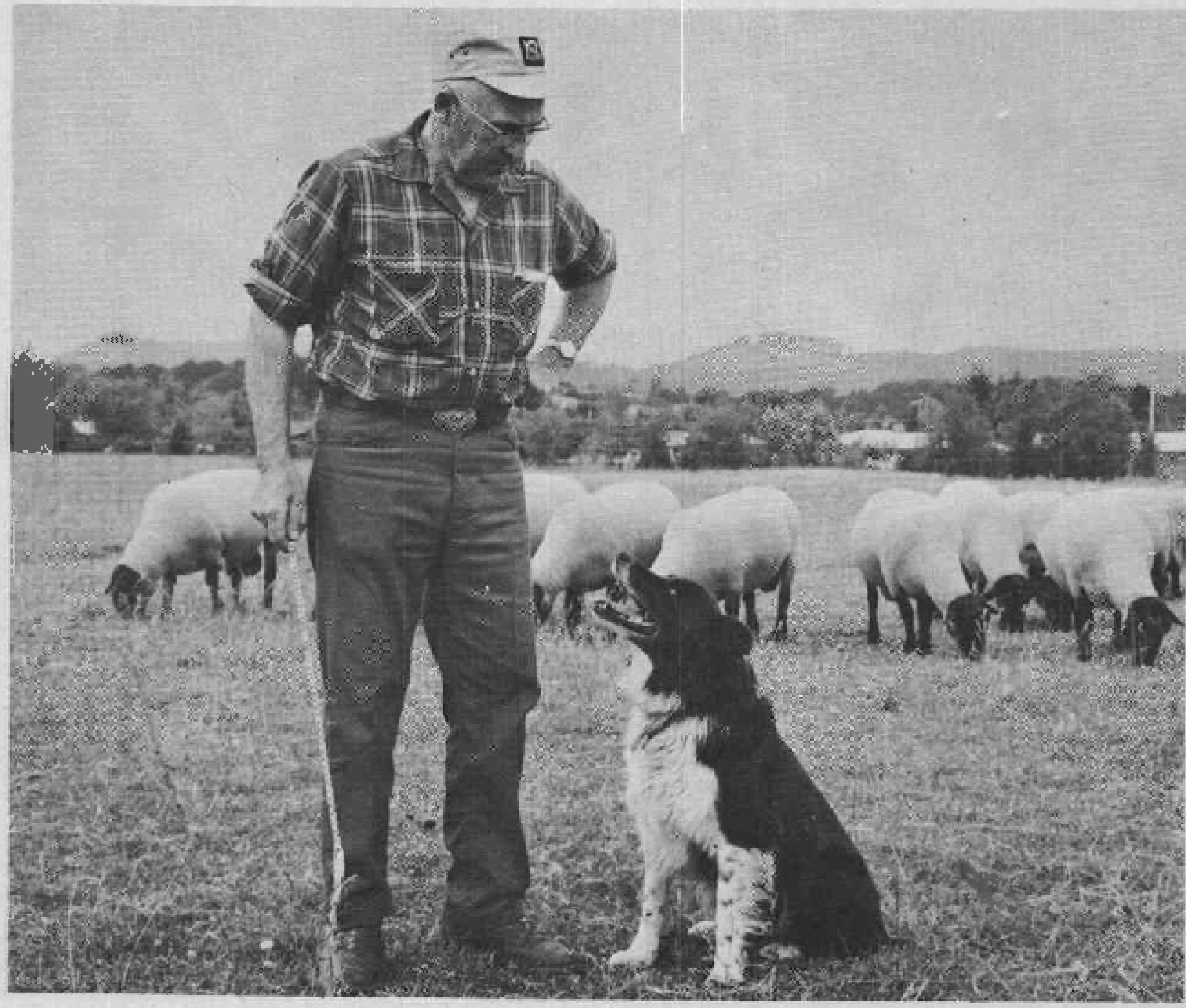

Special Report 382 **May 1973**
Agricultural Experiment Station, Oregon State University, Corvallis

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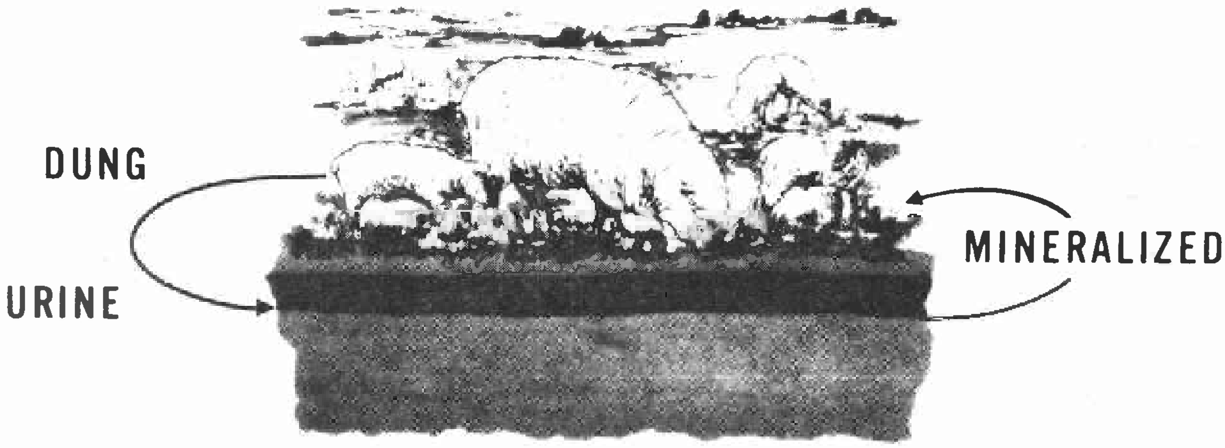
Cover Photo: Mr. Millard Shelton, retiring OSU shepherd, with friend, Bob. Mr. Shelton was head shepherd at OSU from 1960 through 1973.



SOIL - PASTURE - ANIMAL ECOSYSTEM

GRASS-CLOVER PASTURES AND LIVESTOCK PRODUCTION IN OREGON

M. D. Dawson and W. S. McGuire

Oregon's comparative advantage over many states where livestock production dominates is our ability to feed stock high quality pasture. It is no accident that hay is the top dollar value crop in Oregon. It is a sad commentary however, that so few sheep and cattle producers really get the meat and wool per acre western Oregon pastures are capable of producing. Succinctly, we do not capitalize on our comparative advantage in being able to produce and utilize quality pasture. Perhaps we read too many mid-western journals, purchase too much expensive feed grains, worry excessively about live weight gain per animal instead of pounds of meat per acre. Often overlooked is that top pasture management blended with good animal husbandry is a very sophisticated type of farming demanding in knowledge, skill and judgement.

In the comments which follow we shall examine factors important in growing a good grass-clover mixture, matching pasture growth with animal requirements, meat production per acre and recycling nutrients on intensively grazed pastures.

Why Include Clover?

Research and farmer records indicate livestock production grazed on straight grass pastures is seldom as high as from cattle or sheep grazed on pastures which include considerable legume. Several reasons account for this state of affairs including palatability and nutritional advantages, provided by the legume. Also, about 250 and 500 lbs. of fertilizer N is needed per acre annually for non-irrigated and irrigated pastures respectively in fields planted to grass without the legume. Under comparable conditions, where a legume accompanies grass in the mixture, most of this nitrogen can be symbiotically fixed by legume rhizobia on root nodules. This bonus amount of nitrogen made available biologically will assume increasing economic importance as the price of commercial nitrogen fertilizer increases. Scientists predict prices for natural gas (which now supplies the needed hydrogen utilized in the commercial manufacture of fertilizer N) will treble within the next decade.

What Are The Clover Needs?

In any good grass-clover pasture special attention needs to be given to the legume for its successful establishment and production. Assuming one has chosen the best legume for the purpose the farmer has in mind, then nutritional requirements become paramount. Effective nodulation is the first prerequisite for good grass-clover pastures. In data presented in Table 1 below, a proven rhizobium strain is shown to have increased irrigated white clover yield by over 3,500 lbs. of dry matter per acre more than the clover which was presumably nodulated with a partially effective rhizobium.

Table 1. Effect of inoculation with a proven rhizobium strain on New Zealand white clover.

Inoculated		Uninoculated	
Average Yield (dry matter)	Average Plant N	Average Yield (dry matter)	Average Plant N
lbs/A	%	lbs/A	%
11,574	3.17	7,903	2.18

However, equally spectacular in this experiment was the increase in clover N on the inoculated treatments. The increase in clover nitrogen represented an increase of about 225 lbs. plant protein per acre available to the grazing animal.

In another experiment concerned with the establishment of subterranean clover in very acid soils (pH 5.0-5.2) the influence of inoculation and methods of planting were studied. The results are shown in Table 2.

Table 2. Percent effective nodulation of subclover and plant nitrogen content.

Treatment	Percent effective nodulation four weeks after planting			
	Polk County	Washington County	Coos County	Average Plant Nitrogen
	%	%	%	%
Uninoculated	14	2	3	1.29
Inoculated	14	2	44	--
Inoculated and "Lime super mix"[1]	72	96	79	3.54

[1]Equal mixture of 20 percent superphosphate and lime.

Here conventional inoculation was ineffective. In this instance, because of the strong acidity of the soil it was necessary to plant seeds with a lime-superphosphate mixture.

The legume's capacity to utilize applied fertilizer is undoubtedly influenced markedly by the rhizobium strain and effective nodulation. Once so established, available nutrients are essential for top pasture production. The soil test for phosphorus is an excellent guide to determine the fertilizer requirement of this nutrient. Other nutrients are often needed as seen below in Table 3.

Table 3. Mean subterranean clover yields and nitrogen content as influenced by applied sulfur and molybdenum.

Treatment	Dry Matter	Clover Nitrogen	Total Plant Nitrogen
	lbs/A	%	lbs/A
P	3,420	2.06	70
PS	5,220	2.78	145
PSMo	5,982	3.17	190

The data in Table 3 illustrates the effect of applied sulfur and molybdenum on clover yield and reflects the role these nutrients have upon the symbiotic nitrogen fixation efficiency. Such responses have been observed frequently in Oregon. Where grasses and clovers are growing together, grasses utilize almost all the mineral nitrogen made available.

Having produced this good yielding highly nutritious grass-clover pasture is not enough. The pay-off is in its effective utilization.

Annual Stocking Rates and Pasture Utilization

The carrying capacity for various classes and sizes of livestock can be calculated by knowing the yield of pasture, requirements of the particular animals and the percentage utilization of the pastures.

It has been established that the non-irrigated clover-grass pasture can produce 6,000 pounds of dry matter per acre. As much as 8,000 pounds has been recorded. The irrigated pasture is easily capable of 12,000 pounds. Alfalfa will yield 14,000 pounds or more and corn for silage 20,000 pounds, all on a dry weight basis.

Percentage utilization varies greatly. This area depends very much on the management ability of the operator and his stocking rate. We use a conservative figure of 80%. This is the typical amount figured in hay-making. In pasture, it allows for dung and urine patches, trampling effect, weeds, etc. We have operators getting over 90% utilization and some, understocked, getting 40-50%.

Animal requirements are obtained from Nutrient Requirements of Domestic Livestock, National Research Council. Calculations for a 140 lb. ewe throughout the year through late gestation, lactation, dry periods and flushing, plus the feed eaten by one lamb (100% crop) totals about 1,700 lbs. dry matter per year. The non-irrigated pasture at 80% utilization provides 4,800 lbs. of feed. The potential carrying capacity then is 4,800 ÷ 1,700 is 3 ewes plus 100% lamb crop per acre. The good manager could easily raise this above 3 per acre. This is on a full year self-contained basis - i.e., enough hay is saved from surplus pasture during spring flush to carry the ewes through the winter.

Conversion into other animal units can be readily made. For instance, about 5 ewes are equivalent to one cow or two half grown steers or heifers. For growing animals and cows, size is the main factor and feed requirements can be determined as above. Thus, the pasture mentioned above is capable of carrying a cow-calf on two acres, or a steer or heifer per acre.

The above assumes the feed is consumed green or as hay with no more than 20% loss. Feed produced in spring and left to maturity suffers a 50-80% loss because of leaching, bleaching, reduced nutritive value and digestibility. Indeed, the manipulation of kinds of pastures and stocking rates for best feed utilization is a matter of prime concern.

Fitting The Pasture Growth To The Animal Requirements

We have sufficient information to approximate the growth curves for irrigated and non-irrigated pastures. The growth rate at various times throughout the year varies with species, fertility level and weather. We know that annual ryegrass is our best winter grower. Some perennials are nearly as good. Tall fescue and perennial ryegrass make more winter growth than orchardgrass. None of the legumes make appreciable winter growth.

Non-irrigated:

The non-irrigated grass-clover pasture, fertilized for good clover production, has a growth curve as shown in Fig. 1. There is growth during most winters at a rate to carry one ewe. With increased fertility through re-cycling, this can be increased to two ewes. In late gestation (5-6 weeks pre-lambing), the increased nutrition is indicated, with

FIG. 1-GROWTH CURVES FOR SUBCLOVER-GRASS PASTURE (APPROX.) AND SHEEP FEED REQUIREMENTS (3 PER ACRE)

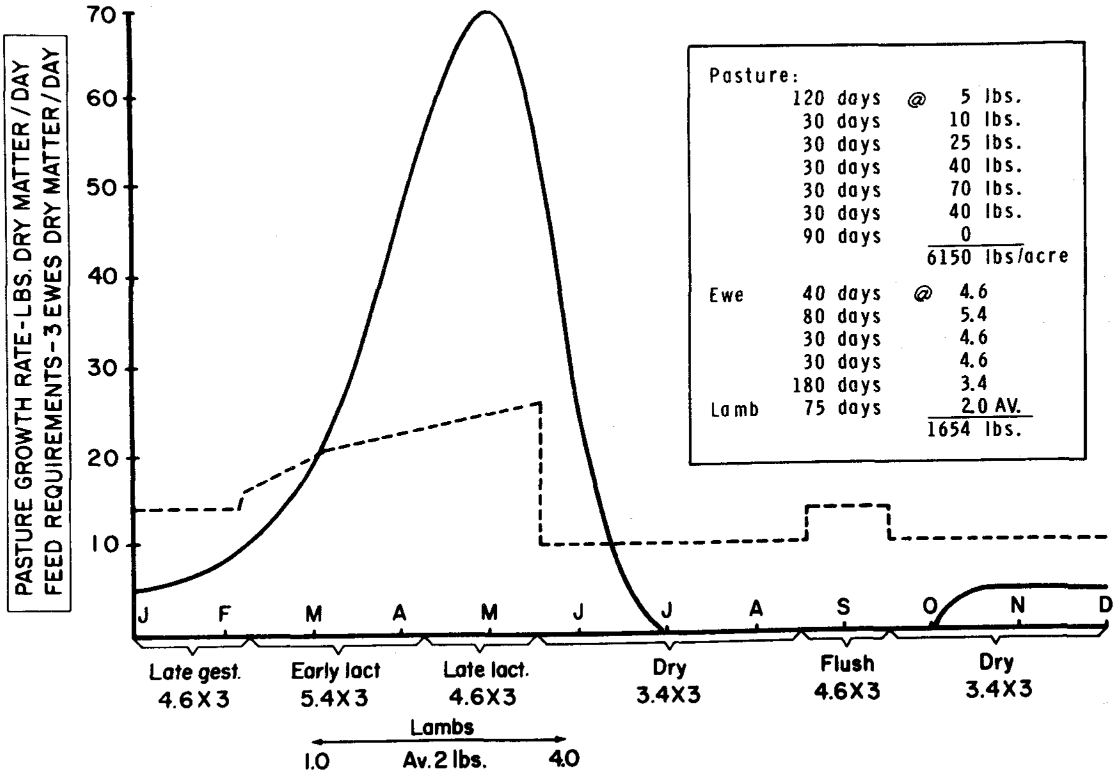
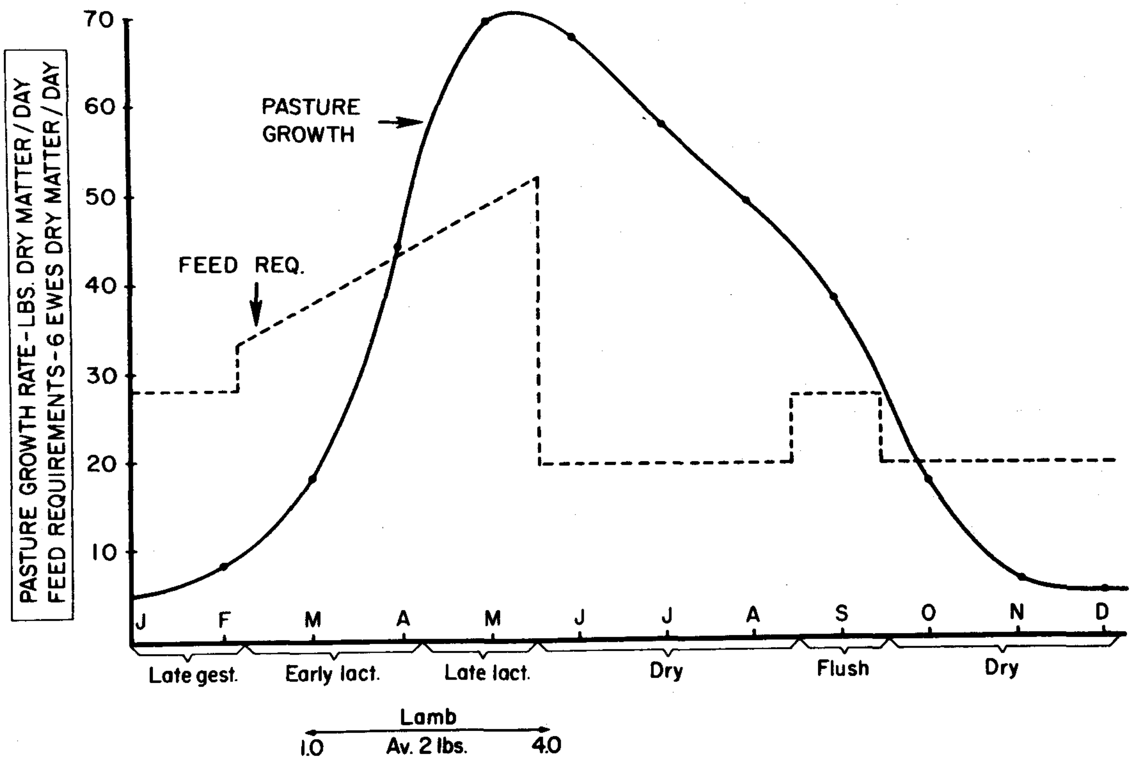


FIG. 2 GROWTH CURVE FOR IRRIGATED PASTURE (APPROX.) AND SHEEP FEED REQUIREMENTS (6 EWES PER ACRE)



further increase for lactation. The additional feed for the lamb is also included, beginning at 2 lb/day for a half grown lamb and increasing to 4 lb/day at 100 lb. weight. The average is about 2 lbs. per day during life of the lamb.

If the lamb is sold fat, the feed requirements drop to that required for maintenance of 3 dry ewes, where it remains until late gestation, except for a flushing period.

Several points are obvious - at the higher stocking rate, on the grass-clover pasture, there will be a shortage of winter green feed. Thus, the need for turnips, annual ryegrass and our continued work on winter-growing perennials with nitrogen fertilization. Otherwise, hand feeding is in order. Also, with the non-irrigated pasture, there will be a surplus of feed in spring. Full utilization of this feed while green is best accomplished by having less conventional pasture and more pastures that grow during the "off-season". Another method would be to buy in early spring and sell when grass is fully utilized - sheep or calves.

It should be clear, however, that with late winter lambing and lamb disposal in June, the growth curve fits the requirements of sheep much better than for beef cattle or dairy. In fact, it is clear, that with dairy, when a uniform supply of milk is desired, the requirements across the year is essentially a straight line. This pasture would be useful only 2 1/2 months or used for silage or hay.

Irrigated:

Tall fescue and orchardgrass are the best summer growers with white clover for irrigated pasture. Perennial ryegrass is useful on the coast where summers are cooler. The growth curve for this pasture is shown in Fig. 2. No data are available for winter growth but there likely is less than for the non-irrigated pasture, mainly because of the presence of orchardgrass, which is our best summer grower (perennial) but a poor winter grower. The spring flush is similar to the non-irrigated flush, and growth continues throughout the season, but at a diminishing rate. The reasons for the decrease are not fully understood. Inclusion of more orchardgrass helps increase production during the high temperature period. N fertilizer can stimulate production, but the economics is doubtful and loss of clover or decreased fixation can occur.

It can be easily seen that this growth curve more nearly fits dairy and beef production requirements. When sheep requirements at six ewes per acre (twice that of the dryland pasture) are superimposed, it is obvious that all sheep requirements are met from about April 1 to early October. The season can be extended by inclusion of tall fescue and saving some of the summer growth for fall use. The winter deficit is increased, requiring more supplementation during the off-season. Another point is that with non-irrigated pasture stocked at 3 ewes per acre, the surplus feed for hay conservation occurs in May-June. For irrigated pasture, which grows at the same rate as the non-irrigated in April-May-early June, but stocked at 6 ewes per acre, most of the surplus occurs June-August. It is left to the individual operator then to fit his management and stocking rate to best use the surplus. Dry ewes at 6 per acre would get fat on irrigated pasture in July-August. Why not reduce acreage to a maintenance diet and conserve the extra feed, or increase the stocking rate, or buy animals for growth or fattening?

Meat Production Per Acre

Meat production can be calculated by estimated TDN and conversion to meat, or by calculation of dry matter requirements of the animals depending on size. For example, a 600 pound steer gaining 2.4 pounds per day requires 18 pounds of dry matter. The non-irrigated pasture, after deducting 20% loss, provides 4,800 pounds or 4,800 ÷ 18 equals 266 steer-grazing days. At 2.4 pounds per day, there is enough pasture, if fed at its best stage of quality, to produce over 600 pounds of beef per acre. Dr. Bedell on the Adair area pastures surpassed this with his grazing tests provided the feed was utilized green. With sheep at 3 per acre and 100% lamb crop, the production per acre is 300 lbs meat plus wool. This is low because the top quality of surplus pasture in spring is lost to maturity. It is at this stage, remembering that 200 pounds of pasture (dry basis) can produce an extra lamb, that the operator must turn attention to lambing percentage. Increase in lambing from 100 to 130% would increase meat production from 300 to 400 pounds per acre, and using pasture that otherwise would represent 4 bales of hay of lesser quality than pasture.

In a similar way, the irrigated pasture is capable of producing 1000 pounds of beef per acre. This has been demonstrated in the Yakima Valley on grass-clover pastures with growing season similar to western Oregon.

Livestock "Feed" Pastures

Upon studying nitrogen and sulfur cycles in grass-clover pastures, we have discovered that heavy livestock use creates a soil-plant-animal inter-relationship that increases soil fertility, pasture yields and animal production.

The introduction of grazing animals into the nitrogen cycle provides a way for nitrogen taken from the soil by plants to be returned to the soil. Clover-fixed nitrogen is returned to the grass through urine which acts as a nitrogen fertilizer. Three or four ewes per acre can return at least 150 pounds of nitrogen per acre annually. The sulfur cycle responds to high grazing intensity in much the same way.

Under such conditions, with sufficient moisture and solar energy, the nitrogen and sulfur cycles virtually become a closed system. Such a system can only be expected where the soil has been exposed to a high number of livestock for a long period. Sulfur appears to be the first limiting element.

On many soils, a decade of annual applications of superphosphate fertilizer and high livestock use are required before the nitrogen and sulfur cycles become virtually self-sustaining.

The "Trinity"!

Intensive grazing of improved pastures under conditions such as in western Oregon, represents a system of farming where maximizing production can be synonomous with optimizing production. The high stocking rates of grass-legume pastures elegantly illustrate a soil-plant-animal inter-relationship (the "Trinity") manifested through the nitrogen and sulfur cycles. Soil fertility, pasture yields, and animal production concurrently increase as improved grass-clover fields are intensively grazed. Production and conservation are seldom such good bedfellows. Improved grass-clover pastures utilized under high stocking systems epitomize conservation management at its best.

The success in producing quality pasture, especially improved hill grass-clover pastures, in western Oregon depends primarily upon the efficiency of the nitrogen and sulfur cycles. The soil-plant-animal "Trinity" together account for the net worth of these cycles and thus livestock production. Under intensive grazing, and in spite of N or S losses through leaching, volatilization, or sale of meat and wool from the farm, good management permits symbiotic fixation of nitrogen and recycling of nitrogen and sulfur in amounts needed for top production.

The clover plant plays a pivotal role in this system of intensive pasture management. Furthermore, on many soils it will require at least a decade of annual applications of superphosphate fertilizer and high stocking rates to reach the point where the cycling of nitrogen and sulfur is sufficient to be virtually self-sustaining. Evidence suggests that in many western Oregon situations, sulfur (not phosphate) becomes the first limiting nutrient for clover if the nitrogen and sulfur cycle are to continue at peak efficiency.

Summary Statement

The ultimate goal is high pasture production and complete and efficient utilization of feed by livestock management to obtain maximum net income per acre. The operator must have a thorough working knowledge of soil-plant-animal. It is much more complex than growing a single crop such as grain, potatoes, hops or grass seed. This is because we are selling the pasture production indirectly through animals, we are working with both annuals and perennials, a mixture of species to be kept in balance and with many harvests per year. The authors believe either the lack of understanding of the problem, or the fear of the complexity of it has left support for pasture research with low priority. Possibly the best demonstration of the concept has been accomplished at the Robert Hiatt farm in Washington County. Others in the Valley, Douglas and Coos Counties are on the way up. The picture is becoming clearer and the strategy is being planned. The potential is there and the price right! Get with it!

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BREEDING-MANAGEMENT RELATIONSHIPS IN SHEEP PRODUCTION

W. D. Hohenboken

In the United States, there are at least 20 recognized pure breeds of sheep. This might seem like a great plenty, but in Great Britian, a fraction of our size, many sheep shows have over 30 breed classes. Even this may not be excessive. Mason reports in an FAO publication that there are over 200 breeds in countries of Europe, the Middle East and Africa bordering the Mediterranean!

This vast array of sheep breeds is indicative of more than just personal or area preferences for certain types and breeds. It also indicates that over centuries of time, shepherds have become convinced that different physical environments demanded or at least favored different strains of sheep. Thus, flock-masters tended to discourage much outside breeding. (Poor roads and transportation, and the attendant limited mobility, also held down "exotic blood".)

Flocks were selected consciously for some preconceived conformational or performance ideal and frequently for some breed trademark as well. At the same time, Mother Nature was selecting, with or without help from the breeder, for adaptation or survivability in the environment. Thus, over dozens of generations, our many sheep breeds were developed.

That specific adaptation developed to a specific environment is one theory which has been advanced to explain the development of breeds. Though this theory has been around at least 200 years, it has only recently been subjected to controlled scientific investigation. We (the animal geneticists) have asked the question, "Does a breed, strain or family which performs best in one environment necessarily perform best in all others?" In this question, the word "environment" is expanded to include husbandry, disease exposure and management as well as terrain and climate.

We can all imagine instances when the answer to this question would be "No". Rambouillets may excel Hampshires for rate of gain in Arizona but not in the Northwest, for example. How general, though, or how frequent are changes in rank between genetic groups with changes in environment? How dissimilar must breeds be or how drastic must environmental differences be before rank changes exert themselves? If these changes, which animal geneticists call genotype x environment interactions, are found between many breeds and for many environments, what effects would this have on our breeding programs? We would have two choices. (1) We could attempt to create or identify separate breeds or strains for each major environment or (2) we could choose breeds adapted to a fairly wide range of environments and put up with less than the anticipated level of performance in other environments. If, on the other hand, genotype x environment interactions are not important, our breeding problems are simplified. We can then choose breeds without regard to their specific adaptation to a terrain, climate or type of management. Also we can select flock replacements from any environment, confident that their superiority will be retained and transmitted to their progeny under our management and environmental conditions.

Experimental Plan and Objectives

In the fall of 1969, OSU began an experiment to study genotype x environment interactions - or breeding management relationships - in sheep production. Two environments were chosen. The first was irrigated and improved valley pasture with high stocking rates and high levels of fertilization. The other was improved hill pasture, characteristic of much of western Oregon. These hill pastures were stocked moderately and were fertilized every other year with superphosphate.

Three breeds were chosen - the Hampshire, the Suffolk and the Willamette. (Willamette sheep were developed by OSU from 15 years of selection within a closed flock resulting from matings of Border Cheviot and Dorset Horn rams with Columbia ewes.) Each year for three years, two rams per breed per location were mated to 8 Hampshire, 8 Suffolk and 8 Willamette ewes. Each year, 288 ewes (144 per location) were involved in the experiment. All possible straightbred and reciprocal crossbred combinations were raised in each environment and in each year.

The objectives of the experiment were: (1) To examine breed x environment interactions in sheep production, (2) to characterize Hampshires, Suffolks and Willamettes for production characteristics, and (3) to determine whether heterosis, or hybrid vigor existed in either or both of the environments.

These objectives were studied at each stage of the life cycle, specifically for ewe production and reproduction traits, for growth traits of lambs and finally for carcass merit of slaughter lambs. This discussion will be limited to the above three objectives for ewe traits only, specifically for fertility, prolificacy, ewe weight, ewe wool production, and pounds of lamb weaned per ewe bred. Lamb growth and carcass traits are still being analyzed and interpreted and will be reported another time.

Results and Discussion

Fertility. Robert DeBaca, Livestock Extension Specialist at Iowa State University, has said that the most important economic trait for any class of livestock is to be born alive. Surely our percent lamb crop sets a ceiling on potential total income from any sheep enterprise.

In this discussion we will divide reproduction into three components: fertility or the proportion of ewes mated which actually conceive, prolificacy or the total lambs born per ewe lambing, and survivability or lambs weaned as a percent of lambs born. By dividing overall reproduction into these three components, we can study more efficiently the genetic and management differences and relationships. Overall reproduction efficiency will be measured by lambs weaned per ewe bred.

Fertility by breed of ewe in each environment is presented in table 1. (Data have been averaged over years.) The black-faced breeds were essentially equal to each other but slightly exceeded Willamettes on valley pastures. On hill pastures, Willamettes were superior to Hampshires and Suffolks. Here is our first hint of a genotype x environment interaction. Perhaps the Willamettes were better adapted to the hill land conditions than the blackfaces. Definite conclusions should not be made, though, until it is seen whether other traits bear out this relationship.

For the entire experiment, 88.4% of ewes which entered mating actually lambed. There was little difference between the two locations. Irrigated pastures yielded 89%, hill pastures 87% fertility. Likewise, the mating system did not result in large differences (table 2). Ewes bred to rams of their own breed on valley pasture scored 87%; ewes bred to another breed to produce crossbred lambs scored 91%. Comparable percentages for hill pastures were 88% for striaghtbred matings, 87% for crossbred matings. Averaged over both environments, heterosis, or % crossbred advantage, was only 1.8%. In last year's OSU Sheep Field Day bulletin, I reported on crossbreeding experiments in sheep in which crossbred matings exceeded straightbred matings for fertility by 6%. In those experiments, average fertility was 72%, so they had more room for improvement or response to crossing. The most likely reason for heterosis in fertility from two breed crosses is lowered embryonic mortality of the crossbred fetus. Our experiment indicates that when fertility is already high, crossing of two breeds won't improve it markedly.

Prolificacy. Prolificacy was measured as the total number of lambs born per ewe lambing. There are indications (table 1) of breed differences in number of lambs born. Hampshires were superior in both environments while Suffolks and Willamettes switched second and third place rank from valley to hill pastures. As with fertility, Willamette ewes were comparatively better on hill pastures than under valley conditions.

There were important environmental differences in prolificacy. Valley ewes dropped 170% lambs while hill pasture ewes dropped 152%. This is probably attributable to pasture differences prior to and during the breeding season with irrigated valley pastures providing better flushing feed. Heterosis (table 2) was marked on valley pastures (6.1%) but negative (-2.0%) on hill pastures. Thus embryonic mortality of straightbred fetuses may have been higher in the irrigated (better nutritional) environment but not on hill pastures. Averaged over both environments, the number of lambs born per ewe bred averaged 1.61.

Survivability. On valley pasture, the blackface ewes scored higher for lamb survivability than Willamettes; on hill pastures the opposite was true. Again we are given a hint of better adaptability of the Willamette to the dryland than to the irrigated pasture conditions.

Average percent survival was 89% on hill pastures, 81% on valley pastures. This difference probably traces to lambing management. Both groups of ewes were lambed out at the main OSU sheep barn. Hill pasture ewes were transferred to pasture earlier than those on irrigated pastures. Valley ewes and lambs spent more time in confined conditions which probably increased the incidence of respiratory and some parasite problems (notably coccidiosis). On valley pastures, heterosis for survivability was 6.5%, on hill pastures -2.2%. Thus a crossbred advantage was shown in the environment in which survivability was poorer, but not in the other environment.

Number of lambs weaned per ewe bred. For the commercial sheepgrower, payday comes at weaning time. The product of fertility, prolificacy and survivability determines the number of lambs weaned per ewe bred. Breed of dam averages for this trait are affected by ewe fertility, prolificacy, maternal care and breed vigor. On irrigated pastures, breed ranking was Suffolk, Hampshire, Willamette; for hill pastures, Willamette, Suffolk and Hampshire. Thus, there appears to exist a genotype x environment interaction for overall reproduction. The Willamette breed seems considerably better adapted to hill land than to irrigated valley conditions. For the blackface breeds, adaptability is similar under the two environments.

Location differences favored valley pastures, 1.22 vs. 1.18 lambs weaned per ewe bred. Prolificacy was higher in the valley, survivability on hills; while fertility was similar in both locations. Heterosis for overall reproduction was 18.3% on valley pastures, -4.9% on hill land for an overall average crossbred advantage of 6.7%. Experiments reviewed in last year's Sheep Day Proceedings reported 20.6% advantage in overall reproduction from two breed crosses. In that experiment reproduction was at a lower level than in our experiment, so again there was room for more improvement from crossing.

Average weaning weight and pounds of lamb weaned per ewe bred. Pounds of lamb weaned per ewe bred is the product of average weaning weight and number of lambs weaned per ewe bred. In valley pastures, Suffolk ewes excelled in both weaning weight and pounds of lamb weaned.

They coupled reproduction and maternal ability. Willamette ewes were poorest in pounds of lamb weaned because of lower reproduction than blackfaces. On hill pastures, Suffolks again excelled in weaning weight. Due to lower reproduction, however, they dropped to second in pounds of lamb weaned. Willamettes were markedly better than either blackface breed in pounds of lamb weaned per ewe bred.

Location differences favored hill pastures for average weaning weight of lambs (92.3 vs. 84.6 pounds) and for pounds of lamb weaned per ewe bred (109.1 vs. 103.4). On valley pastures, heterosis for weaning weight and pounds lamb weaned respectively was 9.2% and 29.3%. Comparable percentages on hill pastures were 4.5 and -0.7%. Averaged over both locations, heterosis was 6.9% for average weaning weight and 14.3% for pounds of lamb weaned per ewe bred.

Ewe weight at mating and wool production. Ewe weight and wool production averages by ewe breeds are also presented in table 1. Weight differences between breeds were small in both environments. Hampshires were slightly heavier on valley pastures, and Suffolks were slightly lighter on hill pastures. Wool production was highest from Willamette ewes in both environments. Valley pastures resulted in ewes about 6 pounds heavier and in an added pound in annual wool production. This probably resulted from better year round feed availability on irrigated pastures.

Gross income per ewe bred. The final line of table 1 presents estimated gross annual income per ewe bred. It is computed as wool production x 72¢ per pound plus lamb production x 27¢ per pound.

These prices were characteristic of market prices (plus wool incentive) during the three years the experiment was run. Breed of ewe differences on valley pastures were quite small, ranging from $32.00 for Hampshires to $32.76 for Willamettes. Thus, according to the yardstick of dollars and cents, the breeds were essentially equal. Heterosis for gross income from lamb was 29.3% ($30.13 for crossbreds vs. $23.30 from purebreds). Since all ewes were straightbred, there could be no heterosis for wool production and it was left out of the computation.

Breed of ewe differences on hill pastures were dramatic, $37.27 for Willamettes, $31.80 for Suffolks and $30.92 for Hampshires. By our economic yardstick, Willamettes excelled the two blackface breeds in hill land conditions. Heterosis for gross income was -0.7%; straightbred and crossbred matings were essentially equal.

Summary

In this crossbreeding experiment, three breeds (Hampshires, Suffolks and Willamettes) were compared in two environments (irrigated valley pastures and dryland hill pastures) for three years (1970-1972 lambing seasons). All possible straightbred and reciprocal crossbred matings were made. The experiment had three objectives: (1) to examine breed x environment interactions, (2) to characterize breeds for productivity and (3) to determine whether heterosis existed for productivity.

Breed x environment interactions did exist in that Willamette ewes were similar or inferior to blackfaces for most traits on irrigated pastures but were superior to blackfaces for most traits on the hill pasture environment. For gross income from lamb and wool per ewe bred, breeds were nearly equal on irrigated pastures. On hill pastures Willamette ewes excelled Hampshires and Suffolks by $6.35 and $5.47, respectively.

Heterosis was near zero or negative for most traits on the hill pasture environment. For gross income from lamb, it was -0.7%. On irrigated pastures, it was strongly positive, equalling +29.3% for gross income from lamb. Thus there was a mating system x environment interaction. On the more productive hill pasture environment, straightbred and crossbred matings were essentially equal in overall productivity. On valley pastures, there were dramatic gains from crossbreeding.

TABLE 1. AVERAGES BY BREEDS AND ENVIRONMENTS FOR EWE PRODUCTION CHARACTERISTICS.

Valley Pasture

	Hamp.	Suff.	Will.	Overall
% Fertility	90	91	88	89
% Prolificacy	173	169	167	170
% Survival	83	81	78	81
% Lambs weaned per ewe bred	129	124	114	122
Weaning wt. (lbs.)	80.3	87.3	86.3	84.6
Lbs. lamb weaned per ewe bred	103.6	108.2	98.4	103.4
Fleece wt. (lbs.)	5.6	4.9	8.6	6.4
Ewe wt. (lbs.)	156.9	148.7	149.3	151.6
Gross income/ewe ($)	32.00	32.74	32.76	32.50

Hill Pasture

	Hamp.	Suff.	Will.	Overall
% Fertility	85	83	93	87
% Prolificacy	157	147	151	152
% Survival	88	89	91	89
% Lambs weaned per ewe bred	118	109	128	118
Weaning wt. (lbs.)	86.4	96.8	93.7	92.3
Lbs. lamb weaned per ewe bred	102.0	105.5	119.9	109.1
Fleece wt. (lbs.)	4.7	4.6	6.8	5.4
Ewe wt. (lbs.)	147.3	141.3	147.8	145.5
Gross income/ewe ($)	30.92	31.80	37.27	33.33

TABLE 2. PUREBRED *VS.* CROSSBRED MATING AVERAGES AND HETEROSIS

Valley Pasture

Trait	Purebred	Crossbred	% Heterosis[1]
Fertility (%)	87	91	4.6
Prolificacy (%)	163	173	6.1
Survivability (%)	77	82	6.5
Lambs weaned per ewe bred (%)	109	129	18.3
Weaning wt.	79.2	86.5	9.2
Lbs. lamb weaned per ewe bred	86.3	111.6	29.3
Gross income from lamb	$23.30	$30.13	29.3

Hill Pasture

Trait	Purebred	Crossbred	% Heterosis[1]	Valley and Hill Average % Heterosis
Fertility (%)	88	87	-1.0	1.8
Prolificacy (%)	153	150	-2.0	2.1
Survivability (%)	91	89	-2.2	2.2
Lambs weaned per ewe bred (%)	122	116	-4.9	6.7
Weaning wt.	89.5	93.5	4.5	6.9
Lbs. lamb weaned per ewe bred	109.2	108.4	-0.7	14.3
Gross income from lamb	$29.48	$29.27	-0.7	14.3

[1]Crossbred average divided by purebred average.

THE PIPESTONE SHEEP PROJECT - WILL IT WORK IN OREGON?

Dwight Holaway

Would you believe a 281% lamb crop alive from 70 ewes aged 24 and 36 months?

Would you believe a 171% lamb crop marketed from crossbred ewes with an average age at lambing of 12 months?

Would you believe 105# of lamb marketed at 100 days of age?

Would you believe a feed conversion ratio of 2.45 pounds of feed to 1 pound of gain?

Would you believe a net income of just under $11,000 from 375 running aged ewes valued at $7,500.00?

Would you believe weaning the lambs from 350 ewes at one day of age?

Would you believe that lambs can be fed out in confinement with just under 3 square feet allotted per lamb?

Would you believe the story about a 35-month-old ewe having a set of six live, healthy lambs?

Would you believe slotted floors are cheaper than straw?

These are some of the things that are now happening at Pipestone, Minnesota that will be discussed in this paper. Included in the discussion will be some conversation about dollars, sheep and, in particular, the sheepman. We'll discuss some of the techniques we're using at Pipestone and it will be up to you to determine whether or not some of these methods and philosophies might be applied to your operations in Oregon.

Before we give the details of the "WOULD YOU BELIEVES", I must confess that these remarks are colored and slanted by my background and a long standing love affair with sheep. Sheep have been the principal provider of groceries for the Holaway table since 1932. My father and brother are still in the sheep business back home in Southwestern Nebraska. I'm prejudiced and biased. I firmly believe there's no farm animal that will make more money, easier than sheep and this comparison can be based on dollar return per dollar invested and/or per hour of labor.

I even have an uncle who says a sheepman can drink whiskey where a cowman can't afford beer. He also says he'd rather buy the afterbirth of an old ewe than have a whitefaced cow given to him.

Now for the "WOULD YOU BELIEVES".

A group of seventy purebred Finnsheep at Pipestone has a 281% lamb crop alive from 70 Finn ewes that lambed at 23 and 35 months of age. Seven lambs born alive have been lost mostly because of mismanagement.

Frank Griebel, last year, marketed 19 lambs from 11 half-Finns that lambed at an average age of 12 months. Now we can say this is only 11 head but this year Frank, who is 69 years young, has added some 1/4 Finns to his flock of 100 ewes and will eventually have Finn blood in all of them.

At Pipestone we're weaning at about eight weeks of age and some of our best doing ram lambs are reaching market at about 100 days of age. Not the majority of them but enough to indicate that we can market more of them in 3.5 months than we do and must strive toward that goal.

Marlin Berg, Vo Ag teacher, has a few head of sheep on eight acres of ground. He buys all of his feed. Last year his feed conversion ratio on some blackface crossed lambs was 2.45 pounds of feed for one pound of gain. Again, an indication of what can be done.

Rog and Lynette Hersrud of Colman, South Dakota last year had a net return to labor, management and investment of $10.757.14 from 375 ewes. That makes a net income per ewe of $30.66. Their cost of feeding their lambs was $6.84 per head. In 1970 their sheep operation was only breaking even.

Mert Bauske of Flandreau, South Dakota in order to reduce investment in facilities and buildings, next year plans on lambing 400 ewes in February, March and April and will wean his lambs at one day of age, keep them in the shed on slotted floors and kick the mothers out on a maintenance diet.

Last year we fed 145 lambs on expanded metal floors. They were confined in an area of 16' x 24'. They were on self feeders and required little management. These same metal floors were used this winter and spring in our lambing operations. Their cost was a bit over $460. We estimate our straw costs at 60¢ per bale would have been $316.80 for bedding our lambing area. When one considers the labor involved in bedding the shed and removing the manure, we believe we've paid for the floors in one year.

At pipestone a 35-month-old ewe gave birth to six live, healthy and hungry lambs. At 12 months she had triplets followed by another set of them at 24 months for a grand total of 12 lambs in less than three years. Total birth weight of the six was 23.6 pounds. But even more important than the six lambs was that she was from a group of 56 ewes who had dropped one set of seven lambs (4 were born dead), the sextuplets, 3 sets of quintuplets, 23 delivered 4 lambs, 15 had triplets, 10 dropped twins and 3 had singles.

What I'm really trying to say in all of these "WOULD YOU BELIEVES" is that we're witnessing some dramatic changes in our sheep and our sheepmen at Pipestone.

There have been changes in attitudes and philosophies, changes in priorities, desires and goals, changes in management, techniques and methods, changes in disease prevention practices and in nutrition, changes in breeding and the use of breeding, and changes in the individual's confidence.

The attitude of the sheepman has changed.

First, there are some who now believe they can produce and market a 200% lamb crop. The Ag Committee of the Chamber of Commerce is sponsoring the collection and distribution of a $1,000.00 prize to the first member who markets a 200% lamb crop from one hundred or more ewes. When this was first proposed about 2 1/2 years ago, there were some who half jokingly said we'd only need to collect $10 and let the interest build to $1,000 before it would be earned and paid out. In 1974, three members plan on winning the $1,000. They will prove it can be done.

Our attitude and complacency toward mortality, both in lambs and mature sheep has changed. We're recording our death losses and reasons for them. We've decided a sheep doesn't just die--something kills it. We're recognizing the economic loss and the reason for it is management and can be largely averted. A number of our members who wouldn't allow a vet on the farm are now freely using them as an indispensible part of a profit team.

We're changing our attitude toward records. We're beginning to realize that without records we're flying blind. They're being used for culling, to check feed efficiency, feed economics, rate of gain, and, to some extent, the ranking of our rams. Record forms for the individual ewe, feed, lambing and death loss are supplied to members at no cost to them.

Our attitude toward rams and their cost has changed. When the program began we were told by a purebred breeder that we would never get area sheepmen to pay more than $75 for a ram. Some of the members have paid as much as $250 for rams to produce market lambs. We're beginning to recognize what a ram can or cannot do for us. We're asking for records on our rams. Our importation and results of using larger rams are prompting our area purebred breeders to seek and buy bigger and better rams.

We're finding out that marketing involves much more than getting the last 25¢ per hundred for our lamb. Even though we have some marketing muscle by group selling on a bid basis, we find this to be only a small part of the game. Dr. Hudson Glimp once told our group that 90% of our marketing decisions were made when we did three things: (1) When we own or buy a ewe with her genetic possibilities, (2) when we buy a ram with his possibilities, and (3) when we turn the two together. Our efforts are extended in this 90% area where we can exert the greatest influence rather than the actual market area where we have little or no control.

Our philosophy toward and assessment of the mother ewe is changing. We've come to the conclusion that she is necessary, working for us some months of the year and working against us the other months. When she is working for us we indulge in giving her nearly everything she wants. But we also know she's generally eating more than she needs, teaching her lambs bad habits and infecting them with disease and parasites. With this in mind, we decide what we can most economically feed her, how we can most easily handle her and how we can thwart her efforts to keep that lamb at her side for the rest of her life. The ewe doesn't raise the lamb--we raise it.

Another change in attitude and philosophy is directed toward the lamb. The moment a lamb hits the ground, we must first decide on what needs to be done to keep him alive. You can't make money on a lamb that isn't there. This done, we than embark on a program to get him to market as rapidly as possible.

We're seeing changes, some subtle and others rather bold, in priorities being established by members. One has leased out his farm land and doubled his ewe operation (from 200 to 400 head), and his number of feeder pigs. Another is phasing out his feeder pig operation and will use the facilities to increase his production ewe herd from 150 to 500 head. Another is planning to gradually replace his 240 sow herd with ewes. He is beginning with 270 head. Still another is planning on putting some of his poorer corn ground into permanent pasture for increasing his flock to 700 head. Yet another has quit a 14 year teaching career and now has 400 head of ewes with plans to increase numbers. Another is beginning to work toward running 500 ewes on six acres. These people are all changing priorities, establishing new ones and looking toward sheep production as a major source of income. They are setting up realistic, short and long term goals based on their desires, abilities and an assessment of their immediate resources such as available capital, present facilities, pasture, residue feeds, hay, sileage, grain and the other tools available to them for increasing income and profit.

Our management and methods are changing. It was a general practice in our area to lamb during February through April with a relatively good job done. When it came time to farm the land in April, the ewes and their lambs were turned to grass by the farmer and forgotten until fall. During the fall months the ewes were finally brought in and the lambs weaned. The lambs in most cases were loaded with parasites and weighed about the same as when they were turned on the grass in the spring. They finally made it to market at about 11 months of age and were at last gone just before the new crop was to be born. No wonder people quit sheep. They were tired of having the lambs around.

Today we lamb in late winter and early spring. To more efficiently use facilities and labor, most are group lambing. The number of ewes in each group is based primarily on the size of the sheepman's lambing area.

Our rams are marked and these fellows designate by their marks the ewes that will be in group 1, 2 or 3.

We wean early at from seven to nine weeks. The ewes are then placed on an austere maintenance diet. The lambs when born are immediately started on creep. We've noticed some lambs beginning on creep feed as early as 48 hours of age. The lambs all go to a self-feeding system until they're slaughtered at from 100 to 180 days of age and at a weight based on feed efficiency.

We're using a vaccinating program on our lambs for enterotoxemia and sore mouth. Our ewes are vaccinated for vibrio and with type C and D during the last third of pregnancy.

Two members syncronized 100 ewes each last year for out-of-season breeding. Another put 140 lambs on slats this past summer. Another will try an automatic water medicator in an attempt to reduce pneumonia losses. Another hand fed 750 ewe lambs and ewes using 12 twelve-foot troughs in a kitchen arrangement, feeding 250 head at a time. His feeding time - 1 hour 15 minutes per day.

Our nutritional programs are based on the feed the member has in the bin. It can be said, however, that our ration for the lambs begins at about a 24% protein level with this being gradually reduced until the lambs are finished on a 15% ration.

We don't castrate the ram lambs. Seems a bit ridiculous to take out the testicles and them implant hormones to do the job the testicles were doing.

Our breeding is gradually changing. We're formulating specifications to be applied to our breeding ewes. These specs involve longevity, hardiness, mothering, milking, size and above all, expected lamb percentage potential. Eighteen of our 49 members are using Finnsheep and/or Border Leicester in a cross breeding program to produce breeding ewes with an anticipated capacity to increase lambs dropped per ewe. Even though our experience is somewhat limited, we like the lambs we're getting from the few Suffolk x Hamp rams we've used.

We believe we're seeing a subtle change in confidence. All members have and use the SID Sheepman's Handbook. They are finding ready answers to their day to day problems from their veterinarians and from the project. One example of increased confidence can be pointed out by one member who was approached to join the project. He said, "I didn't think you'd want me." Today he has 600 ewes and has built a new sheep shed. Speaking of sheds, since the project began 18 of the members have either built new sheds or have done some major remodeling of existing facilities.

Our member numbers are increasing. We now have 49 in the project who own and manage 14,000 ewes. These same people owned 4,685 head before the project began. Of the 49 members, 16 didn't own sheep prior to January 1970.

Both the growth and the change have been encouraged and nurtured by a number of things: (1) Relatively good lamb prices, (2) stable wool returns, (3) increasing success as measured by profits. For example, one member, who marketed an 85% lamb crop before joining the project, changed lambing time and procedures and the next year marketed a 145% lamb crop. This last year his gross income was $22,259.14 from 375 ewes. Expenses amount to $11,502.00 and the operation shows a net of $10,757.14. He intends to do better next year because 100 of the 375 were yearlings. Another has a gross of $8,000 from 150 ewes.

In our project we jointly own equipment that makes our work easier. We have a tilting squeeze for hoof trimming, a portable scale to determine lamb and ewe weights, and docking, drenching and vaccinating equipment. We're designing and plan to build portable corrals and sorting equipment.

During the winter we hold a minimum of twelve evening sessions. Some of these are devoted to reviewing the fundementals of sheep raising, such as common health practices, flushing, rations, etc. We use tele-lecture equipment, which is nothing more than an amplifying device for long distance calls, to talk with experts from all over the U.S. This costs us a bit more than $8.50 per half hour. Our sessions begin at 8:00 p.m. and quit at 10:00, and ordinarily I have to run some of the member-producers out at midnight so the janitor can go home. We're beginning to communicate among ourselves and with sheep people who can help us. We're searching for answers and in most cases finding them. At Pipestone we have no problems - only challenges.

We've only scratched the surface of effectively using the many tools available to us to increase income and reduce labor. We've done no research, but rather have sought information and guidance from those in research. We hope we're to accept new approaches, new thoughts, and never find ourselves in the position of thinking we may have all the answers.

We're optimistic about the future of the U.S. sheep industry and about our future in it.

Will some of these beliefs or practices work for you? You tell me.

FOOTROT RESEARCH AT OREGON STATE UNIVERSITY—A PROGRESS REPORT

S. P. Snyder

Lameness in sheep can be the result of several infectious diseases. Among these are interdigital dermatitis caused by *Spherophorus* (*Fusiformis*) *necrophorus*, foot abscess, post-dipping lameness, and footrot. Of these, footrot is by far the most common and most important economically.

Footrot is typically a localized infection that begins as an inflammation of the skin between the toes and spreads into the horny layers of the claw, causing separation of the wall and sole of the foot from the soft tissue beneath. The bacterium ultimately responsible for these degenerative changes in the hoof is *Bacteroides* (*Fusiformis*) *nodosus*. This organism is an obligate parasite of the sheep's hoof and only survives for a short time (generally less than a week) in the soil. Spread of the disease occurs when a susceptible sheep's feet are contaminated with exudate from an infected animal (1).

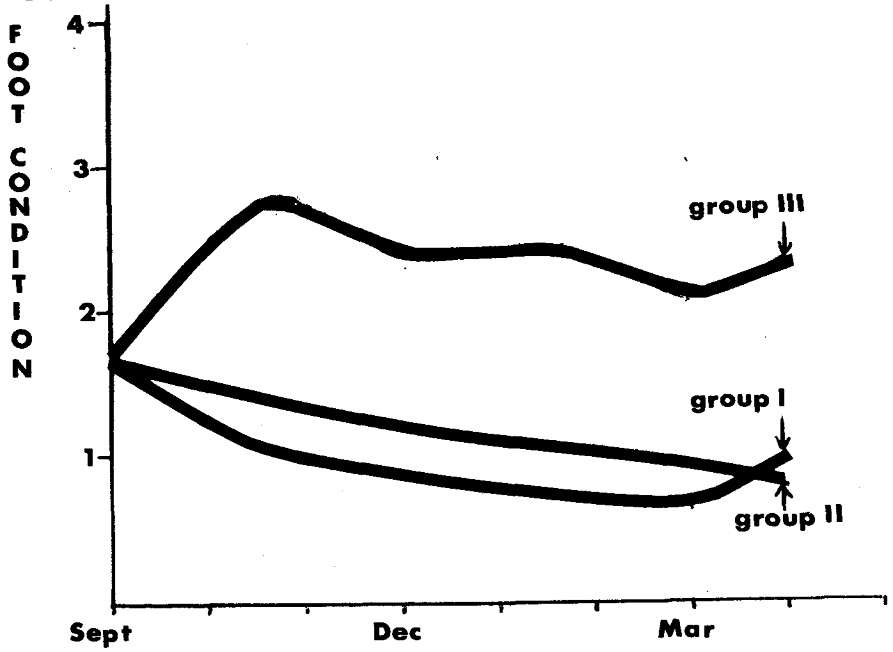
Traditionally, footrot has been controlled by a rigorous process of careful foot trimming, separating infected animals from those without lesions, and foot-bathing with solutions of formalin, copper sulfate, or other bactericidal agent. This procedure has been less than satisfactory in areas such as western Oregon where there is a prolonged period of high rainfall. Labor becomes the principal expense since a conscientious program for controlling the disease involves repeated examination, trimming, and footbathing of all animals. Complicating these problems is the fact that there is virtually no natural immunity to footrot. That is, a sheep is no less susceptible to reinfection with Bacteroides nodosus after being cured of the disease than an animal that has never been previously exposed.

In recent years there has been a considerable effort in Australia and New Zealand to develop immunizing agents against footrot in sheep (2-4). The success of these vaccines has been quite variable. On some farms good protection against challenge has been seen, while on other farms the results have been unsatisfactory. It was later shown that some of the poorer results were where strain differences in the causative organism existed. Since then, additional strains of Bacteroides nodosus have been incorporated in the vaccine and the results of vaccination have generally improved. Recently, several American companies including Phillips-Roxanne, Jen-Sal, and Diamond Laboratories, have initiated research on developing vaccines for footrot since the foreign companies have been unable to meet local demands for their products. As yet, no vaccine is available for trial useage by the American companies.

Experimentation at Oregon State University with the vaccine developed at the McMaster Laboratories in Australia (2) was begun in the fall of 1972. Three groups of sheep were utilized in this trial. Group I was given one dose of the vaccine 6 weeks prior to the anticipated start of the fall rainy season and was revaccinated 4 weeks later. Group II was vaccinated once at the time of giving the second dose to Group I. Group III was left unvaccinated. Each animal was set up and each hoof was examined and trimmed prior to vaccination and monthly thereafter. Serum samples were obtained prior to vaccination and at regular intervals thereafter to test the immunologic response to the vaccination. To insure a severe challenge against the vaccine, animals of all three groups were allowed to intermingle freely and no foot-bathing was done. During the monthly inspections of the animals' feet, lesions were ranked according to their severity, using the system of Egerton and Roberts (5). A score of 1+ indicated limited mild interdigital dermatitis; 2+ extensive interdigital dermatitis; 3+ interdigital dermatitis and underrunning of the horn of the heel or sole; and 4+, severe footrot with extension of the lesions to the walls of the hooves. After each animal in each group was ranked, an average value was obtained for the group as a whole at each inspection. The results are graphically illustrated in Table 1. After vaccination, trimming of the feet was limited to that necessary to establish the presence or absence of infection or to obtain samples for bacterial isolation.

TABLE 1

INCIDENCE OF FOOTROT IN VACCINATED AND CONTROL SHEEP



Although done on a rather small scale because of the limited quantity of vaccine obtained, the results indicate that the Australian vaccine may be of value in minimizing the severity of lesions due to footrot in Oregon. Little difference can be seen between those vaccinated once and those vaccinated twice. As can be readily appreciated, the vaccine is not 100% effective. Some animals were completely cured, some were partially cured, some have about the same severity of lesions now as when we began and a few have more severe foot lesions now than when the project was undertaken. In the unvaccinated animals, the lesions in general became much more severe with the onset of the rainy season and have remained severe since. One must also realize that, since these animals were not foot-bathed, the severity may be more pronounced than they might have been. Efforts at the present are in determining if the strain of Bacteroides nodosus in the flock under investigation is one of the three strains included in the vaccine. Further investigations using this and other available footrot vaccines on other farms will be needed to establish the efficacy of the vaccine. Results may differ when sheep on different farms using different management procedures are vaccinated.

Vaccines for ovine footrot have generally been formulated using either an oil or alum as a carrier or adjuvant. Adjuvants are substances added to vaccines that impede or slow down the rate of absorption of the vaccine from the site of injection. This gives a sustained release of the antigen (in this case the bacterium, B. nodosus) to the cells of the body that confer the immune response. In general, alum-precipitated footrot vaccines (6) are less effective than the oil emulsion vaccines since they are absorbed more rapidly. On the other hand, the oil-containing vaccines produce a rather remarkable local tissue reaction, or granuloma, and are unacceptable for animals intended for slaughter or exhibit (7). Granulomas up to 4 inches in diameter have been produced with the recommended dose of commercial vaccine. With time, these granulomas will regress and no longer be palpable, although small ones are still present after 7 months in a few animals.

The advantages of vaccination over the traditional methods of footrot control, especially in regard to convenience and the consequent saving of time and labor, need no elaboration. It must be emphasized, however, that even in countries where vaccination has become more routine, it is used in conjunction with proper foot-trimming and bathing for maximum control of the disease (8). Also, foot-bathing is still the most satisfactory means of controlling foot scald or interdigital dermatitis. Hopefully, in the not-too-distant future, effective and inexpensive vaccines will be available from American companies for footrot control.

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