March 10, 1958

To the Graduate Council:

I am submitting herewith a thesis written by James A. McDermit 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.

Harold J. Smith
Major Professor

We have read this thesis
and recommend its acceptance:

Charles S. Hobbs

O. Glen Hall

Accepted for the Council:

Dale Hanthorn
Dean of the Graduate School

PERFORMANCE TESTING OF RAMS

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Master of Science

---

by

James A. McDermit

March 1958

28.
33

ACKNOWLEDGEMENT

The writer wishes to express his sincere appreciation to Dr. H. J. Smith for his patient guidance and technical assistance in helping to conduct this study.

James A. McDermit

393262

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
II.	REVIEW OF LITERATURE	3
III.	PROCEDURE	22
IV.	RESULTS AND DISCUSSION	30
V.	SUMMARY AND CONCLUSIONS	45
BIBLIOGRAPHY		49
APPENDIX		55

LIST OF TABLES

TABLE PAGE

I. The Relative Rates of Improvement, Using Different Systems of Breeding, on the Fleece Weights of New Zealand Romney Marsh Sheep 15

II. Record of Performance of Rambouillet Sire Groups 18

III. Heritability Estimates for Various Traits in Sheep 19

IV. Correction Factors for Adjusting Daily Gain of Lambs from Birth to Weaning for Method of Rearing and Age of Dam 29

V. Means and Standard Errors for Gains of Rams During Various Periods of Growth 31

VI. Correlation of Average Daily Gains Made at Different Periods of Growth 33

VII. Analysis of Variance and Heritability Estimates of Gain for Various Periods of Growth for Gain-Tested Rams 36

TABLE (Continued) PAGE

VIII. Performance Records of Gain Tested Sires During Various Periods of Growth and Preweaning Performance of Their Offspring 40

IX. Analysis of Variance and Heritability Estimates of Preweaning Average Daily Gain of Lambs for Different Years 41

X. Analysis of Variance and Heritability Estimate of Preweaning Average Daily Gain of Lambs for Combined Data 43

XI. Correlations and Regression of Average Progeny Performance on Sire Performance 44

CHAPTER I

INTRODUCTION

The relationship of gains made by sheep during successive periods of growth and development has not been investigated.

A knowledge of these relationships may be useful in the development of methods that will aid in early selection of rams capable of transmitting maximum performance to their progeny. If selection could be made at an early age with a high degree of accuracy, it would be a great aid in putting high producing rams into production and culling potential low producers.

Purebred breeders and market lamb producers are faced continually with the problem of securing rams which will sire rapid-gaining, desirable lambs of superior carcass quality. It is the responsibility of purebred breeders to furnish market lamb producers with such rams. Information is needed on methods and procedures that will aid in early selection of high-producing animals and on practical, efficient systems of breeding to aid in the improvement of existing breeds of sheep for traits of economic importance.

The objectives of this study were (1) to determine the relationship between gains made at different periods of growth and development of rams and (2) to investigate whether

differences in individual performance of rams are of value in evaluating probable growth transmitting ability of rams.

CHAPTER II

REVIEW OF LITERATURE

Rice and Andrews (1951) pointed out that the emphasis in selection that should be placed upon a character depends upon its economic importance, its heritability, and the level of performance already attained in the flock. They also stated that 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 feasable to attempt to progeny test all rams. Dickerson and Hazel (1944) found that it is possible, using the best progeny-tested two-year-old rams, to increase progress about 11 per cent for weanling traits and 3 per cent for yearling traits for characters which are only 10 per cent heritable as compared to using the best untested yearling rams. By using an auxiliary flock for testing ram lambs, the increase in progress would be raised to 20 per cent for weanling traits and 5 per cent for yearling traits.

Body weight for age has been used consistently in the measurement of performance of a sire's progeny. Weight

measurements along with type and conformation scores of the animal should be used for best results. Ragab et al. (1953) found high correlations between birth weight, weaning weight and market weight. Rae (1956) suggested that more work should be carried out along this line as continued selection for high weaning weights may tend to favor early maturing animals and the trait may not carry on into maturity. Wallace (1948) found nutrition in late pregnancy had a definite effect on birth weight. Phillips (1940) observed that sex and type of birth affected birth weight, weaning weight and maturity. Male lambs were significantly heavier than females at birth and the differences in sexes became more pronounced with increasing age. 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 and correction factors should be used when summarizing data. There was a definite tendency for all breeds to respond the same in each year. With only one exception Phillips found a highly significant difference between years for body weight, fleece weight, and fleece length. Rae (1956) found weaning weights had a higher heritability in fine wool breeds than in mutton breeds and that milk production affected weaning weight and live weight

gain. Barnicoat et al. (1956) stated that weight of milk rather than its nutritive value gives the best index of its lamb fattening qualities. Turner (1951) reported that ewes milked 138 days varied in production from 71.0 to 77.4 kg., with maximum productivity being reached in the ninth or tenth week. Some of the variations among breeds were rather large. Fuller and Lehinheinz (1904) obtained 2.8 pounds as the average daily milk yield of various breeds of sheep. Neidig and Iddings (1919) obtained milk yields of 19.1 pounds a week for Southdown ewes and 33.5 pounds a week for Hampshires. Pierce (1934) obtained an average of 18.6 pounds a week for Merino ewes. Crossbreeding tended to increase milk production. Since lambs depend chiefly on milk the first three weeks of birth, growth closely followed milk production of the ewes. Wallace (1948) reported ewes with twins had higher milk production than ewes with singles. Hunter (1956) found the date of lambing affected the total milk yield, with late lambing giving less milk than early lambing. Seventeen per cent of the total variation of live weight was attributed to maternal influences. Maternal influences diminished by the eighth month and then genotype became the most effective factor controlling growth of sheep.

Sidwell (1956) found that age of the dam, sex of the lamb, and age of the lamb have an influence on weaning weight.

Terrill and Stohr (1939) obtained a highly significant difference in weight of lambs weaned between ewes with single and ewes with twin lambs. The difference varied with years and there was a significant interaction between type of birth and years. This tended to cause selection for single lambs as they were larger and had more weight for age. In crossbred lambs, a greater per cent of singles than twins reached weaning age, but this was not true for the Navajo's. The crossbred twin lambs had a higher death rate than the Navajo's. Navajo ewes had a 10 per cent advantage in the number of ewes having twins. Wright and Stevens (1953) found that ewes born as twins had more multiple births at all ages except five-years of age. Singles and twins showed no difference in the average number of lambs, raised or born.

Johanson and Hansson (1943) as quoted by Rae (1956) concluded that the hereditary part of the total variance within a breed is low, and of the order of about 10 - 15 per cent. Rae (1956) stated heritability of prolificacy may be low due to relatively large effects of dominance and epistasis. Hazel and Terrill (1945) found 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. The estimate for heritability of weaning weight was 0.30 $\pm$ .04. Ewe lambs, single lambs, and lambs from mature ewes had

higher body type and condition scores than the contrasting groups. Ram lambs had more neck folds and heavier wool on their faces. Phillips (1945) found that measurements on the live sheared animal had more accuracy in measuring characteristics experimenters might want to study. The most accurate measurements were height at the withers, length from the mid-front of scapula to the pin bones, width of shoulders, depth of chest and middle, and circumference of the fore shank. Blunn (1945) obtained 14.2 per cent for Navajo's as compared to 37.4 per cent for crossbreds as the per cent of total variation in weight due to differences between years.

Terrill (1946) observed that ewes which were heavier as yearlings produced more pounds of lamb during their lifetime. A one pound increase in yearling weight of Rambouillet ewes gave a half pound increase in the weaning weight of lambs. Ten pounds additional yearling weight would give an expected 15 pounds increase of lamb produced over the average of the flock during the ewes first 3 productive years. Culling should be done on the basis of the first year's production since it is correlated to production in subsequent years. Ewes that had a lamb the first year, but did not raise it, averaged 14 more pounds of lamb for each of the next 3 years than ewes that were barren the first year. Ewes which raised a lamb the first year averaged 16 more pounds

of lamb the next 3 years than ewes that were barren the first year. Ewes with twins the first year, regardless of whether they raised them or not, averaged 19 more pounds the following 3 years than ewes that were barren the first year.

Botkins et al. (1956) found 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 increase with age and that the birth differences among lambs of the same sex tend to decrease with age. Two-year-old ewes had lower lamb production than mature ewes largely because of less twinning.

DeBaca et al. (1956) stated birth weight was one of the most influential variables on weaning weight and differences between breeds was partly due to differences in birth weight. They found a regression of 2.50 $\pm$ .65 to 5.96 $\pm$ .76 pounds increase in weaning weight for every pound increase in birth weight.

DeBaca et al. further claimed that type of birth had the greatest effect on lamb growth. They found single lambs weighed 17 pounds more at weaning than lambs raised as twins. Growth rates were similar in good years and indicated a

large proportion of the difference is established at birth. Jamison (1946) found that the breed of sire did not greatly influence the size of the head or chest circumference. Cossard (1956) found that twins had larger chest depth than singles but were smaller in other measurements. The offspring of two-year-old ewes were not significantly different in their measurements compared to lambs from mature ewes. Terrill (1951) obtained greater progress in improvement of weaning traits by sire selection than from selection of dams. Sire selection was 40 to 70 times more effective for staple length, 8 to 12 times more effective for face covering, 4 to 11 times more effective for weight and 2 to 3 times more effective for type and condition as compared to selection of dams. Eighty-one to 89 per cent of the expected genetic progress came from selection of the sire.

The relationship between birth weight of lambs and subsequent weights has been rather thoroughly studied. According to Chapman and Lush (1932) approximately 25 to 30 per cent of the variance in the birth weights of lambs is due to genetic differences, 30 to 35 per cent to tangible environment, and 40 to 45 per cent to intangible environment or accident. Phillips (1940) stated that the influence of type of birth may enable the single lamb to develop more rapidly than the twin, possibly because the single lamb generally starts off with an advantage in growth and vigor

over the twin lamb. Twin lambs enter into intra-uterine competition for nourishment and room to grow. Time of birth, birth weight and sex behave as environmental factors. Approximately 30 per cent of the birth weight is attributed to genetic influences. Seventy per cent of the differences in later weight are associated with differences in birth weight.

Kincaid (1943) found an average annual increase of 0.63 pounds in the birth weight of lambs as the age of ewe increased from two to six years. No significant deviation from linearity was found. Lambs sired by Hampshire rams averaged 1.05 pounds heavier at birth than lambs sired by Southdown rams. This difference was highly significant. He also found lambs at birth from the same ewe were 1.15 pounds heavier at the third lambing than they were at the first lambing. There was less difference between the first and third lambings with ewes that lambed first as yearlings compared with ewes lambing first at 10 to 12 months of age. Kincaid also stated that 7.8 per cent of the variation in lamb birth weights was due to breed of sire.

Nelson and Venkatachalam (1949) found the birth weight of males to be 5 per cent heavier than females, lambs from mature ewes were 10 per cent heavier than lambs from two-year-old ewes and single lambs at birth were 22 per cent heavier than twins. At weaning the differences were 6, 5,

and 17 per cent respectively. Estimates were obtained on each breed and then combined for a weighted average.

According to Bogart (1955), as quoted by DeBaca (1956), lamb growth is linear up to 135 days of age and a correction for weight was made to 120 days of age using the following formula.

$$\text{Corrected Wt. (120 days)} = \frac{\text{(Actual Wt.-Birth Wt.)}}{\text{Actual Age in Days}} \; 120 + \text{birth wt.}$$

Karam *et al.* (1949) found, for body weight at 25 weeks of age and daily gain from birth to market weight, that single lambs were 6.2 pounds heavier and gained 0.02 pounds per head daily faster than twins, and wether lambs were 3.5 pounds heavier and gained 0.02 pounds per head daily faster than ewes, respectively. All these differences were highly significant. There were no significant differences for daily gain on feed between lambs raised as twins or singles, or between wethers and ewes.

Phillips (1940) said that weight at a constant age of 20 weeks can be estimated more accurately along the slope of the growth curve in the vicinity of that age, than by the use of estimated average weekly gains. He suggested the following formula as the most accurate:

$$\frac{Z(20^{*} - A)}{(X - A)} = Y$$ where

Y = estimated weight
Z = actual weight
A = age intercept
X = actual age

*20 (Constant Age) varies for age being used.

Kean and Henning (1949) found males to be 0.6 pounds heavier at birth than females and singles 1.4 pounds heavier than twin lambs. The average birth weight of all lambs was 8.5 pounds and single lambs gained 0.15 of a pound more per day than twins. The average daily gain of all lambs slaughtered was .53 pounds. They stated that there tends to be a correlation between birth weight and average daily gain. Sidwell and Grandstaff (1949) obtained 59.4 pounds as the average unadjusted weaning weight at approximately 139 days with a standard deviation of 9.8 pounds. Year of birth, age of dam, breeding of sire, type of birth, type of rearing, sex, and age of lamb at weaning were the important environmental factors which affected the weaning weight of lambs. Two-year-old ewes weaned the smallest lambs and four to seven-year-olds the heaviest, while the three-year-old and eight to eleven-year-old groups weaned the intermediate lambs. Single lambs were 11.2 pounds heavier than twins and 2.9 pounds heavier than twins raised as singles to weaning time. Ewe lambs weighed 4.4 pounds less at weaning than ram lambs. The per cent of lambs weaned in proportion to the

ewes bred was definitely higher for ewes from four to nine-years-old than ewes from two to three-years-old.

Blackwell and Henderson (1955) used the following formulas in adjusting for weaning and birth weights. Weaning weight = general mean ∔ breed ∔ year ∔ sex of lamb ∔ type of birth and rearing ∔ age of dam ∔ age of lamb at weaning ∔ random elements peculiar to the weaning weight of each lamb. Birth weight = general mean ∔ breed ∔ year ∔ sex of lamb ∔ type of birth ∔ age of dam ∔ random elements peculiar to the birth weight of each lamb.

The relationship between age of ewes and birth weight of their lambs was curvilinear for the Corriedales, Hampshires and Shropshires. The linear and quadratic regression coefficients were 0.71 and -0.06 pounds per year, respectively, for all breeds. A positive linear regression line was found to fit the Dorset birth weight data best at 0.57 pounds per day.

Bogart et al. (1957) found that type of birth contributed the most consistent effect on birth weight. Singles were from 1.92 ∔ 0.48 to 2.40 ∔ 0.60 pounds heavier at birth than were twins. The difference between the birth weight of ram and ewe lambs was consistent. The trend in all cases was for ram lambs to be heavier; however, significance resulted in only one of four analyses. Interactions between type of birth and sex were inconsistent and unimportant.

Progeny testing provides a more reliable estimate of a ram's genotype and enables a breeder to make faster progress and greater productivity for some traits than selection based on phenotype alone. The relative rates of improvement in sheep using different systems of breeding obtained by McMahon and as quoted by Williams (1949) are shown in Table I. From data on 2183 weanling range lambs and 892 dam-offspring pairs, Hazel and Terrill (1945) obtained a heritability of about 13 $\pm$ 4 per cent for type and about 4 $\pm$ 3 per cent for condition. Because of these low heritabilities, progeny testing gives much quicker results than normal phenotype selection. Lush (1935) showed that for a progeny test to be beneficial, the progeny test information has to become available early in the test animal's lifetime. The reproductive rate must be low for large increases in productivity and there has to be an early basis for culling. These factors plus short intervals between generations will increase the rate of progress. Opportunity for improvement from selection is greatest for most traits when culling is based on individual performance, family average and pedigree, and on the highly heritable traits of weaning weight, staple length, and fleece weight. Hazel and Terrill (1945) suggested that selection could be improved by grouping lambs according to sex, type of birth and age of dam, and by the use of a selection index at weaning age. Since the ram is

TABLE I

THE RELATIVE RATES OF IMPROVEMENT, USING DIFFERENT SYSTEMS OF BREEDING, ON THE FLEECE WEIGHTS OF NEW ZEALAND ROMNEY MARSH SHEEP

Method of Selection	Per Cent Culled	Progeny Improved (Lb. Per Generation)	Relative Time For One Lb. Improvement (Years)
Ordinary selection (Phenotype)			
Culling Ewes Only	50	0.042	96
Culling Rams Only	90	0.112	36
Culling Rams and Ewes	97 50	0.162	24
Using Progeny-Tested Sires			
Progeny Test 20% Rams at Random, Keep Best 3%		0.75	4
Cull 50% Ewes			
Progeny Test 20% Rams, Keep Best 3%		0.79	4
Culling 80% Rams			
Progeny Test 20% Rams, Keep Best 3%		0.82	4

said to account for 50 per cent of the flock and since only 4 per cent of all ram lambs born are ever used as sires, it is very important to select superior individuals. Terrill (1946) and Phillips et al. (1940) stated that progeny testing has become accepted as the best method of selecting a sire.

Phillips et al. (1940) observed that some of the important obstacles in testing of sires are the lack of objective measures in performance for many important characters, the necessity of considering more than two characters in many cases, the lack of an adequate measure for mutton form or fleece, and the lack of data for evaluating most of the environmental factors.

For a progeny test, Ensminger et al. (1943) found that 8 to 10 offspring gave the most information with a rapid decrease in information from additional animals up to 15 offspring, and anything over 15 offspring gave little additional information. He pointed out that the minimum requirement of a breeding flock of ewes as approximately 50 and suggested the 20 best ewes be used as the stud flock and mated to a sire of known merit. The remaining ewes would be divided into two groups of nearly equal characteristics and mated to the untried sires. A three-way comparison could then be made between the stud sire and the tested sires. The best of the three would become the stud flock sire for

the test the next year. This method would always give a carry over of at least one ram for comparison.

Shelton et al. (1954) tested a total of 576 rams from 1948 through 1952. They did not attempt to draw conclusions from this work except to show that there was a higher average daily gain in 1954 than in 1948, and the minimum staple length in 1954 was almost as great as the maximum in 1948. The record of performance of Rambouillet sire groups in this work is given in Table II.

Heritability estimates for traits of economic importance have considerable significance to the livestock breeder. These estimates of heritability provide some indication of the rate and amount of progress which can be expected from selection and are useful in determining what breeding methods are likely to be most effective. McMahon (1943) found that parents control only about 10 per cent of the variation of their progeny. Of this, only one tenth of the improvement made by culling is passed on to the progeny.

Rea (1956) suggested the reasons for the rate of heritability depends upon the development of the parts. There is less environmental effect on the early developing parts of the body.

Available research data on heritability estimates in sheep are summarized in Table III.

TABLE II

RECORD OF PERFORMANCE OF RAMBOUILLET SIRE GROUPS

Year	Range of Total Gain (Lbs.)	Average Daily Gain (Lbs.)	Clean Fleece Weight*		Staple Length*	
			Range (Lbs.)	Average (Lbs.)	Range (Inches)	Average (Inches)
48-49	72.7-90.8	0.37	6.0-7.3	6.6	2.99-3.58	3.36
49-50	88.0-118.0	0.45	6.2-9.1	7.8	2.94-4.42	3.57
50-51	88.8-127.4	0.49	6.6-9.7	8.1	2.73-3.94	3.34
51-52	69.8-126.8	0.46	5.7-11.3	8.2	2.74-4.13	3.47
52-53	87.0-117.2	0.48	7.4-10.6	8.6	3.13-3.91	3.56
53-54	91.5-129.5	0.51	5.9-12.7	9.3	3.48-4.27	3.80

* 12 months basis.

TABLE III

HERITABILITY ESTIMATES FOR VARIOUS TRAITS IN SHEEP

Authority	Heritability (Per Cent)
Birth Weight	
Ensminger et al., 1943	37
Ibid.	9
Chapman & Lush, 1932	30
Nelson and Venkatachalam, 1949	72
Ibid.	15
Ibid.	61
Yao et al., 1953	24
Ibid.	40
Ibid.	25
Ragab et al., 1953	34
Weaning Weight	
Hazel & Terrill, 1945	30
Hazel & Terrill, 1946	17
Cockerham, 1949	21
Nelson & Venkatachalam, 1949	29
Ibid.	42
Ibid.	33
Ensminger, 1943	10
Ibid.	5
Ragab et al., 1953	10
Ibid.	29
Karam et al., 1953	34
Yearling Weight	
Terrill & Hazel, 1943	40
Morley, 1951	36
Ibid.	21
Morley, 1955	36
Ibid.	9

TABLE III (CONTINUED)

HERITABILITY ESTIMATES FOR VARIOUS TRAITS IN SHEEP

Authority	Heritability (Per Cent)
Yearling Weight	
Hazel & Terrill, 1946	13
Hazel & Terrill, 1946	7
Ensminger *et al.*, 1943	11
Ibid.	31
Yearling Score	
McMahon, 1943	15
Rae, 1948	12
Unpublished Ph.D. Thesis, 1950	14
Terrill & Hazel, 1943	12
Shelton *et al.*, 1954	20
Hazel & Terrill, 1946	4
Hazel & Terrill, 1946	21

Summary of Estimates

Traits	Range	Average Per Cent
Birth weight	9-72	35
Weaning weight	5-42	24
Weaning type score	7-31	16
Weaning condition score	4-21	12
Yearling body weight	9-40	28
Yearling body score	12-20	15

TABLE III (CONTINUED)

HERITABILITY ESTIMATES FOR VARIOUS TRAITS IN SHEEP

Intensity of Inheritance of Body Characteristics		
	Per Cent	
Length of leg	80	Very strong
Bone quality	58	Strong
Breed type	41	Strong
Head	40	Strong
Shoulders	20	Weak
Back	17	Weak
Body as a whole	12	Weak
Loin	11	Weak
Hind quarters	--	Very weak

McMahon from Williams, 1949, Jour. of the Ministry of Agr., Vol. 55, pp. 136-138.

CHAPTER III

PROCEDURE

Source of Data

The data used in this study were obtained from the production records of sheep flocks maintained by the main station and two substations of the Tennessee Agricultural Experiment Station. Data employed in the phase of the study to determine relationships between gains made at different periods of growth were obtained from the performance records of selected Hampshire ram lambs full-fed on record of performance tests during the years 1951 through 1956. Complete performance data for all successive periods of growth studied were available for 90 Hampshire rams (Table IV). Progeny test information was available for 20 rams and 362 lambs (Table VIII). Data on Southdown rams and a few rams of other breeds were not included in the study because of limited numbers. Performance data were available for the rams used in this study for the following periods of growth: (1) birth to weaning (X_1), (2) weaning to beginning of feedlot performance tests (X_2), (3) during feedlot performance tests (X_3) and (4) birth to the end of the feedlot performance tests (X_4). Average daily gain from birth to weaning was expressed in two ways, actual daily gain from birth to weaning with no adjustment for type of rearing or age of

dam (X_1) and average daily gain from birth to weaning adjusted for type of rearing and age of dam (X_{1a}).

The ram lambs, selected at weaning time each year from the purebred Hampshire and Southdown flocks maintained at the main station, Knoxville, were fed in individual feed lot performance tests. They were selected on the basis of weaning weight and type grade at 135 days of age and on productivity of dam. These lambs were dropped primarily in January and February with a few born in late December and early March and weaned at or about 135 days of age during May and June. The lambs were not creep fed except for short periods during the early part of the suckling period while ewes and lambs were confined to the barn or during periods when grazing conditions were very poor. While on pasture, ewes and lambs were not provided with supplemental feeds. Ewes and lambs were carried primarily on either small grain or ryegrass - crimson clover or orchardgrass - ladina clover pastures.

After weaning, the ram lambs selected for performance tests were carried on available permanent pastures, usually orchardgrass - ladino clover or Bermuda-grass, to the time of starting feedlot tests. While on pasture the rams were fed about one-third to one-half pound of a mixture of equal parts by weight of whole oats and shelled yellow corn. The rams were treated for parasites two or

three times during the summer before being placed on test. Phenothiazine drench was generally used two times and a bluestone-nicotine sulfate drench used one time. The lambs were sheared about the first of June, or at the time of purchase, if any were purchased for the test.

The feedlot performance tests were started in most years during September, October or November and continued for 100 days. During the years 1951-1954 the rams were individually fed. In 1951-1952 the rams were fed a ration consisting of alfalfa hay, ad libitum and concentrates at the rate of 1.50 (first 41 days) to 1.75 per cent of body weight. The concentrate mixture contained equal parts by weight of shelled yellow corn and whole oats.

A complete, pelleted feed was used after 1952 in order to obtain more accurate data on feed consumption and to eliminate the difficulties of feeding hay and concentrates separately. The pelleted ration contained 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 deflourinated rock phosphate, and 1 per cent of a complex mineral mixture. The rams were allowed to eat all of this ration that they would consume. Common loose salt, free choice, and water were available to the rams at all times.

During 1955-56 and 1956-57, the rams were sorted into two groups based primarily on size and weight and were group-fed. Feed conversion data were obtained during these years on a group basis only.

Progeny tests of rams were conducted at agricultural experiment stations located at Knoxville, Crossville and Spring Hill. At Knoxville, all ewes were purebred while ewes at other locations were grade commercial ewes.

The ewes at Crossville used in progeny tests were of four kinds, California, Northwestern, Southwestern and native. The Northwestern ewes originated in Montana and were mostly of Hampshire X Rambouillet breeding. The California ewes were mostly of Columbia, Corriedale or Hampshire X Rambouillet breeding. The Southwestern ewes were grade Rambouillets. Native ewes were primarily of Hampshire breeding. All ewes were divided each year into three ram test groups on age, type, weight and breeding for the progeny tests.

The Northwestern, Southwestern, California and native ewes used in progeny tests at Spring Hill were similar in breeding to the ewes at Crossville. Ewes were divided into ram test groups for progeny tests on the same basis as ewes at Crossville.

The ewes at the Knoxville station were purebred Hampshires from the University of Tennessee flock. They have

been maintained there for a number of years.

All ewes were culled if they did not lamb two out of three years, and for various physical defects. Ewes at all three locations were handled in a similar manner. The ewes were bred to lamb primarily in December, January and February. All lambs were docked and the male lambs casterated at one to two weeks of age in the commercial flocks. They were left with their dams on a winter pasture of small grain or ryegrass and crimson clover or other permanent pastures for approximately five months. The lambs were weighed every 28 days and weaned as they reached approximately 80 pounds in weight. They were marketed directly off of their dams and pasture. The ewes were dried up by placing them on poor permanent pasture, usually consisting of Bermuda and bluegrass. They were kept in good thrifty condition, free from parasites, and then placed on a good clean pasture two weeks prior to breeding. Good quality legume hay was used to supplement pasture when needed and some grain was fed from 2 to 4 weeks before and after lambing. If the weather permitted, the ewes were sheared from mid-April to mid-May. They were tagged approximately 2 weeks before the lambing season began, and before breeding, if needed.

Individual ewe groups, for each ram, were used the entire breeding season of approximately 90 days in 1951. In 1952 rams were in individual ewe groups for about 53 days

at Spring Hill and for 90 days at Crossville. In 1953 the rams were in individual ewe groups for 50 days at Spring Hill and 48 days at Crossville. All ewes and rams were run together for the remainder of the breeding season. In order to try to prevent breeding failures because of "shy breeding" rams in individual ewe groups, two rams of different breeds were used in each breeding group during the 1954 and 1955 breeding seasons.

Insofar as possible, only rams of similar type were selected for progeny testing at each location. An effort was made to use rams with as much variation in daily gain as possible based on the feed lot performance tests.

Analysis of Data

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 (X_1), (2) average daily gain from birth to weaning adjusted for type of rearing and age of dam (X_{1a}), (3) average daily gain from weaning to start of feedlot performance tests (X_2), (4) average daily gain during feedlot performance tests (X_3) and (5) average daily gain from birth to the end of the feedlot performance tests (X_4). Average daily gains for the different periods were not adjusted except for gains from

birth to weaning (X_{1a}). Correction factors used in adjusting average daily gains of lambs from birth to weaning were derived from available estimates of the influence of type of rearing and age of dam on weaning weights and gains as reported in the literature review. The correction factors used are given in Table IV.

Heritability of gain from birth to weaning was estimated by paternal half-sib correlation and by correlation of average offspring on sire. The graphical presentation of the relationship between gains made at different periods was obtained by dividing the rams fed on feedlot performance within years into two groups, a high one-half and low one-half, on the basis of unadjusted daily gain from birth to weaning. A ram was kept in the same group for all successive periods of growth.

Statistical analyses of the applicable data were according to techniques described by Snedecor (1956).

TABLE IV

CORRECTION FACTORS FOR ADJUSTING DAILY GAIN OF LAMBS FROM BIRTH TO WEANING FOR METHOD OF REARING AND AGE OF DAM

Age of Ewe (Years)	Multiply Daily Gain by the Following to Adjust to a Single Lamb, Mature Dam Equivalent:			
	Raised as Twin		Raised as Single	
	Male	Female	Male	Female
2	1.22	1.30	1.05	1.13
3/	1.17	1.25	1.00	1.08

CHAPTER IV

RESULTS AND DISCUSSION

Relationships among the average daily gains of rams during the following periods of growth were examined in this study: (1) birth to weaning unadjusted for type of rearing or age of dam (X_1), (2) birth to weaning adjusted for type of rearing and age of dam (X_{1a}), (3) weaning to beginning of feedlot gain tests on a medium level of nutrition (X_2), (4) feedlot gain tests on a high-level fattening ration (X_3) and (5) birth to end of feedlot tests (X_4).

The relationship between the performance of the gain-tested rams and the performance of their offspring was also determined. Heritability estimates were calculated by the half-sib correlation method for gain during periods X_1, X_{1a}, X_2 and X_3. Heritability of preweaning gain in the lamb progenies of gain-tested sires was calculated by half-sib correlation and parent-offspring regression methods.

Detailed performance of individual rams for the different years are given in Appendix Tables I-VI. The means and standard errors for the gains of rams selected and fed in feedlot gain evaluation tests for the years 1951-56 are given in Table V. Differences among years and among various periods of growth under different nutritional levels were highly significant. Gross correlations among average daily

TABLE V

MEANS AND STANDARD ERRORS FOR GAINS OF RAMS
DURING VARIOUS PERIODS OF GROWTH

Year Of Birth	No. Rams[a]	Periods of Growth				
		X_1	X_{1a}	X_2	X_3	X_4
1951	18	.61 ± .021	.66 ± .022	.21 ± .008	.47 ± .022	.35 ± .008
1952	15	.69 ± .024	.76 ± .026	.28 ± .018	.42 ± .019	.45 ± .009
1953	9	.55 ± .037	.62 ± .047	.24 ± .031	.50 ± .023	.39 ± .017
1954	17	.45 ± .012	.49 ± .016	.16 ± .016	.59 ± .025	.35 ± .009
1955	17	.61 ± .017	.65 ± .012	.21 ± .020	.48 ± .025	.43 ± .010
1956	14	.68 ± .018	.74 ± .028	.24 ± .040	.46 ± .053	.48 ± .013
Av.	90	.60 ± .012	.65 ± .004	.22 ± .009	.49 ± .012	.41 ± .004

[a] Includes only rams on which complete data were available for all periods of growth. A few purchased rams fed on feedlot gain tests (X_3) on which preweaning information was not available are not included.

gains for various periods of growth within sire groups and years are presented in Table VI.

The correlations of both unadjusted (X_1) and adjusted (X_{1a}) average daily gain with feedlot gain (X_3) were positive but lacked significance ($< .14$ and $< .11$, respectively). Such low or non-significant correlations might be expected since preweaning gain is largely a function of the dam's maternal ability. It indicates that differences in preweaning gains in highly selected groups of rams such as those included in this study would have little predictive value in estimating feedlot gain where animals are carried on intervening periods of low to medium nutrition before being placed on feedlot gain tests. However, it is encouraging to note that the relationships are positive and not antagonistic.

A significant negative correlation of -.24 between gain from weaning to the beginning of the feedlot tests (X_2) and feedlot gain (X_3) was obtained and indicates that rams which gained faster during period X_2 tended to gain slower during the feedlot period X_3.

These results are in agreement with the findings of Koger and Knox (1951) with cattle who concluded:

> A negative relationship would be expected when environmental conditions are experienced during one period and later removed, allowing a compensation for over or under growth during the first period.

TABLE VI

CORRELATION OF AVERAGE DAILY GAINS MADE AT DIFFERENT PERIODS OF GROWTH[a]

	Correlation With				
Periods	X_1	X_{1a}	X_2	X_3	X_4
X_1	--	$\neq .81^{**}$	-.12	$\neq .14$	$\neq .49^{**}$
X_{1a}		--	-.10	$\neq .11$	$\neq .34^{**}$
X_2			--	$-.24^{*}$	$\neq .29^{**}$
X_3				--	$\neq .48^{**}$
X_4					--

[a]Correlation coefficients were calculated within sire groups and years, df = 84. There were 85 rams sired by 18 sires in 6 years.

$^{*}P < .05$

$^{**}P < .01$

> Growth during periods in which the animals were subject to variable environmental influence showed a low, or in some instances, a negative relationship to growth at other periods. When the environment is held constant for different animals, there is a positive relationship between daily gains made at different periods. This relationship can be obscured or even reversed by variable conditions.

Similar results in cattle were obtained by Kidwell (1954) and McCormick et al. (1956). Urick et al. (1957), working with cattle, obtained high genetic correlations between successive periods of growth.

Genetic, environmental and phenotypic correlations between successive periods of growth were computed in this study but were not considered realistic since all correlations were highly negative and were estimated at -1.0 in many cases. The reasons for this were not apparent from the study. Large sampling errors may occur where the number of sire groups is limited. The amount and kind of selection practiced may also be a factor since the same percentage of ram lambs was not saved from each sire progeny and may have resulted in more uniform samples.

Significant part-whole correlations were obtained for average daily gain during periods X_1, X_{1a}, X_2 and X_3 with gain during period X_4. The correlations were: X_1X_4, $\neq .49$; $X_{1a}X_4$, $\neq .34$; X_2X_4, $\neq .29$; and X_3X_4, $\neq .48$.

The relationship between gains at successive periods of growth are also shown for the different years in Figures 1-6. These growth curves were constructed by dividing rams

on feedlot gain tests into two groups, a high one-half and a low one-half, on the basis of unadjusted average daily gain from birth to weaning. A ram was kept in the same high or low one-half in subsequent periods of growth.

The correlations obtained in this study indicate that gain in one period would not have a high predictive value in estimating the performance of an animal during a subsequent period. This would be particularly true where environmental factors, including nutritional levels, vary considerably for different periods. It appears that genetic and environmental influences expressing themselves independently of influences during prior periods would account for most of the variation in feed lot performance.

Heritability of daily gain calculated by paternal half-sib correlation for each of the five periods was estimated as follows: X_1, 57.1 per cent; X_{1a}, 68.2 per cent; X_2, 73.2 per cent; X_3, 32.5 per cent; and X_4, 6.6 per cent (Table VII). Significant sire differences were obtained for periods X_{1a} and X_2 and approached significance in X_1 and X_3. It should be noted that these estimates are based on relatively small numbers and in sire groups where considerable selection was practiced. The estimates are somewhat higher for most characters than heritability estimates reported in the literature (Table III). Some factors which may contribute to such relatively high estimates are confounding of

TABLE VII

ANALYSES OF VARIANCE AND HERITABILITY ESTIMATES OF GAIN FOR VARIOUS PERIODS OF GROWTH FOR GAIN-TESTED RAMS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Composition of Mean Squares	Variance Components
			X_1		
Total	84	1.0747			
Years	5	.5399	.1080**		
Sires in Years	12	.1272	.0106	$\sigma_r^2 + k_o\sigma_s^2$	.0010
Within Sires	67	.4076	.0060	σ_r^2	.0060

$k_o = 4.67$ $\quad \sigma_r^2 = .0060 \quad \sigma_s^2 = .0010$

$$\text{Half-sib correlation} = \frac{.0010}{.0060 + .0010} = \frac{.0010}{.0070} = .1428$$

$(.1428 \times 4) \times 100 = 57.12$ per cent as estimate of heritability

			X_{1a}		
Total	84	1.3438			
Years	5	.6851	.1370**		
Sires in Years	12	.1705	.0142*	$\sigma_r^2 + k_o\sigma_s^2$	.0015
Within Sires	67	.4882	.0073	σ_r^2	.0073

$k_o = 4.67$ $\quad \sigma_r^2 = .0073 \quad \sigma_s^2 = .0010$

$$\text{Half-sib correlation} = \frac{.0015}{.0073 + .0015} = .1704$$

$(.1704 \times 4) \times 100 = 68.16$ per cent as estimate of heritability

*$P < .05$
**$P < .01$

TABLE VII (CONTINUED)

ANALYSES OF VARIANCE AND HERITABILITY ESTIMATES OF GAIN FOR VARIOUS PERIODS OF GROWTH FOR GAIN-TESTED RAMS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Composition of Mean Squares	Variance Components
			X_2		
Total	84	.7310			
Years	5	.1196	.0239**		
Sires Within Years	12	.1617	.0135*	$\sigma r^2 + k_o \sigma s^2$	.0015
Within Sires	67	.4497	.0067	σr^2	.0067

$k_o = 4.67$ $\quad \sigma r^2 = .0067$ $\quad \sigma s^2 = .0015$

Half-sib correlation $= \frac{.0015}{.0067 + .0015} = \frac{.0015}{.0082} = .1829$

(.1829 x 4) x 100 = 73.16 per cent as estimate of heritability

			X_3		
Total	84	1.1366			
Years	5	.2043	.0408**		
Sires Within Years	12	.2158	.0180	$\sigma r^2 + k_o \sigma s^2$	.0016
Within Sires	67	.7165	.0107	σr^2	.0107

$k_o = 4.67$ $\quad \sigma r^2 = .0107$ $\quad \sigma s^2 = .0016$

Half-sib correlation $= \frac{.0016}{.0107 + .0016} = \frac{.0016}{.0123} = .1300$

(.1300 x 4) x 100 = 32.50 per cent as estimate of heritability

*P < .05
**P < .01

TABLE VII (CONTINUED)

ANALYSES OF VARIANCE AND HERITABILITY ESTIMATES OF GAIN FOR VARIOUS PERIODS OF GROWTH FOR GAIN-TESTED RAMS

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	Composition of Mean Squares	Variance Components
			X_4		
Total	84	.3248			
Years	5	.2246	.0449**		
Sires Within Years	12	.0175	.0014	$\sigma r^2 + k_o \sigma s^2$	.00002
Within Sires	67	.0827	.0012	σr^2	.0012

$k_o = 4.67$ $\quad \sigma r^2 = .0012 \quad \sigma s^2 = .00002$

Half-sib correlation $\dfrac{.00002}{.00002 + .0012} = \dfrac{.00002}{.00122} = .0164$

(.0164 x 4) x 100 = 6.56 per cent as estimate of heritability

*$P < .05$
**$P < .01$

maternal genetic influence with sire influence and selection of uniform samples. Large sampling errors may occur where the number of sires represented is limited. However, if such estimates are valid, performance testing should be an aid in improving the productivity of sheep in general.

The performance records of gain-tested rams during various periods of growth and the preweaning performance of their offspring are given in Table VIII. Analyses of variance and heritability estimates by years and for the combined data are given in Tables IX and X. Heritability estimates of preweaning and average daily gain of lambs (adjusted for type of rearing and age of dam) for 1953, 1954, 1955 and 1956 were 88.9, 27.3, 0 and 0, respectively. The 0 estimates were obtained in years having non-significant differences due to sires. In 1953 sire differences were significant and in 1954 sire differences approached significance. In these two years, individual differences in performance of rams on feedlot gain tests were also much greater as compared to rams used in 1955 and 1956. The intra-sire correlation based on gains of all lambs in all years (Table X) yielded a heritability estimate of 25.3 per cent. This estimate is in fair agreement with other estimates of the heritability of preweaning growth rate of lambs as reported in the literature (Table III).

TABLE VIII

PERFORMANCE RECORDS OF GAIN-TESTED SIRES DURING VARIOUS PERIODS OF GROWTH AND PREWEANING PERFORMANCE OF THEIR OFFSPRING

Sires							Lambs			
Ram No.	Year Gain Tested	X_1	X_{1a}	X_2	X_3	X_4	No. Lambs	Year	X_{1a}	Location
136	1951	.68	.58	.26	.50	.38	26	1953	.57	Crossville
140	1951	.59	.69	.17	.48	.33	30	1953	.64	Crossville
058	1951	.68	.68	.22	.43	.36	7	1953	.64	Spring Hill
056	1951	.72	.84	.23	.60	.41	4	1953	.73	Spring Hill
071	1951	.77	.77	.22	.67	.43	7	1953	.62	Spring Hill
032	1951	.55	.55	.21	.31	.32	7	1953	.54	Spring Hill
071	1951	.77	.77	.22	.67	.43	16	1954	.56	Spring Hill
032	1951	.55	.55	.21	.31	.32	22	1954	.55	Spring Hill
2018	1952	.64	.67	.34	.42	.46	17	1954	.62	Spring Hill
2049	1952	.88	.88	.36	.28	.48	20	1954	.57	Spring Hill
344	1953	.71	.71	.16	.56	.45	21	1955	.63	Spring Hill
032	1951	.55	.55	.21	.31	.32	20	1955	.61	Spring Hill
240	1952	.61	.72	.42	.49	.47	18	1955	.61	Spring Hill
2049	1952	.88	.88	.36	.28	.48	15	1955	.59	Crossville
033	1951	.64	.64	.23	.38	.36	6	1955	.60	Crossville
474	1954	.42	.42	.25	.68	.41	29	1956	.66	Crossville
362	1953	.51	.62	.19	.51	.40	7	1956	.62	Spring Hill
2049	1952	.88	.88	.36	.28	.48	12	1956	.58	Spring Hill
457	1954	.40	.40	.18	.77	.39	7	1956	.60	Spring Hill
442	1954	.49	.49	.18	.43	.33	12	1956	.57	Spring Hill

TABLE IX

ANALYSES OF VARIANCE AND HERITABILITY ESTIMATES OF PREWEANING AVERAGE DAILY GAIN OF LAMBS FOR DIFFERENT YEARS

Source of Variation	df	SS	MS	Theoretical Composition	Variance Components
			1953		
Total	80	.7795			
Stations	1	.0015	.0015		
Sires in Years	4	.1482	.0370	$\sigma r^2 + k_o \sigma s^2$	.0024
Within Sires	75	.6298	.0084	σr^2	.0084

$k_o = 11.92$ $\quad \sigma r^2 = .0084$ $\quad \sigma s^2 = .0024$

$$\text{Half-sib correlation} = \frac{.0024}{.0084 + .0024} = .2222$$

$(.2222 \times 4) \times 100 = 88.88$ per cent as estimate of heritability

- -

			1954		
Total	74	.6449			
Sires	3	.0573	.0191	$\sigma r^2 + k_o \sigma s^2$	.0006
Within Sires	71	.5876	.0082	σr^2	.0082

$k_o = 18.65$ $\quad \sigma r^2 = .0082$ $\quad \sigma s^2 = .0006$

$$\text{Half-sib correlation} = \frac{.0006}{.0082 + .0006} = .0682$$

$(.0682 \times 4) \times 100 = 27.28$ per cent as estimate of heritability

TABLE IX (CONTINUED)

ANALYSES OF VARIANCE AND HERITABILITY ESTIMATES OF PREWEANING AVERAGE DAILY GAIN OF LAMBS FOR DIFFERENT YEARS

Source of Variation	df	SS	MS	Theoretical Composition	Variance Components
			1955		
Total	79	.8678			
Stations	1	.0088	.0088		
Sires In Years	3	.0092	.0031	$\sigma_r^2 + k_o\sigma_s^2$	-.0005
Within Sires	75	.8498	.0113	σ_r^2	.0113

$k_o = 15.54$ $\quad \sigma_r^2 = .0113$ $\quad \sigma_s^2 = -.0005$

$$\text{Half-sib correlation} = \frac{-.0005}{.0113 + (-.0005)} = -.0463$$

$(-.0463 \times 4) \times 100 = -18.52$ per cent as estimate of heritability

			1956		
Total	66	.5271			
Stations	1	.0735	.0735		
Sires in Years	3	.0118	.0039	$\sigma_r^2 + k_o\sigma_s^2$	-.0003
Within Sires	62	.4418	.0071	σ_r^2	.0071

$k_o = 12.17$ $\quad \sigma_r^2 = .0071$ $\quad \sigma_s^2 = -.0003$

$$\text{Half-sib correlation} = \frac{-.0003}{.0071 + (-.0003)} = -.0441$$

$(-.0441 \times 4) \times 100 = -17.64$ per cent as estimate of heritability

TABLE X

ANALYSIS OF VARIANCE AND HERITABILITY ESTIMATE OF PREWEANING AVERAGE DAILY GAIN OF LAMBS FOR COMBINED DATA

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Theoretical Composition of Mean Square	Variance Components
Total	302	2.9019			
Years	3	.0826	.0275*		
Stations in Years	3	.0838	.0279*		
Sires in Stations and Years	13	.2265	.0174*	$\sigma r^2 + k_o \sigma s^2$	.0006
Within Sires	283	2.5090	.0089	σr^2	.0089

$k_o = 14.94$ $\quad \sigma r^2 = .0089 \quad \sigma s^2 = .0006$

$$\text{Half-sib correlation} = \frac{.0006}{.0089 + .0006} = .0632$$

$(.00632 \times 4) \times 100 = 25.28$ per cent as estimate of heritability

*P = < .05.

The relationship of the performance of sires during various seccessive periods of growth and the preweaning growth performance of their offspring is presented in Table XI. In the determination of these relationships (correlations and regressions), individual sire performance records were adjusted for year tested by adjusting individual records to the average gain for all years. Average daily gain of lambs in sire progenies were adjusted for type of rearing and age of dam. Correlation and regression analyses were then made on a within year basis. Although only the correlation between the average daily gain of sires from birth to the end of the feedlot tests (X_4) and the average daily gain of their offspring was significant, correlations between gains of sires in periods X_{1a} and X_3 and gains of offspring were fairly high ($\not$ .30 and $\not$.42, respectively) and approached significance. Heritability of preweaning gain was estimated at 23.4 per cent and is in agreement with estimates obtained by other workers and with the overall estimate of 25.3 per cent obtained in this study for preweaning gain of the performance tested rams. The results of this study indicate that complete performance records, including adjusted preweaning gain, feedlot gain and gain from birth to end of feedlot test, would be of material help in evaluating probable transmitting ability for the selection of rams to be progeny tested.

TABLE XI

CORRELATIONS AND REGRESSIONS OF AVERAGE PROGENY PERFORMANCE ON SIRE PERFORMANCE

Growth Periods For Sires	Adjusted Average Daily Gain from Birth to Weaning of Offspring[b]		
	Degrees of Freedom	Correlation Coefficient[a]	Regression Coefficient[a]
X_1	16	$\neq .12$	$\neq .0458$
X_{1a}	16	$\neq .30$	$\neq .1171$
X_2	16	$\neq .07$	$\neq .0533$
X_3	16	$\neq .42$	$\neq .1262$
X_4	16	$\neq .47^*$	$\neq .5000$

[a]Calculated within years.

[b]Heritability of gain of lambs from birth to weaning (X_{1a}) = .1171 x 2 = .2342 x 100 = 23.4 per cent.

*$P < .05$.

CHAPTER V

SUMMARY AND CONCLUSIONS

Relationships among the average daily gains of rams during the following periods of growth were examined in this study: (1) birth to weaning unadjusted for type of rearing or age of dam (X_1), (2) birth to weaning adjusted for type of rearing and age of dam (X_{1a}), (3) weaning to beginning of feedlot gain tests on a medium level of nutrition (X_2), (4) feedlot gain tests on a high level fattening ration (X_3) and (5) birth to end of feedlot tests (X_4).

The relationship between the performance of the gain-tested rams and the performance of their offspring was also determined. Heritability estimates were calculated by the half-sib correlation method for gain during periods X_1, X_{1a}, X_2 and X_3. Heritability of preweaning gain in the lamb progenies of gain-tested sires was calculated by half-sib correlation and parent-offspring regression methods.

The correlations of both unadjusted (X_1) and adjusted (X_{1a}) average daily gain with feedlot gain (X_3) were positive but lacked significance ($< .14$ and $< .11$, respectively). This indicates that differences in preweaning gains in the highly selected groups of rams included in this study would have little predictive value in estimating feedlot gain where animals are carried on intervening periods

of low to medium nutrition before being placed on feedlot gain tests.

A significant negative correlation of -.24 between (X_2) gain from weaning to feedlot test and (X_3) feedlot gain and indicated that rams which gained faster during period (X_2) tended to gain slower during the feedlot period (X_3). Heritability of daily gain calculated by paternal half-sib correlation for each of the five periods were estimated as X_1, 57.1 per cent; X_{1a}, 68.2 per cent; X_2, 73.2 per cent; X_3, 32.5 per cent; and X_4, 6.6 per cent. Significant sire differences were obtained in periods X_{1a}, and X_2 and approached significance in X_1, and X_3. Heritability estimates of preweaning adjusted average daily gain of lambs; for 1953, 1954, 1955, and 1956 were 88.9, 27.3, 0, and 0, respectively. The 0 estimates were obtained in years having nonsignificant differences due to sires. Intra-sire correlations based on gains of lambs in all years yielded a heritability estimate of 25.3 per cent. Heritability of preweaning gain estimated from the regression of average progeny performance was 23.4 per cent.

The correlations obtained in this study indicate that gain in one period would not have a high predictive value in estimating the performance of an animal during a subsequent period. This emphasizes the importance of complete individual performance records, including preweaning gain,

feedlot gain and total gain from birth to end of feed lot tests, as aids in evaluating probable transmitting ability in the selection of rams to be progeny tested. Heritability estimates obtained in this study are sufficiently high to indicate that real progress can be made through selection based on performance.

BIBLIOGRAPHY

BIBLIOGRAPHY

Barnicoat, C. R., P. F. Murray, E. M. Roberts and G. S. Wilson. 1956. Milk secretion studies with New Zealand Romney ewes. The J. Agricultural Sci. 48:9.

Blackwell, R. L. and C. R. Henderson. 1955. Variation in fleece weight, weaning weight, and birth weight of sheep under farm conditions. J. Animal Sci. 14:831.

Blunn, O. T. 1945. Improvement of the Navajo sheep. J. Heredity. 31:98.

Botkin, M. P., P. O. Stratton and E. K. Faulkner. 1956. Some factors influencing weanling traits in purebred Rambouillet lambs. J. Animal Sci. 15:1227.

Bogart, Ralph and D. W. Hedrick. 1955. Managing sheep on hill pastures. Oregon Agr. Exp. Sta. Bul. 554.

Bogart, Ralph, R. C. DeBaca, L. D. Calvin and O. M. Nelson. 1957. Factors affecting birth weights of crossbred lambs. J. Animal Sci. 16:130.

Burns, R. H. and Johnston Alexander. 1950. Relation of wool type of ewes and breed of rams to lamb and wool production. University of Wyoming. Bul. 296.

Chapman, A. B. and J. L. Lush. 1932. Twinning, sex, ratio and genetic variability in birth weight in sheep. J. Heredity. 23:473.

Coop, I. E. 1950. The influence of level of nutrition during pregnancy and lactation on lamb and wool production of grazing sheep. New Zealand Society of Animal Production. Tenth Annual Conference. 20.

Cossard, D. W., P. W. Gregory, W. C. Weir and J. F. Wilson. 1956. Environmental factors affecting body dimensions in yearling Hampshire ewes. J. Animal Sci. 15:922.

DeBaca, R. C., Ralph Bogart, L. D. Calvin and O. M. Nelson. 1956. Factors affecting weaning weights of crossbred spring lambs. J. Animal Sci. 15:667.

Dickerson, G. E. and L. N. Hazel. 1944. Effectiveness of selection on progeny performance as a supplement to earlier culling in livestock. J. Agr. Research. 69:459.

Ensminger, M. E., R. W. Phillips, R. C. Schott and C. R. Parsons. 1943. Measuring performance of progeny of rams in a small flock. J. Animal Sci. 2:157.

Fuller, J. G. and F. Kleinheins. 1904. Wisconsin Agr. Experiment Station. No. 48.

Hazel, L. N. and C. E. Terrill. 1945. Heritability of weaning weight and staple length of Rambouillet lambs. J. Animal Sci. 4:331.

Hazel, L. N. and C. E. Terrill. 1945. Effect of same environmental factors on weanling traits of range Rambouillet lambs. J. Animal Sci. 4:331.

Hazel, L. N. and C. E. Terrill. 1946. Heritability of type and condition in Rambouillet lambs. J. Animal Sci. 5:55.

Hazel, L. N. and C. E. Terrill. 1946. Heritability of weanling traits in Columbia, Corriedale and Targhee lambs. J. Animal Sci. 5:32.

Hazel, L. N. and C. E. Terrill. 1946. Effects of same environmental factors on weanling traits of range Columbia, Corriedale and Targhee lambs. J. Animal Sci. 5:318.

Hazel, L. N. and C. E. Terrill. 1946. Effects of some environmental factors on fleece and body characteristics of range Rambouillet yearling ewes. J. Animal Sci. 5:382.

Hazel, L. N. and C. E. Terrill. 1946. The construction and use of a selection index for range Rambouillet lambs. J. Animal Sci. 5:412.

Jamison, H. M., R. C. Carter and C. M. Kincaid. 1956. The effect of breed of sire on body size of lambs at birth in mutton type sheep. J. Animal Sci. 15:1226.

Jones, J. M., B. L. Warwick, R. W. Phillips, D. A. Spence, C. B. Godbey, R. E. Patterson and W. H. Dameron. 1946. Inheritance of skin folds of sheep. J. Animal Sci. 5:154.

Karam, H. A., A. B. Chapman and A. L. Pope. 1949. Some of the sources of variation in body weight, rate of gain, type and condition of lambs raised under farm conditions. J. Animal Sci. 8:606.

Kean, G. R. and W. L. Henning. 1949. Birth weight and gain of hothouse lambs. J. Animal Sci. 8:362.

Kidwell, J. F. 1954. Some growth relations in range cattle. J. Animal Sci. 13:54.

Kincaid, C. M. 1943. Influence of sire on birth weight of lambs. J. Animal Sci. 2:152.

Koger, Marvin and J. H. Knox. 1951. The correlation between gains made at different periods by cattle. J. Animal Sci. 10:760.

Lush, J. L. 1945. The inheritance of productivity in farm livestock. Emperial J. Experimental Agr. 3:25.

McCormick, W. C., B. L. Southwell and E. J. Warwick. 1956. Factors affecting performance in herds of purebred and grade polled Hereford cattle. Georgia Agr. Exp. Sta. Tech. Bull. U. S. 5.

McMahon, P. R. 1943. The inheritance of multifactor characters in the sheep. New Zealand Soc. Animal Prod. 70.

Neale, P. E. 1946. Corrective sheep breeding. New Mexico Agriculture Experiment Station. Bul. 334.

Nelson, R. H. and G. Venkatachalam. 1949. Estimates of heritability of birth weight and weaning weight of lambs. J. Animal Sci. 8:607.

Phillips, R. W. and W. M. Dawson. 1940. Some factors affecting survival, growth, and selection of lambs. USDA. Circ. 538.

Phillips, R. W. and G. W. Brier. 1940. Estimating weights of lambs at a constant age. USDA. Circ. 541.

Phillips, R. W., R. G. Schott, W. V. Lambert and G. W. Brier. 1940. Some factors affecting the progeny testing of rams. U. S. Dept. of Agr. Cir. 582.

Phillips, R. W., R. G. Schott and D. A. Spencer. 1945. The genetics, physiology and economic importance of multinipple traits in sheep. U. S. Dept. of Agr. Tech. Bul. 909.

Pohle, E. M. 1942. Relationship between weanling and yearling fleece characters in range sheep. J. Animal Sci. 1:229.

Price, D. A., J. O. Grandstaff and G. M. Sidwell. 1951. Lamb production of Navajo ewes bred to Columbia and Romney rams and Navajo crossbred ewes bred to Lincoln and Costwall rams. J. Animal Sci. 10:274.

Price, D. A. 1953. The effects of some genetic and environmental factors on yearling traits of Navajo and Navajo crossbred ewes. J. Animal Sci. 13:697.

Ragab, M. T., A. A. Asker and M. R. Kadi. 1953. Genetic factors affecting weights of Ossimi lambs. Empire J. Exp. Agr. 21:304.

Rendel, J. 1956. Heritability of multiple birth in sheep. J. Animal Sci. 15:193.

Rea, A. L. 1956. The genetics of sheep. Advances in Genetics. 8:189.

Rice, V. A. and F. N. Andrews. 1951. Breeding and improvement of farm animals. Fourth Edition. 682.

Shelton, Maurice, J. C. Miller, W. T. Magee and W. T. Hardy. 1954. A summary of four years work in ram progeny and performance testing. J. Animal Sci. 13:215.

Sidwell, G. M. and J. O. Grandstaff. 1949. Size of lambs from Navajo ewes. J. Animal Sci. 8:373.

Sidwell, G. M., J. O. Grandstaff and D. A. Price. 1951. Genetic and environmental factors affecting staple length in Navajo and Navajo crossbred weanling lambs. J. Animal Sci. 10:278.

Sidwell, G. M. 1956. Some aspects of twin versus single lambs of Navajo and Navajo crossbred ewes. J. Animal Sci. 15:202.

Terrill, C. E. and L. N. Hazel. 1946. Heritability of face covering and neck folds in range Rambouillet lambs as evaluated by scoring. J. Animal Sci. 5:170.

Terrill, C. E. 1951. Effectiveness of selection for economically important traits in sheep. J. Animal Sci. 10:17.

Urick, J., A. E. Flower, F. S. Willson and C. E. Shelby. 1957. A genetic study in steer progeny groups during successive growth periods. J. Animal Sci. 16:217.

Wallace, L. R. 1948. The growth of lambs before and after birth in relation to the level of nutrition. J. Agriculture Sci. 38:93.

Wright, G. M. and P. G. Stevens. 1953. Lifetime wool production and breeding performance of Romney March and Corriedale ewes. New Zealand J. Science and Tech. 34:430.

Williams, G. L. 1949. Progeny testing of hill rams. Great Britain. J. Ministry Agr. 55:375.

APPENDIX

TABLE I

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1951-52

Ram No.	Sire Name	Sire No.	Dam No.	Age of Dam	Birth: Type Birth	Birth: How Reared	Birth: Birth Date (1950-51)	Birth: Birth Wt.	Weaning: Wean. Date (1951)	Weaning: Wean Wt.	Weaning: Wean Age	Weaning: 135 Da. Wt.	Weaning: Av. Daily Gain[a]	Weaning: Av. Daily Gain[b]
1	Myers	245041	877	3	Tw	Tw	12-22	8	5-19	90	148	82	.55	.64
3	Myers	245041	976	2	S	S	12-22	8	5-19	73	148	67	.44	.46
9	Demp.	233966	59	9	S	S	12-28	9	5-19	104	143	98	.66	.66
032	Demp.	233966	723	5	S	S	1-11	9	5-19	80	128	83	.55	.55
33	Demp.	233966	697	5	S	S	1-12	11	5-19	92	127	97	.64	.64
136	M.Hag.		L424	6	S	S	1-14	12	5-19	84	125	90	.58	.58
39	Demp.	233966	883	3	Tw	Tw	1-15	8	5-19	88	124	96	.65	.76
140	Demp.	233966	883	3	Tw	Tw	1-15	9	5-19	82	124	89	.59	.69
43	M.Hag.		L621	6	Tw	Tw	1-18	10	5-19	81	121	90	.59	.69
44	M.Hag.		L621	6	Tw	Tw	1-18	10	5-19	74	121	82	.53	.62
50	M.Hag.		L292	6	Tw	Tw	1-22	10	5-19	70	117	79	.51	.60
056	Demp.	233966	901	8	Tw	Tw	1-24	7	5-19	90	115	104	.72	.84
058	M.Hag.		L764	6	S	S	1-25	12	5-19	90	114	104	.68	.68
68	M.Hag.		L579	6	Tw	Tw	1-30	11	5-19	62	109	74	.47	.55
70	Demp.	233966	869	8	S	S	2- 1	12	5-19	80	107	98	.64	.64
071	M.Hag.		L649	6	S	S	2- 3	13	5-19	94	105	117	.77	.77
89	Demp.	233966	100	6	S	S	2-15	14	5-19	83	93	114	.74	.74
92	M.Hag.		L 80	6	Tw	Tw	2-20	11	5-19	69	88	100	.66	.77

[a]Unadjusted average daily gain

[b]Adjusted daily gain (for type of rearing and age of dam)

TABLE I (CONTINUED)

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1951-52

Ram No.	Feedlot Gain Test: Daily Gain Wean. to Test	Beg. Wt. 2-19-52	End Wt. 5-12-52	Total Gain 100 Days	Av. Daily Gain	Av. Type Score	Feed Per 100# Gain	Age on 5-12-52	Av. Daily Gain-Birth to 5-12-52
1	.24	155	186	41	.41	16	1586	508	.35
3	.19	125	157	39	.39	14	1328	508	.29
9	.11	133	176	52	.52	14	959	495	.33
032	.21	138	164	31	.31	15	1705	486	.32
33	.23	155	187	38	.38	16	1475	485	.36
136	.26	154	196	50	.50	16	1160	483	.38
39	.19	141	170	35	.35	9	1450	482	.34
140	.17	129	169	48	.48	12	1071	482	.33
43	.20	135	173	45	.45	9	1141	479	.34
44	.23	137	190	63	.63	10	865	479	.38
50	.23	132	165	39	.39	11	1347	475	.33
056	.23	152	202	60	.60	13	950	473	.41
058	.22	149	185	43	.43	12	1222	472	.36
68	.25	129	172	51	.51	12	980	467	.34
70	.24	146	190	52	.52	13	1018	465	.38
071	.22	155	211	67	.67	14	920	463	.43
89	.23	145	188	51	.51	11	994	451	.38
92	.17	115	155	48	.48	12	966	436	.33

TABLE II

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1952-53

Ram No.	Sire Name	Sire No.	Dam No.	Age of Dam	Birth: Type Birth	Birth: How Reared	Birth: Birth Date (1952)	Birth: Birth Wt.	Weaning: Wean. Date (1952)	Weaning: Wean. Wt.	Weaning: Wean. Age	Weaning: 135 Da. Wt.	Av. Daily Gain[a]	Av. Daily Gain[b]
208	My.171	267452	918	3	Tw	Tw	1-11	7	5-21	85	131	88	.60	.70
211	My.171	267452	883	4	Tw	Tw	1-11	6	5-21	86	131	88	.61	.71
216	My.977		839	4	Tw	Tw	1-14	8	5-28	83	129	86	.58	.68
217	My.171	267452	22	2	S	S	1-13	7	5-28	77	129	80	.54	.57
2018	Demp.	233966	007	2	S	S	1-13	10	5-28	93	129	96	.64	.67
228	Demp.	233966	045	2	S	S	1-19	10	6- 4	99	123	107	.72	.76
229	My.171	267452	605	6	S	S	1-19	11	6- 4	93	123	101	.67	.67
236	Demp.	233966	887	4	Tw	S	1-21	9	6- 4	100	121	110	.75	.88
239	My.171	267452	723	6	S	S	1-23	10	6- 4	100	119	113	.76	.76
240	Demp.	233966	006	2	Tw	Tw	1-24	6	6-10	78	118	88	.61	.74
244	Demp.	233966	L537	7	Tw	S	1-28	11	6-10	98	114	114	.76	.89
246	My.977		403	5	S	S	1-28	10	6-10	95	114	111	.75	.75
2049	Demp.	233966	145	7	S	S	1-29	11	6-10	110	113	130	.88	.88
260	My.171	267452	L379	7	Tw	Tw	2-20	8	6-10	80	91	115	.79	.92
274	My.171	267452	L 80	7	Trip	Trip	3- 7	10	6-13	82	98	109	.73	.85

[a]Unadjusted average daily gain
[b]Adjusted daily gain (for type of rearing and age of dam)

TABLE II (CONTINUED)

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1952-53

Ram No.	Feedlot Gain Test: Daily Gain Wean. to Test	Beg. Wt. 9-14-52	End Wt. 12-26-52	Total Gain 100 Days	Av. Daily Gain	Av. Type Score	Feed Per 100# Gain	Age On 12-26-52	Av. Daily Gain-Birth to 12-26-52
208	.31	121	164	43	.43	13	910	350	.44
211	.22	111	150	49	.49	10	750	350	.41
216	.31	117	145	28	.28	11	1241	347	.39
217	.16	95	145	50	.50	12	740	346	.39
2018	.34	130	172	42	.42	14	930	346	.46
228	.20	119	160	41	.41	12	949	342	.43
229	.19	112	150	38	.38	12	978	342	.40
236	.29	130	173	43	.43	13	928	340	.48
239	.28	129	169	40	.40	13	1002	338	.47
240	.42	118	167	49	.49	14	832	337	.47
244	.28	125	178	53	.53	12	758	333	.50
246	.31	125	163	38	.38	12	1032	333	.45
2049	.36	145	173	28	.28	13	1408	332	.48
260	.28	107	149	42	.42	12	939	310	.45
274	.23	103	156	53	.53	12	747	295	.49

TABLE III

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1953-54

Ram No.	Sire Name	Sire No.	Dam No.	Age of Dam	Birth: Type Birth	Birth: How Reared	Birth: Birth Date (1952-53)	Birth: Birth Wt.	Weaning: Wean. Date (1954)	Weaning: Wean. Wt.	Weaning: Wean Age	Weaning: 135 Da. Wt.	Weaning: Av. Daily Gain[a]	Weaning: Av. Daily Gain[b]
7	SS89	273141	157	2	Tw	Tw	12-17	9	5- 1	108	135	108	.73	.89
14	UT101	284362	980	4	Tw	S	12-22	6	5- 6	93	135	92	.64	.75
44	UT101	284362	25	3	S	S	12-31	9	5-14	105	135	105	.71	.71
50	Myers	245041	915	4	Tw	S	1- 8	8	5-23	61	135	61	.39	.46
60	SS 89	273141	L292	8	Tw	Tw	2- 5	11	6-20	68	135	68	.42	.49
62	SS 89	273141	122	2	Tw	S	2-10	7	6-25	76	135	76	.51	.62
67	SS 89	273141	L171	8	Tw	Tw	2-10	7	6-25	65	135	65	.43	.50
70	Demp.	233966	L688	8	S	S	2-12	12	6-27	87	135	88	.56	.56
76	SS 89	273141	33	3	Tw	Tw	2-22	11	7- 7	82	135	83	.53	.62

[a]Unadjusted average daily gain
[b]Adjusted daily gain (for type of rearing and age of dam)

TABLE III (CONTINUED)

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1953-54

Ram No.	Feedlot Gain Test: Daily Gain Wean. to Test	Beg. Wt. 10-24-53	End Wt. 2-1-54	Total Gain 100 Days	Av. Daily Gain	Av. Type Score	Feed Per 100# Gain	Age On 2-1-54	Av. Daily Gain-Birth to 2-1-54
7	.14	132	180	48	.48	15.33	943	411	.42
14	.13	115	170	55	.55	14.00	800	406	.40
44	.16	132	188	56	.56	13.66	814	398	.45
50	.23	97	134	37	.37	11.66	1149	389	.32
60	.31	107	162	55	.55	12.00	827	367	.41
62	.19	99	150	51	.51	13.33	870	356	.40
67	.43	117	156	39	.39	12.33	1127	356	.42
70	.27	119	174	55	.55	12.33	813	354	.30
76	.26	110	160	50	.50	11.00	905	344	.43

TABLE IV

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1954-55

Ram No.	Sire Name	Sire No.	Dam No.	Age of Dam	Birth Type Birth	Birth How Reared	Birth Date (1953-54)	Birth Wt.	Weaning (1954) Wean. Date	Wean. Wt.	Wean. Age	135 Da. Wt.	Av. Daily Gain[a]	Av. Daily Gain[b]
407	Demp.	233966	276	2	S	S	12-25	10	5- 8	80	135	80	.52	.55
409	Moore	289633	157	3	Tw	S	12-27	9	5-10	82	135	82	.54	.63
412	Demp.	233966	889	6	Tw	Tw	12-27	7	5-10	64	135	64	.42	.49
414	Moore	289633	808	6	Tw	Tw	12-28	6	5-11	67	135	67	.45	.53
442	Moore	289633	940	5	S	S	1-20	9	6- 4	75	135	75	.49	.49
446	Myers	289824	223	2	S	S	1-24	7	6- 8	63	135	63	.41	.43
451	Myers	289824	015	4	S	S	1-29	9	6-13	62	135	62	.39	.39
457	Myers	289824	862	6	S	S	1-30	12	6-14	66	135	66	.40	.40
458	Myers	289824	235	2	S	S	1-31	8	6-15	69	135	69	.45	.47
463	UT246	287551	226	2	Tw	S	2- 4	7	6-19	64	135	64	.42	.51
467	UT246	287551	250	2	S	S	2- 7	6	6-22	84	135	84	.58	.61
471	Demp.	233966	040	4	S	S	2- 8	11	6-23	76	135	76	.48	.48
474	UT218	287552	978	5	S	S	2-10	12	6-25	69	135	69	.42	.42
475	UT246	287551	241	2	S	S	2-11	10	6-26	70	135	70	.44	.46
479	Demp.	233966	Myers 605	8	S	S	2-13	12	6-28	73	135	73	.45	.45
481	UT246	287551	195	3	Tw	Tw	2-15	9	6-30	64	135	64	.41	.48
482	UT246	287551	887	6	Tw	S	2-16	9	6-31	71	135	71	.46	.54

[a]Unadjusted average daily gain
[b]Adjusted daily gain (for type of rearing and age of dam)

TABLE IV (CONTINUED)

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1954-55

Ram No.	Feedlot Gain Test: Daily Gain Wean. to Test	Beg. Wt. 11-30-54	End Wt. 3-10-55	Total Gain 100 Days	Av. Daily Gain	Av. Type Score	Feed Per 100# Gain	Age on 3-10-55	Av. Daily Gain-Birth to 3-10-55
407	.11	102	163	65	.65	14.33	652	442	.35
409	.14	110	162	56	.56	13.83	775	440	.35
412	.14	92	132	43	.43	11.83	907	440	.28
414	.05	77	136	63	.63	11.16	619	439	.30
442	.18	108	147	43	.43	12.66	928	414	.33
446	.21	100	161	67	.67	12.33	664	410	.38
451	.24	103	165	67	.67	11.16	360	405	.38
457	.18	96	168	77	.77	11.83	599	404	.39
458	.21	104	147	48	.48	13.00	879	403	.34
463	.21	99	160	66	.66	12.16	598	399	.38
467	.06	93	143	54	.54	13.16	748	396	.34
471	.18	105	166	65	.65	13.16	665	395	.39
474	.25	110	174	68	.68	13.00	616	393	.41
475	.26	111	154	49	.49	12.66	876	392	.37
479	.11	90	144	57	.57	13.00	677	390	.34
481	.20	94	155	65	.65	11.83	675	388	.38
482	.07	82	122	44	.44	11.83	839	387	.29

TABLE V

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1955-56

Ram No.	Sire Name	Sire No.	Dam No.	Age of Dam	Birth: Type Birth	Birth: How Reared	Birth: Birth Date (1955)	Birth: Birth Wt.	Weaning: Wean. Date (1955)	Weaning: Wean. Wt.	Weaning: Wean. Age	Weaning: 135 Da. Wt.	Weaning: Av. Daily Gain[a]	Weaning: Av. Daily Gain[b]
505	UT367	307607	225	3	S	S	1- 3	10	5-18	107	135	107	.72	.72
506	Myers	303948	330	2	S	S	1- 3	9	5-18	90	135	90	.60	.63
518	UT362	307606	130	4	Tw	Tw	1-10	8	5-25	82	135	82	.55	.64
523	Myers	303948	912	6	Tw	Tw	1-13	8	5-28	77	135	77	.51	.60
527	UT367	307607	253	3	Tw	Tw	1-17	10	6- 1	84	135	85	.55	.64
531(a)	UT367	307607	163	4	Tw	Tw	1-18	8	6- 2	91	135	90	.61	.71
533	UT367	307607	026	5	Tw	Tw	1-18	7	6- 2	82	135	83	.56	.66
536	UT367	307607	105	4	Tw	Tw	1-18	8	6- 2	92	135	92	.62	.73
537(a)	Myers	303948	40	5	S	S	1-18	12	6- 2	109	135	109	.72	.72
541	UT367	307607	112	4	Tw	Tw	1-20	8	6- 4	76	135	75	.50	.58
550(a)	UT367	307607	940	6	S	S	1-21	11	6- 5	108	135	108	.72	.72
555	Myers	303948	220	3	S	S	1-22	11	6- 6	90	135	89	.58	.58
556	UT362	307606	276	3	Tw	Tw	1-23	8	6- 7	83	135	84	.56	.66
562	UT362	307606	131	4	S	S	1-25	11	6- 9	96	135	96	.63	.63
563(a)	UT367	307607	233	3	S	S	1-26	11	6-10	101	135	101	.67	.67
564	Myers	303948	338	2	S	S	1-26	10	6-10	95	135	95	.63	.66
570	UT362	307606	944	6	S	S	1-27	10	6-11	89	135	88	.58	.58

[a] Unadjusted average daily gain
[b] Adjusted daily gain (for type of rearing and age of dam)

TABLE V (CONTINUED)

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1955-56

Ram No.	Feedlot Gain Test: Daily Gain Wean. to Test	Beg. Wt. 10-18-55	End Wt. 1-26-56	Total Gain 100 Days	Av. Daily Gain	Av. Type Score	Age on 1-26-56	Av. Daily Gain-Birth to 1-26-56
505	.26	147	198	51	.51	13.17	389	.48
506	.25	129	189	60	.60	14.17	389	.46
518	.33	130	175	45	.45	12.83	381	.44
523	.28	117	143	26	.26	12.33	379	.36
527	.24	118	167	49	.49	13.00	374	.42
531(a)	.11	106	147	41	.41	10.16	373	.38
533	.22	112	144	32	.32	13.83	373	.37
536	.20	119	172	53	.53	12.00	373	.44
537(a)	.15	120	170	50	.50	10.83	373	.42
541	.24	108	148	40	.40	11.83	371	.38
550(a)	.08	119	190	71	.71	13.83	370	.48
555	.22	119	175	56	.56	14.66	369	.44
556	.33	127	170	43	.43	14.33	368	.44
562	.18	120	164	44	.44	13.50	366	.42
563(a)	.07	110	163	53	.53	12.66	365	.42
564	.35	140	198	58	.58	14.50	365	.52
570	.14	107	158	51	.51	13.33	365	.41

TABLE VI

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1956-57

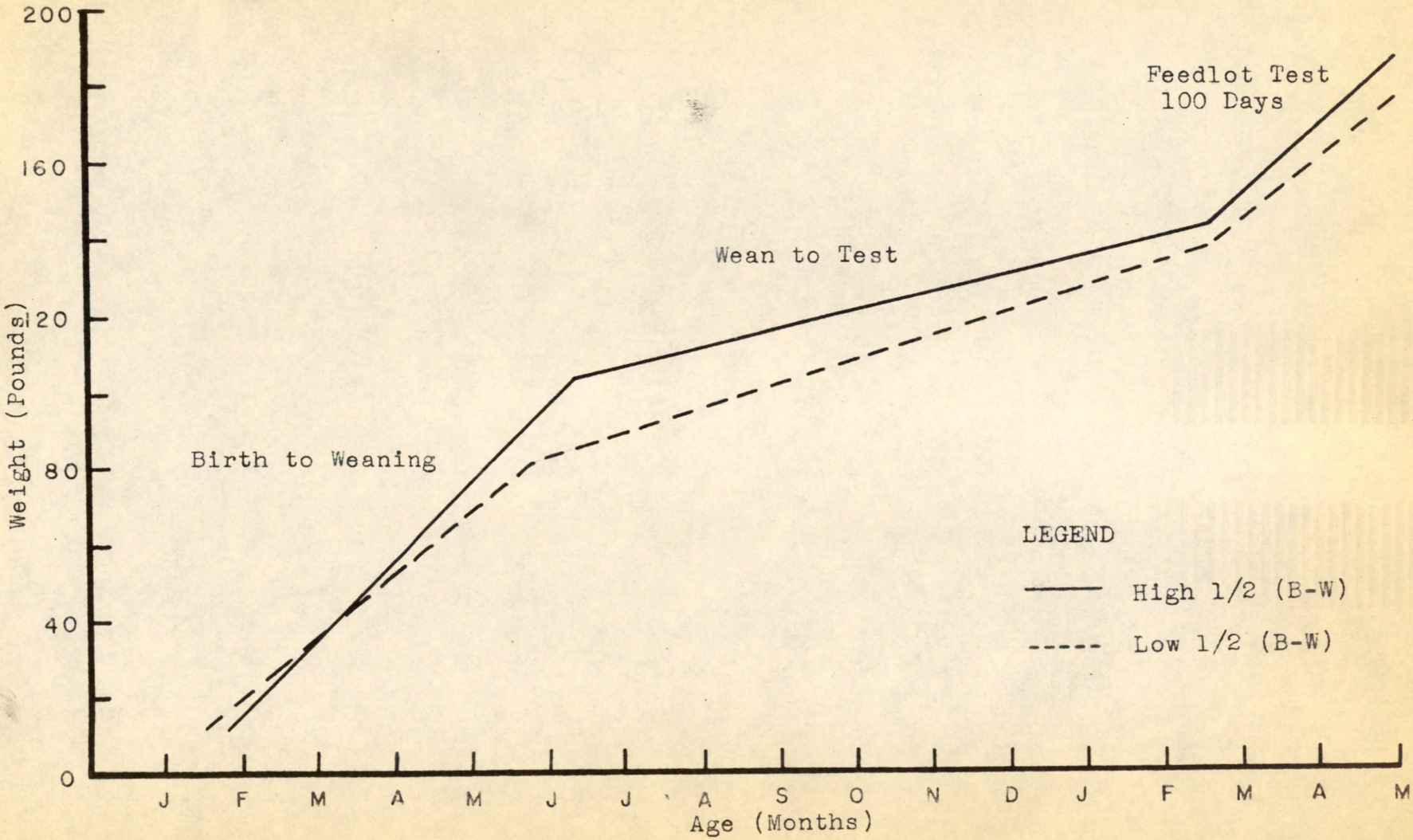
Ram No.	Name	Sire No.	Dam No.	Age of Dam	Birth: Type Birth	Birth: How Reared	Birth: Birth Date (1956)	Birth: Birth Wt.	Weaning: 1956 Wean. Date	Weaning: Wean. Wt.	Weaning: Wean. Age	Weaning: 135 Da. Wt.	Weaning: Av. Daily Gain[a]	Weaning: Av. Daily Gain[b]
46	Myers	267452	262	4	Tw	Tw	1-22	8	6- 6	87	135	88	.59	.69
40	UT367	307607	131	5	S	S	1-20	9	6- 4	102	135	102	.69	.69
27	UT367	307607	261	4	Tw	Tw	1-16	8	5-31	110	135	111	.76	.89
39	UT367	307607	223	4	Tw	Tw	1-19	9	6- 3	112	135	112	.76	.89
55	Moore	289633	233	4	Tw	Tw	1-25	7	6- 9	98	135	97	.67	.78
19	UT367	307607	915	7	Tw	Tw	1- 7	8	5-22	105	135	105	.72	.84
50	Myers	267452	222	4	S	S	1-23	9	6- 7	97	135	97	.64	.64
17	Myers	267452	252	4	S	S	1- 7	9	5-22	113	135	113	.77	.77
84	Myers	267452	352	3	Tw	Tw	3-18	7	7-31	84	135	84	.57	.67
53	Myers	267452	130	5	S	S	1-24	13	6- 8	97	135	97	.62	.62
26	Moore	289633	978	7	S	S	1-15	9	5-30	96	135	95	.64	.64
25	Myers	267452	304	3	S	S	1-13	9	5-28	103	135	103	.70	.70
30	Moore	289633	275	4	Tw	Tw	1-16	9	5-31	114	135	114	.78	.91

[a] Unadjusted average daily gain
[b] Adjusted daily gain (for type of rearing and age of dam)

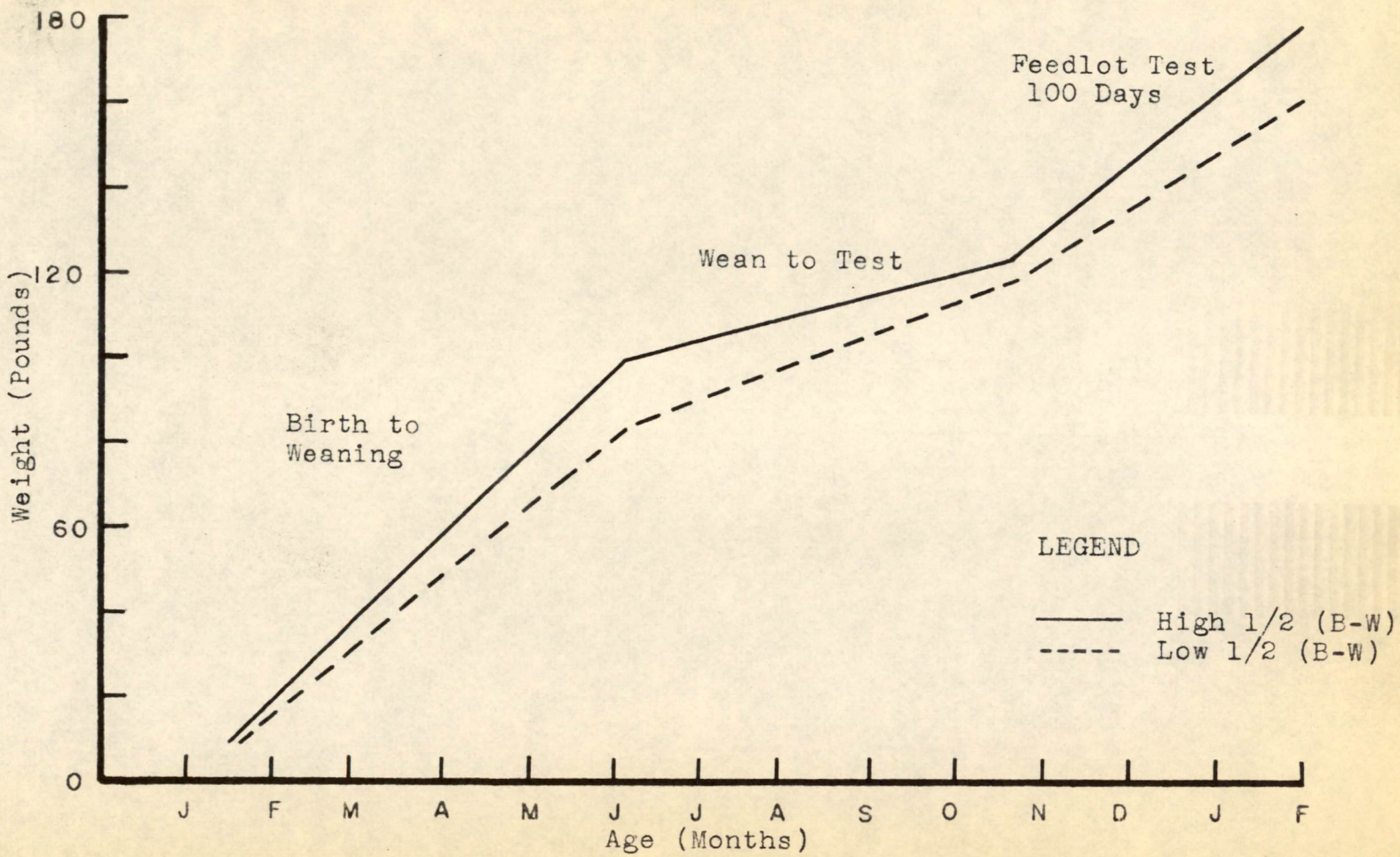
TABLE VI (CONTINUED)

PERFORMANCE RECORDS OF RAMS ON TEST DURING 1956-57

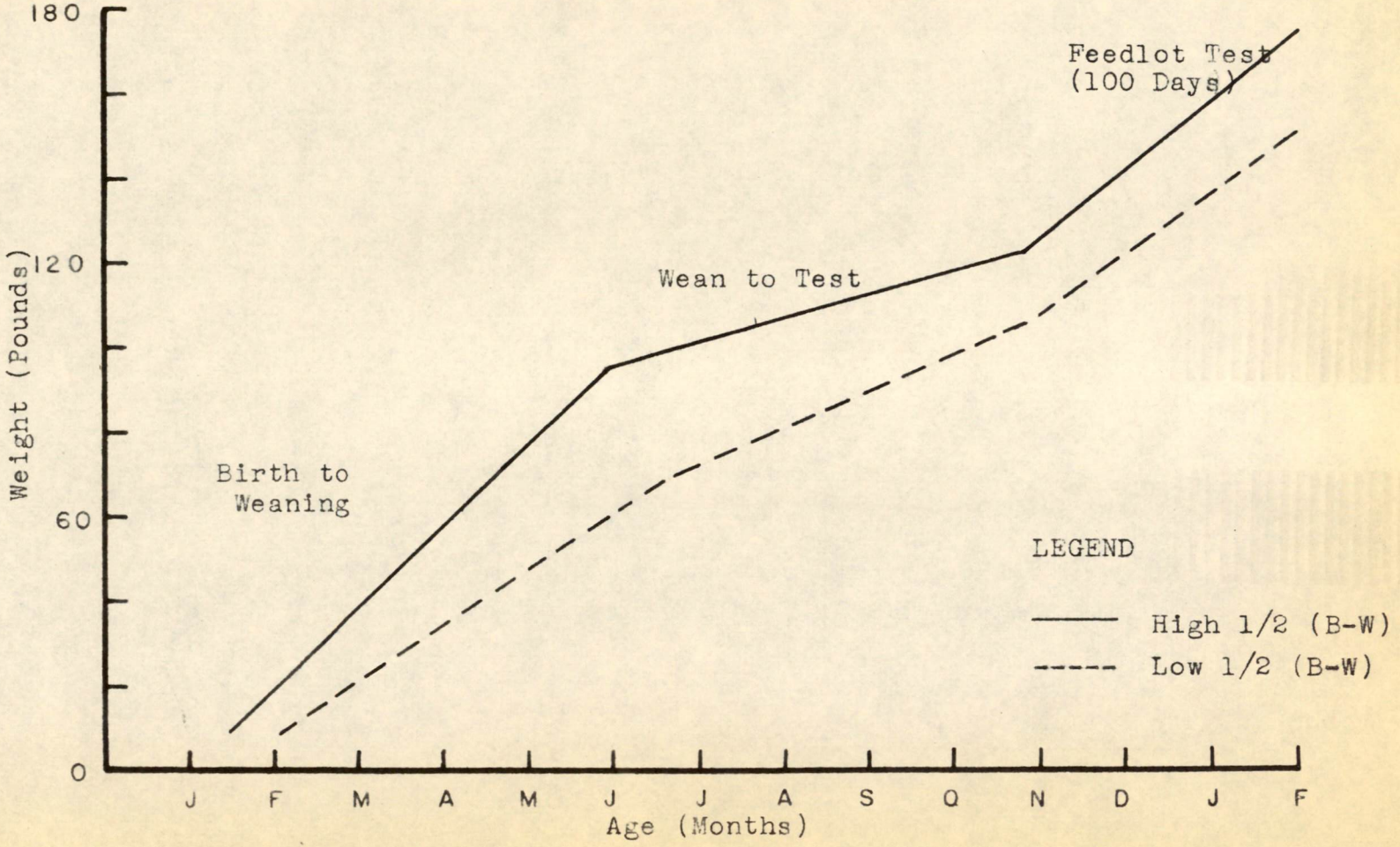
Ram No.	Feedlot Gain Test: Daily Gain Wean. to Test	Beg. Wt. 9-25-56	End Wt. 1-3-57	Total Gain 100 Days	Av. Daily Gain	Av. Type Score	Age On 1-3-57	Av. Daily Gain-Birth to 1-3-57
46	.25	115	165	50	.50	14.00	347	.45
40	.40	147	178	31	.31	14.67	349	.48
27	.39	156	192	36	.36	13.00	353	.52
39	.33	150	192	42	.42	13.67	350	.53
55	.00	98	156	58	.58	13.00	344	.43
19	.33	146	197	51	.51	14.00	362	.52
50	.00	97	173	76	.76	13.33	347	.48
17	.11	127	136	9	.09	12.67	352	.36
84	.29	100	163	63	.63	15.33	292	.53
53	.00	97	184	87	.87	13.00	345	.50
26	.25	136	173	37	.37	15.33	354	.46
25	.42	153	193	40	.40	15.00	356	.52
30	.29	148	187	39	.39	14.67	353	.50



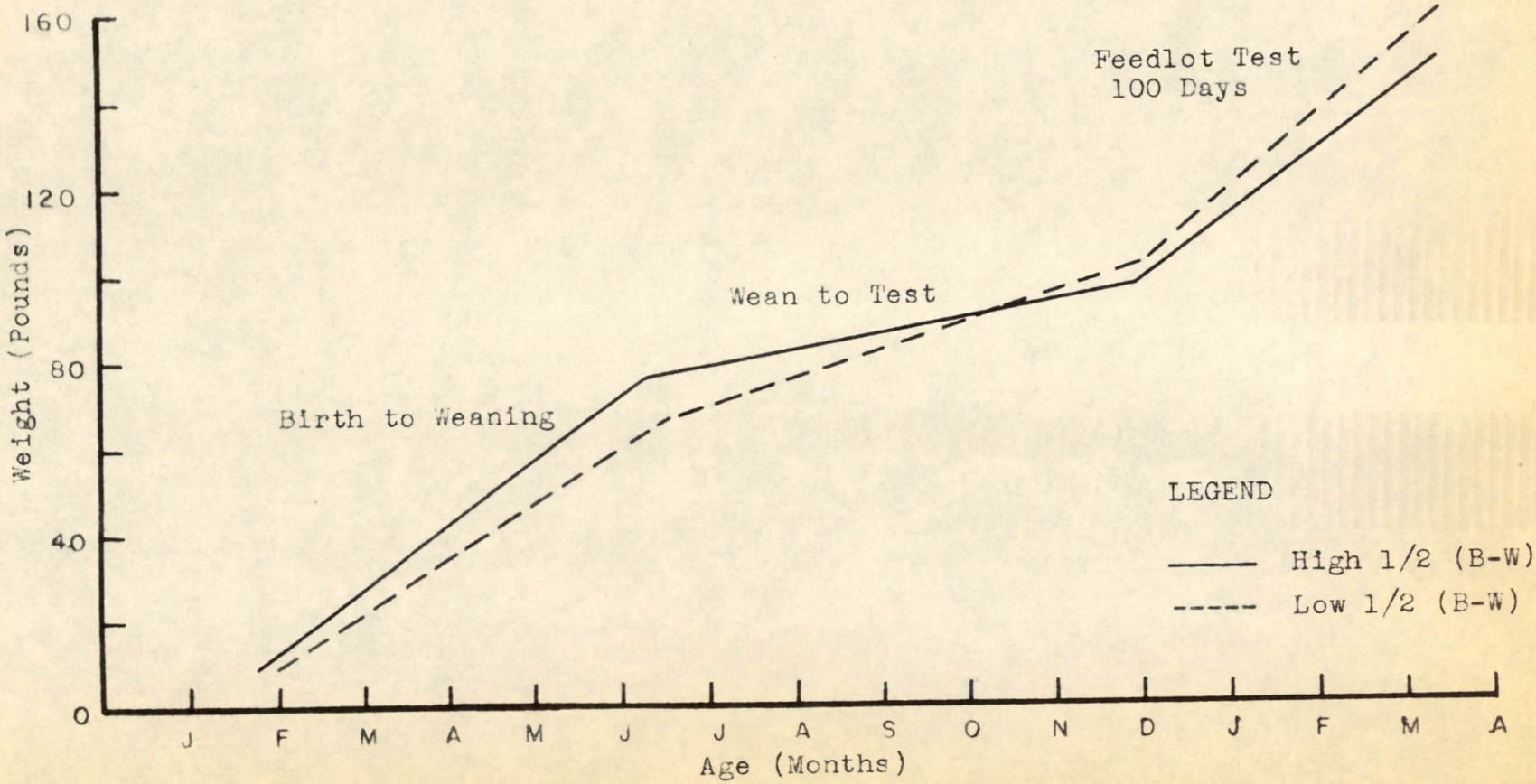
THE RELATIONSHIP BETWEEN GAINS MADE AT DIFFERENT PERIODS IN 1951



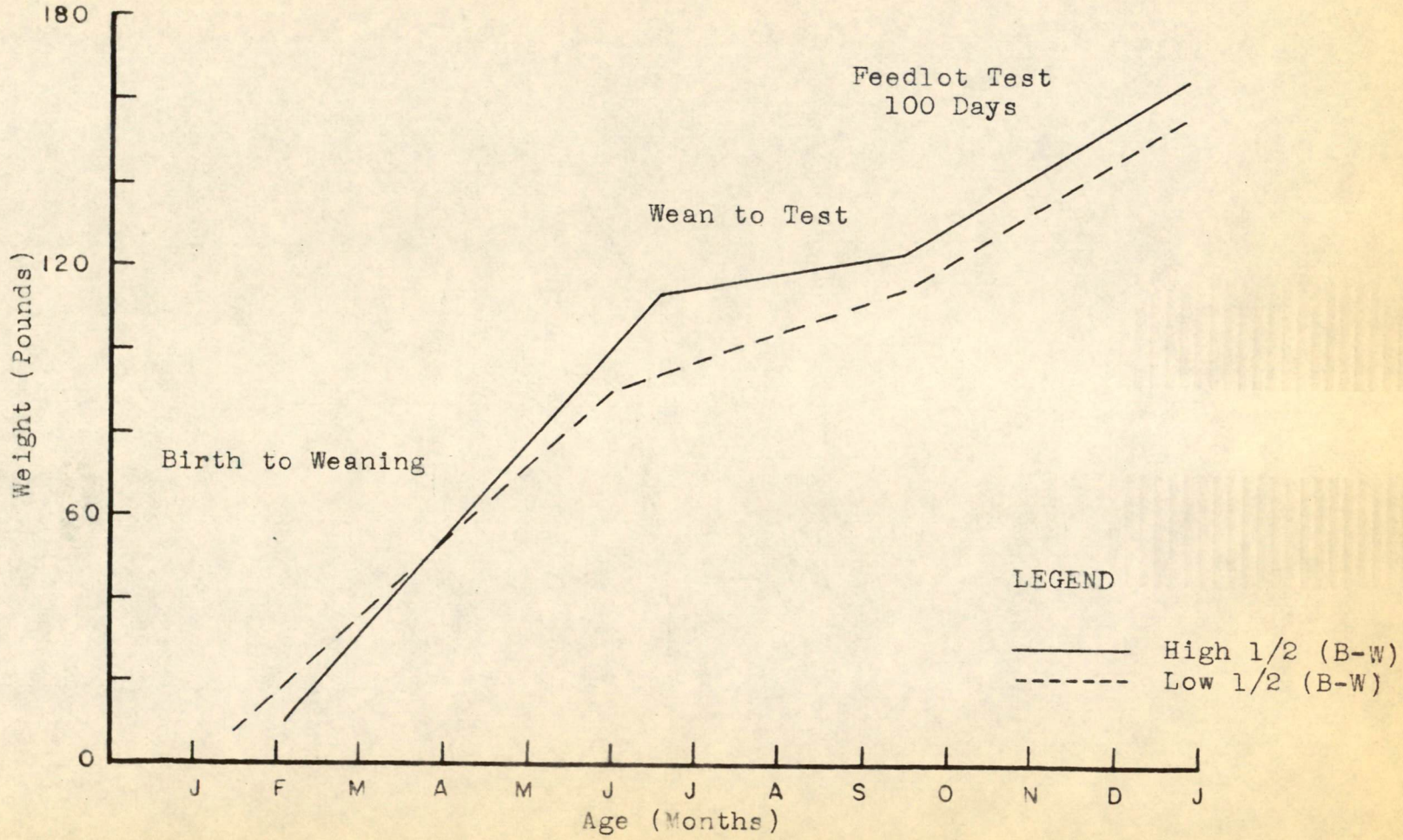
THE RELATIONSHIP BETWEEN GAINS MADE AT DIFFERENT PERIODS IN 1952



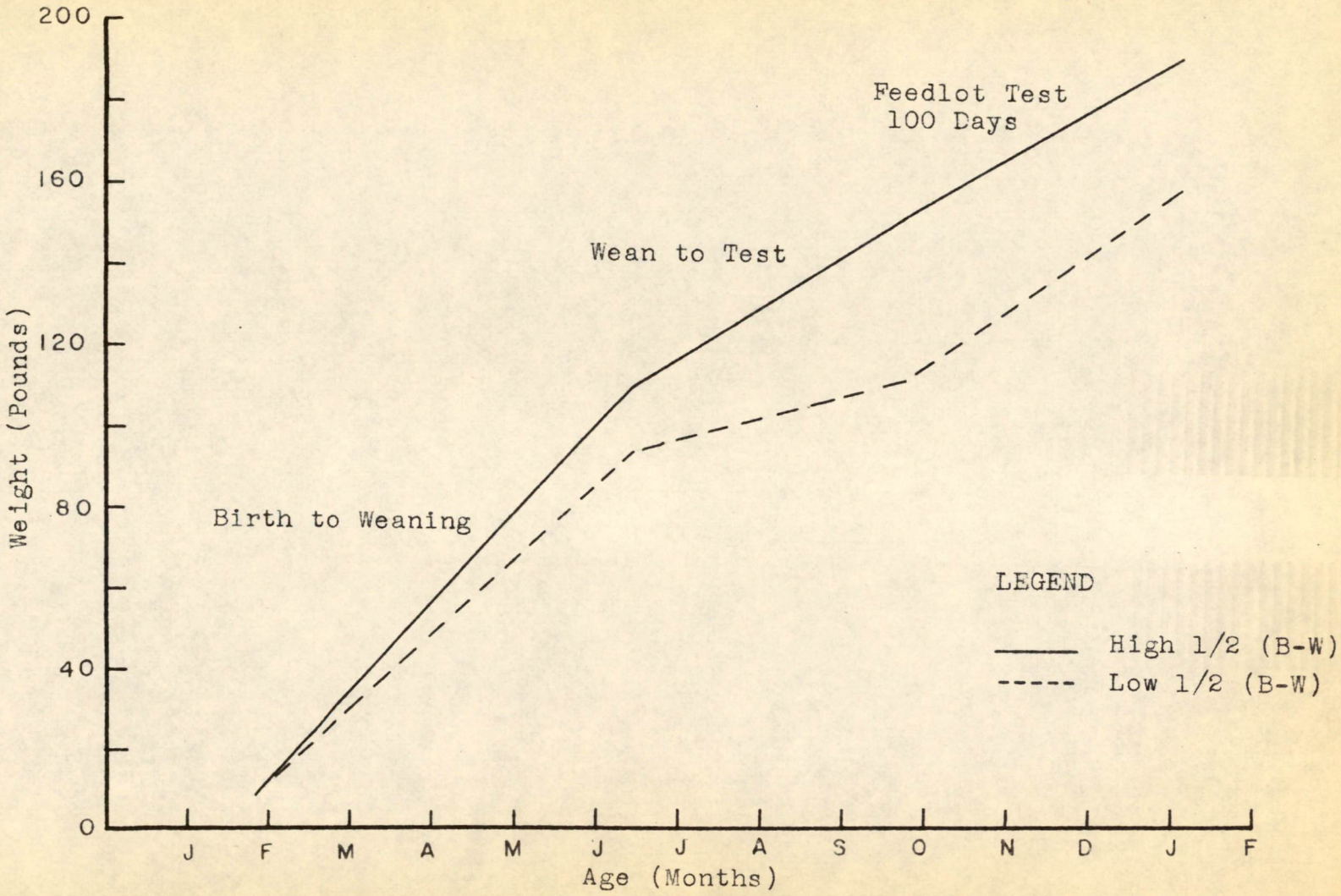
THE RELATIONSHIP BETWEEN GAINS MADE IN DIFFERENT PERIODS OF 1953



THE RELATIONSHIP BETWEEN GAINS MADE AT DIFFERENT PERIODS IN 1954



THE RELATIONSHIP BETWEEN GAINS MADE AT DIFFERENT PERIODS IN 1955



THE RELATIONSHIP BETWEEN GAINS MADE AT DIFFERENT PERIODS IN 1956