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Performance Studies With Suffolk Sheep

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Summary and Conclusions

An 18-year performance study with purebred Suffolk sheep was carried out to determine the value of certain performance tests and records as aids in selection to develop superior strains of sheep.

Performance tests included birth, weaning, and yearling weights; post-weaning feeding trials with ram lambs; and the relationship between ewe weight at different ages and seasons and her average annual production of lamb.

Year, sire, sex, and type of birth and rearing each had highly significant effects ($P \leq .01$) on birth, weaning and yearling weights. Effects of age of dam on birth and weaning weights were highly significant ($P \leq .01$). Yearling and 2-year-old ewes weaned the lightest lambs, followed by ewes 6 years old and older. Age at weaning had highly significant effects ($P \leq .01$) on weaning and yearling weight. Each day difference in weaning age meant an average .58 pound difference in weaning weight.

Except for sire factors, factors affecting the different weights could be considered environmental. Based upon the relative sizes of the mean squares, type of birth had the greatest effect on birth weight; sex, type of birth and rearing, and age at weaning had the greatest effect on weaning weight; and sex had the greatest effect on yearling weight.

The general trends in annual average adjusted birth, weaning, and yearling weights were all upward. Part of this could be credited to environmental changes, and part to selection of larger replacement rams and ewes. When weights were adjusted for year, sex,

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and type of birth and rearing, correlations between the different weights were all positive and highly significant ($P \leq .01$). These correlations were: birth with weaning, .359; birth with yearling, .321; and weaning with yearling, .504.

The average adjusted weights of rams were .7, 9.2 and 60.2 pounds more than for ewes at birth, weaning and yearling.

Correlations between ewe weight at different ages and seasons and her average annual pounds of lamb weaned were all positive, but relatively small. The three significant correlations were .228 ($P \leq .01$) for both the spring yearling and the fall 2-year-old weights and .146 ($P \leq .05$) for the spring 2-year-old weight.

The effect of year on daily rate of gain by ram lambs during the post-weaning feeding trials was highly significant ($P \leq .01$). Sire did not have a significant effect. The relationship between beginning weight and rate of gain was generally negative and in two trials was highly significant ($P \leq .01$).

These studies indicate that slow but positive progress can be made in increasing the size of lambs and yearlings by selecting the larger, growthier types of replacement stock. All weights used as a basis for selection should be adjusted for such important environmental effects as type of birth and rearing and age at weaning. Adjustment in lamb weights also should be made for sex and year when ewes are culled on the basis of lamb production.

A post-weaning feeding test with ram lambs did not yield data of value in selection because sire did not have a significant effect and because the smaller lambs outgained the larger ones.

Future studies of this type would benefit by having a stabilized flock for comparison and additional measures of size to supplement weight. These measures might include length of body and shoulder height.

Performance Studies With Suffolk Sheep

C. W. Hodgson and T. Donald Bell

For several years, swine and beef cattle producers have used performance testing programs to aid in selecting breeding animals. Now there is increased interest in applying similar procedures to sheep. For such a program to be effective, important hereditary effects upon productive traits should be determined, with adjustments made for environmental effects.

The influence of environmental factors upon the weaning weight of lambs has been studied by many investigators (Hazel and Terrill, 1946a and 1946b; Sidwell and Grandstaff, 1949; Blackwell and Henderson, 1955; Warwick et al., 1957; Bell et al., 1967; Ray and Smith, 1966; Bassett et al., 1967; Thrift and Whiteman, 1969). Most of these experiments showed that year, sex, type of birth and rearing, and weaning age had highly significant effects upon weaning weight. Male lambs were heavier than ewe lambs and lambs raised as singles were heavier than those raised as twins or triplets. In general, 2-year-old ewes weaned lambs significantly lighter than mature ewes up to 6 years or older.

Studies concerned with heritability estimates of economically important traits have produced variable results (Terrill and Hazel, 1943; Hazel and Terrill, 1945 and 1946c; Nelson and Venkatchalam, 1949; Blackwell and Henderson, 1955; Warwick and Cartwright, 1957; Harrington et al., 1962; Young et al., 1960a and 1960b; Shelton and Campbell, 1962; Singh and Rempel, 1967; Bassett et al., 1967; Voght et al., 1967; Shelton and Menzies, 1968). In general, however, genetic effects upon such traits as weaning weight and rate of gain were relatively small when compared with some environmental effects upon the same traits.

Experiments designed to study the relationship between ewe weight and average pounds of lamb weaned per head per year (affected by twinning as well as average weight per lamb) have generally shown a relatively low but significant positive correlation (Joseph, 1931; Terrill and Stoehr, 1942; Ruttle, 1958; Nichols and Whiteman, 1966; Ray and Smith, 1966). Hunt (1935) and Winters et al. (1946) found that heavier ewes produced more pounds of lamb per head but less per 100 pounds body weight than did lighter ewes.

An experiment to study systems of breeding sheep was started by the Idaho Experiment Station in 1952. The study was revised in

1961 and continued through 1969. Objectives of this experiment were: (a) to study methods of sheep improvement through breeding; (b) to obtain data to be used in developing selection indices, and (c) to develop superior and better adapted strains of sheep through selective breeding and record-of-performance testing.

One phase of the study involved the use of the purebred Suffolk flock located at the University of Idaho, Moscow. This phase is reported in this bulletin.

Materials and Methods

Approximately 75 registered Suffolk ewes were divided into single-ram breeding flocks. Each year the ewes were assigned to the different breeding flocks on a random basis, except that a conscientious effort was made to prevent close inbreeding. Three breeding flocks were maintained most years. After the breeding season, all ewes were run together to reduce environmental effects.

Over the years, 28 sires representing several flocks were used. Sires were selected by visual appraisal and line of breeding. Some replacement sires were raised and others were purchased. Replacement ewe lambs were produced within the flock and were selected primarily by visual appraisal, with some emphasis to pedigrees and to those lambs that were twins or triplets. Ewes were culled on the basis of health, soundness, and production records.

Considerations included in visual appraisal were overall size; ruggedness; length of body; breed and sex type; mutton conformation; balance; soundness of mouth, feet and legs, back and reproductive organs; and fleece.

Data recorded included birth, weaning, yearling, and mature weights; weaning and yearling conformation and condition scores; fleece grease weight, grade and staple length; type of birth and rearing, and notes of abnormalities, death losses, etc.

The ram lambs were placed on a post-weaning performance feeding test for approximately 56 to 84 days, depending upon the particular year. Before 1961, these lambs were group-fed by sire groups. After revision of the experiment in 1961, each sire group was randomly subdivided into two groups.

Experimental Results and Discussion

Results of these studies will be discussed under the following headings:

1. Factors affecting birth weight, weaning weight, and yearling weight.

2. Relationship between ewe weights and lamb production.

3. Performance feeding of ram lambs.

Factors affecting birth weight, weaning weight, and yearling weight

The effects of year, sire, sex, type of birth and rearing, age of dam, and age at weaning upon birth weight, weaning weight, and yearling weight are summarized in table 1. Except for age of dam on yearling weight, all of these effects were highly significant. (Of course, age at weaning could not affect the birth weight.) The size of the different mean squares gives an indication of the relative magnitude of the different effects. Type of birth had the greatest effect on birth weight.

Factors most affecting weaning weight were age, sex, and type of birth and rearing, and the factor most affecting yearling weight was sex.

Table 1. Factors affecting birth weight, weaning weight and yearling weight of Suffolks[1].

Source	Birth weight		Weaning weight		Yearling weight	
	D.F.	Mean sq.	D.F.	Mean sq.	D.F.	Mean sq.
Year	17	13.90**	17	1321.1**	16	2244.0**
Sire	22	19.10**	20	502.5**	17	853.0**
Sex	2	91.29**	1	30331.0**	1	596997.8**
Type birth and rearing	5	408.19**	5	12838.9**	4	2369.7**
Age of dam	4	103.07**	4	1458.7**	4	312.2
Age regr.			1	66496.9**	1	6233.0**
Error	1706	3.31	1493	162.2	752	410.3
Total	1756		1541		795	

[1] Least squares analyses (Harvey, 1960)
** Significant at 1% level.

Table 2. Code numbers and names of sires used in the study.

Code No.	Sire's name	Code No.	Sire's name
1	Texas	15	2738 (Pee Wee, son of 2194)
2	1243 (son of Texas)	16	2448
3	WPH 5387	17	Winkle
5	Wh. F.	18	3031
6	1572 (son of Texas)	20	3289 (son of Burger)
7	1773 (son of 1243)	21	Hubbard (Flanagan)
8	1715 (son of WPH 5387)	23	Warfield No. 1
10	Burger	24	4552 (son of Larsen)
12	2194 (son of 1572)	25	Warfield No. 2
13	Larsen	26	4993 (son of 4552)
14	2177 (son of 1773)	27	72 (son of Hubbard)
		28	Howland

Sire

Table 2 lists the code number and name of each sire used in the studies. Table 3 ranks these sires on the basis of the average birth weight, weaning weight, and yearling weight, respectively, of their offspring. These average weights were adjusted for all factors except sire.

Some sires—Nos. 28, 13, and 23—rated near the top in all three categories. No. 8 was relatively low in all three weights, while others such as No. 27 were fairly high in one or two but low in the others. Ram No. 28 was the outstanding sire in the study.

The two most important weights are the weaning and yearling weights. Rating high in birth and weaning weights but low in yearling weight might indicate a tendency to early maturity. This was exhibited by the offspring of sire No. 15.

Table 3. Rank of sires on basis of weight of offspring.[1]

Birth wt.		Weaning wt.		Yearling wt.	
Sire code no.	Mean wt.* of offspring	Sire code no.	Mean wt.* of offspring	Sire code no.	Mean wt.* of offspring
	lb.		lb.		lb.
28	12.55a	17	98.1a	28	204.2a
13	11.68 -b	15	95.2ab	2	198.8ab
23	11.15 -bc	28	95.1abc	13	193.6abc
15	11.14 -bc	10	94.3abcd	23	192.8abcd
17	10.96 -bcd	13	93.8abcde	1	192.0abcde
14	10.89 -bcde	14	91.4abcdef	21	189.0 -bcde
10	10.81 - -cdef	23	91.1 -bcdefg	26	188.8 -bcde
27	10.81 -bcdef	21	90.2 -bcdefg	17	187.3abcdef
24	10.75 -bcdef	12	88.8abcdefg	3	187.1abcdef
21	10.66 - -cdef	6	88.2 - -c - -fgh	10	186.9 -bcdef
25	10.65 - -cdef	2	87.2 -bc -efgh	25	186.7abcdef
26	10.36 - -cdef	20	86.8 - -c - -fgh	8	186.6abcdef
20	10.31 - -cdef	26	86.7 - - - - -fgh	6	185.5 -bcdef
3	10.10 - -cdef	3	86.5 -bc -efgh	14	183.5abcdef
7	9.94 - -cdef	1	86.1 - - - - -fgh	20	183.0 -bcdef
2	9.93 - -cdef	8	84.5 - - - - -fgh	24	182.9 -bcdef
8	9.74 - - - -ef	5	84.4 -bc -efgh	15	180.0 -b -def
6	9.71 - - - -e	25	84.4 - -c - -fgh	27	174.9 - - - - -f
1	9.64 - - -def	7	83.1 -bc -efgh		
5	9.54 - - - -e	24	82.8 - - - - -fgh		
12	8.57	27	80.5 - - - - -f -h		

[1] Duncan's Multiple Range Test (Harvey, 1960).

* Mean weights within categories with the same letter subscript are not significantly different from each other ($P \leq .05$).

Table 4. Average adjusted weights of Suffolk lambs by year (1952-1969).

	Birth weights	Weaning weights	Yearling weights
	(lb.)	(lb.)	(lb.)
1952	11.04	88	157.1
1953	10.15	78.3	153.1
1954	10.19	82	162.5
1955	10.39	82.4	166,8
1956	10.49	79.4	172.9
1957	10.19	77.3	175
1958	9.7	76.4	176.3
1959	9.43	84.4	181.8
1960	10.37	78.9	176.5
1961	10.30	84	197.1
1962	10.94	91.3	195.7
1963	10.81	97.5	
1964	10.42	84.6	201.6
1965	11.47	94.9	217.6
1966	11.80	101.2	223.9
1967	11.85	99.8	210.9
1968	12.06	109.3	224.1
1969	11.76	96.1	203.3

Year

Table 4 shows adjusted average birth, weaning, and yearling weights by year. Although there were up and down variations from year to year, the over-all trend was upward in all three categories. This indicates progress in increasing size of sheep in the flock. Some of this increase probably was due to environmental effects but some, undoubtedly, was the result of genetic factors. This was indicated particularly by the general increase in birth weight.

Table 5 shows the correlation between birth, weaning, and yearling weights and the percentage of variation in one weight account-

Table 5. Correlations between birth, weaning and yearling weights and the percent variation in one weight accounted for by the other. (All weights adjusted for year, sex, and type of birth and rearing.)

Weights correlated	Correlation*	Percent variation in one weight accounted for by the other
Birth with weaning	.359	12.9
Birth with yearling	.321	10.3
Weaning with yearling	.504	25.4

* Correlations of .101 or greater are highly significant ($P \leq .01$).

ed for by another. The correlations ran from .321 between birth and yearling weights to .504 between weaning and yearling weights. All were highly significant.

The fact that the correlations involved data adjusted for year, sex, and type of birth and rearing provides further evidence that part of the increase in average weights was due to heredity.

A relatively large part of the variation in yearling weight—25.4%—was accounted for by weaning weight. Birth weight accounted for only 12.9% of weaning weight variations and 10.3% of yearling weight variability.

Sex

Table 6 shows the average adjusted birth, weaning, and yearling weights for rams and ewes. Rams were .7, 9.2, and 60.2 pounds heavier than ewes in these categories. All of these weight differences were highly significant (table 1).

Type of birth and rearing

The overall effect of type of birth and rearing was highly significant on birth, weaning, and yearling weights (table 1).

Table 7 shows the average adjusted birth, weaning, and yearling weights for each type of birth and rearing. Lambs born and raised as singles were significantly heavier at birth and weaning than were those in the other groups. Second heaviest at weaning were lambs born as twins but raised as singles. The effects of type of birth and rearing tended to carry over to the yearling weights.

Table 6. Average adjusted birth, weaning and yearling weights by sex.

Sex	Average adjusted weight, lb.		
	Birth	Weaning	Yearling
Rams	10.4	92.7	218.1
Ewes	9.7	83.5	157.9
Difference	.7	9.2	60.2

Table 7. Average adjusted birth, weaning and yearling weights for each type of birth and rearing.

Type of birth and rearing	Average adjusted weight, lb.		
	Birth*	Weaning*	Yearling*
Born single, raised single	13.4a	101.3a	194.0a
Born twin, raised twin	11.5-b	86.3--c	187.0-b
Born twin, raised single	11.0--c	90.5-b	193.3ab
Born triplet, raised triplet	9.7---d	81.9--c	182.4-b
Born triplet, raised twin	9.8---d	81.2--c	183.3ab
Born triplet, raised single	9.0---d	87.4-bc	-----

* Weights with same letter subscript not significantly different ($P \leq .05$).

Table 8. Average adjusted birth, weaning and yearling weights on the basis of age of dam.

Age of dam	Average adjusted weight, lb.		
	Birth*	Weaning*	Yearling*
2 years & yearlings	9.9-b	85.1--c	186.4a
3 "	10.8a	88.4ab	187.5a
4 "	10.9a	89.9a	187.3a
5 "	11.2a	90.4a	188.2a
6 " & older	11.0a	86.7-bc	190.5a

* Weights with the same letter subscript are not significantly different ($P \leq .05$).

Table 9. Relationship between a ewe's weight at different ages and seasons and her average annual pounds of lamb weaned.

Ewe's age and season	Correlation of ewe's weight with lb. lamb weaned	Pound increase in lamb weight per lb. increase in ewe's weight	% of total variation in lamb production accounted for by ewe's weight
Weaning:	.070	.23	.50
Yearling:			
Spring	.228**	.41	5.20
Fall	.112	.14	.13
2-year-old:			
Spring	.146*	.21	2.10
Fall	.228**	.34	5.20
3-year-old:			
Spring	.060	.08	.36
Fall	.127	.16	1.62
4-year-old:			
Spring	.043	.05	.18
Fall	.130	.20	1.70
5-year-old:			
Spring	.016	.02	.03
Fall	.164	.19	2.60

* Significant at 5% level ** Significant at 1% level

Table 10. Year; number, average beginning weight and average daily gain of lambs; and the sires used for each test.

Test No.	Year	No. of lambs	Average beginning wt. (lb.)	Average daily gain (lb.)	Sires 1	2	3
I	1952-53	42	106.0	.52	T	1243	
II	1954	31	102.2	.75	T	1572	
III	1955	33	98.2	.65	1572	1715	1773
IV	1956	30	115.2	.56	1572	B	
V	1957	25	135.3	.47	B	L	2177
VI	1958-60	125	117.2	.55	B	L	P

Age of dam

The overall effect of age of dam on birth and weaning weights was highly significant but the effect upon yearling weight was not statistically significant (table 1).

Table 8 groups the average adjusted birth, weaning, and yearling weights according to the age of dam. At birth, lambs from 2-year-old ewes and yearling ewes (very few yearling ewes were represented) were significantly lighter than those from older ewes. At weaning, lambs from 2-year-olds and yearlings were still the lightest and those from 4- and 5-year-old ewes were heaviest. Weaning weights of lambs from ewes 6 years and older tended to be lighter than those from the 3, 4 and 5-year-old ewes, probably because some of the older ewes produced less milk.

Age at weaning

The age of lambs at weaning ranged from 97 days in 1968 to 141.9 days in 1957 with an overall average of 124.8 days. In general, the lambs were weaned at a younger age in the latter part of the experiment than in the earlier years. Since the lambs and ewes were run on non-irrigated pastures for a time before weaning, variation in weaning dates from year to year may have influenced the adjusted weaning weights. Possible influences were the different length of time on pasture and also a reduced milk flow in the ewes because of a longer lactation period and more advanced maturity of the forage. These conditions may have favored lambs weaned at a younger age when the weaning weights were adjusted to a standard weaning age.

The effect of each day difference in weaning age upon adjusted weaning weight was .58 pound (table 1). This was highly significant.

Ewe weight and average annual lamb production

Table 9 shows the correlation between ewe weight at different ages and seasons and her average annual pounds of lamb weaned, pounds variation in lamb production per pound ewe weight, and percent of total variation in lamb production accounted for by ewe's weight. The calculations include only those years when a ewe actually weaned at least one lamb. The weaning weight of each ewe was adjusted for age at weaning and type of rearing (single or twin). Her lamb weights were adjusted for age at weaning and sex.

Correlations between ewe weight and average annual pounds of lamb weaned ranged from .016 in the spring for 5-year-olds to .228 in the spring for yearlings and in the fall for 2-year-olds. The .228 correlations were highly significant. Correlation between spring 2-year-old weight and average annual lamb production, .146, was significant at the 5% level. None of the other correlations was statistically significant, although all were positive.

Pounds of increase in average annual lamb production per pound increase of ewe weight were .41, .34, and .21 for the spring yearling, fall 2-year-old, and spring 2-year-old weights, respectively.

Percentages of the total variation in average annual lamb production accounted for by ewe's weight are shown in the last column of the table. The two highest were associated with the spring yearling and the fall 2-year-old weights. Even these were relatively small, each accounting for only 5.2% of the total variation in average annual production of lamb.

This phase of the study indicates that each generation of selecting heavier ewes will produce only small increases in average annual production of lamb per ewe. However, correlations were all positive and this type of selection program should develop a superior producing strain over a period of several generations.

Table 11. Effect of sire upon daily rate of gain.*

Test No.	Year	Average daily gain by sire groups, lb. Sire 1	Sire 2	Sire 3
I	1952-53	.53	.51	
II	1954	.77	.72	
III	1955	.61	.68	.68
IV	1956	.58	.55	
V	1957	.45	.44	.51
VI	1958-60	.52	.56	.57

* Sire effect not statistically significant.

Table 12. Effect of year upon daily rate of gain.*

Test No.	Year	Average daily gain (lb.)
I	1952	.41b
	1953	.63a
VI	1958	.50b
	1959	.63a
	1960	.51b

* The means within a test with different letter suffixes are significantly different at the 1% level.

Table 13. Effect of beginning weight upon average daily gain.

Test No.	Year	Difference in rate of gain for each pound increase in beginning weight (lb.)
I	1952-53	-.00008
II	1954	-.00089
III	1955	-.00070
IV	1956	-.00062
V	1957	.00052
VI	1958-60	-.00185*

* Significant at 1% level.

Performance feeding of Suffolk ram lambs

Ram lambs were fed for approximately 56 or 84 days, depending upon the year, beginning a few weeks after weaning. The period from weaning to the start of feeding was not the same for all years.

The ration each year was 50% by weight of chopped or ground alfalfa hay and 50% concentrate. The concentrate portion was four parts by weight of steam-rolled barley, four parts steam-rolled oats, one part molasses dried beet pulp, one part wheat bran and one part linseed meal. The ration was not pelleted the first year, but was from then on. After a short adjustment period, lambs were fed all they would clean up twice daily. Salt and water were provided free-choice.

The data were analyzed by the least squares method (Harvey, 1960).

The results of this study are reported in two phases. Phase I covers the years 1952 through 1960 and Phase II covers 1961 through 1969. In Phase I, lambs were fed by sire groups. Each new set of sires was considered a separate test, regardless of the number of years involved.

Table 10 gives the number of lambs, average beginning weight and average daily gain of lambs, and the sires used in each test for Phase I. Values for average daily gain were adjusted for the effects of sire, beginning weight, and year, where more than one year was involved.

Sire effect, Phase I

Table 11 shows the effect of sire on average daily gain of the lambs. (See table 10 for identification of sires). In general, differences in average daily gain were small among the different sire groups within any given test. The sire effect was not significant in any of these tests.

Year effect, Phase I

The effect of year on average daily gain of lambs was studied in tests I and VI. In test I, average daily gains were .41 and .63 pound for 1952 and 1953 (table 12). Average daily gain by year in test VI ranged from .50 pound in 1958 to .63 pound in 1959. In both tests the effects of year on rate of gain were significant at the 1% level. The relatively low rate of gain in 1952 may have been caused partly by the non-pelleted ration.

Effect of beginning weight, Phase I

Table 13 shows the effect of beginning weight of lambs on average daily gain. In general, the relationship between beginning weight and average daily gain was small. In most tests, the lighter lambs gained faster. However, in test V the heavier lambs gained slightly faster. Only in test VI was the effect of beginning weight

statistically significant. This test produced an average .00185 pound decrease in daily gain for every pound increase in beginning weight.

In Phase II (1961—1969), each sire group was divided into two sub-groups for feeding. All data were analyzed together, rather than treating each new set of sires as a separate test, as in Phase I. There was some confounding of sire with year, but there was enough overlap of sires from year to year to make the analyses reliable.

The least-squares analyses (table 14) shows that the effects of year and beginning weight were highly significant and effects of sire and sire sub-groups were not significant.

Sire effect, Phase II

Table 15 shows average daily gains for lambs from each sire. Though least-squares analyses (table 14) showed effect of sire on average daily gain was not significant, Duncan's Multiple Range Test (Harvey, 1960) on sire means shows the means for sires 1 and 3 were significantly greater than for sire 11 (table 15). However, the overall conclusion is that sire did not have an important effect on rate of gain during the post-weaning feeding trial.

Table 14. Least squares analysis

Source	D.F.	Mean square
Years (A)	8	.181040**
Sires (S)	10	.017307
A x S	9	.015592
Pens: AS (Sire subgroups)	28	.009914
Initial weight regression	1	.286480**
Error	317	.015811

** Highly significant ($P \leq .01$).

Table 15. Number of lambs and average daily gain of lambs in each sire group.

Sire No.*	No. of lambs	Average daily gain (lb.)**
21	85	.603a
13	24	.595ab
20	34	.624a
17	5	.631ab
15	13	.634ab
23	22	.580ab
24	16	.571ab
25	66	.583ab
26	71	.553ab
27	19	.592ab
28	19	.492 -b

*See Table 2 for identification.

**The average daily gains with the same letter suffix are not significantly different ($P \leq .05$).

Table 16. Effect of year upon average daily gain made by lambs.

Year	Number of lambs	Average daily gain (lb.)*
1961	36	.573 -b
1962	35	.555 -b
1963	31	.581 -b
1964	23	.478 - -c
1965	35	.677a
1966	49	.526 -bc
1967	60	.680a
1968	45	.667a
1969	60	.547 -bc

* The average daily gains with the same letter suffix are not significantly different ($P \leq .05$).

Year effect, Phase II

Least-squares analyses (table 14) show the overall effect of year on average daily gain was highly significant. Duncan's Multiple Range Test (table 16) divides the years into three groups as far as average daily gain is concerned. Year 1965, 1967 and 1968 were significantly higher than the others, while 1964 was significantly lower than all except 1966 and 1969.

Effect of beginning weight, Phase II

Least-squares analyses (table 14) show the effect of beginning weight on average daily gain was highly significant. Regression analysis of the effect of beginning weight on average daily gain showed that for every pound increase in beginning weight, a lamb made .0163 pound less average daily gain. That is, the lighter lambs outgained the heavier ones. This agrees with results obtained by Williams (1969).

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