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REPRODUCTIVE EFFICIENCY OF FINE-WOOL SHEEP

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CONTENTS

SUMMARY

Improved lamb production will strengthen the competitive position of the Texas sheep industry. A real opportunity exists for improvement in reproductive efficiency since the average lamb crop weaned in Texas over the past 5-year period was approximately 75 percent. In comparison, individual flocks have weaned up to 120 percent lamb crop. Small experimental flocks have a lambing rate of 150 percent.

The best reproductive rate is obtained when mature fine-wool ewes, 3 to 5 years of age, are bred to fertile rams of another breed. The ewes should be smooth, open-faced and in medium to strong flesh, weighing 120 or more pounds. They should have lambed regularly in previous years and preferably raised twins. Both ewes and rams should be free of infectious disease. Also, the animals should be protected from heat stress at mating and during gestation. Maximum reproductive efficiency is obtained when ewes are bred in the fall to lamb in the spring, but it may be desirable to deviate from this due to other factors to be considered in the management program. Adequate nutrition is necessary during gestation to insure well-developed lambs and to prevent losses from pregnancy disease.

Data are included to indicate degree of loss in reproductive efficiency associated with various degrees of deviation from the optimum.

Observations over the state indicate the following as some of the main causes of poor lambing results.

Lack of size or development of yearling ewes,

High percentage of yearling ewes in the flock,

Poor condition of mature ewes,

Heat stress during mating or gestation,

The increasing tendency to breed at the seasons of low fertility,

Heavy death losses of lambs due to poor nutrition of ewes or adverse weather conditions at lambing,

Lack of culling for reproductive efficiency.

Reproductive Efficiency of Fine-wool Sheep

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In Texas and much of the Southwest, income from the sale of wool usually exceeds that obtained from the sale of lamb and mutton. While many consider this a favorable status of the wool industry, it also denotes an unfavorable situation of the market lamb industry. Improved lamb production with continued high levels of wool income will help improve the competitive position of the sheep industry.

Lamb production depends on fertility of the ewe flock and growth rate of lambs from birth to market. This bulletin summarizes investigations from this and other locations concerning variables known to affect reproductive efficiency of sheep.

Reproductive efficiency is influenced by variations in the occurrence of estrus, ovulation rate, conception, maintenance of pregnancy and lamb mortality. All of these variables, except lamb mortality, are considered in this publication.

The Potential

Assuming once per year lambing, the production of an individual ewe may vary from none to two lambs. With multiple lambing, two lambs per ewe per year is no longer the theoretical upper limit. However, it is the overall performance of the flock expressed as number of lambs raised per 100 ewes bred which is of greater economic importance.

There are instances where individual flocks approached or even exceeded the theoretical 200 percent in national lambing competition. Lamb drops as high as 150 percent have been realized from Rambouillet ewes under commercial conditions. This can be compared with data in Table 1 which indicate the realized lamb crop for Texas and the United States as a whole. The low lamb crop realized usually is dictated, in part, by environmental conditions of the ewe flock and the feasibility of improving the environment depends on many variables. However, producers should know the factors contributing to fertility so that they may alter their management practices wherever possible to obtain maximum reproductive efficiency. A realistic upper limit under production conditions for once per year lambing in Texas might be 120 percent for range flocks and somewhat higher for more intensively managed farm flocks.

TABLE 1. AVERAGE LAMB CROP (LAMBS WEANED PER 100 EWES IN FLOCK) FOR TEXAS AND U. S.*

	10 year average 1950-59 inclusive	1960	1961	1962	1963	1964
Texas	73	80	79	75	73	69
U. S.	93	95	95	94	95	92

*From U. S. Department of Agriculture, Statistical Reporting Service.

The Male

In the reproductive process, the male is less frequently the limiting factor (Figure 1). Infertile rams, or those of low fertility, primarily affect the number of ewes which conceive, but they may also be a factor in the number of multiple births. The reproductive organs of the male are diagrammed in Figure 2 and sperm cells are pictured in Figure 3.

The males may reach puberty as early as 4 to 5 months or any time thereafter when they approach or exceed approximately 90 pounds in weight, depending on breed. They should be removed from the ewes before this time. Ram lambs may be used during their first season with a few ewes for progeny test purposes. Well-developed rams are capable of a full-breeding load as a yearling or at any time thereafter as long as the ram remains healthy and vigorous. With advancing age, after 2 or 3 years, libido (sexual drive) is likely to decrease, but a ram may give good service up to 8 years of age.

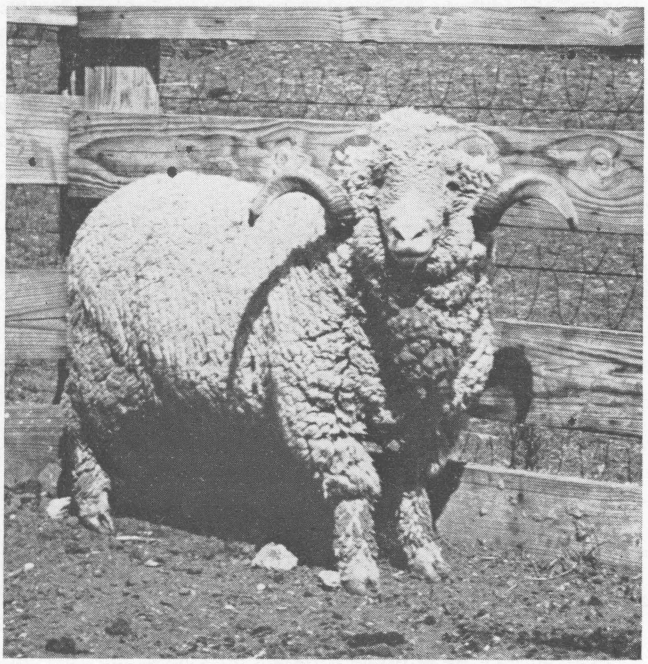

Figure 1. Well developed, vigorous rams usually are highly fertile, but producers should be aware of potential detrimental factors such as epididymitis and high environmental temperatures.

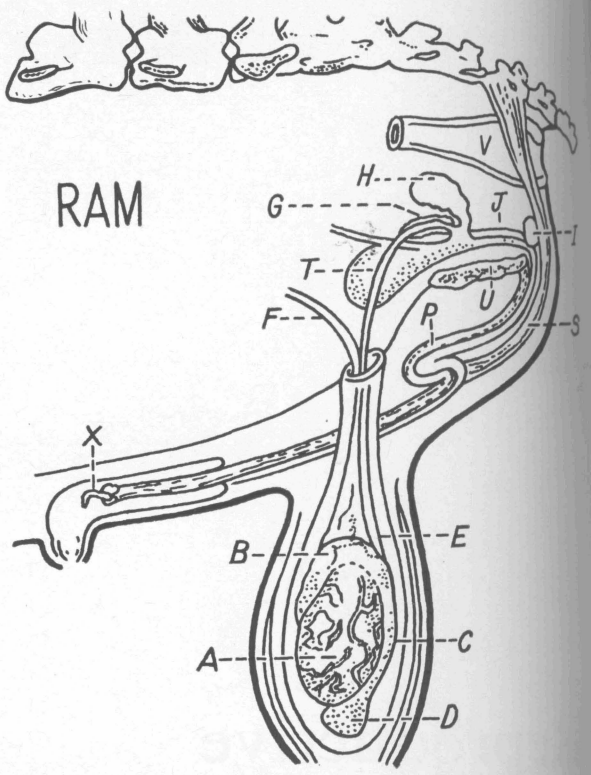

Figure 2. Male reproductive system: A. testis, B. head of epididymis, C. body of epididymis, D. tail of epididymis, E. deferent duct, F. spermatic vessel and nerves, G. ampulla, H. vesicular gland, I. Cowpers gland, J. prostate disseminate, P. penis, S. retractor penis muscle, T. Bladder, U. symphis of pelvis, V. rectum, X. urethral process.

A healthy, vigorous ram has a tremendous capacity for sperm production and thus an almost unlimited theoretical breeding potential. The normal ejaculate of a ram usually will contain about 4 billion sperm. In one series of observations (1), some rams mated as many as 40 times daily and averaged 26 times daily for a short duration, while less vigorous ones mated 12 to 15 times daily over extended periods. However, since a short intense breeding season is desired under conditions which are usually somewhat less than ideal, a standard and apparently satisfactory practice is to use three rams per 100 ewes. Under good conditions and when rams are strong and vigorous, a smaller number may be used during the cool season. More rams should be used with yearling ewes, in hot weather, in very large pastures and when very young or old rams are being used.

Multi-sire matings usually are preferred, as opposed to single-sire matings, although the efficiency of each ram is much less with multi-sire matings. Caution should be taken in mixing several rams with a group of ewes in a small enclosure. Under these conditions, one ram may tend to dominate the others (2) and in effect, single-sire mating with even a larger number of ewes might be practiced. If the dominant ram is infertile or becomes

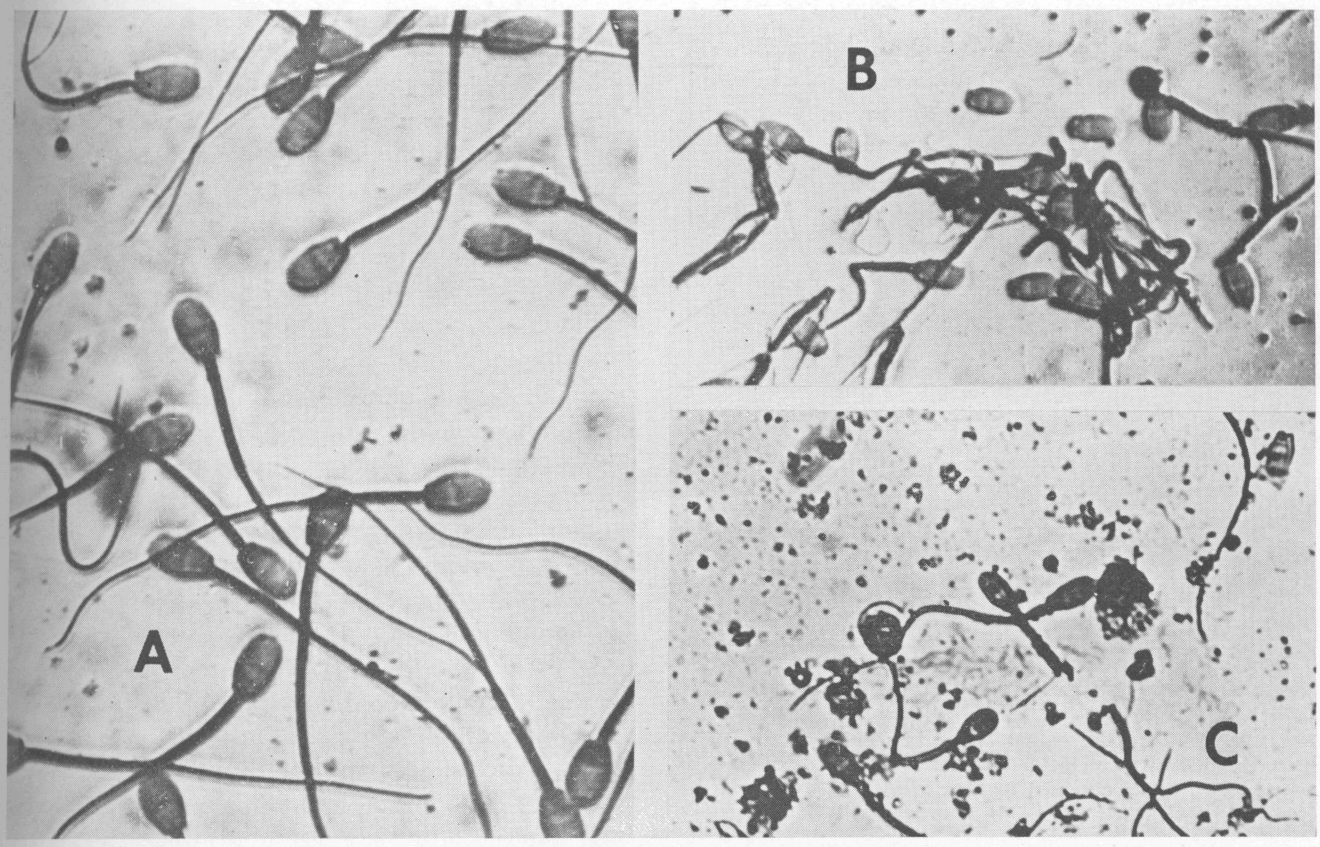

Figure 3. Types of sperm cells from rams — (A) normal and (B and C) abnormal types due to heat degeneration.

infertile, possibly from fighting, serious consequences could result in that fewer ewes might become pregnant.

Some Causes of Infertility in Rams

The major causes of infertility in rams are undernutrition, disease and high environmental temperatures.

NUTRITION

Under Texas conditions, no single nutrient deficiency is known to be a specific cause of infertility of rams. However, general undernutrition often has been observed as a contributing factor. In these cases, development or condition of the animal is a good indication of the nutritional state. The nutritional elements most likely to contribute to undernutrition in the ram are energy, protein, phosphorus and vitamin A, but a long continued deficiency of any of these will manifest itself in the appearance of the animal.

HIGH TEMPERATURES

High environmental temperatures contribute to lowered breeding efficiency of the ram in two respects. The first is reduced mating desire from climatic stress. The second, and much more serious, is the direct effect of temperature on sperm production. For many years it has been known that high temperatures can cause a failure of germ cell production in males of many species, including sheep (3). This first grew out of the observation that cryptorchid animals, those with testicles retained in the body, were sterile (4). From this it was established that the scrotum serves a thermoregulatory function in which the temperature of the testes is maintained at approximately 96° F., 7 degrees below the internal body temperature. Spermatogenesis will be interfered with, when environmental conditions make it impossible for the animal to maintain normal scrotal temperature. Under Texas conditions, practically all rams are affected to some degree during the summer, but the problem is likely to be severe only when temperatures remain above 90° F., with an extended period of high humidity. In drier atmospheres, severe temperature stress or seminal degeneration does not usually occur below 100° F. The length of exposure, such as hours in the day or number of days of high temperatures, are also important factors. Under extreme conditions, a complete cessation of sperm production may occur, with up to 8 weeks required for complete recovery, Figure 3.

Over a period of years, data have been collected at College Station, McGregor and Sonora. Most data on improved breeds of sheep show some drop in semen quality during the summer, but the degree of this effect

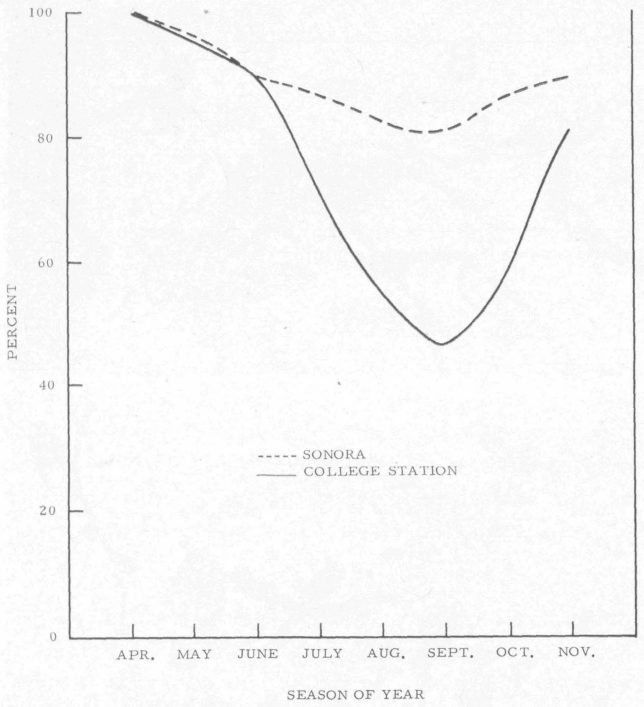

Figure 4. Influence of season of year on estimated total live sperm production per ejaculate of fine-wool rams expressed as a percent of values obtained for April.

has been quite variable. Some results of evaluating semen quality of rams at College Station and Sonora are shown in Figure 4. Only rams of fine-wool breeding (Rambouillet and Delaine Merino) are represented, but a different group of rams and different seasons are represented at each location. Except for total sperm production at Sonora, all seminal characteristics measured showed some drop in summer or early fall months. The degree of effect was much greater at College Station and recovery came much later. Examination of the data suggests that at Sonora nearly all rams would have remained fertile throughout the summer but would have had lowered total breeding efficiency. However, at College Station it appears that 40 to 50 percent of the fine-wool and all the medium-wool rams would probably have been sterile during late summer or fall. Complete recovery of all rams did not occur until after September. Rams which had a sterile period early in the summer recovered earlier than those showing a sterile period later in the season. Other conclusions from this series of studies indicate that (a) rams of medium-wool breeding are affected more severely than fine-wool rams, (b) heavy use of rams adversely affects semen quality, (c) late spring or summer shearing has a beneficial effect, (d) young rams, particularly lambs or yearlings, are more severely affected than mature rams, particularly if they are fat going into the summer season. No complete solution is known, but consideration of the foregoing facts offers some suggestions for minimizing the effect of high environmental temperatures on fertility.

Use of a larger number of rams on a rotational basis usually is advantageous. Also, removing rams from the flock to shade and rest during the day has some advantage (5). Under range conditions in the Edwards Plateau or West Texas where late fall breeding is practiced, high environmental temperatures are not a serious problem.

DISEASE

Any disease which brings about an extended period of fever or elevated body temperature can cause infertility of rams.

In recent years, a disease known as epididymitis (Figure 5), specifically associated with the reproductive organs of rams has been identified. This condition, caused by infectious agents known as *Actinobacillus seminis* and *Brucella ovis* has been identified in Texas (6). In one Texas survey (7) the overall incidence of affected rams was 7 percent, but the incidence in individual flocks ranged from 0 to 50 percent. This disease appears to be increasing. Rams with this defect are not completely or permanently sterile, but the presence of the disease in a flock has been definitely associated with a lowered lamb crop. Affected animals should be sold for slaughter.

Affected rams usually show one or more enlarged or swollen testicle or epididymis or some part thereof. Most producers can train themselves to identify infected animals by palpating the testis. Producers should learn the structure and texture of the normal testis, and any deviation from the normal in terms of an enlargement or hardening is cause to suspect the ram. A recently produced vaccine for this disease has received only limited testing in Texas. This disease is thought to be passed from one ram to another by mounting. Incidence of the disease can be reduced by starting with a group of clean ram lambs and keeping them separate at all times from older rams. There also is circumstantial evidence that the disease can be passed by rams to the ewes resulting in abortion or birth of weak or dead lambs.

Figure 5. Enlarged testicles due to epididymitis. Either or both testicles may be affected.

Fertility Testing of Rams

Fertility testing of rams has been used to a limited extent, but there are serious limitations. None of the several methods of collecting semen for examination are entirely satisfactory. Semen obtained by means of the artificial vagina provides a good basis for estimating the fertility of rams. Most rams in Texas are too wild to serve an artificial vagina without spending much time in training. The second method of semen collection is by the use of the electro-ejaculator. Using this procedure, samples can be collected from a large number of rams in a short time. However, the correlation between fertility and semen quality rating of samples obtained by this procedure is not high (8). A good rating of semen obtained by this method is almost a positive assurance of fertility if the ram is vigorous and has a normal mating desire with no physical limitations. However, if all rams showing poor semen quality by this procedure were discarded, a large number of good rams would be sacrified. A second test at a later date will help clear up some of the questionable rams.

A third collection procedure that has been used to a limited extent consists of allowing the ram to serve the ewe, and aspirating semen from the vagina. This ewe may be a restrained ewe or one which is in a normal heat or one previously treated with stilbestrol. A good estimation of the fertility of a ram can be obtained by this procedure, but it is not very practical for a large number of commercial rams. This procedure usually can be utilized satisfactorily for testing a small number of gentle rams such as stud rams.

Because of the equipment and training required, fertility testing of rams must be done by a qualified veterinarian or specialist with experience in this field.

The Ewe

Ewes may reach sexual maturity as early as 7 months if they have been grown out properly. Commercial programs in some areas call for placing these ewe lambs with rams in order to lamb at 1 year of age. In general, this has not proved satisfactory in Texas. Spring-born, range-raised ewe lambs seldom have the size necessary for breeding at this early age. Fall-born ewe lambs out of a milk-lamb program may have adequate size to breed their first year, but this requires that they be bred in spring or summer when often they are losing weight. Ewe lambs were exposed to rams in the spring and summer for 2 years at the Livestock and Forage Research Center, McGregor, with only a 15 percent lamb crop realized. This could no doubt be improved if environmental limitations such as temperature, nutrition and parasitism in the summer could be improved.

Subject to seasonal or other restrictions, the ewe begins to exhibit heat periods when she reaches an adequate stage of development (approximately 85 pounds and up). In young ewes (lambs or yearlings) this heat period usually is of low intensity and lasts from 12 to 20 hours, while older ewes show a much more active heat period which may last 30 to 36 hours. Ovulation occurs near the end of the heat period. This suggests that if a ewe is mated only once, she should be mated in the latter part of the heat period. However, under natural conditions, each ewe usually is mated several times if enough vigorous males are present; thus, timing is relatively unimportant.

The estrous cycle (period of time from one heat period to the next) lasts approximately 17 days, but may vary 1 or 2 days. The gestation period (time from mating to parturition) lasts approximately 149 days for all breeds except the Southdown, which usually is shorter. Ewes dropping twin lambs usually have a shorter gestation period.

EFFECT OF AGE

Age of the ewe influences fertility. Management decisions relating to age include age to breed, desirable age to cull and any management decisions which might possibly alleviate the effects of age on reproductive performance. Lambing at 18 months may yield satisfactory results if this can be worked into the management program; otherwise, lambing at 2 years of age is the standard practice. The effect of age on ewe performance under range conditions at the Ranch Experiment Station, Sonora, is shown in Table 2. These data (9) indicate an annual

TABLE 2. RELATION OF AGE TO PERFORMANCE OF RAMBOUILLET EWES UNDER RANGE CONDITIONS (SONORA)

Age of ewe	Number of observations	Average body weight pounds	Percent dry ewes	Percent lambs		Pounds of lamb weaned per ewe bred	Percent ewes lost	Fleece weight pounds
				Born	Raised			
2	871	94.3	30.0	77.4	65.7	42.7	3.5	9.5
3	679	103.3	11.8	106.9	97.0	66.8	3.1	9.9
4	525	112.8	11.4	116.4	103.2	72.7	3.7	9.7
5	427	115.0	11.5	113.8	99.8	74.7	4.4	9.4
6	339	117.2	9.8	118.9	105.3	71.8	5.8	9.2
7	241	117.3	12.9	114.1	101.2	67.2	6.3	8.6
8 plus	216	115.2	19.9	106.5	90.3	57.4	10.3	7.9

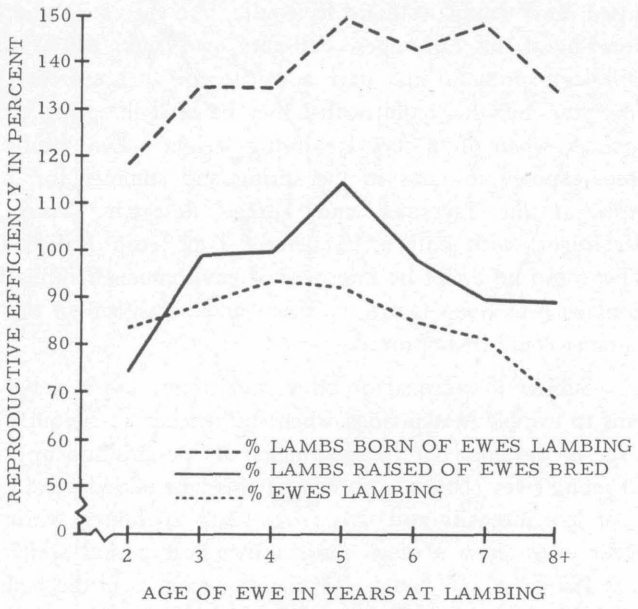

Figure 6. The relation of age of ewes to various measures of reproductive performance (McGregor flock data).

increase for up to 5 years in pounds of lamb weaned per ewe bred and then a fairly constant decline. A somewhat similar analysis involving data collected at McGregor is shown in Figure 6. Data from both stations indicate that a major deterrent to good breeding performance stems from poor results with yearling ewes. The average flock may contain 25 percent or more yearlings. Thus, a major effort should be made to maximize the performance of this age group.

Ewe performance tends to drop after 6 years of age. However, assuming that perennially barren ewes and those with broken mouths and bad udders are removed, aged ewes are likely to perform better than yearlings, even to the advanced age of 8 years. This, plus the comparative value of aged ewes and cost of replacement ewe lambs or yearling ewes, strongly suggests that aged ewes should remain in service as long as they are capable of producing lambs. The exact age at which culling is necessary depends on environmental conditions.

A decline in breeding performance seems to begin earlier in the McGregor flock than in the Sonora flock. This may be related to the rate of early development since the ewes in the McGregor flock are grown out much faster as lambs. Although not shown by these data, the more extreme length of productive life often is obtained on ewes raised under range conditions and later transported to the improved conditions often found in farm flock-type operations.

BREEDING OR MANAGEMENT FACTORS AFFECTING LONGEVITY

Length of productive life is a valued characteristic of breeding sheep. Many producers have expressed a desire to select for this characteristic. The heritability of longevity is not known; however, by comparison with similar productive traits, one would predict it to be low. In addition, there are the added complications of extensive record keeping, and an inability to measure this characteristic until the animal is approaching or has passed its stage of maximum usefulness. These complications plus the fact that some selection for longevity is automatic in nature unless ewes routinely are culled at a constant age, tend to indicate that extensive programs selecting specifically for longevity under commercial conditions are not justified at present.

However, management factors affecting longevity should receive immediate consideration. The rate of early development is related to length of productive life. This was first noted between species or between breeds. Merino sheep grow at a slower rate than Rambouillets but usually remain in the productive flock for a longer time.

The rate of early development also is related to length of productive life. Data collected at Sonora show this phenomenon applies as well to range-raised fine-wool sheep. Figure 7 shows the relationship of weaning and yearling weights to length of productive life. These data show that extremely heavy ewe lambs (above 85 pounds) or yearling ewes (above 115 pounds) do not remain in the breeding flock as long as those grown out at a slower rate. Likewise, underdeveloped yearling ewes remain in the productive flock for a shorter period. However, lightweight ewe lambs apparently are satisfactory if given an opportunity to develop properly before entering the breeding flock. An explanation for the effect of developmental rate on longevity is not known, but this phenomenon has some important implications for livestock producers. Under commercial conditions, consideration should be given to selling or extensive culling of heavy commercial ewe lambs and keeping lambs with more intermediate weights for replacement purposes. This practice would partially eliminate the automatic selection against twins in range flocks.

EFFECT OF SIZE AND CONDITION

Size, development and fatness appear to be the key to much of the observed variation in reproductive performance. It is difficult, if not impossible, to visually distinguish size as a measure of skeletal growth and development from the influence of condition or amount of fat.

Analysis of data collected on the Sonora station (10) indicates a direct linear increase in all aspects of reproductive performance as yearling body weight increases up to approximately 115 pounds. This is realized through fewer dry ewes, a higher percentage of lambs born and raised, larger lambs and greater longevity in the producing flock. The combined effects result in approximately 4.5

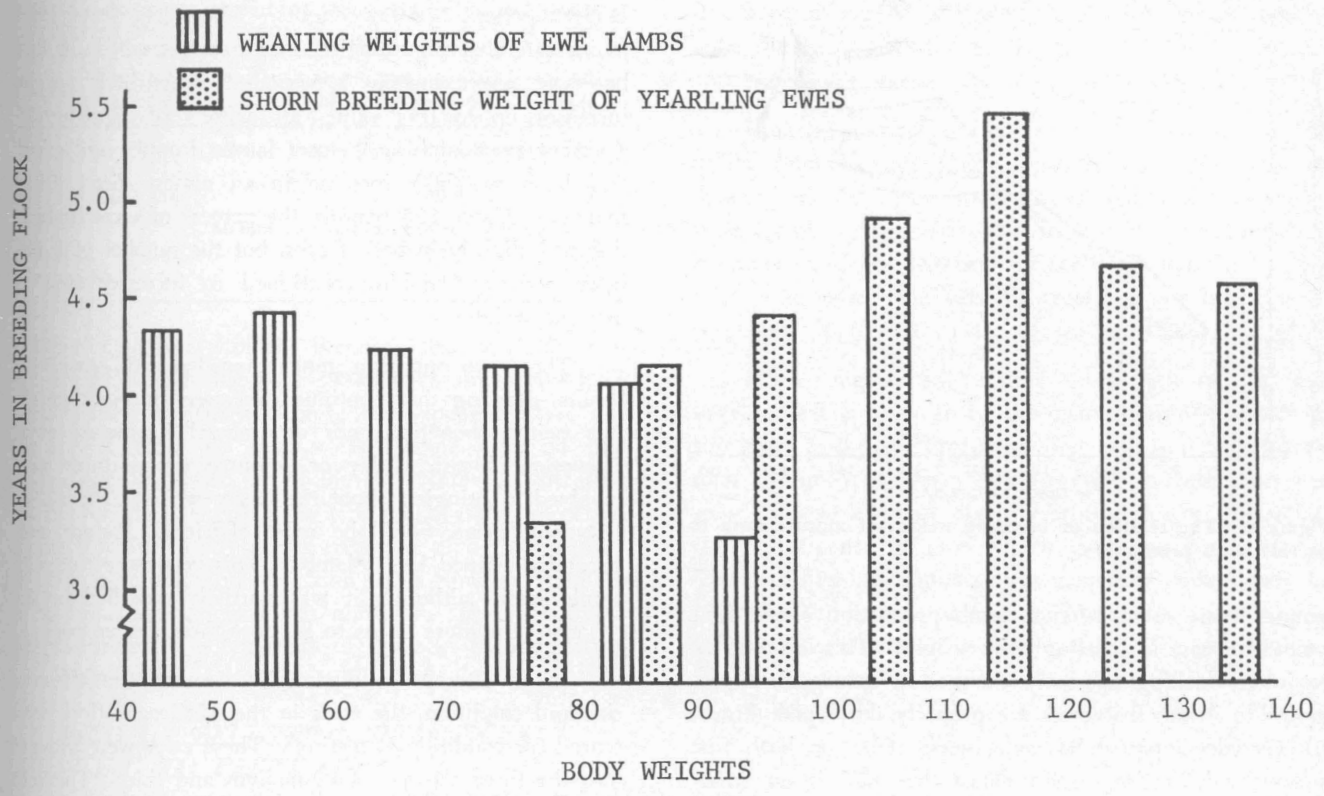

Figure 7. Relation of body weights of lambs and yearlings to length of time in the breeding flocks.

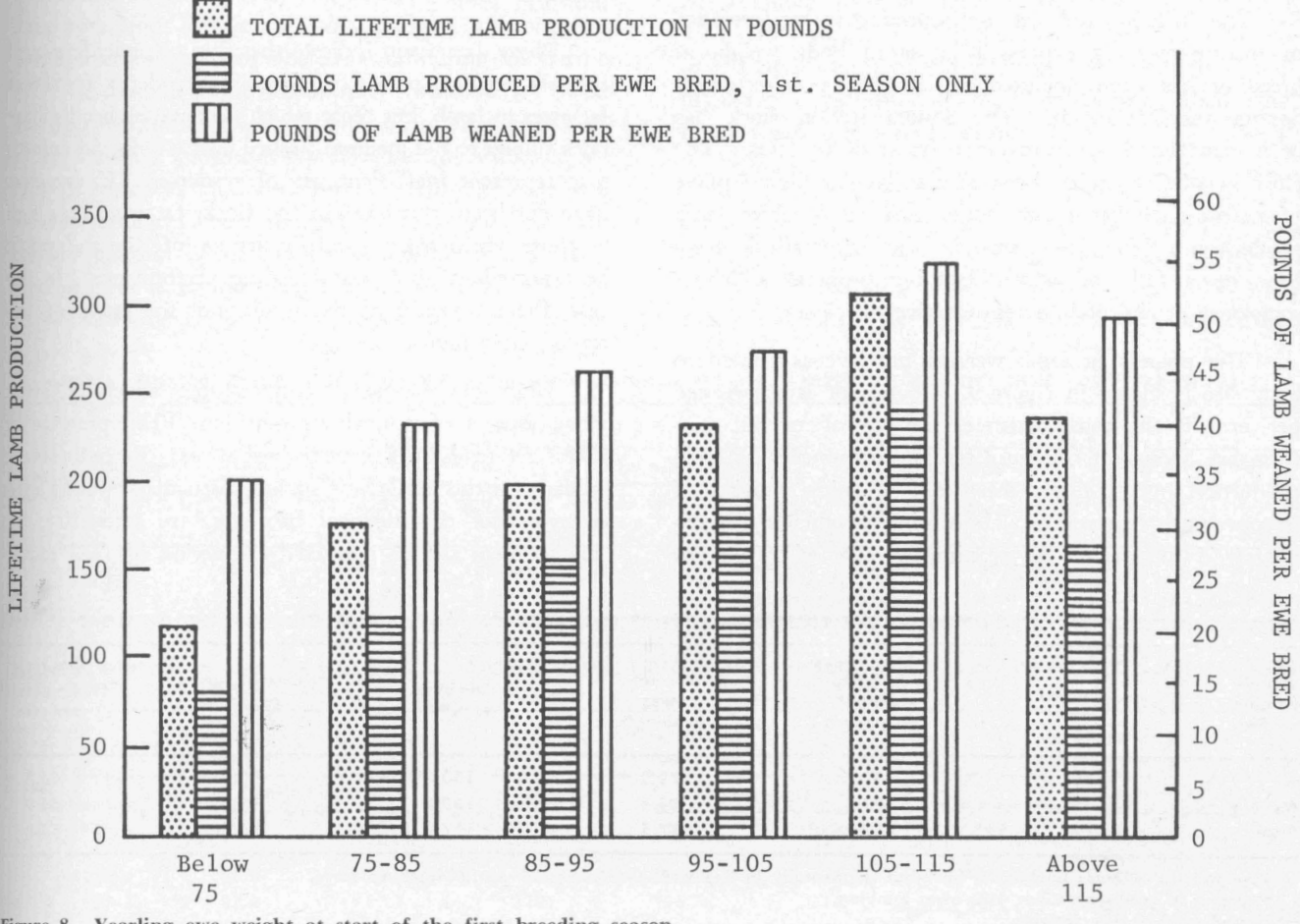

Figure 8. Yearling ewe weight at start of the first breeding season.

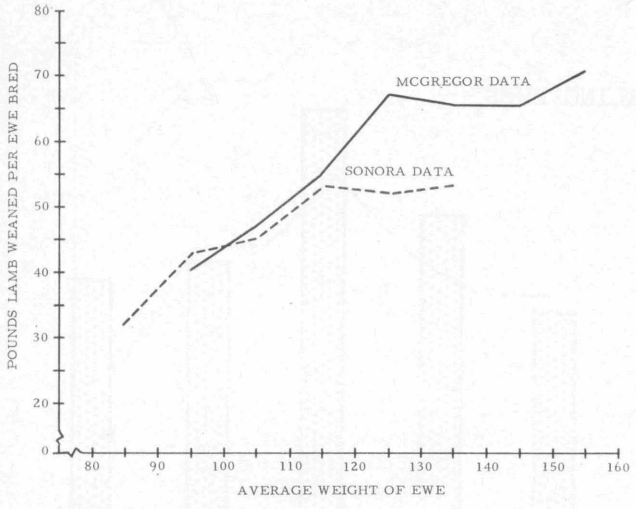

Figure 9. The relation of breeding weight of mature ewes to overall lamb production.

pounds increase in lifetime lamb production for each 1 pound increase in yearling body weight. This is sufficient to justify making necessary changes in management programs to insure that ewes are properly developed, Figure 8. Overdevelopment has an adverse effect on both first season and lifetime performance, but this is an infrequent occurrence under range conditions.

The influence of size on reproductive performance of mature ewes as expressed by shorn body weight at breeding has been analyzed utilizing data collected at Sonora and McGregor. The Sonora station flock has been managed similarly to range flocks of the area. The flock at McGregor has been managed on a higher plane of nutrition, as are many flocks used in slaughter lamb production. However, ewes in the latter flock have been on a fall and winter lambing program which is somewhat detrimental to reproductive efficiency.

The pounds of lamb weaned per ewe as related to body size is shown in figure 9. Pounds of lamb weaned per ewe is the most accurate measure of overall performance because it combines several components of lamb production into a single measure. Weaning weights of Sonora lambs represent actual weaning weights at approximately 6 months. The weaning weights of McGregor lambs represent 120-day weights. These data clearly seem to indicate that physiological maturity is reached for this breed at approximately 125 pounds. As body weight increases up to this value, all aspects of reproduction (percent ewes lambing, percent lambs dropped and raised and lamb weights) increase in an almost direct linear manner. Above 125 pounds, the percent of ewes lambing dropped slightly in both flocks, but the number of lambs born per ewe lambing continued to increase, even at extreme weights.

These two opposing trends cancelled each other with results showing that continued increase in body weight was neither beneficial nor detrimental in mature ewes. However, if cash outlay or resource expenditures were involved in bringing about the larger weights, the 120 to 130-pound ewe would be most efficient. Larger ewes generally weaned larger lambs. This was more true with single lambs although it was partially cancelled by the tendency for more twins to be born from larger ewes.

In an attempt to distinguish between the effect of size and condition, the ewes in the McGregor flock were scored for condition at mating. These ewes were grouped into the three classes: fat, medium and thin. The relationship of condition score to reproductive performance is shown in Table 3.

These data again indicate that thin or underdeveloped animals perform poorly. There is a tendency for fewer fat ewes to lamb, but those which do have higher lambing rates similar to the medium-fleshed ewe. Thus, fat animals may represent inefficient use of resources. If dry ewes have not been identified in the flock, fat ewes may well be those which are perennially dry or infertile and would be expected to give poor breeding performance. In this case, the fat would be the result, not the cause, of low reproductive performance.

High environmental temperatures adversely affect many aspects of animal reproduction. The presence of excess fat tends to aggravate heat stress. Exceedingly fat animals on the McGregor station, particularly young ewes or ewes not of fine-wool breeding, are often dry, but this problem can be reduced by a period of feed restric-

TABLE 3. THE RELATION OF CONDITION SCORE TO REPRODUCTIVE PERFORMANCE OF FALL-LAMBING EWES ON THE McGREGOR STATION

Classification of ewe	Number ewes	Average weight in pounds	Percent ewes lambing*	Lambing rate**	Percent lambs raised of ewes bred	Pounds of lamb weaned per ewe bred***
Fat	358	147.8	79.3	150.0	93.3	66.3
Medium	668	129.5	84.4	135.3	92.8	66.9
Thin	129	111.8	77.5	117.0	74.4	53.2

*The percent of ewes lambing is low, but is generally in line with that expected of fall-lambing ewes.
**Number of lambs born per 100 ewes lambing.
***Based on 120-day weights.

TABLE 4. EFFECT OF RESTRICTED FEED INTAKE ON FAT EWES IN ADVANCE OF BREEDING SEASON

Treatment	Number ewes	Breeding weight	Percent ewes lambing	Lambing rate
		Yearling ewes—Rambouillet breeding		
Control	49	123.5	71.4	
Restricted feed	113	112.1	89.4	
		Mature ewes—Rambouillet breeding		
Control	63	141.2	92.1	153.4
Restricted feed	55	130.9	90.9	146.4

tion well in advance of the breeding season. This does not apply to aged fine-wool ewes which previously have been lambing regularly, because they apparently are less seriously affected by heat stress. Some data on this phenomenon is shown in Table 4. Note the different reaction of the two groups to a period of feed restriction before breeding. Treatments consisted of drylot confinement on a submaintenance ration for a time sufficient to bring about the weight losses indicated. Feed restriction was terminated at a minimum of 2 weeks before placing ewes with rams.

CULLING OR SELECTION PRACTICES RELATING TO FERTILITY

Since fertility or overall reproductive efficiency is one of the most important components of a successful sheep enterprise, this factor also should receive consideration in selection practices. Selection or culling for fertility may have goals of improving fertility in the current breeding flock or in future generations. The first goal deals with a function known as repeatability, the value of one season's record as an indication of performance in subsequent seasons. The second objective would deal with the phenomenon of heritability or the degree to which superiority or inferiority would be passed from one generation to the next. In general, repeatability of reproductive performance is moderate to high, whereas heritability generally is low. However, these are not fixed quantities and depend greatly on the conditions involved.

Culling practices related to improvement of fertility in the flock have been investigated using data from the Sonora and McGregor flocks (11). The data relating to such factors as age, size, condition and so forth should be considered in selection or culling practices. Data relative to using one season's record as an indicator of subsequent performance are shown in Tables 5 and 6.

With range-raised yearling ewes, lack of size and development is likely to be the major limiting factor. In this case, failure to breed the first year seriously affects total lifetime performance. However, in following seasons, ewes which were dry as yearlings closely approached the performance of ewes which lambed their first year. Thus, culling of similar ewes generally would not be recommended because of failure to breed their first season. Where lack of size and development is not a limiting factor, ewes dry in a given year generally will perform less satisfactorily in following season, Table 6. This is true because a dry group will contain many permanently infertile animals which generally cannot be identified visually. The desirability of culling these ewes is largely an economic question and a management decision to be made from year to year depending on sale value and cost or availability of replacement ewes. In most cases, a dry mature ewe will produce more satisfactorily than range-raised yearling ewe replacements.

A ewe raising twin lambs is a better prospect than a ewe raising a single, and a ewe which has lost one or more lambs is the least desirable prospect of the three but would be preferred over a dry ewe. Culling a ewe which raised only a single or a ewe which lost one or both

TABLE 5. LIFETIME PRODUCTION—SONORA DATA—CONTRASTING EWES WHICH WERE WET AND DRY THEIR FIRST YEAR IN FLOCK

Yearling breeding record	Number ewes	Ewe years	Lifetime record				Excluding first year			
			Percent lambs		Total production		Percent lambs		Total production	
			Born	Raised	Pounds per ewe	Pounds per ewe bred	Born	Raised	Pounds per ewe	Pounds per ewe bred
Dry	217	1125	74.8	65.3	215.7	41.6	92.6	80.9	215.7	51.5
Wet	302	1536	96.3	83.3	277.0	54.4	95.4	83.3	225.7	55.3

TABLE 6. RELATION OF ONE INFERTILE SEASON TO REPRODUCTIVE PERFORMANCE THE FOLLOWING SEASON OF MATURE RAMBOUILLET EWES AT SONORA AND McGREGOR STATION

Group	Sonora data (Mature ewes)			McGregor data (Yearling ewes)			McGregor data (Mature ewes)		
	Number ewes	Percent lambs		Number ewes	Percent lambs		Number ewes	Percent lambs	
		Born	Raised		Born	Raised		Born	Raised
Dry	178	88.2	75.8	56	108.9	91.1	43	104.7	83.7
Wet	978	97.0	87.1	238	125.7	115.1	497	131.6	113.5

lambs generally is not recommended unless some additional fault is present.

Numerous analyses have shown that a ewe, dry 2 years in succession, is a very poor breeding prospect and always should be culled (12). Producers should establish a practice of identifying such dry ewes by ear notching at shearing or drafting into a separate pasture. If dry ewes are not culled after one dry season, they always should be culled at the second.

Selection for fertility with a goal of long-term improvement in reproductive efficiency has not been practiced widely in commercial flocks and may not be justified because of the low to moderate heritability and the complicated record keeping required. If management practices and nutritional level are such that twin-born lambs or the highly fertile ewes are not discriminated against, some selection for fertility is automatic in nature. If fertility information is available in ram selection, it should be looked on with favor.

Selection directly for fertility in both experimental or stud flocks should receive considerably more attention than at present. Recent reports (13, 14, 15) indicate that some aspects of fertility such as the occurrence of multiple births may be more responsive to selection than previously thought. There is little or no evidence that inheritance is a major factor in the number of dry ewes.

One of the simpliest schemes in selecting for fertility would be to use only twin-born rams and to favor twin-born ewes where possible. Other procedures would favor animals born as twins under less favorable conditions such as age of ewe, season, etc. or to have collateral relatives with a high level of twinning. In addition to fertility selection, particularly ovulation or lambing rate, there are certain easily identified, highly heritable characteristics which also are related to reproductive efficiency. In many cases, these should receive emphasis in selection programs. One characteristic is size or rate of growth. Selection for increased size may reflect genetic differences as well as the effect of a favorable environment. Increases in size usually will result in improved fertility and should be looked at favorably at least up to the weight range representing physiological maturity for the breed involved (115 to 125 pounds for Rambouillet). Increases in size above this range may not contribute to improved efficiency of the flock.

A large number of body wrinkles are adversely related to fertility (16, 17) but generally this is not a problem with sheep in this country. Reports (18, 19, 20) show that open-faced animals are more fertile than those with wool covering the face. The adverse effects of wool on the face seem to result from partial blinding; however, other unexplained physiological factors also appear to be involved.

A study of this question seems to indicate the following conclusions: A wool-blind animal, or one potentially capable of becoming blind, should be culled when identified, Figure 10. An animal completely open-faced below the level of the eyes is desired, but it should be approached most cautiously using records or estimates of wool production and visual face-covering scores. Great emphasis on face covering without careful consideration of wool production usually will result in some loss of fleece weight.

The adverse effects of face covering are less serious in flocks shorn twice per year or in those grazed in brushy rangelands where the wool around the eyes is pulled out while animals graze. The presence of wool covering on the face is more serious in flocks grazing ranges where needlegrass or speargrass is prevalent. Too much emphasis on the absence of face cover in purchase of ewes for fall lamb production or for a multiple-lambing program may result in a ewe that is less satisfactory for out-of-season

Figure 10. Selecting for more open-faced sheep is one means of selecting for increased fertility.

lamb production. This is not a direct effect of face covering, but is probably the result of genes from nonfine-wool sheep having been introduced to obtain the open-faced characteristic.

INFLUENCE OF SEASON

In their natural state, sheep are almost completely seasonal breeders which mate in the fall and drop lambs in the spring. Domestication has caused the breeding season to be extended. Breeds or types of sheep vary widely in this respect, and fine-wool sheep, such as Rambouillet, are recognized as being the least restricted in their breeding habits. Numerous reports have shown that some Rambouillet ewes will exhibit estrus at any season of the year, but many will show a short anestrous period (a failure to exhibit estrus) in the spring. The presence of or sudden joining with rams plays a part in termination of this anestrus.

Recent studies show other factors relating to reproductive efficiency vary with season as well as the occurrence of estrus. Heat periods are likely to be less intense immediately before or after the anestrus. Ovulation without heat frequently occurs at this time. As a result, the overall conception rate as a percent of the cycling ewes may be still lower in the early spring. In addition, the frequency of twin or multiple ovulations are higher in the fall.

The data on which these conclusions are based were collected at McGregor and are shown in Table 7 and Figure 11. These data were based on 6-week mating periods starting on March 21, June 21, September 21 and December 21. Overall results indicate it is possible to produce lambs any season, but considerable variation in reproductive efficiency should be expected. The low point apparently is obtained from matings in April, and the highest ovulation rate occurs in September. In this study, temperature apparently acted to lower the lambing rate below that of the December mating. Lambs born from spring matings will be dropped over a longer period of time. Within the Rambouillet breed, different groups of ewes will vary widely in the degree of seasonal restriction due to breeding, age (young ewes are more restricted) and, apparently, geographic location.

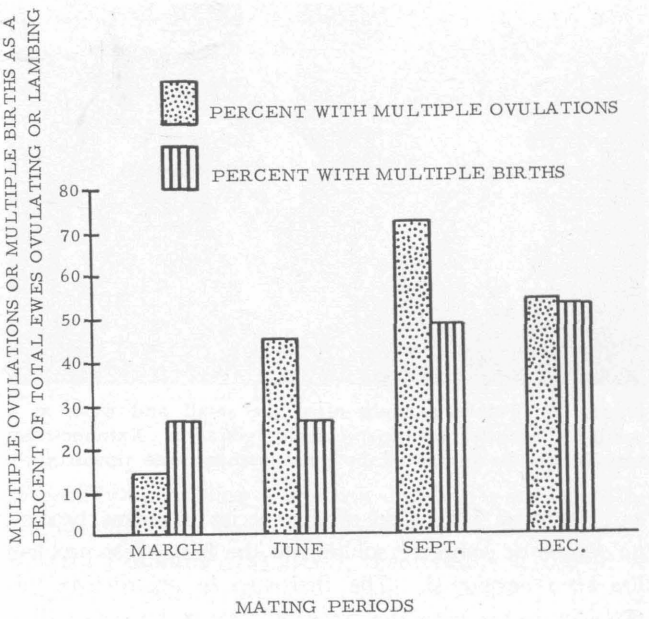

Figure 11. Influence of season on frequency of multiple ovulation or multiple births.

INFLUENCE OF TEMPERATURE

High temperature is a major obstacle to efficient livestock production in Texas and much of the South, and its effect is particularly marked on the reproductive process in the sheep. Table 7 presents data showing the ovulation and lambing rate of aged Rambouillet ewes by season. These data indicate fewer lambs were obtained from the June and September mating periods than the potential indicated by total ovulations. This apparently can be attributed to some of the various effects of temperature on reproduction. However, the loss would be expected to vary considerably in different years and differing sets of environmental conditions.

As many as five different functions have been identified whereby fertility of the sheep is adversely affected by high environmental temperatures. Since the climatic aspect of the animals' environment is difficult to alter

TABLE 7. INFLUENCE OF SEASON OF YEAR ON THE OCCURRENCE OF ESTRUS, OVULATION AND LAMB PRODUCTION OF AGED RAMBOUILLET EWES ON A CONSTANT PLANE OF NUTRITION

Season	Total number of ewes	Percent showing estrus	Percent ovulating	Total ovulations as percent of ewes in group*	Percent ewes lambing	Total lambs dropped**	
						Percent of ewes in group	Percent of ewes lambing
March	116	84.5	92.6	105.6	66.1	83.9	127.0
June	167	96.4	94.7	140.8	76.5	96.5	126.2
September	142	97.2	100.0	175.4	84.5	126.8	150.0
December	114	99.1	98.1	151.9	87.0	135.2	155.3

*Based on an observational laparotomy of a sample of half of the ewes in each group.
**Based on the lambing results from the sample half not laparotomized.

Figure 12. Fall-born lambs often are small and weak as a result of heat stress on the ewe during gestation. Extreme cases usually can be prevented by good management practices.

and improved adaptation of the species is a slow process, no simple or complete solution to the heat stress problem has been developed. The first step in overcoming this problem is knowing the ways heat stress lowers fertility and some of the factors which contribute to or lessen heat stress.

Perhaps the most serious effects of environmental temperature on fertility is lowered semen quality of the male. In the ewe, extreme heat stress causes a period of anestrus in midsummer. Other workers (21, 22) have shown conclusively that heat stress at any time from mating to approximately 8 days after mating can cause embryonic losses in sheep. The physiological mechanism involved here is not understood completely, but it appears the ovum is damaged to the extent that it does not develop beyond the early stages of cell division. Workers mentioned previously were dealing with a constant 90° F. while the sheep were confined in a temperature control chamber. Although temperatures equal to or above 90° F. for a part of the day are a common occurrence during the mating season in the South, this does not represent sufficient stress under natural conditions to cause embryo loss. However, this may not be true of more extreme conditions when temperatures are above 100° F. much of the day. In one experiment at McGregor, the effect of cooling yearling ewes for a short time after a July mating was investigated. In this case a small, nonsignificant increase in the lamb crop was obtained by cooling at mating. The importance of this factor needs further investigation.

Extensive work at McGregor (23, 24) has shown high environmental temperatures can cause fetal dwarfing (Figure 12) and increased death loss of lambs. Extreme conditions also can cause complete embryo loss (25), but this does not appear to be a major loss under natural conditions. Reduced birth weight of lambs is almost universally observed at fall lambing, but this can be of major or minor importance, depending on the presence or absence of other complicating factors. Some factors are undernutrition of the ewe, age of the ewe, breeding of the ewe and amount of shade (Figure 14). Good shade with air movement is the most practical procedure for reducing

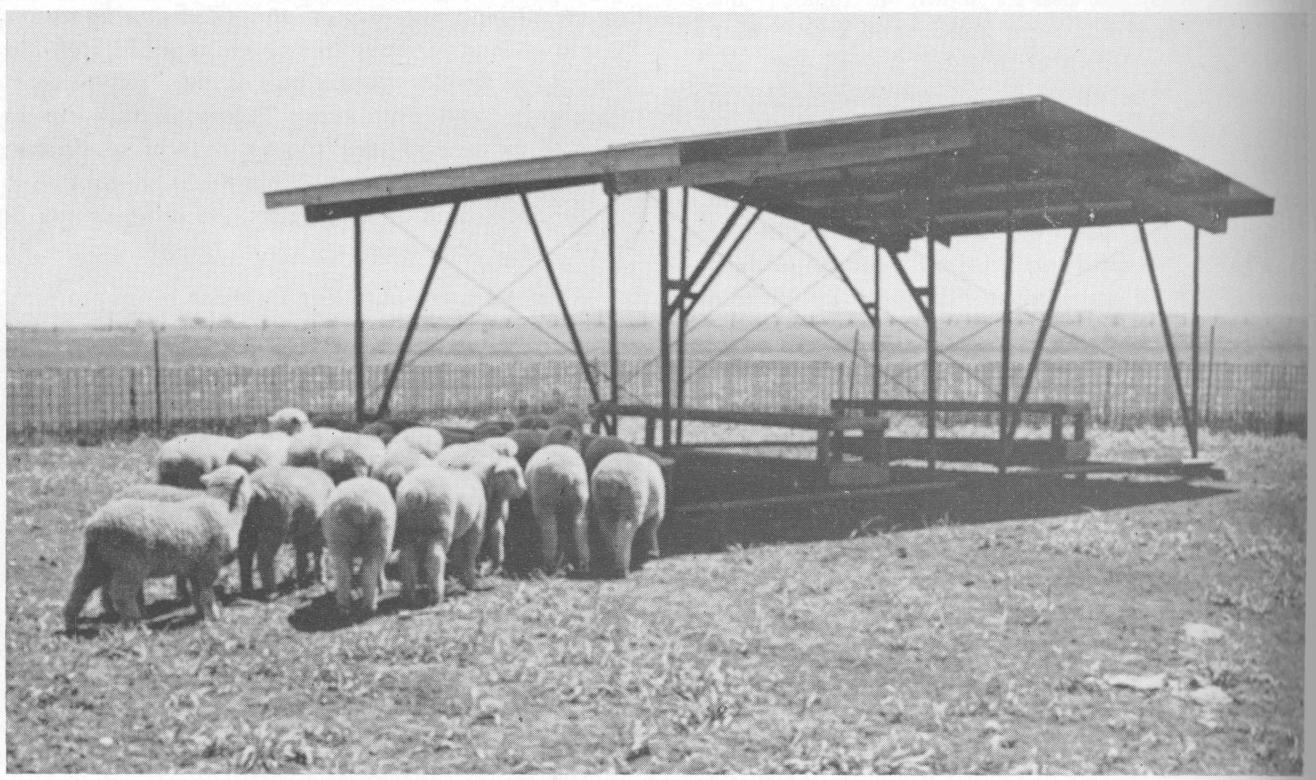

Figure 13. Good shade with air movement is the most practical procedure for reducing heat stress.

heat stress. Shade in the pasture is not in itself assurance of proper shading. The habit of sheep grazing into the wind may pull them away from available shade, or the flocking instinct may cause a large flock to gather around a shade which is adequate for only a few head. High temperature has a direct effect on nutrition of the ewe through reduced grazing time and through voluntary reduction in feed intake to reduce endogenous heat production. Young ewes or ewes with nonfine-wool breeding are affected more seriously. Confining to barns or enforced shading (26) of the ewes (Figure 13) plus adequate supplemental feeding in late gestation will usually alleviate serious fetal dwarfing (27). Where this phenomenon has been observed or remains a problem, matings should be scheduled so lambing will not occur before early November.

FLUSHING

Flushing has been one of the most extensively investigated and discussed practices relating to sheep fertility. Yet, it still is not possible to provide producers with clear-cut advice about the value of this practice. A majority of the literature relating to this subject reports a favorable response; however, many experiments with negative or inconsistent results are not recorded. Flushing generally implies having the ewes on a rising plane of nutrition or increasing the amount of feed available to them just before mating in hopes of increasing the lamb crop obtained. Thus, some weight response must occur from flushing. With the general exception of fat yearling ewes or medium-wool ewes bred in hot environment, any gain in body weight would be expected to result in increased lamb crop dropped. Knowledge of the flock's condition should permit one to estimate the approximate response to flushing. Data collected in the Edwards Plateau (28, 29) involving over 4,000 ewes shows a modest increase of 8.4 percent in lambs marked (approximately 2 weeks of age) was obtained by flushing. This was 1.5 percent more than estimated requirements to equal the feed costs. Other work (30) indicates that no advantage should be expected from flushing yearling ewes since one of the primary advantages expected from flushing would be an increase in number of twin births. These are neither expected nor desired from yearling ewes. This work further clarified the period likely to give the greatest response as one equal to or greater than one estrous cycle prior to mating.

It appears that flushing should be strongly considered with aged ewes in thin to moderate flesh. The flushing period should be initiated at least 3 weeks and preferably for a longer period prior to mating. A good flushing ration should provide an increase in energy with adequate protein and vitamin supplementation. These commonly would be approximately equal parts of sorghum grain and cottonseed meal fed at the rate of ½ to ¾-pound daily. Oats or corn may be substituted for the sorghum grain. Alfalfa hay at a higher level may be used to substitute for both ingredients.

MULTIPLE LAMBING

The nutrients expended by the ewe in lamb production are comparatively minor, except during the 6 weeks prior to lambing and 8 weeks after lambing. On a high level of nutrition or intense management, ewes may become very fat; whereas, under adverse conditions the remainder of the year may be required to regain the weight loss associated with lamb production. When ewes are on a high level of nutrition, or when this is practical, the possibility of lambing more than once per year should be considered. Since sheep have a gestation period of approximately 5 months (149 days), theoretically it should be possible to obtain two lamb crops per year. In practice this is not possible because ewes will not consistently breed back early enough after lambing. The only ewes at McGregor that lambed twice in a 12-month period were those that lost their lamb or lambs at or shortly after lambing. Since ewes will not uniformly breed while nursing lambs, multiple lambing should be practical only in connection with early weaning. Age at which the lambs are weaned has a major influence on the frequency lambing can occur. In experiments at the McGregor station ewes have produced two lamb crops in as little as 14 months. Over a 4-year period, a group of mature ewes has dropped as high as 242 percent lamb crop, but heavy death losses reduced the number weaned to approximately 160 percent. With more intense supervision to cut down death loss of lambs (35 percent) and with earlier weaning, it should be possible to improve this. Other workers (31) using crossbred ewes and weaning lambs at 4 weeks, along with confinement rearing, obtained a lamb crop of 252 percent dropped and 225 percent raised.

USE OF HORMONES

The possibility of using exogenous hormones to stimulate fertility in sheep has long held the interest of producers and research personnel. Many have successfully accomplished this on a research basis, but as of this writing this practice has not been successfully adapted to commercial practice. Several gonadotropic hormone preparations have been used successfully to stimulate ovulation. but numerous problems have been encountered in adapting these preparations to commercial practice. These products have not been successfully produced synthetically and are available only from animal origin. They are both expensive and of questionable standardization and purity. This, plus the natural animal variation has made it impossible to develop a dosage relationship which will give two lambs. Less than two would be of no advantage and more than

two is undesirable. A second problem has been that ovulation occurring as a direct result of gonadotropic stimulation usually occurs without coincident estrus, and mating does not occur. It is possible to circumvent this problem by establishing the estrous cycle with vasectomized rams and injecting gonadotrophins (500-1000 I.U.) in the pro-estrous phase (13-15 days) of the cycle (32). A second procedure is to treat the ewe with progesterone prior to gonadotrophin therapy (33). This adds substantially to the expense and has not given consistent results. These problems combine to make the procedure relatively unworkable in commercial practice, but daily progress is being made in this area and it is likely that a workable procedure will be available in the near future.

Two other hormone preparations have been used in connection with efforts to improve sheep fertility. One has been the synthetic steriod, diethystilbestrol. Use of this product causes only psychic heat or estrus and is more likely to reduce or delay the lamb crop than improve it (34). A second group of compounds investigated are the synthetic products with progestational activity. Several, when used in oral form or as intravaginal suppositories have proved highly effective in synchronizing estrus in sheep; however, conception rate at the first or sychronized estrus has been variable and often low. Most ewes remain largely synchronized at the second estrus at which fertility is normal, but the variation in length of estrous cycle compounded with normal variation in the length of the gestation period provides for only a modest degree of synchronization of lambing (35). These limitations, plus the cost involved impose serious limitations on the use of this practice (36).

DISEASES

Any diseased condition which seriously affects the well-being of the animal could be expected to adversely affect reproductive performance. On a worldwide basis, several pathogenic organisms have been identified (*Brucella ovis, Vibrio fetus.* Toxoplasma and Streptococci) which are associated with reproduction of sheep (37). Most have not been identified as being present or as being a major cause of loss in Texas. There is circumstantial evidence which indicates the organism that causes epididymitis in rams can cause abortion or the birth of weak or dead lambs.

Vibrionic abortion caused by a bacteria-like organism, *Vibrio fetus,* is specifically associated with abortion in the ewe. This disease is fairly widespread in the northwestern part of the United States, but has not been identified as a cause of serious loss in Texas. Producers losing lambs from abortion should get the advice of veterinarians or experts in this field.

One condition producers should be familiar with is known variously as pregnancy disease, ketosis, lambing paralysis and twin lamb disease. This is not caused by an infectious agent but is of metabolic origin. Heavy losses from this condition occur in Texas and in most other states. Extensive research has been done on the disease (38, 39), and the physiological basis for its occurrence seems to be fairly well understood. This disease occurs primarily among ewes bearing twin fetuses and in the late stage of pregnancy. The great demand for energy (glucose or blood sugar) by two fetuses often exceeds that available from daily feed intake. This is especially true if the ewes are not on a good feeding program or if some management procedure, such as movement, shearing or other stress factors, causes them to be off feed for a period in late pregnancy. Under these conditions, a heavy and often incomplete breakdown of body fat occurs resulting in an accumulation of ketones or aldehydes in the blood. If the concentration of these compounds becomes high enough, the disease occurs. Early symptoms are loss of appetite, lethargy and grinding of the teeth, which progresses to loss of vision and the inability to stand or move about. In the final stages, the ewe will be down with the head pulled back to one side. The animal may not die for several days after entering the final stage of the disease. If caught in the very early stages, the disease often can be reversed and the animal saved, but the condition rapidly becomes irreversible because of permanent damage to vital organs or systems. Giving of glycerol or propylene glucol by means of a drench or stomach tube is the best treatment. A 4- to 5-ounce dose should be administered at 6- to 12-hour intervals until the ewe is back on feed or until it is obvious that no benefit is being obtained. When the ewe is back on feed, she should be fed a good ration containing an adequate supply of readily available energy. Ewes showing symptoms of this condition should receive at least 1 pound of concentrates daily and "ad lib" roughage intake.

Prevention is much more important than cure for pregnancy disease. Two primary precautions are recommended. One is to provide heavy ewes in late pregnancy with supplemental energy (approximately ¾-pound of concentrate). It is equally important to prevent any situation that might cause the ewes to be under stress or interrupt feeding for a day or more. Techniques which permit identification of twin bearing ewes would aid rangers in preventing this disease in their flocks.

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