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To the Graduate Council:

I am submitting herewith a thesis written by Venkatesh K. Kulkarni entitled "Performance Testing of Rams." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.

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PERFORMANCE TESTING OF RAMS

A Thesis

Presented to

the Graduate Council of

The University of Tennessee

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Venkatesh K. Kulkarni

December 1965

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CHAPTER I

INTRODUCTION

I. PERFORMANCE TESTING OF RAMS

A good deal of progress has been made in improving the productivity of sheep through selection of performance-tested and progeny-tested breeding animals in recent years. The ram represents one-half of the sheep flock. Thus careful selection of high producing rams which will sire fast-gaining and good-type lambs of desirable market quality is of importance. There has been considerable emphasis on intrinsic qualities of the individual, the performance merit of families and the value of proven sires with ability to transmit their superior characters to their offspring. The best and most reliable method of accomplishing greater production in a reasonable period of time is through selection and breeding of superior producing animals. A new approach to make selection more effective is by the collection and use of accurate records of performance on prospective breeding rams as a supplement to the practice of selecting rams by visual appraisal, as it is impossible or impractical to collect records on every animal.

The performance record on prospective breeding rams is a most valuable and useful technique in continued flock improvement through selection of performance-tested and progeny-tested rams. The data affords an opportunity to eliminate undesirable traits and to evaluate

the quality and performance of sheep due to differences in inherent potential. These differences cannot be predicted accurately by visual selection because of variation in environment and genetic makeup. Studies that involve high-performing rams indicate that they are capable of siring lambs of considerably greater value than those sired by low-performing rams.

Breeding experience has shown that the most important consideration in lamb selection should be individual performance. Performance testing is a great aid in selecting high-producing rams, capable of transmitting maximum performance to their progeny, at an early age with a high degree of accuracy. It has been observed that a ram which produces good lambs one year usually continues to do so throughout his working life. Progeny testing is an accurate way of selecting, but, unfortunately, it is slow. Even if a progeny testing program is followed with prospective stud rams before they are used in the main flock, only a small percentage of the most promising rams can be progeny tested. Hence performance testing of rams is often used to determine the importance of individual merit of rams when used in breeding programs. Performance testing provides a safe and solid stepping stone towards the improvement of production efficiency and better profits of sheep through early selection of high-producing animals.

The main purposes of this study were:

1. To evaluate various performance criteria for selection of rams on the basis of the relative effects of various factors such as sex, type of birth, age of dam, season of birth, and rearing on birth weight and birth to weaning weight, grades and post-weaning performance;

2. To determine the improvement in quality and quantity of lamb and wool through the selection of performance tested rams; and

3. To determine the relationship of performance records taken at different times during the growing period.

CHAPTER II

REVIEW OF LITERATURE

A vast amount of research has been done in sheep breeding and a part of it has been devoted to studies of the value of performance testing. Birth weight, birth to weaning weight, grades, and post-weaning performance are influenced by various factors including the age, size, and nutrition of dam, gestation period, sex of the new born, and size of the litter. There are many environmental differences between flocks which may be greater than the genetic differences.

Body weight for age with type and confirmation scores have been consistently used in performance testing. Chapman and Lush (1932) studied the genetic portion of variance in birth weight in the Iowa Agricultural Experiment Station flock of high grade Hampshires and found that approximately 25 to 30 per cent of variation in the birth weight of lambs was due to genetic differences, 30 to 35 per cent to tangible environment, and 40 to 45 per cent to intangible environment or accident of development. Phillips and Dawson (1937) conducted investigations to evaluate the influence of various factors on lamb traits from birth to weaning, using 829 Southdown lambs. They found that single lambs were heavier at birth than twins. Lambs that were heavier at birth also tended to be heavier at three months of age. Lambs born early in the season were heavier at three months of age than late lambs. On the average, they found that an increase of 4.3 pounds in weight at three months

of age could be expected for each increase of 1 pound in birth weight of single males. They also pointed out that single male lambs would weigh 0.14 pounds less on the average at three months of age for each day's increase in birth date. In another study of 508 Hampshire, 521 Shropshire, and 835 Southdown lambs born from 1921 to 1934, Phillips and Dawson (1940), found that sex, time of birth, and type of birth affected birth weight, weaning weight, and mature weight. Male lambs were significantly heavier than females at birth and differences in sex became more pronounced with increasing age. There was a tendency for more early than late lambs to survive. A significantly higher proportion of the lambs that were heavy at birth survived than of the light lambs. The effect on growth from birth to maturity of twins or triplets was to a large extent overcome as maturity increased. There were significant differences between rams within a breed and between breeds. However, large differences were generally due to yearly differences in environment.

Kean and Henning (1949) compared birth weights and average daily gains in the 882 lambs of ten breeds and crosses and indicated that the Dorset x Corriedale-Merino cross was heaviest at birth and gained fastest. The average birth weight of males was 8.9 pounds and that of females was 8.3 pounds. They found singles to be 1.4 pounds heavier than twin lambs. The average daily gains of males, females, twins, and singles were 0.54, 0.51, 0.45, and 0.60 pounds, respectively. The average birth weight of all lambs was 8.5 pounds and average daily gain of all lambs slaughtered was 0.53 pounds. They stated that there tends to be a correlation between birth weight and average daily gain.

In a study to calculate heritability estimates of birth weight and weaning weight of lambs, Nelson and Venkatachalm (1949) showed that significant portions of variation in these were due to differences in sex, type of birth, and age of dam. On the average, the birth weight of males was 5 per cent heavier than females; lambs from mature ewes were 10 per cent heavier than those from two-year-old ewes, and single lambs were 22 per cent heavier than twins. The corresponding figures at weaning were 6 per cent, 5 per cent, and 17 per cent, respectively. The estimates were obtained on each breed and then combined for weighted averages.

Wallace (1948) reported that both weight of the lamb and milk yield of ewes are affected by the level of nutrition of the ewes during the last six weeks of pregnancy. By extreme ill feeding during this period the birth weight of twin lambs may be approximately halved.

Barnicoat et al. (1949) observed that the differences in birth weight were associated with differences in nutrition of ewes and that under Fat Lamb farming conditions milk intake was of most importance during the first six to eight weeks. In a later study Barnicoat et al. (1956) concluded that milk production of the ewe is the major factor influencing rate of liveweight gain of the lamb. Weight of milk rather than its nutritive value estimated from composition gave the best index of its lamb fattening qualities.

Kincaid (1943) compared birth weight of lambs sired by Hampshire and Southdown rams and found that lambs sired by Hampshire rams averaged 1.05 pounds heavier at birth than lambs sired by Southdowns, the

difference being highly significant. He observed an average annual increase of 0.63 pounds in the birth weight of lambs as the age of the ewe increased from two to six years. Kincaid also stated that 7.8 per cent of the variation in lamb birth weights was due to breed of sire.

Bogart et al. (1957) conducted a study on the factors affecting birth weights of crossbred lambs at Oregon State College using records of 280 crossbred lambs born over a two-year period. Type of birth contributed the most consistent of all effects on birth weight. Singles were from 1.92 pounds to 2.40 pounds heavier at birth than twins. There was also significant difference between years for birth weight. There was a small difference between the birth weight of male lambs and ewe lambs.

Shelton (1964) analyzed birth weights and death losses of 2,368 fall-born lambs and stated that type of birth and system of mating affected significantly birth weight and death losses. Twin lambs weighed 1.6 pounds less and had a 9.2 per cent higher death loss than those born as singles. As a group, crossbred lambs (Rambouillet ewes bred to Hampshire, Suffolk, Dorset, and Columbia rams) weighed 0.6 pounds more and had 3.7 per cent less death losses than straight Rambouillet lambs. Only Dorset-sired lambs were smaller than Rambouillet. Death losses were closely related to birth weight. Losses ranged from a high 65.3 per cent for lambs weighing less than 4 pounds to a low of 6.4 per cent of lambs weighint 10 to 11 pounds. Above this weight, death losses tended to increase. Birth weight was also correlated with post-weaning gains or 120-day weight. It was estimated that an increase of

6.8 pounds in 120-day weight was associated with each 1 pound increase in birth weight. Birth weight was shown to have a significant positive correlation with clean fleece weight.

In another study involving 103 ewes to determine the effect of high environmental temperature (100 to 105°F.) during gestation on birth weight and lamb mortality, Shelton (1964) reported that high temperature during gestation significantly reduced birth weight and increased lamb mortality.

Weaning weight of lambs is subject to great variation due to sex, age of dam, year, type of birth, and age at weaning.

Hazel and Terrill (1945) in a study using 2,183 range Rambouillet lambs observed the differences in weaning weight between ram lambs and ewe lambs, single lambs and twin lambs, and lambs from mature ewes and two-year-olds were 8.3, 9.2, and 6.1 pounds, respectively. In a later study with 478 Columbia, 238 Corriedale, and 366 Targhee lambs raised in 1941 and 1942 at the U. S. Sheep Experiment Station, Dubois, Idaho, Hazel and Terrill (1946), found the differences in weaning weight between ram lambs and ewe lambs, lambs from mature and two-year-old dams, and single and twin lambs were 10.8, 8.7, and 11.7 pounds, respectively.

In a Wisconsin study by Karam et al. (1949) of 439 lambs raised from ewes in farm flocks, it was found that single lambs were 6.2 pounds heavier at twenty-five weeks of age and had a 0.02 pounds higher average daily gain from birth to market than twins. Wether lambs were 3.5 pounds heavier at twenty-five weeks and had an 0.02 pounds higher average daily gain than ewe lambs. All these differences were highly significant.

Blackwell and Henderson (1955) studied the factors affecting weaning weight of 1,295 lambs from 463 ewes and of factors influencing birth weight of 2,158 lambs from 560 ewes. The lambs consisted of Corriedale, Dorset, Hampshire, and Shropshire breeds. The age of dam did not significantly affect weaning weight in Dorset lambs. However, there were statistically significant differences among birth weights of lambs from different ages of dams in the Corriedale, Hampshire, and Shropshire breeds. Ram lambs were heavier at birth and weaning than ewe lambs. Lambs born as singles were heavier at birth than twins. Single lambs were heavier at weaning than lambs born as twins and reared as either single or twins. Studies were conducted on the effects of season on birth weight and weaning weight in Dorset lambs. The lambs born in the spring were 0.40 pounds heavier at birth than lambs born in the fall and were 2.85 pounds heavier at weaning. There were significant differences among years.

Botkin et al. (1956) reported that ram lambs were 9 pounds heavier than ewe lambs when weaned at 129 days and 15 pounds heavier than ewe lambs when weaned at 202 days. Single lambs were 14 pounds heavier than twin lambs in the group weaned early as compared to 8 pounds for the late group. Twins raised as singles made gains about the same as single lambs. These data indicated that sex differences increased with age and that the birth differences among lambs of the same sex tend to decrease with age.

Debeca et al. (1956) conducted studies over a period of two years to compare factors affecting weaning weight using 280 crossbred lambs.

They stated that birth weight is one of the most influencial variables on weaning weight. They found that the range in increase in weaning weight varied from 2.50 $\pm$ 0.65 pounds to 5.96 $\pm$ 0.76 pounds for each pound increase in birth weight. The weaning weight of single lambs was significantly greater than weaning weight of twin lambs. Single lambs averaged 17 pounds heavier at weaning than did twin lambs.

Wilder and Goode (1962) studied the effect of early weaning on market lamb production in a series of experiments on 104 lambs. The lambs were assigned to weaned and nonweaned treatment groups at 17 $\pm$ 14 days of age. The overall average daily gain of nonweaned and weaned lambs was 0.52 and 0.49 pounds, respectively. The difference was not significant. Lambs born early in the winter outgained those born later ($P < .01$). The decrease in gain associated with season was less pronounced in the weaned lambs. Sex, twin, or single birth did not affect rate of gain. There was a nonsignificant negative correlation between age at weaning and rate of gain in the weaned lambs. Final market grade was not affected by early weaning.

Shelton and Campbell (1962) estimated the importance of factors affecting weaning weight of range Rambouillet lambs using least squares procedure. Male lambs grew 7.2 per cent faster than females. Single lambs grew 4.6 per cent faster than twins raised as singles and 10 per cent faster than twin lambs raised as twins. Lambs out of two-year-old dams weighed 5.1 pounds or 8 per cent less than lambs out of mature ewes (3 through 7 years). Very old ewes weaned lambs weighing 7.6 pounds or 11.7 per cent less than ewes in years of peak production.

In a study to evaluate the influence of age of dam, type of birth, age at shearing, and per cent inbreeding on grease fleece weight, clean fleece weight, staple length, body weight, condition, face covering, and neck folds on 359 Columbia and 213 Targhee yearling rams born from 1941 to 1945, Terrill et al. (1948) found the effect of environmental factors was greatest on grease fleece weight, body weight, and clean fleece weight and least on face covering and staple length. Year of birth was the most important environmental source of variation and age of dam was least important. Age of dam was more important in Columbias, while age at shearing was more important in Targhees.

Single rams had heavier bodies and fleece than twins. Fleece and body weight, staple length, type and condition improved with increasing age at shearing and became poorer with inbreeding. Inbreeding had a greater detrimental effect on body weight, type, and condition than on other traits. Inbreeding had a noticeably greater effect on Targhees than on Columbias. Greater effectiveness of selection is the practical result of adjusting for environmental effects.

In another study involving 499 yearling Rambouillet rams, Terrill et al. (1948) showed that differences between years had the most important environmental effect upon yearling Rambouillet ram traits of any factor studied followed by inbreeding. Type of birth, age of dam, and age at shearing did not have important effects on yearling Rambouillet ram traits with the possible exception of age at shearing on grease and clean fleece weights and type of birth on clean fleece weights. Differences among years were greatest for neck folds, body weight, and grease

fleece weight. Inbreeding had adverse effects on body weight, grease fleece weight, clean fleece weight, type score, and condition score. Staple length and face covering were least affected by environmental factors. Yearling rams excelled ewes for every trait studied except type and neck folds and in these traits the differences were slight. The greatest differences were found for body weight and grease fleece weight.

Wiggins et al. (1954) conducted studies on the effect of year, breed, age, and number of ewes bred on fertility in 1,109 range rams bred to 31,473 ewes over a 15-year period. Targhee rams had the highest average fertility followed in order by Corriedales, Rambouillets, Columbias, and eleven rams of three other breeds. There did not appear to be significant differences in the fertility of rams of different ages and there was no trend in fertility with increasing age. In actual percentages of ewes lambing four-year-old rams were highest and were followed in order by two-year-olds, yearlings, three-year-olds, and ram lambs. There was no trend in fertility with increasing number of ewes up to fifty. The average fertility in pens of more than fifty ewes was slightly lower than the fertility in pens of less than fifty ewes but only a relatively small number of rams were bred to more than fifty ewes.

Sabin and Brown (1962) analysed the growth records of 291 northern Arkansas lambs over a five-year period and showed that:

1. Single lambs were heavier at birth, grew faster, and were almost 8 pounds heavier at sale age than twins reared as twins.

2. The ewes tended to be progressively better producers up to 6 years of age.

3. The age of the ewes had little or no influence on lamb growth when differences due to the ages of the dams were eliminated.

4. Some breed-of-dam differences in lamb growth can be expected.

5. The breed of the lamb's sire had little real bearing on the lamb's growth, providing that both the size and the mutton conformation of the sires were adequate and comparable.

6. Differences were obtained in the growth of lambs among years and for season of birth within years.

The earlier in season a lamb was dropped, the heavier it was at any given date. However, late lambs did tend to be heavier at birth and grew at a slightly faster rate than early lambs.

In a study on 707 lambs of Corriedale and Columbia breeds over a seven-year period to evaluate the influence of environmental factors on feed-lot performance, Botkin (1964) found that ram lambs gained significantly faster than ewe lambs regardless of year, method of feeding, or length of feeding period. Twins and singles gained essentially the same. Weaning weight and initial weight on test had little influence on gains, and age had no consistent influence on gains. However, weaning weight and initial weight were closely related with final weight of test.

Heritability estimates for traits of economic importance provide valuable and useful information of the rate and amount of progress which can be expected not only for selecting for economic quality, but also in adopting effective methods of breeding.

Hazel and Terrill (1946) conducted studies on Columbia, Corriedale, and Targhee lambs to obtain estimates of heritability of several weaning traits. Estimates were made from half-sib correlations based on 1,711 lambs by 99 sires and from regression of offspring on dam based on 798 pairs. The average estimates of heritability and their standard errors were: weaning weight, 0.17 $\pm$ 0.05; length of staple, 0.43 $\pm$ 0.06; body type, 0.07 $\pm$ 0.04; condition, 0.21 $\pm$ 0.05; face covering, 0.46 $\pm$ 0.06; and neck folds, 0.08 $\pm$ 0.04.

Nelson and Venkatachalam (1949) calculated heritability estimates of birth weight and weaning weight of lambs. The heritability figures obtained for birth weight were: 0.72 $\pm$ 0.10 from intra-sire regression of offspring on dam based on 504 pairs and 0.15 $\pm$ .17 by the paternal half-sib correlation method. For weaning weight the figures were 0.29 $\pm$ 0.14 by the parent offspring method based on 348 pairs and 0.42 $\pm$ 0.21 by half-sib method. The weighted averages of the two methods were 0.61 $\pm$ 0.09 and 0.33 $\pm$ 0.12 for birth weight and weaning weight, respectively.

Rea (1956) observed that weaning weight had a higher heritability in fine wool breeds such as the Rambouillet and Merinos than in mutton breeds. Body conformation score was low in heritability. Apart from this, the body form was influenced by nutrition and other environmental factors. Estimates of heritability which have been reported on condition score are 0.13 in New Zealand Romneys, 0.12 in yearling Rambouillets, and 0.21 in lambs. Where heritability is low, greater emphasis needs to

be placed on aids to selection such as the use of progeny tests, sib tests, and information on ancestors and collateral relatives.

Felts et al. (1957) conducted investigations at the University of Wisconsin to obtain the constant for age of dam, type of birth, and rearing on 120-day weights using records from thirty-two flocks. Pooled type of birth and rearing effects expressed in deviations from the overall mean were 7.9 pounds for a male single; 2.3 pounds for a male twin; 1.98 pounds for a twin reared as a single; 2.8 pounds for a female single; -7.1 pounds for a female twin; and -3.2 pounds for a female twin reared as a single. The age of the dam effects expressed as deviations from overall mean were -14.26 pounds for a one-year-old ewe; 0.06 pounds for a two-year-old ewe; 4.23 pounds for a three-year-old ewe; 4.57 pounds for a four-year-old ewe; 3.73 pounds for a five-year-old ewe; 2.00 pounds for a six-year-old ewe and 0.34 pounds for a seven-year-old ewe.

Shelton (1959) reported the results of a ten-year study to determine the heritability of performance records on forty different tested Rambouillet rams used as sires in the flocks of the Texas Agricultural Experiment Station and to develop a selection index for application to performance records on fine wool rams. Estimates of the relative economic importance, phenotypic, and genotypic correlations and heritability of rate of gain, body conformation, face covering, skin folds, staple length, and clean wool production were included. The heritability estimates obtained for weaning weight and rate of gain were 0.22; conformation, 0.04; face covering, 0.54; skin folds, 0.34; staple length, 0.48,

and clean wool, 0.22. The index derived indicated that primary emphasis should be placed on rate of gain, face covering, and staple length.

Shelton and Campbell (1962) reported that the estimate of heritability for weaning weight of range Rambouillet lambs was 13.8 per cent using adjusted values.

Harrington et al. (1962) presented the results of a four-year study on 671 crossbred milk lambs contained in thirty-one sire-progeny groups. The heritability estimates for rate of gain from birth to approximately 50 pounds ranged from 0.09 ± 0.07 to 0.13 ± 0.08. The heritability estimates for rate of gain from birth to market weight of approximately 90 pounds ranged from 0.34 ± 0.12 to 0.36 ± 0.12.

Botkin (1964) reported estimates of heritability for weaning weight, initial weight on test, final weight, gain from weaning to final weight, and feed-lot gain to be 0.59, 0.68, 0.56, 0.32, and 0.24, respectively, when obtained by full-sib correlations. From intra-sire half-sib correlations, the corresponding heritability estimates were 0.21, 0.24, 0.20, 0.08, and 0.12 for weaning weight, initial weight, final weight, gain from weaning to final weight, and feed-lot gain, respectively.

Galal et al. (1965) conducted investigations on relationships among linear measurements and body weight in approximately 1,400 lambs. Measurements and weights studied were: metacarpus and metatarsus width and breadth, hook width, birth weight, adjusted 30-day weight, and adjusted weaning weight. Generally birth weight was the most valuable for predicting weaning weight. Sex, year, breeding, location, and type

of birth were significant sources of variation for all characters. Simple correlations between chilled carcass weight, per cent of live weight, and the area of rib-eye muscle were 0.00 and -.44 with metacarpus length, 0.80 and 0.51 with metacarpus lateral diameter, 0.46 and 0.51 with metacarpus anterior-posterior diameter, 0.31 and 0.37 with metatarsus lateral diameter, 0.32 and 0.57 with metatarsus anterior-posterior diameter and 0.44 and 0.71 with hock-bone width, respectively. Heritabilities as estimated from offspring-dam regressions and correlations at birth were 0.46 and 0.38 for cannon length and 0.38 and 0.37 for hock bone width, respectively.

Selection of superior animals usually involves the use of an index because one has to judge strong points against the weak points of each animal in order to rank the animals from the best to the poorest.

Hazel and Lush (1942) reported that selection for a total score or index of net desirability is much more efficient than selection for one trait at a time. They found that the progress made in any one trait by the total score method or index based on equally important uncorrelated traits is only $\frac{1}{\sqrt{n}}$. They showed that selection for several traits by using independent culling levels for each is more efficient than tandem selection for one trait at a time but is generally less efficient than selection on index.

Lush (1945) has presented an objective basis for determining emphasis on several traits in an index by giving emphasis in proportion to their heritability times their economic importance. Heritability measures the probable genetic gain from selection, and economic

importance measures the value of that gain. Relationships among traits may alter weights that are applied to the various traits in the index.

Rice et al. (1957) stated that emphasis in selection should be placed on a character depending upon its economic importance, its heritability and level of performance already attained in the flock. They also pointed out that the individual performance and family averages in production are the basic criteria on which initial selection of breeding stock should be based. Animals are originally selected for progeny testing on the basis of their own performance and that of their relatives. Progeny testing is a secondary selection criterion because it is not feasible to attempt to progeny test all rams.

Terrill (1951) showed greater progress in improvement of weaning traits by sire selection than from selection of dams. Sire selection was forty to seventy times more effective for staple length, eight to twelve times more effective for face covering, four to eleven times more effective for weight, and two to three times more effective for type and condition as compared to selection of dams. Eighty-one to 89 per cent of expected genetic progress came from selection of sires.

Progeny testing of rams provides more reliable estimates of genotype and will result in much more rapid improvement of flock for some traits than selection based on phenotype alone. Ensminger et al. (1943) reported that selection of sires on the basis of their progeny gave the best results. However, some difficulties occur in small flocks where the number of females that can be placed in test plans is inadequate to test several rams within a season. He pointed out that the

minimum requirement of a breeding flock of ewes was approximately fifty and suggested that the twenty best ewes be used as the stud flock and mated to a sire of known merit. The remaining ewes should be divided into two groups of nearly equal characteristics and mated to untried sires. A three-way comparison could then be made between the stud sire and tested sires. The best of the three would become the stud flock sire for the next test year.

Dickerson and Hazel (1944) stated that a regular plan of progeny testing is unlikely to increase and may reduce progress unless (1) the progeny test information becomes available early in the tested animal's life time, (2) the reproductive rate is low, and (3) the basis for making early selection is relatively accurate. Opportunity for improvement from selection is nearly maximum for most traits when (1) culling is based on individual performance and family average pedigree, and (2) the interval between generation is kept short.

Shelton et al. (1954) reported a summary of four years' work on progeny and performance testing of rams involving 576 rams consisting mostly of Rambouillets with a small number of Corriedales, Columbias, Merinoes, and Suffolk. They indicated that important and highly heritable differences exist between the performance of offspring of different sires. Initial weight has an important influence on the performance of the animal during the test. Average daily gain is significantly correlated with wool production and body conformation. Open-faced lambs tend to gain faster (nonsignificant) and the wooly-faced lambs tend to produce more wool.

CHAPTER III

MATERIAL AND METHODS

I. SOURCE OF DATA

The present study involves data collected as a part of the pure-bred Hampshire sheep breeding program of the University of Tennessee Animal Husbandry-Veterinary Science Department, Main Experiment Station, Blount Farm, Knoxville. The data on the performance of 204 ram lambs over the 15-year period, 1951 to 1965 inclusive, were obtained from the production records of sheep flocks maintained by the Main Experiment Station. The data used in this study to determine the relationships between gains made at different periods of growth were taken from the performance records of selected Hampshire ram lambs on feed tests during the years 1951 through 1965.

II. FLOCK MANAGEMENT

The flock involved in the present study was composed of Hampshire ewes bred to rams of the same breed. During spring, summer, and fall months, the ewes were grazed on permanent pastures consisting of either native pastures or orchardgrass with ladino clover or alfalfa, and fescue with ladino clover or alfalfa. The winter pasture for ewes and lambs was mainly oats and crimson clover mixtures. High-quality hay was made available to the ewes when pastures were inadequate or during periods of

severe cold weather. The ewes were fed grain (one-half pound per head daily) about two weeks prior to lambing. After lambing, the grain was increased to about one pound per head daily. No grain was used after pastures became available. Iodized salt and water were provided free-choice. Strict parasitic control measures were taken to prevent infestation of common internal parasites. The ewes were bred to lamb primarily in December, January, and February. The ewes were sheared generally during mid-April and mid-May. They were tagged approximately two weeks prior to lambing season and before breeding, if needed. The lambs were weighed and identified when born. The birth date, birth weight, sex, type of birth, year of birth, and dam number were recorded when each lamb was born. The lambs were creep fed during the early period while ewes and lambs were kept in a barn during the winter months. No ram lambs were castrated before weaning or about 135 days of age. The feeding, breeding, and management practices followed in the flock were not greatly different through the years included in this study.

III. SELECTING RAM LAMBS FOR TESTING

All ram lambs of a lamb crop were tested concurrently under similar conditions. The characters that were important in selecting were weaning weight or rate of gain, body conformation, and type score or grade at 135 or 120 days of age and productivity of dam. From 1951 to 1957 the ram lambs were grazed on available permanent pastures with supplemental feed consisting of about one-third to one-half pound of a mixture of equal parts by weight of whole oats and shelled yellow corn

from weaning to the time of starting feedlot tests. From 1958 to 1965 the ram lambs were placed on feedlot test immediately following weaning. From 1951 to 1958 the rams were drenched with Phenothiazine twice and once with a copper sulfate-nicotine sulfate during the summer before being placed on test to prevent infestation with roundworms, tapeworms, and other internal parasites. From 1958 to 1965 the rams were drenched with Phenothiazine or Thiabenzole at weaning. To control footrot, the feet of all sheep were examined periodically and trimmed if needed. Further treatment and control measures consisted of a foot bath of either 10 per cent formaldehyde or a saturated solution of copper sulfate. The lambs were sheared about the first of June or when put on test each year.

IV. THE FEEDLOT PERFORMANCE TESTS

The rams were weighed and identified individually at the start of the test. From 1951 to 1957 the rams were placed on feedlot test during September, October, and November for 100 days. From 1958 to 1965 the rams were placed on feedlot test at weaning in late May and continued for 100 days. In 1951 and 1952 the ration consisted of alfalfa hay, ad libitum and a concentrate mixture containing equal parts by weight of shelled yellow corn and whole oats at the rate of 1.5 per cent of body weight for the first 41 days and 1.75 per cent for the remainder of the test. During the years 1951 to 1954 the rams were individually fed. After 1952 all the rams were fed a complete pelleted ration to eliminate the difficulties of feeding hay and concentrates separately and to

obtain more accurate data on feed consumption. The pelleted ration consisted of 50 per cent number two alfalfa hay, 20 per cent ground yellow corn, 10 per cent ground oats, 10 per cent molasses, 7 per cent soybean meal, 1 per cent salt, 1 per cent defluorinated rock phosphate and 1 per cent of a mineral mixture. The pelleted feed, common loose salt and water were provided free-choice. The rams were weighed individually at 15-day intervals. For the period from 1951 to 1957 inclusive, the feedlot performance tests were started after summer period and the summer average daily gain was calculated.

V. STATISTICAL ANALYSIS

The average daily gain of lambs from birth to weaning was calculated using the formula:

$$\text{Average Daily Gain (ADG)} = \frac{\text{Weaning weight - birth weight}}{\text{Weaning age in days}} .$$

The 120-day weights of lambs were derived from the formula:

120-day weight = (ADG x 120) + birth weight.

Type of birth: 1, single; 2, twin.

Type of rearing: 1, single; 2, twin.

Type of birth and rearing: 1, born single and raised single; 2, born twin and raised as single; 3, born twin and raised as twin.

Season of birth: 1, November to December 31; 2, first day to thirtieth day of year; 3, thirty-first day to sixtieth day of year; 4, sixty-first day to ninetieth day of year.

Type score: 11, high good; 12, low choice; 13, choice; 14, high choice; 15, low fancy.

Gross correlations between gains made at different periods were calculated on a within sire and year basis for the following:

1. Average daily gain from birth to weaning unadjusted for type of rearing or age of dam.
2. Average daily gain from weaning to start of feedlot performance tests.
3. Average daily gain during feedlot performance tests.
4. Average daily gain from birth to the end of feedlot performance tests.

The average daily gains for different periods were not adjusted except for gains from birth to weaning.

The complete performance records of all ram lambs born during the 1951 lambing season through the 1965 lambing season were transferred to IBM cards. A listing was made at the University of Tennessee Computing Center giving the data in the same order that it came from the original data sheets.

The correlations between various traits during different periods of growth were computed and correlation coefficients were calculated on a within sire and year basis at the Computer Center. There were 114 rams sired by 28 sires in the 1951 to 1957 period and 96 rams sired by 21 sires during the 1958 to 1965 period, the degrees of freedom being 85 and 74, respectively, for the two period groups. Statistical analysis of the applicable data was carried out as suggested by Snedecor (1956) to determine correlations among the different traits.

CHAPTER IV

RESULTS AND DISCUSSION

The relationships among the various characters such as the birth weight, weaning weight, average daily gain from birth to weaning, 120-day weight, and type score at weaning and the performance of the rams on feed test were studied. Data on the detailed performance of individual rams tested from 1951 to 1957 are presented in Table I and for 1958 to 1965 in Table II. The yearly averages and the overall averages of the various traits studied for the period 1951 to 1957 are given in Table III and for the 1958 to 1965 period in Table IV.

Correlations among the different traits during the various periods of growth were computed on a within sire and year basis. Correlation coefficients between the various traits for the period from 1951 to 1957 are presented in Table V and for 1958 to 1965 in Table VI. A comparison of the performance of the tested rams during the different years for the periods from 1951 to 1957 and 1958 through 1965 was made. In these data, correlation coefficients of 0.211 and 0.275 and above for the 1951 to 1957 period and correlation coefficients of 0.226 and 0.294 and above for the 1958 to 1965 period were significant at the 5 per cent level ($P < .05$) and 1 per cent level ($P < .01$), respectively.

TABLE I

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1951 TO 1957

Sire	No. rams	Birth Wt.	Type of birth	Age of dam	Type of rearing	Weaning Wt.	Weaning age	ADG (Br.-Wn.)	120-day Wt.	Summer ADG	Initial Wt. (feed-test)	Final Wt. (feed-test)	ADG (feed-test)	Age at end of (feed-test)	Type score	ADG birth to end of feedtest	Season of birth	Type of birth and rearing
		(lb.)		(years)		(lb.)	(days)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(days)		(lb.)		
									1951									
032	2	9.70	2.00	6.0	2.00	77.5	121	0.56	77.0	0.22	136.0	181.5	0.56	480	9.5	0.38	2.00	3.00
046	4	11.7	1.25	6.0	1.25	84.5	115	0.64	88.2	0.23	147.5	189.3	0.51	474	13.3	0.40	2.25	1.50
077	1	11.2	2.00	6.0	2.00	62.0	109	0.47	68.0	0.24	129.0	172.0	0.52	468	12.0	0.37	2.00	3.00
709	8	9.96	1.38	5.88	1.38	87.4	120	0.65	87.9	0.20	142.4	180.8	0.47	479	12.9	0.38	2.13	1.75
877	2	8.00	1.50	2.50	1.50	81.5	148	0.50	67.5	0.22	140.0	171.5	0.39	507	15.0	0.34	1.00	2.00
913	1	11.00	2.00	6.00	1.00	69.0	88	0.66	90.0	0.17	115.0	155.0	0.49	447	12.0	0.35	3.00	2.00
Average		10.23	1.50	5.55	1.45	82.6	119.8	0.61	83.5	0.21	140.3	179.8	0.48	479	12.7	0.38	2.06	1.94
									1952									
050	7	8.37	1.71	5.00	1.57	86.1	126	0.62	83.3	0.24	111.1	154.7	0.42	333	12.0	0.47	2.43	2.43
709	6	9.53	1.50	3.83	1.33	96.3	135	0.64	86.8	0.32	127.1	170.5	0.42	339	13.0	0.50	2.00	1.83
877	2	9.15	1.50	4.50	1.50	89.0	135	0.60	80.5	0.31	121.0	154.0	0.32	340	11.5	0.46	2.00	2.00
Average		8.94	1.60	4.47	1.46	90.6	131	0.625	84.3	0.28	119.1	160.9	0.41	336	12.3	0.48	2.20	2.13
									1953									
101	2	7.75	1.50	3.50	1.00	99.0	135	0.68	89.0	0.15	123.5	179.0	0.56	402	13.9	0.45	1.00	1.50
189	6	9.35	1.83	5.17	1.17	80.7	135	0.53	72.7	0.25	112.8	160.3	0.48	372	12.5	0.43	2.33	2.00
709	2	9.85	1.00	6.00	1.00	85.0	135	0.56	77.0	0.28	117.5	171.0	0.54	352	13.7	0.49	3.00	1.00
877	1	8.60	2.00	4.00	1.00	61.0	135	0.39	55.0	0.23	97.0	134.0	0.37	389	11.7	0.34	2.00	2.00
Average		9.08	1.63	4.91	1.09	83.0	135	0.55	74.8	0.23	114.2	163.3	0.49	375	12.9	0.44	2.18	1.73
									1954									
218	1	12.20	1.00	5.00	1.00	69.0	135	0.42	63.0	0.26	110.0	174.0	0.64	393	13.0	0.44	3.00	1.00
246	5	8.42	1.60	3.00	1.20	70.6	135	0.46	63.4	0.16	95.8	146.8	0.51	392	12.3	0.37	3.00	1.80
252	3	8.27	1.67	4.67	1.67	74.7	135	0.49	67.0	0.12	98.3	148.3	0.50	430	12.6	0.35	1.33	2.33
294	4	9.33	1.00	3.50	1.00	65.0	135	0.43	61.3	0.21	100.8	152.8	0.52	406	12.1	0.38	2.00	1.00
709	4	10.23	1.25	5.00	1.25	73.3	135	0.45	64.3	0.14	97.3	151.3	0.54	416	13.1	0.37	2.00	1.50
Average		9.25	1.35	4.00	1.24	70.5	135	0.45	63.7	0.17	98.6	151.1	0.53	408	12.5	0.37	2.23	1.59

TABLE I (continued)

Sire	No. rams	Birth Wt.	Type of birth	Age of dam	Type of rearing	Weaning Wt.	Weaning age	ADG (Br.-Wn.)	120-day Wt.	Summer ADG	Initial Wt. (feed-test)	Final Wt. (feed-test)	ADG (feed-test)	Age at end of (feed-test)	Type score	ADG birth to end of feedtest	Season of birth	Type of birth and rearing
		(lb.)		(years)		(lb.)	(days)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(days)		(lb.)		
									1955									
334	5	10.00	1.20	3.60	1.40	91.6	135	0.60	82.4	0.24	125.0	175.0	0.50	375	13.3	0.47	2.00	1.40
362	5	9.40	1.40	4.00	1.40	90.0	135	0.60	81.0	0.26	126.2	173.0	0.47	373	13.4	0.46	2.00	1.80
367	7	9.00	1.71	4.14	1.71	89.6	135	0.60	80.6	0.17	113.1	161.6	0.48	371	12.5	0.44	2.00	2.43
Average		9.41	1.47	3.94	1.53	90.3	135	0.60	81.2	0.22	120.5	168.9	0.48	373	13.0	0.45	2.00	1.94
									1956									
050	6	9.17	1.33	4.17	1.33	94.8	136	0.63	84.7	0.21	116.0	173.2	0.57	339	13.9	0.51	2.33	1.67
252	3	8.33	1.67	5.00	1.67	98.0	136	0.66	87.0	0.23	127.3	172.0	0.45	350	14.3	0.49	2.00	2.33
367	4	8.50	1.75	5.00	1.25	107.3	136	0.73	95.8	0.36	149.8	189.8	0.40	354	13.9	0.54	2.00	2.00
Average		8.77	1.54	4.61	1.38	99.4	136	0.67	88.6	0.26	129.0	178.0	0.49	346	14.0	0.51	2.15	1.92
									1957									
249	1	14.00	1.00	2.00	1.00	82.0	113	0.60	86.0	0.18	112.0	155.0	0.43	311	12.7	0.50	4.00	1.00
252	5	8.80	1.80	5.20	1.80	81.0	162	0.44	62.2	0.29	113.2	160.8	0.48	366	13.3	0.44	2.00	2.60
503	10	9.00	1.60	3.30	1.50	93.4	157	0.54	73.7	0.21	117.0	160.4	0.44	361	12.6	0.45	2.00	2.10
564	7	10.14	1.29	5.86	1.29	89.0	152	0.52	70.7	0.20	113.4	163.3	0.50	356	13.4	0.46	2.14	1.57
Average		9.52	1.52	4.43	1.48	88.9	154	0.51	70.8	0.22	114.9	161.1	0.47	358	13.0	0.45	2.13	2.00

TABLE II

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1958 TO 1965

Sire	No. rams	Birth Wt.	Type of birth	Age of dam	Type of rearing	Weaning Wt.	Weaning age	ADG (Br.-Wn.)	120-day Wt.	Initial Wt. (feed-test)	Final (feed-test) Wt.	ADG (feed-test)	Age at end of (feed-test)	Type score	ADG birth to end of feedtest	Season of birth	Type of birth and rearing
		(lb.)		(years)		(lb.)	(days)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(days)		(lb.)		
									1958								
503	9	9.06	1.00	3.33	1.00	90.7	129	0.64	85.4	96.9	155.0	0.46	282	13.1	0.55	2.00	1.00
629	7	8.46	1.29	3.71	1.14	93.0	131	0.64	85.6	99.6	161.1	0.49	282	12.7	0.57	2.00	1.43
Average		8.79	1.13	3.50	1.06	91.7	130	0.64	85.5	98.1	157.7	0.47	282	12.9	0.56	2.00	1.19
									1959								
629	12	8.99	1.50	4.08	1.50	85.5	133	0.58	78.4	83.8	137.6	0.49	251	12.7	0.55	2.20	2.00
730	7	8.17	1.86	5.14	1.71	82.1	128	0.58	77.6	81.0	124.0	0.39	244	12.8	0.51	2.30	2.57
Average		8.69	1.63	4.47	1.58	84.3	131	0.58	78.1	82.7	132.6	0.45	248	12.8	0.53	2.20	2.21
									1960								
629	4	10.35	1.75	4.50	1.25	87.8	126	0.62	84.5	92.3	149.3	0.62	233	12.9	0.64	2.00	2.00
684	3	10.67	1.00	4.00	1.00	83.3	123	0.63	85.7	92.7	151.3	0.64	228	13.0	0.66	2.30	1.00
730	4	10.20	1.50	3.25	1.00	98.3	136	0.65	87.8	97.5	145.8	0.52	262	11.7	0.56	1.30	1.50
Average		10.38	1.45	3.91	1.09	91.7	129	0.63	86.0	94.3	148.5	0.59	242	12.5	0.62	1.80	1.55
									1961								
903	2	10.75	1.50	4.00	1.50	62.5	99	0.53	72.5	61.0	104.0	0.43	207	13.0	0.51	4.00	2.00
951	5	8.92	1.40	3.20	1.40	74.6	105	0.64	85.8	85.0	131.4	0.46	229	13.5	0.57	3.40	1.80
Average		9.44	1.43	3.43	1.43	71.1	103	0.61	82.0	78.1	123.6	0.45	223	13.4	0.55	3.60	1.86
									1962								
176	2	10.65	1.00	4.00	1.00	75.0	99	0.64	87.5	81.0	133.5	0.53	215	13.9	0.62	2.50	1.00
903	4	8.45	1.75	5.25	1.50	87.3	123	0.64	85.8	90.5	137.8	0.47	239	13.5	0.58	1.80	2.50
949	4	8.80	1.50	3.25	1.50	88.5	124	0.65	86.3	92.3	140.3	0.48	240	13.6	0.59	2.00	2.00
Average		9.03	1.50	4.20	1.40	85.3	118	0.64	86.3	89.3	137.9	0.49	234	13.6	0.59	2.00	2.00

TABLE II (continued)

Sire	No. rams	Birth Wt.	Type of birth	Age of dam	Type of rearing	Weaning Wt.	Weaning age	ADG (Br.-Wn.)	120-day Wt.	Initial Wt. (feed-test)	Final Wt. (feed-test)	ADG (feed-test)	Age at end of (feed-test)	Type score	ADG birth to end of feedtest	Season of birth	Type of birth and rearing
		(lb.)		(years)		(lb.)	(days)	(lb.)	(lb.)	(lb.)	(lb.)	(lb.)	(days)		(lb.)		
									1963								
159	6	9.12	1.67	5.17	1.33	80.3	121	0.59	80.3	86.8	143.3	0.57	233	13.1	0.58	2.00	2.00
261	1	9.30	1.00	5.00	1.00	75.0	103	0.64	86.0	83.0	147.0	0.64	215	13.0	0.64	3.00	1.00
949	3	9.67	1.67	4.67	1.00	86.0	124	0.62	83.7	93.7	141.0	0.47	236	13.8	0.55	2.00	1.67
Average		9.30	1.60	5.00	1.20	81.5	120	0.60	81.9	88.5	143.0	0.55	232	13.3	0.58	2.10	1.80
									1964								
034	1	12.40	2.00	3.00	2.00	88.0	114	0.66	92.0	84.0	123.0	0.39	225	13.7	0.49	3.00	2.00
261	1	10.10	1.00	2.00	1.00	85.0	112	0.67	90.0	91.0	120.0	0.29	242	14.7	0.45	2.00	1.00
949	6	11.15	1.33	5.50	1.17	90.5	124	0.64	88.3	93.7	132.2	0.39	254	13.6	0.48	2.00	1.50
Average		11.18	1.37	4.75	1.25	89.5	121	0.65	89.0	92.1	129.5	0.37	249	13.8	0.48	2.10	1.50
									1965								
034	8	9.49	1.63	3.00	1.25	77.1	106	0.64	86.3	77.1	128.4	0.51	206	13.4	0.58	3.00	1.88
321	5	10.74	1.80	6.20	1.60	94.4	132	0.63	86.6	94.4	138.2	0.44	232	13.8	0.55	2.00	2.40
949	2	11.20	2.00	5.00	2.00	107.0	124	0.78	104.0	107.0	158.5	0.52	224	13.5	0.66	2.00	3.00
Average		10.13	1.74	4.33	1.47	86.9	117	0.66	88.7	86.9	135.7	0.49	217	13.5	0.58	2.50	2.20

TABLE III

YEARLY AVERAGES OF TRAITS OF PERFORMANCE TESTED RAMS DURING 1951 TO 1957

	No. rams	Birth Wt. (lb.)	Type of birth	Age of dam (years)	Type of rearing	Weaning Wt. (lb.)	Weaning age (days)	ADG (Br.-Wn.) (lb.)	120-day Wt. (lb.)	Summer ADG (lb.)	Initial Wt. (feed-test) (lb.)	Final Wt. (feed-test) (lb.)	ADG (feed-test) (lb.)	Age at end of (feed-test) (days)	Type score	ADG birth to end of feedtest (lb.)	Season of birth	Type of birth and rearing
									1951									
	18	10.23	1.50	5.55	1.45	82.6	119.8	0.61	83.5	0.21	140.3	179.8	0.48	479	12.7	0.38	2.06	1.94
									1952									
	15	8.94	1.60	4.47	1.46	90.6	131	0.63	84.3	0.28	119.1	160.9	0.41	336	12.3	0.48	2.20	2.13
									1953									
	11	9.08	1.63	4.91	1.09	83.0	135	0.55	74.8	0.23	114.2	163.3	0.49	375	12.9	0.44	2.18	1.73
									1954									
	17	9.25	1.35	4.00	1.24	70.5	135	0.45	63.7	0.17	98.6	151.1	0.53	408	12.5	0.37	2.23	1.59
									1955									
	17	9.41	1.47	3.94	1.53	90.3	135	0.60	81.2	0.22	120.5	168.9	0.48	373	13.0	0.45	2.00	1.94
									1956									
	13	8.77	1.54	4.61	1.38	99.4	136	0.67	88.6	0.26	129.0	178.0	0.49	346	14.0	0.51	2.15	1.92
									1957									
	23	9.52	1.52	4.43	1.48	88.9	1.54	0.51	70.8	0.22	114.9	161.1	0.47	358	13.0	0.45	2.13	2.00
Overall Average	114	9.37	1.51	4.54	1.39	86.21	136	0.57	77.5	0.22	119.4	165.8	0.48	384	12.9	0.44	2.13	1.90

TABLE IV

YEARLY AVERAGES OF TRAITS OF PERFORMANCE TESTED RAMS DURING 1958 TO 1965

	No. rams	Birth Wt. (lb.)	Type of birth	Age of dam (years)	Type of rearing	Weaning Wt. (lb.)	Weaning age (days)	ADG (Br.-Wn.) (lb.)	120-day Wt. (lb.)	Initial Wt. (feed-test (lb.)	Final Wt. (feed-test (lb.)	ADG (feed-test) (lb.)	Age at end of (feed-test) (days)	Type score	ADG birth to end of feedtest (lb.)	Season of birth	Type of birth and rearing
									1958								
	16	8.79	1.13	3.50	1.06	91.7	130	0.64	85.5	98.1	157.7	0.47	282	12.9	0.56	2.00	1.19
									1959								
	19	8.69	1.63	4.47	1.58	84.3	131	0.58	78.1	82.7	132.6	0.45	284	12.8	0.53	2.20	2.21
									1960								
	11	10.38	1.45	3.91	1.09	91.7	129	0.63	86.0	94.3	148.5	0.59	242	12.5	0.62	1.80	1.55
									1961								
	7	9.44	1.43	3.43	1.43	71.1	103	0.61	82.0	78.1	123.6	0.45	223	13.4	0.55	3.60	1.86
									1962								
	10	9.03	1.50	4.20	1.40	85.3	118	0.64	86.3	89.3	137.9	0.49	234	13.6	0.59	2.00	2.00
									1963								
	10	9.30	1.60	5.00	1.20	81.5	120	0.60	81.9	88.5	143.0	0.55	232	13.3	0.58	2.10	1.80
									1964								
	8	11.18	1.37	4.75	1.25	89.5	121	0.65	89.0	92.1	129.5	0.37	249	13.8	0.48	2.10	1.50
									1965								
	15	10.13	1.74	4.33	1.47	86.9	117	0.66	88.7	86.9	135.7	0.49	217	13.5	0.58	2.50	2.20
Overall Average	96	9.49	1.49	4.20	1.32	86.1	123	0.62	84.3	89.0	139.8	0.48	243	13.2	0.56	2.23	1.81

TABLE V

CORRELATION AMONG TRAITS OF PERFORMANCE TESTED RAMS DURING 1951 TO 1957

	Birth Wt.	Type of birth	Age of dam	Type of rearing	Weaning Wt.	Weaning age	ADG (Br.-Wn.)	120-day Wt.	Summer ADG	Initial Wt. (feedtest)	Final Wt. (feedtest)	ADG (feedtest)	Age at end of (feedtest)	Type score	ADG birth to end of feedtest	Season of birth	Type of birth and rearing
1. Birth Wt.	1.000	-0.513**	0.220*	-0.499**	0.394**	-0.243*	0.365**	0.510**	-0.121	0.232*	0.323**	0.135	-0.229*	-0.021	0.390**	0.135	-0.504**
2. Type of birth		1.000	0.003	0.834**	-0.488**	-0.224*	-0.330**	-0.392**	0.164	-0.267*	-0.282**	-0.045	-0.140	-0.227*	-0.178	0.176	0.969**
3. Age of dam			1.000	-0.037	-0.130	-0.238*	-0.080	-0.041	-0.013	-0.143	-0.146	-0.006	-0.207	-0.170	-0.037	0.132	0.005
4. Type of rearing				1.000	-0.536**	-0.140	-0.424**	-0.472**	0.190	-0.275**	-0.278**	-0.026	-0.088	-0.214*	-0.202	0.080	0.927**
5. Weaning Wt.					1.000	0.181	0.886**	0.886**	-0.264*	0.565**	0.565**	0.057	0.276**	0.161	0.405**	0.311**	-0.523**
6. Weaning age						1.000	-0.241*	-0.252*	-0.016	0.074	-0.081	-0.197	0.572**	0.175	-0.319**	-0.533**	-0.235*
7. ADG (Br-Wn)							1.000	0.980**	-0.239*	0.515**	0.590**	0.153	0.048	0.111	0.518**	-0.064	-0.362**
8. 120-day Wt								1.000	-0.241*	0.516**	0.601**	0.166	0.019	0.103	0.540**	-0.036	-0.419**
9. Summer ADG									1.000	0.599**	0.184	-0.455**	-0.098	0.224*	0.214*	0.210	0.158
10. Initial Wt. (feedtest)										1.000	0.663**	-0.319**	0.236*	0.312**	0.493**	-0.140	-0.297**
11. Final Wt. (feedtest)											1.000	0.497**	0.073	0.345**	0.878**	-0.018	-0.303**
12. ADG (Feedtest)												1.000	-0.184	0.077	0.537**	0.143	-0.036
13. Age at end of (feedtest)													1.000	0.107	-0.388**	-0.879**	-0.140
14. Type score														1.000	0.274*	-0.037	-0.236*
15. ADG birth to end of (feedtest)															1.000	0.372**	-0.196
16. Season of birth																1.000	0.168
17. Type of birth and rearing																	1.000

* P = < .05

**P = < .01

TABLE VI

CORRELATION AMONG TRAITS OF PERFORMANCE TESTED RAMS DURING 1948 TO 1965

	Birth Wt.	Type of birth	Age of dam	Type of rearing	Weaning Wt.	Weaning age	ADG (Br.-Wn.)	120-day Wt.	Initial Wt. (feedtest)	Final (feedtest) Wt.	ADG (feedtest)	Age at end of (feedtest)	Type score	ADG birth to end of feedtest	Season of birth	Type of birth and rearing
1. Birth Wt.	1.000	-0.455**	0.204	-0.336**	0.533**	-0.069	0.443**	0.559**	0.479**	0.466**	0.093	0.106	0.229*	0.402**	-0.085	-0.428**
2. Type of birth		1.000	0.034	0.704**	-0.455**	0.227*	-0.532**	-0.556**	-0.449**	-0.327**	0.121	0.007	-0.112	-0.326**	-0.016	0.936**
3. Age of dam			1.000	-0.070	-0.105	-0.044	-0.101	-0.072	-0.134	-0.001	0.207	-0.072	0.053	0.015	-0.039	-0.018
4. Type of rearing				1.000	-0.351**	0.306**	-0.498**	-0.507**	-0.370**	-0.344**	-0.047	0.169	-0.225	-0.441**	-0.117	0.897**
5. Weaning Wt.					1.000	0.178	0.833**	0.855**	0.925**	0.782**	-0.053	0.389**	0.328**	0.592**	-0.339**	-0.430**
6. Weaning age						1.000	-0.372**	-0.343**	0.030	0.024	-0.003	0.729**	-0.157	-0.300**	-0.739**	0.276*
7. ADG (Br-Wn)							1.000	0.990**	0.853**	0.734**	-0.027	-0.034	0.388**	0.743**	0.088	-0.543**
8. 120-day Wt.								1.000	0.865**	0.755**	-0.008	-0.006	0.403**	0.750**	0.059	-0.562**
9. Initial Wt. (feedtest)									1.000	0.832**	-0.082	0.325**	0.405**	0.660**	-0.225	-0.434**
10. Final Wt. (feedtest)										1.000	0.482**	0.230*	0.412**	0.885**	-0.191	-0.348**
11. ADG (feedtest)											1.000	-0.111	0.093	0.555**	0.041	0.052
12. Age at end of (feedtest)												1.000	0.039	-0.225	-0.805**	0.087
13. Type score													1.000	0.367**	-0.106	-0.188
14. ADG birth to end of (feedtest)														1.000	0.186	-0.395**
15. Season of birth															1.000	-0.058
16. Type of birth and rearing																1.000

* P = < .05

**P = < .01

I. BIRTH WEIGHT

The birth weights ranged from 7.75 pounds in 1953 to 14 pounds in 1957, during the period from 1951 to 1957. They averaged 9.37 pounds. For the 1958 to 1965 period, birth weights varied from 8.17 pounds in 1959 to 12.40 pounds in 1964. The average birth weight was 9.49 pounds.

Significant ($P < .01$) correlations were found between birth weight and the following characteristics for the 1951 to 1957 period and 1958 to 1965 period, respectively: type of birth, -0.513 and -0.455; type of rearing, -0.499 and -0.336; weaning weight, 0.394 and 0.533; average daily gain from birth to weaning, 0.365 and 0.443; 120-day weight, 0.510 and 0.559; final weight of feed test, 0.323 and 0.466; average daily gain from birth to end of feed test, 0.390 and 0.402, and type of birth and rearing, -0.504 and -0.428.

During 1951 to 1957, there were significant ($P < .05$) correlations between birth weight and the following traits: age of dam, 0.220, weaning age, 0.243, initial weight at the beginning of feed test, 0.232 and age at the end of feed test, -0.229. For 1958 to 1965, a significant ($P < .01$) correlation of 0.479 between birth weight and initial weight at the starting of feed test was observed. There was also a significant ($P < .05$) correlation of 0.229 between birth weight and type score. A positive relationship was found between birth weight and subsequent weight gain of ram lambs. These results are similar to those reported by Kean and Henning (1949).

II. TYPE OF BIRTH

Type of birth varied from single to twin for the entire period of study. There were significant ($P < .01$) correlations between type of birth and the following traits for the periods of 1951 to 1957 and 1958 to 1965, respectively: birth weight, -0.513 and -0.455; type of rearing, 0.834 and 0.704; weaning weight, -0.488 and -0.455; average daily gain from birth to weaning, -0.330 and -0.532; 120-day weight, -0.392 and -0.556; final weight of feed test, -0.282 and -0.327, and type of birth and rearing, 0.969 and 0.936.

During 1951 to 1957, significant ($P < .05$) correlations were found between type of birth and the following characteristics: weaning age, -0.224, initial weight of feed test, -0.267 and type score, -0.227. For 1958 to 1965, type of birth showed significant ($P < .01$) correlations of -0.449 and -0.326 with initial weight of feed test and average daily gain from birth to end of feed test. There was also a significant ($P < .05$) correlation of 0.227 between type of birth and weaning age.

Ram lambs born as singles were heavier at birth and weaning than lambs born as twins. These observations are in agreement with those of Phillips and Dawson (1937), Blackwell and Henderson (1955), Bogart et al. (1957), and Maurice Shelton (1964). Single lambs gained more per day than twins. This is consistent with the findings of Kean and Henning (1949) and Shelton and Campbell (1962).

III. AGE OF DAM

Age of dam showed some variations within years. The maximum age of dam was six years and minimum was two years during the 1951 to 1957 period with an average age of 4.54 years. For the period from 1958 to 1965, age of dam varied from two years to 6.20 years with an average of 4.20 years.

During the period 1951 to 1957 only, age of dam showed significant ($P < .05$) correlations of 0.220 and -0.238 with birth weight and weaning age.

There were no significant correlations between age of dam and rate of gain in lambs in this study. However, it was observed that ram lambs from mature ewes (3 through 7 years) were heavier at birth and weaning time. These findings correspond with those of Nelson and Venkatachalam (1949) and Blackwell and Henderson (1955).

IV. TYPE OF REARING

For both the periods of 1951 to 1957 and 1958 to 1965, some ram lambs were born as singles and reared as singles, some were born as twins and reared as singles, while others were born as twins and reared as twins.

Significant ($P < .01$) correlations were found between type of rearing and the following traits for the 1951 to 1957 period and 1958 to 1965 period, respectively: birth weight, -0.499 and -0.336; type of birth, 0.834 and 0.704; weaning weight, -0.536 and -0.351; average daily

gain from birth to weaning, -0.424 and -0.498; 120-day weight, -0.472 and -0.507; initial weight of feed test, -0.275 and -0.370; final weight of feed test, -0.278 and -0.344, and type of birth and rearing, 0.927 and 0.897.

During 1951 to 1957 there was a significant ($P < .05$) correlation of -0.214 between type of rearing and type score, while for 1958 to 1965 weaning age and average daily gain from birth to end of feed test showed significant ($P < .01$) correlations of 0.306 and -0.441, respectively.

The results indicated that ram lambs born as singles and reared as singles gained faster than lambs born as twins and reared as either singles or twins. Blackwell and Henderson (1955) observed similar findings.

V. WEANING WEIGHT

Weaning weights ranged from 61 pounds in 1953 to 107.3 pounds in 1956 with an overall average of 86.21 pounds for the years 1951 to 1957. In the year groups for 1958 to 1965, the highest weaning weight was 107 pounds in 1965 and lowest 62.5 pounds in 1961. The average weaning weight for the above period was 86.1 pounds.

Significant ($P < .01$) correlations were found between the weaning weight and the following traits for the 1951 to 1957 period and 1958 to 1965 period, respectively: birth weight, 0.394 and 0.533; type of birth, -0.488 and -0.455; type of rearing, -0.536 and -0.351; average daily gain from birth to weaning, 0.886 and 0.833; 120-day weight, 0.886 and 0.855; initial weight at the beginning of feed test, 0.565 and 0.925;

final weight of feed test, 0.565 and 0.782; age at end of feed test, 0.276 and 0.389; average daily gain from birth to end of feed test, 0.405 and 0.592; season of birth, -0.311 and -0.339, and type of birth and rearing, -0.523 and -0.430.

During 1951 to 1957, there was a significant ($P < .05$) correlation of -0.264 between weaning weight and summer average daily gain. For 1958 to 1965, type score showed a significant ($P < .01$) correlation of 0.328 with weaning weight.

The ram lambs heavier at birth, born and reared as singles and from mature ewes (3 through 7 years) were heavier at weaning than ram lambs that were lighter weight at birth, born and reared as twins, and from two-year-old ewes. These observations agree in general with those of Hazel and Terrill (1945), Nelson and Venkatachalam (1949), Blackwell and Henderson (1955), and Debaca et al. (1956).

VI. WEANING AGE

Weaning age varied from 88 days to 162 days during the period from 1951 to 1957 with an average weaning age of 136 days. For 1958 to 1965, weaning age ranged from 99 days to 136 days with an average weaning age of 123 days.

There were significant ($P < .01$) correlations between weaning age and the following characteristics for the periods of 1951 to 1957 and 1958 to 1965, respectively: age at end of feed test, 0.572 and 0.729; average daily gain from birth to end of feed test, -0.319 and -0.300, and season of birth, -0.533 and -0.739.

During 1951 to 1957, significant ($P < .05$) correlations were found between weaning age and the following traits: birth weight, -0.243; type of birth, -0.224; age of dam, -0.238; average daily gain from birth to weaning, -0.241; 120-day weight, -0.252; and type of birth and rearing, -0.235.

For 1958 to 1965, weaning age showed significant ($P < .01$) correlations with the following characteristics: type of rearing, 0.306, average daily gain from birth to weaning, -0.372 and 120-day weight, -0.343. There were significant ($P < .05$) correlations of 0.227 and 0.276 between type of birth and type of birth and rearing with weaning age.

The data indicated that ram lambs weaned at a younger age made faster gains on feed test than those weaned at a later age. There was a nonsignificant negative correlation between weaning age and rate of gain in weaned lambs. This is consistent with the findings of Wilder and Goode (1962) who reported nonsignificant negative correlation between age at weaning and rate of gain in weaned lambs.

VII. AVERAGE DAILY GAIN FROM BIRTH TO WEANING

Average daily gain (Br.-Wn.) varied with years for the period from 1951 to 1957 from 0.39 pounds in 1953 to 0.73 pounds in 1956. The overall average daily gain was 0.57 pounds. For 1958 to 1965, the highest average daily gain from birth to weaning was 0.78 pounds in 1965, while the lowest was 0.53 pounds in 1961, with a mean average daily gain of 0.62 pounds.

Significant ($P < .01$) correlations were found between average daily gain from birth to weaning and the following traits for the 1951 to 1957 period and 1958 to 1965 period, respectively: birth weight, 0.365 and 0.443; type of birth, -0.33 and -0.532; type of rearing, -0.424 and -0.498; weaning weight, 0.886 and 0.833; 120-day weight, 0.98 and 0.99; initial weight of feed test, 0.515 and 0.853; final weight of feed test, 0.59 and 0.734; average daily gain from birth to end of feed test, 0.518 and 0.743; and type of birth and rearing, -0.362 and -0.543.

During 1951 to 1957, there were significant ($P < .05$) correlations of -0.241 and -0.239 between weaning age and summer average daily gain with average daily gain from birth to weaning. For 1958 to 1965, weaning age and type score showed significant correlations ($P < .01$) of -0.372 and 0.388 with average daily gain from birth to weaning.

Ram lambs that were born single and twin lambs raised as singles gained more than twins reared as twins. There was some variation in rate of gain of lambs born as twins and reared as twins compared to those born as twins and reared as singles. These observations agree with those of Phillips and Dawson (1937), Hazel and Terril (1945), Kean and Henning (1949), Nelson and Venkatachalm (1949), Blackwell and Henderson (1955), DeBaca et al. (1956), and Shelton and Campbell (1962). The data suggest that ram lambs born as singles and reared as singles grew fastest.

There was no significant correlation between the age of dam and rate of gain from birth to weaning. However, some variations in average

daily gains were observed for lambs from different ages of dam. Lambs from mature ewes (3 through 7 years) were heavier at weaning time than lambs from two-year-old ewes. These observations agree with those of Sabin and Brown (1962).

VIII. 120-DAY WEIGHT

The average 120-day weight between 1951 and 1957 ranged from 55 pounds in 1953 to 95.8 pounds in 1956 with an overall average of 77.5 pounds for 1951 to 1957. During the period from 1958 to 1965, 120-day weight varied from 72.5 pounds in 1961 to 104 pounds in 1965. The aggregate average 120-day weight was 84.3 pounds.

There were significant ($P < .01$) correlations between 120-day weight and the following characteristics for the periods 1951 to 1957 and 1958 to 1965, respectively: birth weight, 0.510 and 0.559; type of birth, -0.392 and -0.556; type of rearing, -0.472 and -0.507; weaning weight, 0.886 and 0.885; average daily gain from birth to weaning, 0.980 and 0.990; initial weight at the beginning of feed test, 0.516 and 0.865; final weight of feed test, 0.601 and 0.755; average daily gain from birth to end of feed test, 0.540 and 0.750 and type of birth and rearing, -0.419 and 0.562.

During 1951 to 1957, weaning age and summer average daily gain showed significant ($P < .05$) correlations of -0.252 and -0.241 with 120-day weight. For 1958 to 1965, significant ($P < .01$) correlations of -0.343 and 0.403 were found between 120-day weight and weaning age and type score, respectively.

The data suggest that 120-day weight is closely related to weaning weight. Though neither age of dam nor season of birth showed any significant correlation with 120-day weight, variations were noted in 120-day weights of lambs among years in which they were born and for season of birth within years. These yearly variations seem to suggest the effect of different genetic, nutritional, climatic and other environmental factors. These findings correspond to those of Sabin and Brown (1962).

IX. SUMMER AVERAGE DAILY GAIN

For the years 1951 to 1957, the rams were carried through the summer and put on feed test in September. Summer average daily gain during the intervening period between weaning time and feed tests varied with years. The highest rate of gain was 0.36 pound coming in 1956 and the lowest was 0.12 pound in 1954. They averaged 0.22 pound.

During the 1951 to 1957 period only, significant ($P < .01$) correlations of 0.599 and -0.455 were found between summer average daily gain and initial weight of feed test and average daily gain on feed test, respectively. There were also significant ($P < .05$) correlations between summer average daily gain and the following traits: weaning weight, -0.264; average daily gain from birth to weaning, -0.239; 120-day weight, -0.241; type score, 0.224; and average daily gain from birth to end of feed test, 0.214.

X. INITIAL WEIGHT (FEED TEST)

Initial weight at the start of feed tests for the period 1951 to 1957 ranged from 95.8 pounds in 1954 to 149.8 pounds in 1956 with an average of 119.4 pounds. For 1958 to 1965, the highest initial weight at starting feed test was 107 pounds in 1965 and lowest was 61 pounds in 1961, with an average of 89 pounds.

There were significant ($P < .01$) correlations between initial weight at the beginning of feed test and the following characteristics during the periods of 1951 to 1957 and 1958 to 1965, respectively: type of rearing, -0.275 and -0.37; weaning weight, 0.565 and 0.925; average daily gain from birth to weaning, 0.515 and 0.853; 120-day weight, 0.516 and 0.865; final weight of feed test, 0.663 and 0.832; type score, 0.312 and 0.405; average daily gain from birth to end of feed test, 0.493 and 0.66; and type of birth and rearing, -0.297 and -0.434.

For 1951 to 1957, significant ($P < .01$) correlations of 0.599 and -0.319 were found between initial weight of feed test, summer average daily gain, and rate of gain on feed test. There were also significant ($P < .05$) correlations between initial weight at the start of feed test and the following traits: birth weight, 0.232; type of birth, -0.267; and age at end of feed test, 0.236. During 1958 to 1965, initial weight at the start of feed test showed significant ($P < .01$) correlations of 0.479, -0.449, and 0.325, with birth weight, type of birth, and age at end of feed test, respectively.

Variations in the initial weight of lambs at starting feedlot test was closely associated with birth weight, type of birth, type of rearing, weaning weight, rate of gain from birth to weaning, and 120-day weight.

XI. FINAL WEIGHT (FEED TEST)

Large differences were found in the final weights within the year groups. For the 1951 to 1957 period, final weights varied from 134 pounds in 1953 to 189.8 pounds in 1956 with an average of 165.8 pounds. The range between the final weights during the period from 1958 to 1965 was from 104 pounds in 1961 to 161.1 pounds in 1958 with an average of 139.8 pounds.

Significant ($P < .01$) correlations were found between final weight at the completion of feed test and the following traits for the 1951 to 1957 period and 1958 to 1965 period, respectively: birth weight, 0.323 and 0.466; type of birth, -0.282 and -0.327; type of rearing, -0.278 and -0.344; weaning weight, 0.565 and 0.782; average daily gain from birth to weaning, 0.59 and 0.734; 120-day weight, 0.601 and 0.755; initial weight of feed test, 0.663 and 0.832; average daily gain on feed test, 0.497 and 0.482; type score, 0.345 and 0.412; average daily gain from birth to end of feed test, 0.878 and 0.885, and type of birth and rearing, -0.303 and -0.348.

During 1958 to 1965, there was a significant ($P < .05$) correlation of 0.230 between final weight of feed test and age at end of feed test.

XII. AVERAGE DAILY GAIN (FEED TEST)

The rate of gain for approximately 100-day period feed tests varied within year groups. In the 1951 to 1957 period the average daily gain ranged from 0.32 pound in 1952 to 0.64 pound in 1954, with an average of 0,48 pound. For the 1958 to 1965 period the maximum average daily gain was 0.64 pound in 1960 and 1963 and minimum was 0.29 pound in 1964 with an overall average daily gain of 0.48 pound.

There were significant ($P < .01$) correlation between average daily gain on feed test and the following characteristics for the periods 1951 to 1957 and 1958 to 1965, respectively: final weight at the end of feed test, 0.497 and 0.482; and average daily gain from birth to end of feed test, 0.537 and 0.555. During 1951 to 1957, significant ($P < .01$) correlations of -0.455 and -0.319 were found between average daily gain on feed test, summer average daily gain, and initial weight at the beginning of feed test.

There were nonsignificant correlations between average daily gain during feed test and birth weight, type of birth, type of rearing, age of dam, weaning weight, weaning age, rate of gain from birth to weaning, 120-day weight, age at end of feed test, type score, season of birth and type of birth and rearing.

The data indicated that rams that gained faster during the period from weaning to starting of feed tests gained slower during feed test periods. The correlations observed between rates of gain among various periods of growth provide a basis to suggest that the relationships have

little predictive value in estimating the performance of rams in subsequent periods.

XIII. AGE AT END OF FEED TEST

In the 1951 to 1957 period there was variation in the age of rams at the end of feed test, the highest being 507 days in 1951 and the lowest 311 days in 1957 with an average age of 384 days at the completion of the tests. During the period from 1958 to 1965, the age of rams at the end of feed test ranged from 206 days in 1965 to 282 days in 1958. The average age at the end of feed test for this period was 243 days.

Significant ($P < .01$) correlations were found between age at end of feed test and the following traits for 1951 to 1957 period and 1958 to 1965 period, respectively: weaning weight, 0.276 and 0.389; weaning age, 0.572 and 0.729; and season of birth, -0.879 and -0.805.

During 1951 to 1957, there was a significant ($P < .01$) correlation of -0.388 between age at end of feed test and average daily gain from birth to end of feed test. Type of birth and initial weight at the beginning of feed test showed significant ($P < .05$) correlations of -0.229 and 0.236 with age at end of feed test. For 1958 to 1965, there was a significant ($P < .01$) correlation of 0.325 between age at end of feed test and the initial weight at the starting of feed test. There was also a significant ($P < .05$) correlation of 0.23 between age at end of feed test and final weight of feed test.

It was observed that the ram lambs weaned at a younger age made faster gains on feed test than those weaned at a later age.

XIV. TYPE SCORE

For the 1951 to 1957 period, type scores ranged from 9.5 to 15.0 with an average of 12.9. During the 1958 to 1965 period, the maximum type score was 14.7 and the minimum was 11.7. The average type score for this period was 13.2.

There were significant ($P < .01$) correlations between type score and the following characteristics during the period groups of 1951 to 1957 and 1958 to 1965, respectively: initial weight at the beginning of feed test, 0.312 and 0.405, and final weight at the completion of feed test, 0.345 and 0.412.

For 1951 to 1957, significant ($P < .05$) correlations were found between type score and the following traits: type of birth, -0.227; type of rearing, -0.214; summer average daily gain, 0.224; average daily gain from birth to end of feed test, 0.274; and type of birth and rearing, -0.236. During 1958 to 1965, type score showed significant ($P < .01$) correlations with the following characteristics: weaning weight, 0.328; average daily gain from birth to weaning, 0.388; 120-day weight, 0.403; and average daily gain from birth to end of feed test, 0.367. There was also significant ($P < .05$) correlation of 0.229 between type score and birth weight.

It was noted that ram lambs heavier at birth, weaning, 120-day age, and at the starting and completion of feed test had an advantage in type score.

XV. AVERAGE DAILY GAIN FROM BIRTH TO END OF FEED TEST

It was noted that there was variation in rate of gain from birth to end of feed test. Average daily gain of rams from birth to the end of feedlot tests varied, with the highest 0.51 pounds in 1956 and the lowest 0.34 pounds in 1951 and 1953. The average daily gain for 1951 to 1957 was 0.44 pounds. During the period from 1958 to 1965, the rate of gain from birth to end of feed tests ranged from 0.48 pounds in 1964 to 0.66 in 1960 and 1965. The average for this period was 0.56 pounds.

Significant ($P < .01$) correlations were found between average daily gain from birth to end of feed test and the following characteristics during the periods of 1951 to 1957 and 1958 to 1965, respectively: birth weight, 0.39 and 0.402; weaning weight, 0.405 and 0.592; weaning age, -0.319 and -0.3; average daily gain from birth to weaning, 0.518 and 0.743; 120-day weight, 0.54 and 0.75; initial weight at the starting of feed test, 0.493 and 0.66; final weight at the end of feed test, 0.878 and 0.885; and average daily gain on feed test, 0.537 and 0.555.

For the 1951 to 1957 period, significant ($P < .01$) correlations of -0.388 and 0.372 were found between age at end of feed test, and season of birth with average daily gain from birth to end of feed test. There were also significant ($P < .05$) correlations between average daily gain from birth to end of feed test, and summer average daily gain, 0.214 and type score, 0.274. During the 1958 to 1965 period, average daily gain from birth to end of feed test showed significant ($P < .01$) correlations with the following traits: type of birth, -0.326; type of

rearing, -0.441; type score, 0.367; and type of birth and rearing, -0.395.

It was observed that ram lambs born as singles and reared as singles tended to gain more per day than any other type of birth and rearing combination. There was no significant corrrelation between the age of dam and rate of gain from birth to end of feed test. However, lambs born to two-year-old dams tended to gain less than lambs out of mature ewes (3 to 7 years). Birth weight, weaning weight, weaning age, average daily gain from birth to weaning, 120-day weight, initial weight at the beginning of feed test, final weight at the end of feed test and rate of gain on feed test were closely related to average daily gain from birth to end of feed test. Karam et al. (1949) and Botkin (1964) observed similar results.

XVI. SEASON OF BIRTH

Season of birth ranged from early lambing season (from November to January) to the sixty-first to ninetieth day of the succeeding year. Each year the ewes were bred during the same period and as a result lambed at about the same time each season.

There were significant ($P < .01$) correlations between season of birth and the following traits for the 1951 to 1957 period and 1958 to 1965 period, respectively: weaning weight, -0.311 and -0.339; weaning age, -0.553 and -0.739; and age at end of feed test, -0.879 and -0.805.

During 1951 to 1957, a significant ($P < .01$) correlation of 0.372 was found between season of birth and average daily gain from birth to end of feed test.

It was noticed that ram lambs born during the first thirty days of the year through the nintieth day of the year were heavier than lambs born earlier. Lambs born late were heavier at birth and grew slightly faster than early lambs. These observations are in general agreement with those of Blackwell and Henderson (1955), Sabin and Brown (1962), and Wilder and Goode (1962).

XVII. TYPE OF BIRTH AND REARING

Type of birth and rearing were almost the same for the entire period of study. They varied from ram lambs born as single and reared single to lambs born as twins and raised as twins or born twins and reared single.

Significant ($P < .01$) correlations were found between type of birth and rearing and the following characteristics for the period 1951 to 1957 and 1958 to 1965 period, respectively: birth weight, -0.504 and -0.428; type of birth, 0.969 and 0.936; type of rearing, 0.927 and 0.897; weaning weight, -0.523 and -0.430; average daily gain from birth to weaning, -0.362 and -0.543; 120-day weight, -0.419 and -0.562; initial weight at the beginning of feed test, -0.297 and -0.434; and final weight at the completion of feed test, -0.303 and -0.348.

During 1951 to 1957, weaning age and type score showed significant ($P < .05$) correlations of -0.235 and -0.236 with type of birth and

rearing. For 1958 to 1965, a significant ($P < .01$) correlation of -0.395 was found between average daily gain from birth to end of feed test, and type of birth and rearing. There was also a significant ($P < .05$) correlation of 0.276 between type of birth and rearing and weaning age.

It was noted that ram lambs born as singles and reared as singles weighed more at birth, weaning time, and 120-day age, and gained more per day than any other type of birth and rearing combination. These findings correspond with those of Phillips and Dawson (1937), Kean and Henning (1949), Nelson and Venkatachalm (1949), Blackwell and Henderson (1955), Bogart et al. (1957), and Shelton and Campbell (1962).

CHAPTER V

SUMMARY AND CONCLUSIONS

A study was conducted to determine the relationships among the various traits on the performance of gain of the tested rams during different periods of growth at The Tennessee Agricultural Experiment Main Station, Knoxville. The records of 204 Hampshire ram lambs born over a fifteen-year period, from 1951 to 1965, were used.

In this study, it was observed that there was a significant correlation between birth weight and type of birth and rearing, weaning weight, 120-day weight, weaning age, average daily gain birth to weaning, and average daily gain birth to end of feed test. There was no significant correlation between birth weight with average daily gain during feed test. In all comparisons ram lambs heavier at birth gained faster than lighter lambs. Ram lambs born as singles and reared as singles gained faster than any other type of birth and rearing combination.

There was no significant correlation between age of dam and average daily gain from birth to weaning, weaning age and season of birth. However, lambs born to two-year-old dams gained less than lambs from mature ewes (3 through 7 years).

The most noticeable observation was the correlations among birth weight, weaning weight, average daily gain from birth to weaning, 120-day weight, summer average daily gain, average daily gain during feed test, type score and average daily gain from birth to end of feed test.

It was noted that birth weight was closely related to weaning weight, 120-day weight, type score and rate of gain during various periods of growth. There were significant correlations between weaning weight, birth weight, average daily gain from birth to weaning, 120-day weight, type score, and average daily gain from birth to end of feed test. There were significant correlations between the average daily gain from birth to weaning and birth weight, type of birth and rearing, weaning weight, weaning age, 120-day weight, summer average daily gain, type score, and average daily gain from birth to end of feed test. The results indicated that ram lambs born and reared as singles grew fastest. The data suggest that 120-day weight is closely related to weaning weight. It was found that the lambs weaned at a younger age made faster gains on feed test than those weaned at a later age.

The ram lambs born from the first day through the ninetieth day of the year were heavier at birth and grew slightly faster than lambs born from November to January 1. The individual variations in performance of rams were great; this variability may be attributed in part to genetic and/or yearly differences in environmental factors.

It was noticed that lambs, heavier at birth, weaning time, 120-day age and at the starting and completion of feed tests also had a higher type score.

There was a significant correlation between average daily gain during feed test and the rate of gain from birth to end of feed test. The correlations obtained between rates of gain during different periods of growth suggest that rams which gained more during the period from

weaning to the beginning of feed test on a medium level of nutrition, gained less during feed tests and that preweaning gains were of little value in estimating feed test gains. It was observed that gain in one period would have little predictive value in estimating the performance of an animal during a subsequent period.

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