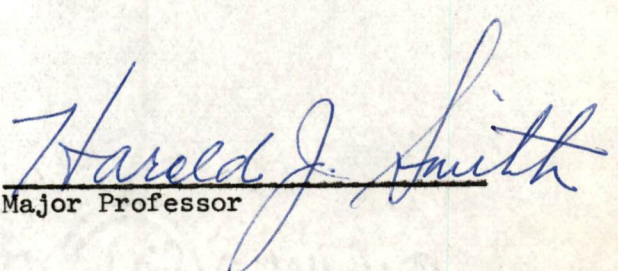


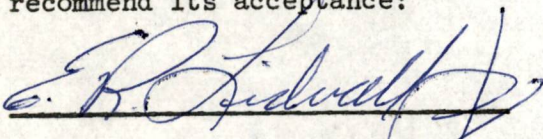
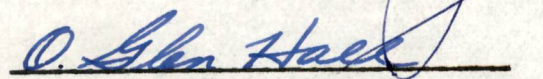
March 27, 1963

To the Graduate Council:

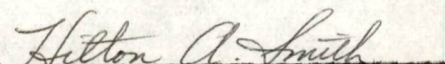
I am submitting herewith a thesis written by Carlos E. Webb entitled "Factors and Their Effects on Birth Weight, Average Daily Gain, and 120-Day Weight of Purebred Hampshire Lambs." I recommend that it be accepted for nine quarter hours of credit in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Husbandry.


Major Professor

We have read this thesis and
recommend its acceptance:

Accepted for the Council:


Dean of the Graduate School

FACTORS AND THEIR EFFECTS ON BIRTH WEIGHT, AVERAGE DAILY GAIN,
AND 120-DAY WEIGHT OF PUREBRED HAMPSHIRE LAMBS

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
Carlos E. Webb

June 1963

28
33

ACKNOWLEDGEMENTS

The author wishes to express his most sincere appreciation to the following persons who assisted in the preparation of this thesis:

To Dr. H. J. Smith, Major Professor, for guidance and assistance in suggesting, planning and conducting this study and especially to his critical reading of the manuscript for this thesis.

To Professor E. R. Lidvall and Dr. C. S. Hobbs for their constructive criticisms during the preparation of the manuscript.

To Mr. Haley Jamison for his untiring efforts in assisting with the statistical analysis for this thesis.

To Mr. Roger Kiwimagi of the computing center for carrying out the statistical analysis.

To the shepherds and herdsmen at the University farm for diligently recording and keeping the records of each ewe and lamb.

TABLE OF CONTENTS

CHAPTER	PAGE
I. INTRODUCTION.	1
II. REVIEW OF LITERATURE.	2
III. EXPERIMENTAL PROCEDURE.	9
Source of Data.	9
Flock Management.	9
Statistical Analysis.	12
IV. RESULTS AND DISCUSSION.	16
Birth Weight.	16
Average Daily Gain.	21
120-Day Weight.	28
Adjustment Factor	34
V. SUMMARY AND CONCLUSIONS	41
LITERATURE CITED.	44
APPENDIX.	47

LIST OF TABLES

TABLE	PAGE
I. Analysis of Variance for Birth Weight.	17
II. Adjusted Means and Least Squares Estimates of the Effects of Age of Dam, Season of Birth, Sex, Type of Birth, and Year of Birth on Birth Weight.	18
III. Analysis of Variance for Average Daily Gains	22
IV. Adjusted Means and Least Squares Estimates of the Effects of Age of Dam, Season of Birth, Sex, Type of Birth, Type of Birth and Rearing, and Year of Birth on Average Daily Gain.	23
V. Analysis of Variance for 120-Day Weights	29
VI. Adjusted Means and Least Squares Estimates of the Effects of Birth, Sex, Type of Birth, Type of Birth and Rearing, and Year of Birth on 120-Day Weight	30
VII. Adjustment Factors for the Effects of Age of Dam on Birth Weight, Average Daily Gain, and 120-Day Weight	35
VIII. Adjustment Factors for the Effects of Season of Birth on Birth, Weight, Average Daily Gain, and 120-Day Weight	36
IX. Adjustment Factors for the Effects of Sex on Birth Weight, Average Daily Gain, and 120-Day Weight	37
X. Adjustment Factors for the Effects of Type of Birth on Birth Weight, Average Daily Gain, and 120-Day Weight	38

TABLE

PAGE

XI. Adjustment Factors for the Effects of Type of Birth and Rearing on Birth Weight, Average Daily Gain, and 120-Day Weight	39
---	----

CHAPTER I

INTRODUCTION

Sheep production in Tennessee is comprised predominantly of the commercial production of milk fat spring lambs with some purebred production and a very limited amount of lamb feeding. The production of spring lambs is a special type of enterprise in Tennessee. These spring lambs are produced primarily by mating either native, western crossbred or grade fine wool ewes to rams of the Hampshire, Suffolk or Southdown breeds. The success of spring lamb production demands breeding for the desired type and weight of lamb and providing succulent, highly nutritious, cheap feed. The object is to produce fast-growing lambs that are properly finished at market time in May and June.

Since the purebred breeder is the source of supply of rams for the commercial sheepman, it is the purebred breeder's responsibility to provide the kind of rams for market lamb production which will sire fast-gaining, good-type lambs of desirable market quality. Therefore, the purebred breeder must continually strive to improve performance if he is to meet this responsibility. Research results indicate that improvement can be made in the productivity of sheep through selection. Performance records and their use in a selection program provides an effective tool which can be used by breeders to improve productivity. However, before performance records can be used effectively as a basis for selection, the records of individual animals must be placed on a

comparable basis. Many environmental and other factors operate to conceal true genetic merit, thereby confusing the breeder and obstructing his efforts to select those animals having the greatest breeding value. In many cases, variation due to environmental factors can be eliminated or controlled but in others adjustment or correction for major environmental effects is necessary to place animals on a comparable basis. Information is needed on the extent and magnitude of these effects in sheep in order to adjust performance records before selections are made.

The purposes of this study were (1) to evaluate the effects of various factors including age of dam, season of birth, sex, type of birth, type of birth and rearing and year of birth on birth weight, average daily gain from birth to weaning and 120-day weight in purebred Hampshire sheep and (2) to determine correction factors to be used to adjust performance records of lambs for these effects.

CHAPTER II

REVIEW OF LITERATURE

A number of studies have been made to estimate the effects of various factors on lamb traits from birth to weaning. Because these studies have not all been conducted under similar management practices and environmental conditions and with ewes of similar breeding, they have not all been in agreement.

The early pioneers of this work, Phillips and Dawson (1937), in a study using 835 Southdown lambs, reported that single lambs were heavier at birth than twins and that, on the average, one would expect an increase of 4.3 pounds in weight at three months of age for each increase of one pound in birth weight of single males. Also, they reported that single male lambs would be expected to weigh 0.14 pound less on the average at three months for each day's increase in birth date.

Hazel and Terrill (1945) found, in a study involving 2,183 range Rambouillet lambs, that ram lambs were 8.3 pounds heavier than twin lambs, and lambs from mature ewes were 6.1 pounds heavier at weaning than lambs from 2-year-old ewes. In another study using 1,082 lambs, Hazel and Terrill (1946) reported differences in weaning weight between ram lambs and ewe lambs, single lambs and twin lambs, and lambs from mature and 2-year-old dams to be 10.8, 11.7 and 8.7 pounds respectively.

In a study of data from 437 lambs raised from ewes in farm flocks

in Wisconsin, Karam et al. (1949) found that single lambs were 6.2 pounds heavier at 25 weeks and had a 0.02 pound higher average daily gain from birth to market than twins. Wether lambs were 3.5 pounds heavier at 25 weeks and had a 0.02 pound higher average daily gain than ewe lambs. The differences were statistically significant.

Blackwell and Henderson (1955), at Cornell University, analyzed the records of 1,295 lambs from 463 ewes for factors affecting weaning weight and the records of 2,158 lambs from 560 ewes for factors affecting birth weight. The lambs consisted of Corriedale, Dorset, Hampshire and Shropshire breeds. They found that 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, Shropshire, and Hampshire breeds. Males were heavier at birth and weaning than ewe lambs. Single lambs were heavier at birth than twins. Single lambs were heavier at weaning than lambs born as twins and reared as either single or twins. In the Dorset lambs, an analysis was made to evaluate the effects of season of birth on birth weight and weaning weight. The results showed that lambs born in the spring were 0.40 pound heavier at birth than lambs born in the fall and were 2.85 pounds heavier at weaning. They also found that differences among years were significantly different.

Debaca et al. (1956) in a study with 280 crossbred lambs over a two-year period, reported that birth weight was the most influential of all the variables studied which affected the weaning weight. Four

analyses were made and they found that the range in increase in weaning weight varied from 2.50 ± 0.65 pounds to 5.96 ± 0.76 pounds for each pound increase in birth weight. The weaning weight of single lambs was significantly greater than the weaning weight of twin lambs. Single lambs averaged 17 pounds heavier at weaning than did twin lambs.

At the University of Wisconsin, Felts et al. (1957) used the records from 32 flocks to obtain the constant for the age of dam, type of birth and rearing on 120-day weight. Pooled type of birth and rearing effects expressed in deviations from the overall mean were: 7.9 pounds for male single, -02.3 pounds for a male twin; 1.98 pounds for a male 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 dam effects expressed as deviations from the overall mean were: -14.26 pounds for a 1-year-old ewe; 0.06 pound for a 2-year-old ewe; 4.23 pounds for a 3-year-old ewe; 4.57 pounds for a 4-year-old ewe; 3.73 pounds for a 5-year-old ewe; 2.00 pounds for a 6-year-old ewe; and -0.34 pound for a 7-year-old ewe.

Bogart et al. (1957) at Oregon State College analyzed records of 280 crossbred lambs born over a 2-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 a significant difference between years for birth weight. There was a small difference between the birth weight of male lambs and ewe lambs.

Harrington et al. (1958) studied the records of 300 Dorset X

Rambouillet and Dorset X Rambouillet-Panama crossbred lambs born over a two-year period. They found that effects due to type of birth and type of rearing became less important as the lambs grew older. There was also a difference due to the years in which the lambs were born. During both years, the male lambs were heavier than the female lambs and the sex difference was about the same in both years. Birth weight was the most important source of variation in the lamb weights at different ages.

Givens et al. (1960) estimated the phenotypic parameters (120-day weight and average daily gain from birth to marketing) from the fixed effects which included sex, type of rearing, and year of birth. Four hundred ninety-eight ewe and wether crossbred lambs born in eight seasons were used for this study. They found that a wether lamb was 4.7 ± 0.9 pounds heavier than a ewe lamb and a single lamb was 10.7 ± 0.09 pounds heavier than a twin lamb at 120 days with an estimated mean of 82.7 ± 1.1 pounds. A wether lamb had a 0.037 ± 0.007 pound higher average daily gain than a ewe lamb, and a single lamb had a $0.077 \pm .008$ pound higher average daily gain than a twin lamb with an estimated mean of 0.572 ± 0.008 pound.

Brown et al. (1961) analyzed the records of 132 crossbred lambs and 121 inbred Hampshire lambs with complete preweaning growth records. The difference in birth weight between male and female lambs was not significant. However, there was a significant difference in weight between males and females at 120 days in inbred lambs with males averaging about 2 pounds heavier. The birth weight of single lambs was

about 1 pound heavier than twins raised as twins, and about one-half pound heavier than lambs born as twins but reared as singles. The 120-day weight for inbred single lambs was 8 pounds heavier than twins reared as twins and crossbred singles were 7 pounds heavier than twins reared as twins. The 120-day weight for twins reared as singles was 3 pounds heavier than singles reared as singles. This may have been due to the fact that there were only a small number of twin lambs reared as singles. Lambs from mature inbred ewes (4, 5, and 6-year-olds) were about 1 pound heavier at birth than lambs from young ewes (2 and 3-year-olds), and about 5 pounds heavier at 120 days. The difference in birth weight of inbred lambs from aged ewes (over 7 years old) and mature ewes was not significant. Birth weight was not significantly affected by age of dam in crossbred lambs. Crossbred lambs from young ewes were significantly heavier than lambs from mature ewes at the 120 days of age with a difference of about 8 pounds. Brown indicated that the reason for the difference in the pattern for age of dam effects in crossbred lambs and inbred lambs was not clear. He further stated that the larger number of lambs from aged inbred ewes gave some indication that they had a longer productive life. However, inbred ewes reach a mature production at a later age which may contradict the above statement. Management, nutrition, and selection may provide the clues to the reasons for differences in age of dam affects between inbred and crossbred ewes.

Sabin and Brown (1962) analyzed the growth records of 291 inbred Hampshire lambs. They found that wethers were 2.25 pounds heavier at

sale time, 3.26 pounds heavier at 120 days, and 0.15 pound heavier at birth than ewe lambs. Single lambs were about 8 pounds heavier at sale time and 120 days than were twin lambs. Age of dam effects were statistically significantly different only when sale weight was being considered. However, the ewes were progressively better producers up to 6 years of age. The age of the ewe had no effect on birth weight of lambs. Differences were obtained in the growth of lambs among years in which the lambs were born and for season of birth within years. A lamb's sale weight was reduced by about one-half pound for each day later in the season in which it was born. However, lambs born late were heavier at birth and grew at a slightly faster rate than early lambs.

CHAPTER III

EXPERIMENTAL PROCEDURE

Source of data. The data used in this study were collected as a routine part of the purebred Hampshire sheep breeding program of the Tennessee Agricultural Experiment Station at the Main Station, Knoxville. The data were collected over a 13-year period, 1950-1962 inclusive. The size of the Hampshire flock at this station remained relatively constant from one year to another during this period with about 60-75 ewes bred to lamb each year. Except for a limited number of ewe lambs which were bred in some years, replacement ewe lambs were carried over and bred for the first time at about 18 months of age. One group of 35 ewes were purchased in 1950 from the Mt. Haggin Land and Livestock Company. These ewes lambed first in 1951. All other replacement ewes were selected from within the flock.

Flock management. The Blount County Animal Husbandry Farm of the Tennessee Agricultural Experiment Station is located about seven miles south of Knoxville. The experiment station lies in the valley between the Great Smoky Mountains and the Cumberland Mountains. The breeding, feeding, and management practices followed in the flock of purebred Hampshire sheep maintained at this station throughout the years included in this study were not greatly different from those followed in any good sound program of sheep production in Tennessee. Throughout most of each year (spring, summer and fall) the ewes were grazed on pasture.

During the usual grazing season the ewes were grazed on good permanent pastures consisting of either native pastures (Bermuda grass, Bluegrass, and White Dutch clover), orchard grass and ladino clover, or fescue and ladino clover. They were maintained on these pastures until winter pastures had adequate growth for grazing. These pastures were used primarily for ewes and their lambs. The winter pastures consisted of either rye grass and crimson clover or oats and crimson clover mixtures. The amount of grazing obtained from winter pastures depended upon the time of seeding, fall and winter temperatures and rainfall. High-quality hay was made available to the ewes during periods when pastures were inadequate or during periods of severe cold weather and snow. Also, the ewes were fed grain (one-half pound per head daily) when needed usually starting about two weeks prior to lambing. After lambing the grain was increased to about 1 pound per head daily. Grain feeding of the ewes was discontinued when grazing conditions provided adequate feed, usually in mid-March. The lambs were creep fed from birth until grazing conditions became so good that the lambs refused creep feed. The usual procedure was to put the ewes and lambs on winter pastures and then rotate to permanent pastures in late April and May. Adequate salt and water were always available ad libitum. After lambing phenothiazine was added to the salt at the rate of nine parts of salt to one part of phenothiazine.

All ewes were identified and a complete record of each ewe was kept. If a ewe was barren for two consecutive years, she was culled. The ewes were rotated to a very good pasture 2 weeks before breeding

so they would be in a gaining condition at breeding time. This practice of "flushing" is thought to bring the ewes into estrus earlier and at a more uniform rate, and to give a higher conception rate at first service and a higher per cent of twins. The rams were sheared 2 times per year about May 1st and 2 weeks prior to the beginning of the breeding season. Rams were turned with the ewes between July 25 and August 10. They were taken away from the ewes October 15 to November 1. Thus, the lambing season in most years started between December 15 and January 5.

Beginning at the time the first lamb was born, the ewes were brought to the barn (a shed-type barn used strictly for sheep) at night. They were given plenty of exercise by letting them run on pasture during the day time. Lambing pens were set up in the barn and ewes and lambs were put in the pen immediately after lambing. Each ewe was checked to see if she was giving milk from both sides of the udder, and if the lamb was strong enough to nurse its dam. Heat lamps were placed over each lambing pen when 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. When the lambs had gained strength and were well started (2 to 5 days) they were taken from the lambing pen with their dam and put in a group with other ewes and lambs so that close attention could be given to them if needed. Very little castration was done before weaning since it was the practice to wait until that time to select ram lambs to be saved for performance tests. Lambs were docked at 3 to 10 days of age.

A strict parasite control program was practiced to prevent

infestation with roundworms, tapeworms, and other internal parasites. The ewe flock was drenched three times per year (June, August, and October) and at other times if needed. Internal parasites were thought to present no serious problems during the years of this study. 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 blue stone (copper sulfate). Footrot was brought into this flock in 1957 and was a critical problem through 1961. This could possibly have had a bearing on the performance data obtained during this period.

The ewes were sheared about May 1 each year.

The replacement ewes were obtained in this flock by selecting the lambs which were born early, with faster gains and higher weaning weights, and from the better dams. Also, type and conformation and breed character were considered.

Some of the rams used during the period included in this study were kept from this flock and several were purchased from other pure-bred Hampshire breeders.

Statistical analysis. Estimates of the effects of age of dam, season of birth, sex, type of birth, and year upon birth weight and the effects of age of dam, season of birth, sex, type of birth, type of birth and rearing, and year of birth upon average daily gain and 120-day weight were obtained by least squares methods described by Harvey (1960).

The complete performance records of all lambs born during the 1950 lambing season through the 1962 lambing season, whether born alive or dead, were transferred to IBM punch cards. Also, cards were punched for the ewes which did not lamb but were barren during the lambing season. However, these cards were not usable in the analysis to estimate effects. Detailed information concerning data punched on IBM cards is found in the Appendix.

In the analysis of data on birth weights, the records of all lambs on which birth weights were available were used. In the analysis of average daily gains and 120-day weights, only the records of lambs which survived to weaning were used.

The average daily gain of lambs was calculated using the following formula:

$$\text{Average Daily Gain (ADG)} = \frac{\text{weaning weight minus birth weight}}{\text{weaning age in days}}$$

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

$$\text{120-day weight} = (\text{ADG} \times 120) + \text{birth weight}$$

After the cards were punched, they were taken to the University of Tennessee computing center and a listing was made giving the data in the same order that it came from the original data. This listing was then checked with the original records to insure maximum accuracy. A total of 1009 cards were used for the birth weight analysis and 723 for average daily gain and 120-day weight analysis.

Before estimates of the effects due to age of dam, season of birth, sex, type of birth, type of birth and rearing, and year could

be obtained, it was necessary to select a mathematical model that would describe the population from which the data came. Least squares analysis was used to estimate the effects, due to an unequal number of lambs in each subclass. The following mathematical model was used to obtain least squares constants:

$$X_{ijklmno} = u + a_i + b_j + s_k + t_l + r_m + y_n + e_{ijklmno}$$

where:

$X_{ijklmno}$ = The birth weight, average daily gain, or 120-day weight for the o^{th} lamb, the i^{th} age of dam group, j^{th} season of birth class, the k^{th} sex group, the l^{th} type of birth class, the m^{th} type of birth and rearing class, and the n^{th} year of birth group. The m^{th} effect was deleted in the determination of effects on birth weight.

u = An effect common to all individuals in the population sampled and the theoretical mean.

a = The effect of age of dam with i classifications, $i = 1, 2, \dots, 10$ as follows:

- | | |
|-------------------|---------------------|
| 1. 1-year-old ewe | 6. 6-year-old ewe |
| 2. 2-year-old ewe | 7. 7-year-old ewe |
| 3. 3-year-old ewe | 8. 8-year-old ewe |
| 4. 4-year-old ewe | 9. 9-year-old ewe |
| 5. 5-year-old ewe | 10. 10-year-old ewe |

b = The effect of season of birth with j classifications, $j = 1, 2, \dots, 5$ as follows:

1. 304th day through 365th day (previous year)
2. 1st day through 30th day (current year)
3. 31st day through 60th day (current year)
4. 61st day through 90th day (current year)
5. 91st day through 303th day (current year)

s = The effect of sex with k classifications, $k = 1$ and 2 as follows:

1. Female
2. Male

t = The effect of type of birth with 1 classifications,
 $1 = 1, 2$ and 3 as follows:

1. Single
2. Twin
3. Triplet

r = The effect of type of birth and rearing with m
 classifications, $m = 1, \dots, 5$ as follows:

1. Born as a single and reared as a single
2. Born as a twin and reared as a single
3. Born as a twin and reared as a twin
4. Born as a triplet and reared as a single
5. Born as a triplet and reared as a twin

y = The effect of year of birth with n classifications,
 $n = 1, 2, \dots, 13$ as follows:

- | | |
|---------|----------|
| 1. 1950 | 8. 1957 |
| 2. 1951 | 9. 1958 |
| 3. 1952 | 10. 1959 |
| 4. 1953 | 11. 1960 |
| 5. 1954 | 12. 1961 |
| 6. 1955 | 13. 1962 |
| 7. 1956 | |

e_{ijklmo} = The random effect peculiar to the o^{th} lamb.

In the mathematical model, birth weight, average daily gain, and 120-day weight are called right hand members of the model and each effect on the other side of the model are called independent variables. The right hand members are dependent upon the independent variables. Only one right hand member can be measured at a time. All of the independent variables in the mathematical model for this study are fixed.

CHAPTER IV

RESULTS AND DISCUSSION

Birth weight. The effect due to sex of lambs in this study was highly significant (Table I). The average birth weight was 8.38 pounds for male lambs and 7.97 pounds for female lambs, with a difference of .41 pound in favor of male lambs (Table II).

The effect due to sex obtained in this study is in agreement with that of Blackwell and Henderson (1955) who reported a significant difference in birth weight between males and females with males being heavier than females. Bogart et al. (1957) reported a small difference between the birth weight of ram lambs and ewe lambs. Harrington et al. (1958) found that males were heavier than females at birth. Sabin and Brown (1962) found that male lambs were 0.15 pound heavier at birth than female lambs. However, Brown et al. (1961) in other studies found no significant difference in birth weight between male and female lambs.

Age of dam influences on birth weight were highly significant (Table I). Lambs born to ewes ranging from 3 years old through 9 years old were from 1.73 pounds to 2.20 pounds heavier at birth than lambs from 1-year-old ewes, 0.76 pound to 1.33 pounds heavier than lambs born to 2-year-old ewes, and 0.64 pound to 1.11 pounds heavier than lambs born to 10-year-old ewes (Table II). There was a definite trend for birth weight to increase with age of dam up to 5 to 6 years, and then remain relatively constant to about 9 years of age. These findings are

TABLE I
ANALYSIS OF VARIANCE FOR BIRTH WEIGHTS

Source	Degrees of freedom	Mean square	F
Age of dam	9	31.43	10.74**
Season of birth	4	19.10	6.52**
Sex	1	41.79	14.28**
Type of birth	2	289.02	98.74**
Years	12	9.33	3.18**
Error	980	2.93	

* $P < 0.05$

** $P < 0.01$

TABLE II

ADJUSTED MEANS AND LEAST SQUARES ESTIMATES OF THE EFFECTS
OF AGE OF DAM, SEASON OF BIRTH, SEX, TYPE OF
BIRTH, AND YEAR OF BIRTH ON BIRTH WEIGHT

Effects studied	Least squares estimates	Adjusted mean	Standard error
Overall mean	8.17		0.17
Age of dam			
1. 1 year old	-1.74	6.44	0.56
2. 2 year old	-0.77	7.41	0.20
3. 3 year old	-0.01	8.17	0.19
4. 4 year old	0.17	8.35	0.20
5. 5 year old	0.48	8.66	0.20
6. 6 year old	0.72	8.90	0.22
7. 7 year old	0.64	8.81	0.24
8. 8 year old	0.68	8.85	0.30
9. 9 year old	0.46	8.64	0.36
10. 10 year old	-0.65	7.53	0.63
Season of birth			
1. 304th day through 365th day	-0.47	7.70	0.25
2. 1st day through 30th day	0.29	8.46	0.18
3. 31st day through 60th day	0.31	8.48	0.20
4. 61st day through 90th day	0.47	8.65	0.22
5. 91st day through 303rd day	-0.59	7.58	0.33
Sex			
1. Female	-0.21	7.97	0.18
2. Male	0.21	8.38	0.18
Type of birth			
1. Single	1.17	9.34	0.13
2. Twin	-0.42	7.76	0.13
3. Triplet	-0.75	7.42	0.43

TABLE II (continued)

Effects studied	Least squares estimates	Adjusted mean	Standard error
Year			
1. 1950	0.44	8.62	0.26
2. 1951	0.20	8.37	0.25
3. 1952	-0.27	7.90	0.25
4. 1953	0.72	8.89	0.27
5. 1954	-0.15	8.02	0.23
6. 1955	0.03	8.44	0.24
7. 1956	-0.18	8.00	0.25
8. 1957	0.20	8.37	0.26
9. 1958	-0.26	7.91	0.31
10. 1959	-0.24	7.94	0.29
11. 1960	0.48	8.66	0.27
12. 1961	-0.37	7.81	0.27
13. 1962	-0.60	7.57	0.26

in general agreement with those of Blackwell and Henderson (1955) who reported significant differences in birth weight due to age of dam in the Corriedale, Shropshire, and Hampshire breeds. Brown et al. (1961) reported that inbred Hampshire ewes 4, 5, and 6 years old gave birth to lambs that were 1 pound heavier than lambs from 2 and 3-year-old inbred Hampshire ewes. However, there were no significant differences in birth weight due to age of dam in crossbred lambs. Blackwell and Henderson (1955) also reported no significant differences in age of dam effects on birth weight in Dorset lambs.

Because there are breed, geographic, environmental and management differences, the reports on effects due to age of dam were not all similar.

The effect of season of birth on birth weight of lambs was highly significant (Table I). Lambs born during the first 30 days of the year, from the 31st day through the 60th day and from the 61st day through the 90th day were heavier at birth than lambs born from the 90th day through the 303rd day of the year by 0.88, 0.90 and 1.07 pounds, respectively, and were heavier than lambs born from the 304th day through the 365th day of the previous year by 0.76, 0.78 and 0.94 pound, respectively (Table II). This agrees with Blackwell and Henderson (1955) who reported that fall lambs were 0.40 pound lighter than spring lambs.

The difference in birth weights of lambs due to the effects of type of birth were highly significant (Table I). Lambs born as singles were 1.58 pounds heavier than lambs born as singles and 1.92 pounds heavier than lambs born as triplets (Table II). These results are

similar to those reported by Phillips and Dawson (1937), Blackwell and Henderson (1955), Bogart et al. (1957), and Brown et al. (1961).

The effects due to year of birth upon birth weight was highly significant (Table I). However, there was no definite trend observed in the 13-year period of study. Differences in climatic conditions from one year to another which would affect growth of pastures and other factors is a possible explanation for these differences due to years. The results of Bogart et al. (1957) also indicate significant differences in birth weight due to year effects.

Average daily gain. A highly significant difference was obtained for the sex effect on the average daily gain of lambs included in this study (Table III). Males lambs gained 0.54 pound and female lambs gained 0.49 pound per day with a difference of 0.05 pound per day in favor of male lambs (Table IV). This difference is slightly higher than estimates by Karam et al. (1949) and Givens et al. (1960) of 0.02 and 0.037 pound, respectively. However, in their studies the lambs were wether lambs while in this study the majority of male lambs were ram lambs.

The differences due to age of dam effects on average daily gain were not significant (Table III). However, there were some differences in average daily gains for lambs from different ages of dam. Lambs born to dams from 3 years old through 7 years old were similar in their rate of gain. Since only a small number of lambs were born to 1-year-old ewes, the estimate of 0.54 pound per day may not be a reliable estimate for this age of dam subclass. If this 1-year-old group is not considered,

TABLE III
ANALYSIS OF VARIANCE FOR AVERAGE DAILY GAINS

Source	Degrees of freedom	Mean square	F
Age of dam	9	.0122	1.86
Season of birth	4	.0518	7.86**
Sex	1	.3934	59.70**
Type of birth	2	.2122	32.20**
Twins reared as twins vs. twins reared as singles	1	.0948	14.39**
Triplets reared as singles vs. triplets reared as twins	1	.0001	0.02
Years	12	.0955	14.50**
Error	692	.0065	

*P < 0.05

**P < 0.01

TABLE IV

ADJUSTED MEANS AND LEAST SQUARES ESTIMATES OF THE EFFECTS
OF AGE OF DAM, SEASON OF BIRTH, SEX, TYPE OF BIRTH,
TYPE OF BIRTH AND REARING, AND YEAR OF
BIRTH ON AVERAGE DAILY GAIN

Effects studied	Least squares estimates	Adjusted mean	Standard error
Overall mean	0.515		0.016
Age of dam			
1. 1 year old	0.026	0.541	0.041
2. 2 year old	-0.009	0.506	0.017
3. 3 year old	0.012	0.526	0.016
4. 4 year old	0.020	0.535	0.017
5. 5 year old	0.001	0.516	0.017
6. 6 year old	0.018	0.533	0.017
7. 7 year old	-0.003	0.512	0.019
8. 8 year old	-0.012	0.502	0.022
9. 9 year old	-0.029	0.486	0.025
10. 10 year old	-0.025	0.490	0.040
Season of birth			
1. 304th day through 365th day	0.045	0.559	0.019
2. 1st day through 30th day	0.030	0.545	0.016
3. 31st day through 60th day	0.012	0.527	0.017
4. 61st day through 90th day	-0.021	0.493	0.018
5. 91st day through 303rd day	-0.066	0.448	0.026

TABLE IV (continued)

Effects studied	Least squares estimates	Adjusted mean	Standard error
Sex			
1. Female	-0.024	0.491	0.016
2. Male	0.024	0.537	0.016
Type of birth			
1. Single	0.031	0.546	0.008
2. Twin	-0.024	0.490	0.008
3. Triplet	-0.007	0.507	0.043
Type of birth and rearing			
1. Single reared as single	0.031	0.546	0.008
2. Twin reared as single	0.019	0.534	0.017
3. Twin reared as twin	-0.019	0.496	0.016
4. Triplet reared as single	0.006	0.520	0.057
5. Triplet reared as twin	-.0057	0.509	0.033
Years			
1. 1950	0.019	0.534	0.021
2. 1951	-0.000	0.514	0.019
3. 1952	0.025	0.540	0.019
4. 1953	0.033	0.548	0.020
5. 1954	-0.120	0.394	0.020
6. 1955	0.156	0.671	0.019

TABLE IV (continued)

Effects studied	Least squares estimates	Adjusted mean	Standard error
7. 1956	0.029	0.543	0.019
8. 1957	-0.050	0.465	0.019
9. 1958	0.030	0.544	0.022
10. 1959	-0.001	0.514	0.021
12. 1960	-0.005	0.509	0.020
13. 1961	0.023	0.538	0.020
14. 1962	0.002	0.516	0.020

there was a trend for average daily gain of lambs to increase through 6-year-old dams. Lambs born to 7 and 8-year-old dams gained at about the same rate, and lambs born to 9 and 10-year-old ewes decreased in their rate of gain. The average daily gains by age of dam groups are found in Table IV. One of the possible reasons for the lack of significant differences might be that this was a select group of purebred Hampshire sheep and they were maintained on a high level of nutrition.

The influence of season of birth on average daily gain was highly significant (Table III). The results as given in Table IV show that the lambs born during the period including the 1st day through the 30th day, 31st day through the 60th day, and the 304th day through the 365th day of the previous year had similar daily gains of 0.54, 0.53, and 0.56 pound, respectively. However, lambs born from the 61st day through the 90th day and the 91st day through the 303rd day only gained 0.49 pound per day and 0.45 pound per day. Table IV shows the above gains. The reason for a slower rate of gain for lambs born after the 61st day is not readily apparent but might be due to the effects of higher temperatures later in the season on lamb gains and possibly to greater infestation of internal parasites in late born lambs.

The differences in average daily gain due to type of birth were highly significant (Table III). The daily gains were 0.55 pound per day for singles, 0.49 pound per day for twins, and 0.51 pound per day for triplets. Thus, single lambs gained 0.06 pound per day faster than twins and 0.04 pound faster than triplets (Table IV). Only a small number of lambs born as triplets were available for use in the

study. Thus, this may be a poor estimate for triplets because of small sample size. Givens et al. (1960) observed similar differences. In their study they found singles gained 0.08 pound faster than twins with an estimated mean for singles of 0.572 pound per day. Karam et al. (1949) reported a 0.02 pound difference in average daily gain between singles and twins.

The sums of squares were partitioned for type of birth and rearing effects on average daily gain. Lambs gained 0.55 pound per day when born as singles and reared as singles, 0.53 pound per day when born as twins and reared as singles, 0.50 pound per day when born as twins and reared as twins, 0.52 pound per day when born as triplets and reared as singles, and 0.51 pound per day when born as triplets and reared as twins (Table IV). There was a significant difference between lambs born as twins and reared as twins compared to those born as twins and reared as singles (Table III). The results show that lambs born and reared as singles gained faster than any other type of birth and rearing combination. This might be expected since they are larger lambs at birth and this possibly enabled these lambs to utilize more milk from their dam and more creep feed and grass.

Highly significant differences for average daily gains were found among years (Table II). Daily gain during 1954 was much lower than that for any other year. An account cannot be given for this large variation. The other year differences were probably due to management, climatic, and genetic differences. Table IV shows the least squares estimates from the overall mean.

120-day weight. The difference due to the effect of sex on 120-day weight was highly significant (Table V). Least squares means showed that male lambs weighed 73.29 pounds and female lambs weighed 67.11 pounds at 120 days with a difference in favor of male lambs of 6.18 pounds (Table VI). Karam et al. (1949) found that male lambs were 3.5 pounds heavier at 25 weeks of age, and Hazel and Terrill (1945) reported that male lambs were 8.3 pounds heavier at weaning. The results obtained in this study of the effect of sex on 120-day weight is in agreement with results of work by Given et al. (1960), Brown et al. (1961), and Sabin and Brown (1962). Since the male lambs were heavier at birth and gained faster than ewe lambs, they were heavier at 120 days of age.

The age of dam effect on 120-day weights was significant (Table III). However, these differences did not follow a definite trend. This may be due to differences in subclass numbers. As shown in Table VI, lambs born to ewes from three years old through seven years old had approximately the same 120-day weights. The results do agree with Brown et al. (1961) who reported that lambs from mature inbred ewes (4, 5, 6 years old) were about 1 pound heavier at 120 days than lambs born to young ewes (2 and 3 years old).

The season of birth effects on 120-day weight of lambs was highly significant in this study (Table III). Least squares adjusted means for lambs born between the 304th day through the 365th day of the previous year, from the 1st day through the 30th day, from the 31st day through the 60th day, from the 61st day through the 90th day, and from the 91st

TABLE V
ANALYSIS OF VARIANCE FOR 120-DAY WEIGHTS

Source	Degrees of freedom	Mean squares	F
Age of dam	9	203.30	1.97*
Season of birth	4	636.43	6.18**
Sex	1	6500.62	65.10**
Type of birth	2	4649.91	45.14**
Twins reared as twins vs. twins reared as singles	1	1352.19	13.12**
Triplets reared as singles vs. triplets reared as twins	1	2.19	.0213
Years	12	1378.80	13.38**
Error	692	103.02	

*P < 0.05

**P < 0.01

TABLE VI

ADJUSTED MEANS AND LEAST SQUARES ESTIMATES OF THE EFFECTS OF
BIRTH, SEX, TYPE OF BIRTH, TYPE OF BIRTH AND REARING,
AND YEAR OF BIRTH ON 120-DAY WEIGHT

Effects studied	Least squares estimates	Adjusted mean	Standard error
Overall mean	70.20		2.00
Age of dam			
1. 1 year old	0.90	71.02	5.10
2. 2 year old	-1.45	68.74	2.07
3. 3 year old	1.47	71.68	2.00
4. 4 year old	2.53	72.73	2.10
5. 5 year old	0.57	70.77	2.09
6. 6 year old	2.80	73.00	2.14
7. 7 year old	0.20	70.40	2.33
8. 8 year old	-0.97	69.23	2.77
9. 9 year old	-2.90	67.30	3.08
10. 10 year old	-3.06	67.14	5.05
Season of birth			
1. 304th day through 365th day	4.82	75.02	2.35
2. 1st day through 30th day	3.47	73.67	2.02
3. 31st day through 60th day	1.55	71.75	2.08
4. 61st day through 90th day	-2.20	68.01	2.31
5. 91st day through 303rd day	-7.65	62.55	3.26

TABLE VI (continued)

Effects studied	Least squares estimates	Adjusted mean	Standard error
Sex			
1. Female	-3.09	67.11	2.04
2. Male	3.09	73.29	2.03
Type of birth			
1. Single	4.88	75.08	1.03
2. Twin	-3.31	66.89	1.10
3. Triplet	-1.57	68.63	5.44
Type of birth and rearing			
1. Single reared as single	4.88	75.08	1.03
2. Twin reared as single	2.28	72.48	2.14
3. Twin reared as twin	-2.28	67.92	2.04
4. Triplet reared as single	0.80	71.00	7.10
5. Triplet reared as twin	-0.80	69.40	4.17
Year			
1. 1950	2.46	72.66	2.59
2. 1951	0.06	70.26	2.39
3. 1952	2.49	72.69	2.36
4. 1953	4.73	74.93	2.52
5. 1954	-14.46	55.74	2.45
6. 1955	2.05	72.25	2.36

TABLE VI (continued)

Effects studied	Least squares estimates	Adjusted mean	Standard error
7. 1956	3.30	73.50	2.33
8. 1957	-5.81	64.39	2.40
9. 1958	3.40	73.60	2.72
10. 1959	-0.26	69.94	2.59
11. 1960	-0.60	69.60	2.48
12. 1961	2.97	73.17	2.50
13. 1962	-0.31	69.89	2.45

day through the 303rd day were 75.02, 73.67, 71.75, 68.01, and 62.55 pounds, respectively (Table VI). This shows a linear trend. Lambs born from the 304th day of the previous year to the 60th day of the current year were 8.20 pounds heavier than lambs born from the 61st day through the 303rd day of the current year.

The type of birth effects on 120-day weight of lambs were highly significant (Table V). Single lambs were 8.18 pounds heavier than twins and 6.45 pounds heavier than triplets at 120-days (Table VI). Since there was such a small number of lambs born as triplets, the 6.45 pounds may not be a good estimate for the difference between singles and triplets. This may partially account for the fact that triplets were heavier than twins. This agrees with work by Brown et al. (1961) and Sabin and Brown (1962). However, Givens et al. (1960) found that single lambs were 10.7 pounds heavier at 120 days than twin lambs.

The sums of squares were partitioned for the type of birth and rearing effects on 120-day weight. Lambs born as singles and reared as singles, born as twins and reared as singles, born as twins and reared as twins, born as triplets and reared as singles and born as triplets and reared as twins weighed 75.08, 72.48, 67.92, 71.00, and 69.40 pounds, respectively, at 120 days of age (Table VI). The analysis of variance showed that lambs born as twins and reared as twins were highly significantly different in 120-day weight from lambs born as twins and reared as singles (Table V).

Year effects on 120-day weight were highly significant (Table V).

Differences from one year to another were quite variable (Table VI) and probably reflect the effect of different nutritional, climatic and other factors affecting lamb weights from one year to another. These findings are in agreement with those reported by Sabin and Brown (1962).

Adjustment factor. Adjustment factors were calculated from adjusted means to correct birth weights, average daily gains, and 120-day weights of lambs for the effects of age of dam, season of birth, sex, type of birth, and type of birth and rearing. The following were used as standards in the calculation of these adjustment factors:

1. Age of dam - 6 years old
2. Season of birth - 1st day through the 30th day of the year.
3. Sex - male
4. Type of birth - single
5. Type of birth and rearing - single reared as a single.

Adjustment factors were not calculated for year of birth effects since the records of lambs would usually be compared on a within year basis. However, if the records of lambs born in different years were to be compared, it would be necessary to correct for this effect. Adjustment factors for the various effects are presented in Tables VII through XI.

Adjustment factors are necessary in order to eliminate as much environmental variation as possible in performance records of different animals. Use of adjustment factors permits correction of records so that selection in an actual breeding program becomes more accurate, and as a consequence animals with greater genetic merit are selected for

TABLE VII

ADJUSTMENT FACTORS FOR THE EFFECTS OF AGE OF DAM ON BIRTH
WEIGHT, AVERAGE DAILY GAIN, AND 120-DAY WEIGHT^a

Age of dam	Trait		
	Birth weight	Average daily gain	120-day weight
1 year old	1.38	.98	1.03
2 year old	1.20	1.05	1.06
3 year old	1.09	1.01	1.02
4 year old	1.06	1.00	1.00
5 year old	1.03	1.03	1.03
<u>6 year old</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
7 year old	1.02	1.04	1.04
8 year old	1.00	1.06	1.05
9 year old	1.03	1.10	1.08
10 year old	1.05	1.09	1.09

^aFor correction to a 6-year-old dam.

TABLE VIII

ADJUSTMENT FACTORS FOR THE EFFECTS OF SEASON
OF BIRTH ON BIRTH, WEIGHT, AVERAGE
DAILY GAIN, AND 120-DAY WEIGHT^a

Season of birth	Trait		
	Birth weight	Average daily gain	120-day weight
304th day through 365th day	1.10	.97	.98
1st day through 30th day	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
31st day through 60th day	1.00	1.03	1.03
61st day through 90th day	.98	1.10	1.08
91st day through 303rd day	1.12	1.21	1.18

^aFor correction to a January lamb.

TABLE IX

ADJUSTMENT FACTORS FOR THE EFFECTS OF SEX ON BIRTH WEIGHT,
AVERAGE DAILY GAIN, AND 120-DAY WEIGHT^a

Sex	Trait		
	Birth weight	Average daily gain	120-day weight ^a
Male	1.00	1.00	1.00
Female	1.05	1.10	1.09

^aFor correction to a male lamb.

TABLE X

ADJUSTMENT FACTORS FOR THE EFFECTS OF TYPE OF BIRTH
ON BIRTH WEIGHT, AVERAGE DAILY GAIN,
AND 120-DAY WEIGHT^a

Type of birth	Trait		
	Birth weight	Average daily gain	120-day weight
Single	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>
Twin	1.20	1.11	1.12
Triplet	1.26	1.08	1.09

^aFor correction to a single lamb.

TABLE XI
ADJUSTMENT FACTORS FOR THE EFFECTS OF TYPE OF BIRTH
AND REARING ON BIRTH WEIGHT, AVERAGE DAILY
GAIN, AND 120-DAY WEIGHT^a

Type of birth and rearing	Trait	
	Average daily gain	120-day weight
Born as a single and reared as a single	<u>1.00</u>	<u>1.00</u>
Born as twin and reared as single	<u>1.02</u>	<u>1.04</u>
Born as twin and reared as twin	1.10	1.10
Born as triplet and reared as single	1.05	1.06
Born as triplet and reared as twin	1.07	1.08

^aFor correction to a lamb born as a single and reared as a single.

breeding and propagation. This would bring about greater improvement in the traits concerned than selection based on unadjusted records.



CHAPTER V

SUMMARY AND CONCLUSIONS

Birth weight records for 1,009 purebred Hampshire lambs and average daily gain and 120-day weight records for 723 purebred Hampshire lambs were analyzed by least squares methods to determine the effects of age of dam, season of birth, sex, type of birth and year of birth on birth weight and the effects of age of dam, season of birth, sex, type of birth, type of birth and rearing, and year of birth on average daily gain and 120-day weight.

Age of dam influences on birth weight were highly significant. Lambs from ewes 3 through 9 years of age were 1.73 pounds to 2.20 pounds heavier at birth than lambs from 1-year-old ewes, 0.76 pound to 1.33 pounds heavier than lambs from 2-year-old ewes and 0.64 pound to 1.11 pounds heavier than lambs from 10-year-old ewes. There was a definite trend for birth weight to increase with age of dam up to 5 to 6 years of age and then remain relatively constant to about 9 years. Although differences due to age of dam effects were not significant, there was a tendency for average daily gain of lambs to increase with age of dam up to 6 years and then decline through 10 years of age. Age of dam significantly influenced 120-day weight of lambs. The 120-day weights of lambs from 3, 4, 5, and 6-year-old ewes were very similar. Lambs from 2, 7, 8, 9 and 10-year-old ewes were about 6, 4, 5, 8 and 9 per cent lighter than lambs from 6-year-old ewes, respectively.

The season of birth effects were highly significant for birth weight, average daily gain, and 120-day weight. Lambs born from the 1st day through the 90th day of the year (January, February, and March) were 0.83 pound heavier than lambs born from the 304th day through the 365th day of the previous year (November and December) and 0.95 pound heavier than lambs born from the 91st day through the 303rd day of the year (April through October). Lambs born from the 304th day of the previous year through the 60th day of the current year gained from 0.56 pound per day to 0.53 pound per day with lambs born from the 61st day through the 303rd day of the current year, gaining from 0.49 pound per day to 0.45 pound per day. The least squares adjusted mean for 120-weights were 75.02 pounds for a lamb that was born from the 304th day through the 365th day of the previous year, 73.67 pounds for lambs born the 1st day through the 30th day of the current year, 71.75 pounds for lambs born from the 31st day through the 60th day of the current year, 68.01 pounds for lambs born from the 61st day through the 90th day of the current year, and 62.55 pounds for lambs born from the 91st day through the 303rd day of the current year.

Sex was highly significant for birth weight, average daily gain and 120-day weight. Male lambs were 0.41 pound heavier at birth, gained 0.05 pound faster per day, and were 6.18 pounds heavier at 120-days than ewe lambs.

Type of birth was highly significant for birth weight, average daily gain, and 120-day weight. Single lambs were 1.58 pounds heavier at birth, gained 0.06 pound per day faster, and weighed 8.18 pounds

more at 120 days than twins. The difference between singles and triplets were 1.92 pounds, 0.04 pound per day, and 6.45 pounds, respectively.

Lambs born as singles and reared as singles had an average daily gain which was faster by 0.01 pound per day than twins reared as singles, 0.05 pound per day than twins reared as twins, 0.03 pound per day than triplets reared as singles and 0.04 pound per day than triplets reared as twins. Singles reared as singles were heavier at 120 days by 2.60 pounds than twins reared as singles, 7.16 pounds than twins reared as twins, 4.08 pounds than triplets reared as singles, and 5.68 pounds than triplets reared as twins. Lambs born as twins and reared as twins were highly significant in birth weight differences, average daily gain differences, and 120-day weight differences.

The year effects were highly significant for birth weight, average daily gain, and 120-day weight.

LITERATURE CITED



LITERATURE CITED

- Blackwell, R. L. and C. R. Henderson. 1955. Variation in Fleece Weight, and Birth Weight of Sheep Under Farm Conditions. J. Animal Sci. 14:831.
- Bogart, Ralph, R. C. DeBaca, Lyle D. Calvin, and O. M. Nelson. 1957. Factors Affecting the Birth Weight of Crossbred Lambs. J. Animal Sci. 16:130.
- ✓ Brown, C. J., C. A. Baugus and Samuel Sabin. 1961. Evaluation of Factors Affecting the Growth of Spring Lambs. Ark. Agr. Exp. Stat. Bul. 646.
- DeBaca, R. C., Ralph Bogart, Lyle D. Calvin, and O. M. Nelson. 1956. Factors Affecting Weaning Weights of Crossbred Spring Lambs. J. Animal Sci. 15:667.
- ✓ Felts, V. L., A. B. Chapman, and A. L. Pope. 1957. Estimates of Genetic and Phenotypic Parameters for Use in a Farm Flock Ewe Selection Index. J. Animal Sci. 16:1048.
- ✓ Givens, C. S., Jr., R. C. Carter, and J. A. Gaines. 1960. Selection Indexes for Weanling Traits in Spring Lambs. J. Animal Sci. 19:134.
- ✓ Harrington, R. B., J. V. Whiteman, and R. D. Morrison. 1958. Estimates of Some Sources of Variation in the Body Weights of Crossbred Lambs at Different Ages. J. Animal Sci. 17:743.
- Harvey, Walter R. 1960. Least Squares Analysis of Data with Unequal Subclass Numbers. U.S.D.A. ARS-20-8.
- Hazel, L. N. and C. E. Terrill. 1945. Effects of Some Environmental Factors on Weanling Traits of Range Rambouillet Rams. J. Animal Sci. 4:331.
- Hazel, L. N. and C. E. Terrill. 1946. Effects of Some Environmental Factors on the Weanling Traits of Range Columbia, Corriedale, and Targhee Lambs. J. Animal Sci. 5:318.
- 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.

Phillips, Ralph W. and W. M. Dawson. 1937. The Relation of Type and Time of Birth and Birth Weight of Lambs to their Survival, Growth, and Suitability for Breeding. Proc. Amer. Soc. Animal Prod. 296.

Sabin, S. W. and C. J. Brown. 1962. Analysis of Sale Weights and Growth Rates of Arkansas Milk Fat Spring Lambs. Ark. Exp. Stat. Report Series 104.



CRANESFEST CREST

APPENDIX

CRANESFEST CREST

DATA PUNCHED ON IBM CARDS FOR ANALYSES

<u>IBM Card Column Numbers</u>	<u>Data</u>	<u>Code No.</u>
1-2	Experiment No. 1	01
3-4	Location (Knoxville)	01
5-8	Lamb (flock) no. Use actual number: 2049 649	2049 0649
9-11	Birth Date Use day in year born Dec. 21 Jan. 7	355 007
12-13	Year Born Use actual year 1961 1962	61 62
14-15	Born alive or dead Born alive Born dead	01 02
16-17	Sex Female Male	01 02
18-20	Birth Weight Use actual birth weight 9.5 lbs. 12.5 lbs.	095 125
21-22	Type of birth Single Twin Triplet	01 02 03



DATA PUNCHED ON IBM CARDS FOR ANALYSES (continued)

<u>IBM Card Column Numbers</u>	<u>Data</u>	<u>Code No.</u>
23-25	Sex Combination (birth)	
	Female	001
	Male	002
	FF	011
	FM	012
	MM	022
	FFF	111
	MMM	222
	FFM	112
	FMM	122
26-27	Breed of Sire Hampshire	01
28-30	Sire Number Use actual number or code 690	690
31-32	Breed of Dam Hampshire	01
33-36	Dam Number Use actual number 2409 720	2409 0720
37-38	Year Dam was Born Use actual year born 1961 1962	61 62
39-40	Type of rearing Single Twin Triplet	01 02 03
41-43	Sex Combination (rearing) Female Male FF FM MM	001 002 011 012 022

DATA PUNCHED ON IBM CARDS FOR ANALYSES (continued)

<u>IBM Card Column Numbers</u>	<u>Data</u>	<u>Code No.</u>
	FFF	111
	MMM	222
	FFM	112
	FMM	122
44-46	Weaning Weight	
	Use actual weight	
	97 lbs.	097
	110 lbs.	110
47-49	Weaning Age	
	Use actual weaning age	
	119 days	119
	150 days	150
50-51	Av. daily gain	
	Use actual daily gain	
	.55 lbs.	55
	.90 lbs.	90
52-54	120-day weight	
	Use actual weight	
	91.3 lbs.	091
	101.6 lbs.	102
	Round off to nearest whole number	
55-57	Type score	
	Use actual score	
	11.0	110
	13.5	133
58-60	Condition score	
	Use actual score	
	11.0	110
	13.5	135
61-62	Data Complete	
	Complete data on lamb	01
	Incomplete data on lamb	02
63-64	Raised as (Sex)	
	Female	01
	Male	02
	Wether	03

DATA PUNCHED ON IBM CARDS FOR ANALYSES (continued)

The IBM 1620 computing machine was used to code this data for the following:

<u>IBM Card Column Numbers</u>	<u>Data</u>	<u>Code No.</u>
65-66	Combinations of type of birth plus types of rearing	
	Born as single and reared as a single	01
	Born as twin and reared as a twin	02
	Born as twin and reared as a twin	03
	Born as triplet and reared as a single	04
	Born as triplet and reared as a twin	05
67-68	Age of Dam	
	1 year old	01
	2 year old	02
	3 year old	03
	4 year old	04
	5 year old	05
	6 year old	06
	7 year old	07
	8 year old	08
	9 year old	09
	10 year old	10
69-70	Seasons of Birth	
	305th day through 365th day	01
	1st day through 30th day	02
	31st day through 60th day	03
	61st day through 90th day	04
	91st day through 303rd day	05
71-72	Year of Birth	
	1950	01
	1951	02
	1952	03
	1953	04
	1954	05
	1955	06
	1956	07
	1957	08
	1958	09
	1959	11
	1960	10
	1961	12
	1962	13