FACTORS INFLUENCING LENGTH OF GESTATION IN SHEEP

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INTRODUCTION

Each species of mammals has a characteristic gestation length. An individual in that species may, however, have a gestation length which varies from the normally expected pregnancy period. Like many other biological characteristics gestation length is affected by different factors, and is quite variable in a breed, although there is some semblance of a normal pattern.

The relationship of gestation length to other factors would be valuable information if it were possible to substantiate these relationships. Few analyses have been concerned with the effects of heredity and environment on the length of pregnancy in sheep. What influence different breeds of dam might have is a question. Within a breed, what effect might be expected from individual differences. The sire's influence through the heredity of the lamb is another unknown facet of this problem.

Nutritional differences would certainly be expected to cause differences in length of gestation. Workers have noted a slight influence of the sex of the fetus upon the period of time it is carried *in utero*. Seasonal influences would be expected to exert some influence. Other environmental fluctuations which might cause changes in length of gestation are certainly pertinent to the problem.

Numerous workers have noted the normal variation associated with gestation length of sheep, but, in comparison to cattle, few detailed analyses have been accomplished to determine where this variation occurs and how much the various factors involved affect the duration of pregnancy. The noticeable lack of literature pertaining to gestation length in sheep, coupled with the presence of a considerable quantity of data available for a statistical analysis of some of the factors influencing or associated with gestation length provides the incentive to study some variables in relation to duration of pregnancy.

LITERATURE REVIEW

Although there is an abundance of literature pertaining to the duration of pregnancy in cattle, few studies have been published for sheep. Domestic sheep have a gestation length which may vary normally from 138 to 157 days. Most breed averages vary from 144 to 152 days. It has been generally observed that mutton type breeds have shorter gestation lengths, with means within the range of 144 to 148 days, than do the fine wool breeds (Merino and Rambouillet) whose means may vary from 148 to 152 days. The long wool mutton type breeds such as the Lincoln have pregnancy periods intermediate in length, varying normally from 146 to 149 days in length.

Information concerning the factors which might cause length of gestation to vary is rather scant for sheep, but many studies have been conducted with cattle to determine the effect of the various hereditary and environmental factors.

Age of Dam

Terrill and Hazel (1947), after analyzing 2,499 gestation periods, concluded the age of the ewe was the most important non-hereditary source of variation in length of gestation. They calculated there was an average increase of twenty-seven hundredths (0.27) day for each advancing year of age. Earlier Terrill (1944) reported eight to nine-year-old ewes averaged nearly two days

longer in gestation than two to three-year-olds. Similar findings were noted and published by Daley and Eastoe (1943) who found slightly shorter gestation periods in two to four-year-old ewes than in older ewes. Using reciprocal egg transfers in Lincoln and Welsh ewes, in an attempt to study maternal environment, Dickinson et al. (1962) observed the average effect of the Lincoln maternal environment significantly increased gestation length by about two days in comparison with the Welsh maternal environment. They noted gestation length of Lincoln lambs in Welsh recipients was almost two days shorter than that of Welsh lambs in Lincoln recipients.

The analysis of results obtained from beef and dairy cattle records has resulted in contrasting conclusions. Numerous workers reported that age of dam did not significantly affect the length of gestation (Lasley et al, 1961; Davis et al., 1954; Copeland, 1930; Burris and Blunn, 1952; and McCandlish, 1922). Other investigators have, however, found differences ranging from one to three days between the mean gestation lengths of two-year-old dams and mature cows (Herman and Spalding, 1947; Knoop and Hayden, 1935; Knott, 1932). Herman and Spalding (1947) stated their data indicated a slight increase in gestation length for mature cows as compared to first and second-calf heifers. This was substantiated by Herman et al., (1953). An increase of approximately 1.5 days per gestation for each advancing gestation up to six years of age was reported by Knott (1932). Stallcup et al., (1956) noted similar figures when they reported length of pregnancy was increased by 1.6 and 1.5 days in Holsteins and Jerseys, respectively, in cows

five years and older as compared to two and three-year-old heifers. In an analysis by Knoop and Hayden (1935) two-year-old Holstein heifers carried calves 2.58 fewer days than did six-year-old cows. Also the gestation length of two-year-old Jersey heifers was 2.63 days shorter than that of six-year-old cows.

When considering the difference in gestation length it would seem pertinent to add other points of interest. Among these would be the statement by Knapp et al., (1940) who reported there was an apparent tendency for a particular cow to have a characteristic gestation period. Ineichen (1946) found that cows of the same age may differ in duration of pregnancy by 2.9 days with the heavier cows exceeding the lighter cows. There was also a tendency for the shortening of length of gestation to be frequently inherited by the daughters.

A reasonable explanation is available for the contradictory results presented. Since a statistical analysis was not employed in most of the earlier papers small mean differences would appear insignificant. Sample size in later studies would affect the possibility of obtaining significance.

Sex of Fetus As a Factor Affecting Gestation Length

Certain workers (McCandlish, 1922; McDowell et al., 1959) reported sex of fetus did not have a significant effect on gestation length, but most investigators with dairy cattle have reported a significant difference between male and female calves as to the length of time spent in utero. Workers have found sex of the lamb in sheep to be of no real consequence in influencing gestation

length (Terrill and Hazel, 1947; Carlyle and McConnell, 1902; and Bonfert, 1933). McKeown and MacMahon (1956) reported a small but non-significant difference in mean duration of pregnancy between males and females of the Suffolk and Romney Marsh breeds. Dickinson et al. (1962), using reciprocal egg transfers in ewes, reported an average sex difference in gestation length of 0.61 days which was not significant. In a later study, they found Lincoln and Welsh lambs transferred into a Blackface maternal environment differed little in average gestation length but males were carried about one day longer than were females.

Generally most investigators report a one day longer gestation period for male calves than for female calves. Burris and Blunn (1952), upon analyzing beef cattle gestation lengths noted the mean differences of the sexes was significant only for the Angus breed. Studying 351 Hereford calves, Lasley et al. (1961) reported bull calves were carried in utero an average of 0.8 days longer than heifer calves, but this difference did not contribute significantly to the variation. Knoop and Hayden (1935) found that 407 Jersey and Holstein male calves were carried an average of 278.85 days which was 1.19 days longer than 398 female calves of the same two breeds. Long et al. (1948) and Foote et al. (1959) observed that male calves were carried 1.3 days and 1.44 days, respectively, longer than female calves. In conjunction with the longer period by 1.3 days noted by Long et al. (1948), there was an increase in weight of male calves over the female calves by an average of 1.3 pounds.

Highly significant figures were reported by several other workers with regard to variation in duration of pregnancy as influenced by sex of the offspring. Rollins et al. (1956), from the records of 1353 gestation periods of 427 cows of an inbred Jersey herd, observed male calves were carried a highly significant period of two days longer than female calves. These results were very similar to those of Jafar et al. (1950) who noted that cows producing male calves had a gestation length of 1.97 days longer than those producing females. Brakel et al. (1952) found Jersey and Holstein males were carried a highly significant period of 0.77 days longer than females, but the other dairy breeds had mean differences that could have been attributable to chance alone. They pointed out that small mean differences may be misleading when samples are relatively small.

Influence of Breed

Early workers, after study of breeding records, reported average gestation lengths for some of the present day breeds of sheep. McKenzie and Phillips (1932) noted the following average gestation lengths for Hampshires, Shropshires, and Southdowns; 144.6, 144.6, and 143.7 days, respectively. These findings tend to substantiate results by Carlyle and McConnell (1902) which indicate that the more compact and quick maturing the breed the shorter the period of gestation and vice versa. Quinlan and Mare (1931) found the duration of pregnancy among 338 Merino ewes in South Africa varied from 142 to 156 days but the average duration might be considered to be 149 days. Daley and Eastoe (1943),

studying Dorset Horn, reported an average gestation length of 144.05 days. An analysis of 2,130 pregnancies of straight-bred Navajoes over a six-year period by Blunn (1943) resulted in the finding of an average duration of gestation of 149.4 days. In a comparison of the mean differences of two breeds, Kelley (1943) reported the mean length of all gestation periods recorded for Merino ewes was significantly greater than that for Dorset Horn ewes. Terrill and Hazel (1947), studied the gestation length of four breeds, Rambouillets, Columbias, Targhees and Corriedales, and noted differences in means were significant except for that between Targhees and Corriedales.

McCandlish (1922), in an investigation which included all the major dairy breeds except Brown Swiss, reported breed of dam had no significant influence on gestation length. Much evidence has since been reported which indicates breed is a contributing factor to differences in gestation length. Rife et al. (1943) reported a difference of 16.2 days longer pregnancy period for Hereford cows carrying Hereford calves (289.0 days) as compared to Angus cows carrying Angus calves (272.8 days). They observed that dams carrying crossbred calves show gestation periods intermediate between the purebreds, regardless of which way the cross was made (281.4 days). These results with crossbreds indicate that duration of pregnancy depends more on the genotype of the fetus than upon that of the dam (Rife et al., 1943). Long et al. (1948) also reported that crossbred calves have an intermediate gestation period. Gerlaugh et al. (1951) noted crossbred calves from Hereford and Angus reciprocal crosses had an intermediate

length of gestation, which they stated indicated additive gene action with very little heterosis. McDowell et al. (1959), using first generation crosses of Red Sindhi bulls on Jersey cows, found each 25 percent of Sindhi inheritance increased gestation length approximately three days. This additive genetic conclusion was hypothesized when it was noted gestation length varied directly with the degree of Red Sindhi inheritance carried by the offspring.

Studies involving breeds other than Hereford and Angus or both dairy and beef cattle have illustrated further that breed may be of major importance in influencing duration of gestation. Burris and Blunn (1952) found that differences of the Angus, Hereford and Shorthorn breeds in average gestation length were highly significant. Livesay and Bee (1945) found average gestation length for three dairy breeds (Jersey, Holstein and Aryshire) was a highly significant period of 5.8 days shorter than the average gestation period for two beef breeds (Hereford and Angus).

Inter-Sire Differences

Knott (1932) early recognized the possibility of paternal influence on the duration of gestation. This was substantiated by Rife et al. (1943), who, as a result of crossbreeding Angus and Herefords, concluded the sire was of utmost importance in determining the duration of pregnancy because, irrespective of the breed of sire, the mean gestation lengths of the crossbred progeny were almost intermediate between those of their parents. Bonadonna and Valerani (1946) and Alexander (1950) reported marked

differences between sire groups as to the period progeny spent *in utero*. Burris and Blunn (1952) reported, however, that while a few sires seemed to have considerable effect on the gestation length, the analysis showed that within breeds sire effects were not significant. These results deviated from those of McDowell *et al.* (1959), and Lasley *et al.* (1961). Both groups reported highly significant differences between sire groups within breeds. Brakel *et al.* (1952) reported that inter-sire difference was not significant in the Aryshire breeds.

Terrill and Hazel (1947) observed from comparing the variance between sires with the variance within sires that there is certainly more similarity in the gestation periods of ewes mated to the same sires than would have been expected by chance alone. They found that after adjusting for the effects of inbreeding, it appeared that between thirty and forty percent of the variance in length of gestation period could be attributed to hereditary factors which had direct effects upon the lambs.

Kelley (1943) noted that when Merino ewes were mated to Merino rams, breed of sire had a significant effect. Chittenden and Walker (1936) mated 1,472 grade Rambouillet ewes to Hampshire and Rambouillet rams and found gestation lengths averaged two days less for Hampshire bred ewes as compared to ewes bred to Rambouillet rams.

Influence of Multiple Birth

Although Vasin (1940) noted in swine that the greater the litter size the shorter the gestation period, this relationship

has no significance in sheep. Both Kelley (1943) and Terrill and Hazel (1947) reported that twin births did not significantly decrease the duration of pregnancy. Kelley (1943) noted a weighted mean difference of only 0.3 days between periods preceding single and multiple births. Terrill and Hazel (1947) did note, however, that single lambs averaged 0.6 days longer *in utero* than twin lambs.

Gestation lengths for twin calves may range an average of four to nine days less than similar periods for singly-born offspring. Herman and Spalding (1947) observed that twins (29 pairs) had an average gestation length of 271.56 days as compared to 279.4 days in 1957 pregnancies resulting in singles. Similar results were obtained by Knott (1932) who noted a difference of 4.4 days less time spent *in utero* for 86 twins as compared to single births. Gestations terminating with the birth of twins were shorter in length by 9.6 days for Holsteins and 4.1 days for Jerseys (Stallcup *et al.*, 1956). Ineichen (1946) found pregnancy in Swiss Brown averaged 291.46 days for 1599 male calves, 290.22 days for female calves, 286.2 days for 30 male twin pairs, 285.0 days for 56 mixed twin pairs and 283.0 days for 34 female twin pairs, resulting in an overall average of 284.75 days for 120 twin pairs versus 290.85 days for 3226 single calves. Brakel *et al.* (1952) reported gestations preceding the birth of twins, in which at least one of each pair was alive at birth, averaged 3.4 days less than gestations terminated by single births.

Seasonal Effects

In most instances, the studies concerning the seasonal

difference in gestation length indicate winter freshening cows have the shortest gestation (Alexander, 1950; Herman et al., 1953). The mean differences reported by these investigators range for 0.8 to 3 days. Ineichen (1946), whose study included 3,105 gestations, found that the gestations terminated by spring births were longest and that the shortest gestations preceded the autumn births. As might be expected, many workers (Lasley et al., 1961; Dessousky and Rakha, 1961; Rollins et al., 1956; and Jafar et al., 1950) have reported there was no difference due to seasonal effects.

Terrill and Hazel (1947) noted that ewes bred early in the season tended to have greater gestation lengths than those bred late in the season. The average decrease of .03 day in length of gestation with the progress of each day in the breeding season was highly significant.

The seasonal increase in gestation length was attributed by Ineichen (1946) to the difference in environmental influences, such as a lack of green feed, sunlight and exercise during the winter season, and to the seasonal difference in the frequency of using sires. In the bovine, the so-called seasonal effect is apparently confounded with other variables not wholly related to season.

The evidence presented in the literature indicates the length of gestation is strongly influenced by the heredity as well as environment of the lamb. Terrill and Hazel (1947) calculated that at least 30-40 percent of the variance in duration of pregnancy could be attributed to hereditary factors, indicating

gestation length could be altered fairly rapidly by selection if such were desired. The statement by Vasin (1940) that gestation length was influenced equally by the sire and dam, and therefore, could be reduced or prolonged by selection is in agreement with the preceding conclusion.

EXPERIMENTAL PROCEDURE

A flock of 200 grade Rambouillet and 1/4 Panama - 3/4 Rambouillet ewes were purchased in April and May 1955 and placed at the Fort Reno Agricultural Experiment Station. These same ewes have been maintained since their original purchase. Only those ewes which developed defects or unsoundnesses were culled. These ewes have been bred each year to purebred Dorset rams purchased from purebred sheep breeders in Oklahoma. In only one year, 1961, were rams of another breed used in addition to Dorsets. Thirteen such matings to two Hampshire rams are, therefore, included in this study.

The breeding and lambing records of the original 200 ewes were used to study the influence of some natural variables on length of gestation. The data were collected over a period of eight years from 1955 to 1962. A total of 906 gestation periods from these ewes constitutes the data to be analyzed to test factors which might cause variation from the normal duration of pregnancy.

Ewe lambs from the Rambouillet and 1/4 Panama - 3/4 Rambouillet ewes mated to purebred Dorset rams were kept for replacements starting with the fall of 1957 lamb crop. These 1/2 Dorset ewes were bred to Dorset, Hampshire, Suffolk, and Rambouillet rams during the years 1960, 1961 and 1962 to test breed of sire effects

on length of gestation by analysis of variance techniques. Mating records for 306 resultant pregnancy periods were used in this analysis.

The breeding season has changed only slightly since the project was originated. In 1955 and 1956, breeding began on or after May 20th and lasted for forty-eight days. In 1957 matings began on June 1st and were continued for thirty-two days. From 1958 to 1962 breeding has started May 20th and lasted for approximately forty days. If the ewes do not conceive they are rebred to lamb in January. In this study only those gestation periods which occurred during the summer months were used for analysis. The ewes were managed according to the usual practice of the commercial sheep breeders in Oklahoma. They were bred on pasture in the spring and remained on pasture through the summer months until six weeks before lambing. At this time a supplemental feeding of 1/2 to 3/4 lb. of grain was provided daily until parturition.

The length of gestation refers to that period of time from the day of mating to the day of lambing. The rams were turned with the ewes only at night. Each male was equipped with a marking harness to detect mountings. All mating records which were questionable were excluded from the study. Also excluded were matings which resulted in the production of triplet offspring. The large number of observations available made it possible to eliminate gestation lengths which were apparently the result of an error in the mating records. All unusually long or short gestation lengths were removed from the analysis. This refers to

gestation periods shorter than 140 days and longer than 158 days, where conception apparently occurred at an earlier or later estrual period. The rams on the breed of sire study were rotated every other night. One night white faced rams were used, and the following night black faced rams were placed in the mating pens. It became necessary to exclude matings when a ewe conceived to both a white-faced and a black-faced ram on successive nights.

Because of confounding of age of dam and year effects, it was necessary to analyze that data on a within year basis. The analysis of variance technique for any number of groups with unequal numbers of observations described by Steel and Torrie (1960) was used to test the differences between the mean values obtained for length of gestation.

The correlation between adjusted lifetime body weight and average gestation length was calculated. An average gestation length was calculated only for those ewes which had three terminal pregnancy periods resulting in the birth of live offspring. The adjusted body weight was a lifetime body weight which had been corrected for a constant condition score by regression analysis.

RESULTS AND DISCUSSION

Length of gestation, as previously defined, was calculated to be that period beginning with the day of fertile service and terminated with the day of birth of a live offspring. All gestation estimates were tested for significance by the analysis of variance technique described by Steel and Torrie (1960). The standard deviations of the gestation lengths in table 2 were determined by the use of the formula $s = \sqrt{\frac{s_x^2}{N - 1}}$. Standard errors were computed by the formula $s/\sqrt{n}$.

The data reported in table 1 indicates that as the ewe becomes older there is a yearly increase in the duration of pregnancy. Because age of dam was confounded with year effects it was not possible to ascertain whether this increase in age of ewe was a significant contributing environmental factor to the increase in length of gestation. Apparently age of dam is of some major consequence because year effects was found to be a highly significant variable contributing to differences in length of gestation (table 15). Since year effects would be somewhat erratic, it appears the gradual tendency for gestation length to become longer is due mainly to the effect of age of dam.

The regression of average gestation length on age of dam

TABLE 1

LENGTH OF GESTATION AS AFFECTED BY AGE OF EWE

Breed of Ewe	Age of Ewe at Breeding							
	1	2	3	4	5	6	7	8
1/4 Pan.-3/4 Ramb.								
Ave. Length	143.09	144.98	145.15	146.43	146.46	146.59	147.66	147.69
Number	44	67	66	72	69	61	35	32
Rambouillet								
Ave. Length	144.29	145.57	146.60	147.29	146.74	147.35	148.60	147.52
Number	63	79	62	73	66	62	30	25
Mean								
Ave. Length	143.79	145.30	145.85	146.86	146.60	146.98	148.09	148.05
Number	107	146	128	145	135	123	65	57

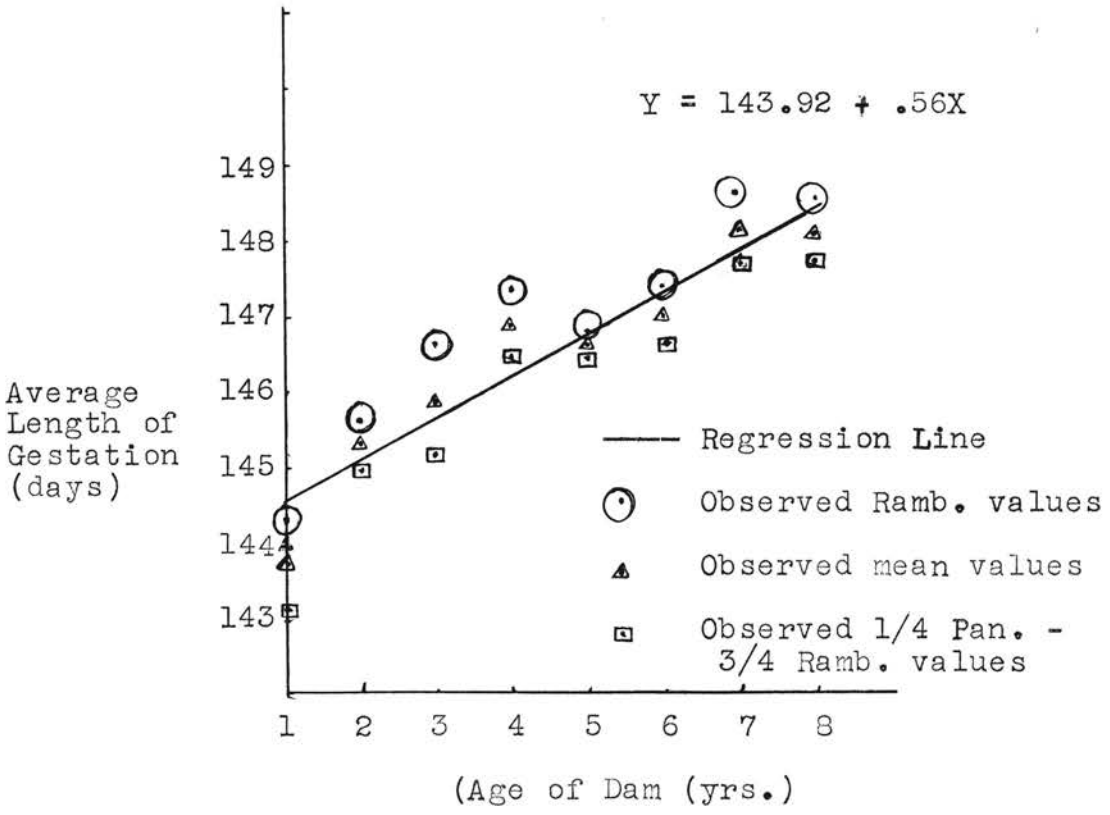

Figure 1. Regression of Average Gestation Length on Age of Dam.

(figure 1), illustrated as age of dam increases one year, the average gestation length increases 0.56 days. The use of linear regression may not be completely applicable, but it does provide a method of testing an increase in one variable against that of another variable. The same linear increase would in all probability not be expected to occur between one and two-year-old ewes as that between five and six-year-old ewes.

The effects of year differences are plainly illustrated when the observed values associated with the two breed groups and the mean of the two breeds are also plotted (figure 1). Until 1959 there had been a linear increase in gestation length. The reason for the deviations seen in the following years is not known, but conditions shortened the duration of pregnancy. Except for two years, 1959 and 1962, when the ewes were five and eight years of age, respectively, gestation length in the Rambouillet ewes increased at the rate of almost one day per gestation period. The same statement would be essentially true for the 1/4 Panama - 3/4 Rambouillet ewes.

The results obtained in this study are comparable to those reported in the literature. The yearly increase of 0.56 day is greater than that of 0.2 day reported by Terrill and Hazel (1947). The increase in duration of pregnancy was also noted by Terrill (1944) and Daley and Eastoe (1943). The studies of both groups substantiated the findings of an average increase of nearly three days in gestation length in eight-year-old ewes as compared to the two-year-old ewes.

The average gestation length and its standard deviation was obtained for each breed, and these values are expressed in table 2. The Rambouillet ewes averaged almost one day longer than the 1/4 Panama - 3/4 Rambouillet ewes over the period of years during which the records were collected.

TABLE 2

AVERAGE LENGTH OF GESTATION AND STANDARD DEVIATION IN TWO BREEDS

Breed	Average	Standard Deviation
1/4 Panama - 3/4 Ramb.	145.77 ± .12	2.35
Rambouillet	146.46 ± .12	2.54
Mean	146.12 ± .08	2.47

The standard deviation value of 2.47 for the two breeds combined is very similar to that of Lush (1945), who reported a standard deviation for all sheep of 2.4 days. Both breeds of ewes had remarkably uniform gestation periods as shown by standard deviations of 2.35 and 2.54 for the 1/4 Panama - 3/4 Rambouillet and Rambouillet breeds, respectively.

The average gestation length for the Rambouillet breed of 146.46 days differed from that reported by Chittenden and Walker (1936), who observed an average of 149.64 days for 1,472 grade Rambouillet ewes. The ewes in this study were bred primarily to Dorset rams while those of Chittenden and Walker (1936) were bred to Hampshire and Rambouillet rams. This factor could

serve as a very plausible explanation for the differences in the observed gestation lengths, since the use of larger type rams has been shown to increase the length of gestation (Carlyle and McConnell, 1902).

Analysis of variance within years revealed that breed of dam is a significant factor in influencing the period of time the offspring are carried. These results are presented in the appendix tables 7 to 15 inclusive. In a majority of the analyses it was found to be of real importance, but this significant influence was not noted in all years. In all probability the lack of significance for breed of dam was associated with the decrease in degrees of freedom in the analysis of variance (tables 14 and 15). Fewer observations in the latter years of the study decreased the probability of detecting significant differences, since the test may not have been critical enough to find small differences which may have been present.

The fact that two Hampshire rams were used in 1961 in addition to the Dorset rams made no apparent difference. Breed of sire means expressed in table 6 indicate that ewes mated to either Hampshire or Dorset rams have similar gestation lengths. The average associated with ewes bred to Hampshire rams was 146.47 days as compared to 146.14 days for ewes mated to Dorset rams. Analysis of variance, table 13 in the appendix, leads to the conclusion that this variable did not contribute significantly to differences in gestation length for the year 1961 when the ewes were seven years of age.

Another important factor, known to influence cattle

gestations by as much as two days, is the sex of the fetus. Mean values with their associated standard errors as reported in table 3, indicates average gestation length for male single lambs is only slightly longer than that for female single lambs.

TABLE 3

LENGTH OF GESTATION AS AFFECTED BY SEX OF SINGLE LAMBS

Breed	Male Singles	Female Singles	Mean
1/4 Panama - 3/4 Ramb.	145.97 ± .20	145.68 ± .18	145.82 ± .13
Rambouillet	146.50 ± .22	146.22 ± .24	146.37 ± .16
Average	146.24 ± .15	145.92 ± .15	146.09 ± .10

Analysis of variance (tables 7-15) reveals the environmental factor of sex of the single fetus does not contribute significantly to differences in length of gestations. Although mean differences indicate males are carried 0.3 day longer than females the difference is small enough it could be due to chance occurrence. The difference was not statistically significant. These results are in agreement with those reported in the literature. Essentially all workers have reported the sex of a single fetus does not influence gestation length to any significant degree (Terrill and Hazel, 1947; McKeown and MacMahon, 1956).

A comparison of the mean gestation lengths associated with single and twin-born lambs is an illustration of the effects the birth of twins may have on gestation length. Table 4 indicates that there is little if any difference in length of time carried for twin or single lambs. This is in contrast to the reports of different groups studying dairy cattle who observed twin calves have gestation lengths ranging an average of four to nine days less than similar periods for singly born offspring.

TABLE 4

COMPARISON OF THE MEAN GESTATION LENGTHS OF SINGLE AND TWIN-BORN OFFSPRING

Breed of Dam	Singles	Twins	Average
1/4 Panama - 3/4 Ramb.	145.82 ± .13	145.67 ± .23	145.77 ± .12
Rambouillet	146.37 ± .16	146.62 ± .18	146.46 ± .12
Average	146.09 ± .10	146.19 ± .15	146.12 ± .08

The birth of twin lambs as compared to single lambs did not significantly influence the duration of pregnancy as shown by analysis of variance within years. When the within year values were pooled, it was again noted that whether pregnancy was terminated by the birth of single or twin lambs did not significantly influence the length of the period the offspring were carried (table 15). For the most part, these results are

in agreement with those of Kelley (1943) and Terrill and Hazel (1947). They reported twin births did not significantly decrease the duration of pregnancy in sheep as it seemingly does in cattle. Kelley (1943) found a weighted mean difference of only 0.3 days between periods preceding single and multiple births. Single lambs were found to average 0.6 days longer *in utero* than twins (Terrill and Hazel, 1947).

A comparison of the different types of multiple births was made to determine if any one set of twins deviated from that of the others. Basically the gestation lengths of male twins, female twins and a set of twins where both a male and female offspring are produced do not generally have largely deviating periods of time spent *in utero* (table 5).

While the gestation period of 1/4 Panama - 3/4 Rambouillet male twins averaged 0.8 day longer than the female and mixed set of twins, this difference did not contribute significantly to the variation in gestation lengths. The Rambouillet twin groups had almost identical mean gestation lengths.

TABLE 5

LENGTH OF GESTATION AS AFFECTED BY SEX OF MULTIPLE BIRTHS

Breed of Dam	Male Twins	Female Twins	Male and Female Twins
1/4 Panama - 3/4 Ramb.	146.60 ± .42	145.43 ± .42	145.41 ± .33
Rambouillet	146.44 ± .30	146.60 ± .29	146.75 ± .33
Mean	146.51 ± .24	146.08 ± .25	146.09 ± .24

Only for the within year variance for 1955 (table 7) was it noted that male twins' gestation lengths deviated significantly from that of female twins. In all other years, the variable of sex of multiple offspring was not a significant influencing factor on the differences of length of gestation associated with these two breed groups of mature grade ewes.

However, when the within year values were pooled in table 15, pregnancies which terminated with the birth of male twins as compared to those terminating with the birth of female twins were significantly different in duration. Table 5 presents figures which indicate that male twins are carried slightly longer than female twins.

The influence of breed of sire on gestation length was tested using three different age groups of two types of crossbred ewes produced by the 200 ewes purchased originally to begin the project. One group was the result of a Dorset X Rambouillet cross while the other was ewes produced by Dorset X (Rambouillet X Panama-Rambouillet) matings. These ewes were mated to Dorset, Hampshire, Rambouillet, and Suffolk rams. The results obtained are presented in table 6.

The means and standard errors reported in table 6 indicated that ewes mated to Dorset, Suffolk, and Hampshire rams had almost identical gestation lengths over a period of three mating seasons. The same breed groups of ewes when mated to Rambouillet rams, however, had gestation periods averaging one day longer than when mated to the other breeds of rams. The difference of one day longer associated with the Rambouillet rams is

TABLE 6

LENGTH OF GESTATION AS AFFECTED BY BREED OF SIRE

Breed of Dam	Breed of Sire							
	Dorset		Hampshire		Suffolk		Rambouillet	
	Sire Groups	Average Length	Sire Groups	Average Length	Sire Groups	Average Length	Sire Groups	Average Length
Dorset X RPR	15	146.02 ± .27	6	146.11 ± 25	3	145.67 ± .65	4	147.67 ± .40
Dorset X Ramb	15	146.28 ± .28	6	146.88 ± .49	3	146.78 ± .37	4	147.78 ± .39
Average	15	146.14 ± .19	6	146.47 ± .28	3	146.22 ± .38	4	147.72 ± .27

particularly significant when it is noted they were mated to the youngest age group of ewes the first year of the study (1960). The youngest age group would be expected to have the shortest mean gestation length as was illustrated in table 1. The two-year-old ewes had an average gestation length of 145.30 days in comparison to an average gestation length of 148.09 days for the seven-year-old ewes.

The preceding differences between Rambouillet males and other breeds of sires agree with those of Chittenden and Walker (1936). They noted Rambouillet ewes mated to Hampshire rams had a two day shorter gestation length than when mated to Rambouillet rams.

Analysis of variance techniques (tables 16, 17, and 18) were used to test the significance of the variable breed of sire. They revealed it was a significant contributing factor only in the year of 1960 (table 16). These findings are difficult to explain because in this year only the Rambouillet rams were bred to the youngest ewes, and it would be expected that the means would be more alike. The smallest differences would be more likely to appear this year than any other.

In 1961 and 1962 the rams were more randomly assigned. As a consequence all age groups were mated to all four breeds of rams. Analysis of variance for these two years leads to the conclusion breed of sire did not significantly influence length of gestation (tables 17, 18).

The mean values obtained in the breed of sire analysis are subject to some controversy. The mean value associated with

the Dorset rams is probably a true estimate of the gestation length of crossbred 1/2 Dorset ewes, when mated to purebred Dorsets, because with 15 sire groups the breed has been at least fairly sampled. However, the mean values of the other breeds of sires may not be representative, because the number of sire groups is small. The mean values could be criticized because the other breeds were poorly sampled. Therefore, any sire which causes a ewe to have an unusually long or short gestation period will bias the mean value up or down readily because the number of sire groups is so small. This may not be a true sample of the sires in a breed.

When age of dam was partitioned out in the analysis of variance it was found to be a significant contributing factor only in the 1962 mating season. The same was true of the factor breed of dam. These results are presented in table 18.

To test for a possible relationship between body weight and gestation length, average body weight was computed for all of the 200 Rambouillet and 1/4 Panama - 3/4 Rambouillet ewes which had not been culled by the end of the 1961 lambing season. As discussed previously the average body weight was determined by regression analysis while correcting for a constant condition score. An average gestation length was also calculated for each ewe which had completed three or more successful gestation periods. All ewes which had lambed only twice or less were dropped from the analysis. The correlation between average body weight and average gestation length was then computed. The

value of -.11 was obtained for the correlation between average gestation length and unadjusted average body weight. The correlation between adjusted average body weight and average gestation length was -.026. These two values were both non-significant, indicating there is little if any correlation between average body weight and average gestation length.

SUMMARY

An analysis of existing data was initiated to study some of the naturally occurring variables which influence duration of pregnancy in sheep. The gestation periods, 906 observations in all, were drawn from breeding and lambing records collected over an eight year period from 1955 through 1962. The ewes involved were 200 grade Rambouillet and grade 1/4 Panama - 3/4 Rambouillet ewes purchased as yearlings in 1955 and mated to purebred Dorset rams except in 1961 when thirteen matings by two Hampshire rams were included in the study. Analysis of variance techniques were employed to test the effect of the variables, breed of dam, type of birth, sex of lamb, and breed of sire on gestation length.

Because age of dam was confounded with year, it was impossible to test this variable with analysis of variance. However, the table of means indicated a fairly linear relationship between age of dam and average gestation length. This was further exhibited by the regression analysis of average gestation length on age of dam. It was found that for an increase of one year in age there was an increase in average gestation length of 0.56 days.

Breed of dam, for the most part, was found to contribute significantly to differences in length of gestation. The

Rambouillet ewes averaged nearly one day longer for 435 pregnancies than did 414 pregnancy periods in 1/4 Panama - 3/4 Rambouillet ewes. The standard deviation for the two combined breed groups was 2.47.

Sex of single lambs and the occurrence of multiple birth did not significantly influence the duration of pregnancy. Male singles were carried 0.3 days longer than females. The different types of multiple births varied only slightly and non-significantly in their mean differences. The analysis of variance table with the values pooled across years indicated the effect of having male twins versus female twins is a significant variable.

The correlation of average gestation length to adjusted average body weight and unadjusted average body weight were -.026 and -.11, respectively. These negative, non-significant values indicated little if any relationship between the two variables.

An analysis was also computed to test the effect of breed of sire on gestation length. Dorset, Rambouillet, Hampshire, and Suffolk rams were mated to replacement lambs produced by Dorset males mated to Rambouillet and 1/4 Panama - 3/4 Rambouillet ewes.

Breed of sire was a significant variable only one year. Breed means indicated the Dorset, Hampshire, and Suffolk rams affected gestation length in the dams similarly, while ewes mated to Rambouillet rams averaged one day longer in length of time the fetus is carried <u>in utero</u>.

LITERATURE CITED

Alexander, M. H. 1950. Length of gestation in the five major breeds of dairy cattle. J. Dairy Sci. 33:377 (Abstr.).

Blunn, C. T. 1943. Characteristics and production of old-type Navajo sheep. J. Heredity. 34:141.

Bonadonna, T. and L. Valerani. 1946. Investigations and observations on the fertility of several Lombardy herds. Zootec. e Vet. 1:129. An. Breed. Abstr. 15:174.

Bonfert, A. 1933. Contribution to the study of the sexual life of sheep. Bulet. Asoc. Gen. Med. Vet. Romania 45:215. An. Breed. Abstr. 2:114.

Brakel, W. J., D. C. Rife and S. M. Salisbury. 1952. Factors associated with the duration of gestation in dairy cattle. J. Dairy Sci. 35:179.

Burris, M. J. and C. J. Blunn. 1952. Some factors affecting gestation length and birth weight of beef cattle. J. Animal Sci. 11:34.

Carlyle, W. L. and T. F. McConnell. 1902. Some observations on sheep breeding from the experiment station flock records. Wis. Agr. Exp. Sta. Bul. 95.

Chittenden, D. W. and A. H. Walker. 1936. The rate of breeding and lambing and the length of gestation period of range ewes. Proc. Am. Soc. Animal Prod. 29:232.

Copeland, L. 1930. Length of gestations in Jersey cows. J. Dairy Sci. 13:257.

Daley, C. J. and R. Eastoe. 1943. Breeding habits of the Dorset Horn. The gestation period and the occurrence of multiple births. Agr. Gaz. of New South Wales. 54:75.

Davis, H. P., M. Plum and B. Brost. 1954. Studies of herd management records. II. Relation of gestation length to birth weight of Holstein calves of both sexes at various calvings. J. Dairy Sci. 37:162.

Dessouky, F. I. and A. H. Rakha. 1961. Studies on the gestation period and postpartum heat of Friesian cattle. J. Agr. Sci. 57:325.

Dickinson, A. G., J. L. Hancock, G. J. R. Hovell, St. C. S. Taylor and G. Wiener. 1962. The size of lambs at birth--a study involving egg transfer. An. Prod. 4:64.

Foote, W. D., W. J. Tyler and L. E. Casida. 1959. Effect of some genetic and maternal environmental variations on birth weight and gestation length in Holstein cattle. J. Dairy Sci. 42:305.

Gerlaugh, P., L. E. Kunkle and D. C. Rife. 1951. Crossbreeding beef cattle. Ohio Agr. Exp. Sta. Res. Bul. 703:9.

Herman, H. A. and R. W. Spalding. 1947. A study of factors affecting the length of gestation in dairy cattle. J. Dairy Sci. 30:545.

Herman, H. A., R. W. Spalding and K. W. Bower. 1953. Factors affecting length of gestation period in dairy cattle. Mo. Agr. Exp. Sta. Bul. 529.

Ineichen, B. 1946. Relations between gestation period and internal and external factors in a breeding herd of Swiss Brown cattle. Dissertation, Vet. Med. Fak., Univ. Zurich, An. Breed. Abstr. 16:222.

Jafar, S. M., A. B. Chapman and L. E. Casida. 1950. Causes of variation in length of gestation dairy cattle. J. Animal Sci. 9:593.

Kelley, R. B. 1943. The length of gestation preceding single and multiple births in sheep. Australian Vet. J. 19:43.

Knapp, B. Jr., W. V. Lambert and W. H. Black. 1940. Factors influencing length of gestation and birth weight in cattle. J. Agr. Res. 61:277.

Knoop, C. E. and C. C. Hayden. 1935. A study of the gestation length and service record of dairy cows. Ohio Agr. Exp. Sta. Bimon. Bul. 19:8.

Knott, J. C. 1932. A study of the gestation period of Holstein-Friesian cows. J. Dairy Sci. 15:87.

Lasley, J. F., B. N. Day and J. E. Comfort. 1961. Some genetic aspects of gestation length, and birth and weaning weights in Hereford cattle. J. Animal Sci. 20:737.

Livesay, E. A. and U. G. Bee. 1945. A study of the gestation periods of five breeds of cattle. J. Animal Sci. 4:13.

Long, J. F., P. Gerlaugh and D. C. Rife. 1948. A genetic study of gestation in cattle. Genetics 38:618. (Abstr.).

Lush, J. L. 1945. Animal Breeding Plans. Collegiate Press, Ames, Iowa. Third Edition.

McCandlish, A. C. 1922. Studies in the growth and nutrition of dairy calves. J. Dairy Sci. 5:301.

McDowell, R. E., J. L. Fletcher and J. C. Johnson. 1959. Gestation length, birth weight and age at first calving of crossbred cattle with varying amounts of Red Sindhi and Jersey breeding. J. Animal Sci. 18:1430.

McKenzie, F. F. and R. W. Phillips. 1932. The period of gestation in the ewe. Mo. Agr. Exp. Sta. Bul. 310:17.

McKeown, T. and B. MacMahon. 1956. Sex differences in length of gestation in mammals. J. Endocr. 13:309.

Quinlan, J. and G. S. Mare. 1931. The physiological changes in the ovary of Merino sheep in South Africa and their practical application in breeding. Seventeenth Rep. Direct. Vet. Serv. and Anim. Indust. Union of S. Africa. 663-703. Cited by Terrill and Hazel, 1947.

Rife, D. C., P. Gerlaugh, L. Kunkle, G. W. Brandt, and L. H. Snyder. 1943. Comparative lengths of the gestation periods of Aberdeen-Angus and Hereford cows carrying purebred and crossbred calves. J. Animal Sci. 2:50.

Rollins, W. C., R. C. Laben and S. W. Mead. 1956. Gestation length in an inbred Jersey herd. J. Dairy Sci. 39:1578.

Stallcup, D. T., O. H. Horton and C. J. Brown. 1956. The duration of gestation in dairy cattle. Ark. Agr. Exp. Sta. Bul. 576.

Steel, R. G. D. and J. H. Torrie. 1960. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York.

Terrill, C. E. 1944. The gestation period of range sheep. J. Animal Sci. 3:434.

Terrill, C. and L. N. Hazel. 1947. Length of gestation in range sheep. Am. J. Vet. Res. 8:66.

Vasin, R. N. 1940. Variability and inheritance of the duration of embryonic development. Trud. Inst. Genet. 13:155. An. Breed. Abstr. 10:142.

APPENDIX

TABLE 7

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1955)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	37.00	4.57**
Type of Birth	4	12.66	1.56
S vs T[a]	(1)	12.73	1.57
MS vs FS[b]	(1)	.03	
MT vs FT[c]	(1)	26.07	3.22*
M-FT vs MT-FT[d]	(1)	11.79	1.46
Error	101	8.09	

[a]Singles vs twins
[b]Male singles vs female singles
[c]Male twins vs female twins
[d]Mixed sex twins vs single sexed twins
** $P < .05$
* $P < .10$

TABLE 8

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1956)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	12.35	3.74*
Type of Birth	4	1.72	
S vs T	(1)	2.92	
MS vs FS	(1)	1.53	
MT vs FT	(1)	2.29	
M-FT vs MT-FT	(1)	.12	
Error	140	3.30	

* $P < .10$

TABLE 9

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1957)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	66.78	17.08**
Type of Birth	4	4.64	1.19
S vs T[a]	(1)	3.27	
MS vs FS	(1)	10.90	2.79
MT vs FT	(1)	4.22	1.08
M-FT vs MT-FT	(1)	.18	
Error	122	3.91	

** $P < .01$

TABLE 10

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1958)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	26.62	5.25*
Type of Birth	4	8.12	1.60
S vs T[a]	(1)	8.87	1.75
MS vs FS	(1)	15.87	3.13
MT vs FT	(1)	7.70	1.52
M-FT vs MT-FT	(1)	.04	
Error	139	5.07	

[a] See Table 7

* $P < .025$

TABLE 11

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1959)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	2.62	1.08
Type of Birth	4	4.39	1.65
S vs T[a]	(1)	6.67	1.10
MS vs FS	(1)	4.44	1.46
MT vs FT	(1)	5.92	
M-FT vs MT-FT	(1)	.55	
Error	129	4.05	

TABLE 12

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1960)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	17.98	4.00*
Type of Birth	4	1.87	
S vs T[a]	(1)	2.27	
MS vs FS	(1)	.64	
MT vs FT	(1)	.34	
M-FT vs MT-FT	(1)	4.23	
Error	117	4.49	

[a]See Table 7
* $P < .05$

TABLE 13

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1961)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	14.36	3.83
Breed of Sire	1	4.45	1.18
Type of Birth	4	1.71	
S vs T[a]	(1)	.94	
MS vs FS	(1)	1.69	
MT vs FT	(1)	.55	
M-FT vs MT vs FT	(1)	3.65	
Error	58	3.75	

TABLE 14

ANALYSIS OF VARIANCE FOR LENGTH OF GESTATION (1962)

Source	Degrees of Freedom	Mean Square	F (ratio)
Breed of Dam	1	9.72	2.95
Type of Birth	4	1.72	
S vs T[a]	(1)	.72	
MS vs FS	(1)	1.36	
MT vs FT	(1)	1.09	
M-FT vs MT-FT	(1)	3.69	1.12
Error	51	3.30	

[a]See Table 7

TABLE 15

ANALYSIS OF VARIANCE TO TEST THE POOLED FACTORS AFFECTING GESTATION LENGTH

Source	Degrees of Freedom	Mean Square	F (ratio)
Years	6	189.93	58.80**
Breed of Dam	7	25.39	7.86**
Type of Birth	28	5.02	1.55
S vs T[a]	(7)	5.38	1.66
MS vs FS	(7)	5.01	1.55
MT vs FT	(7)	6.73	2.08*
M-FT vs MT-FT	(7)	2.94	
Error	801	3.23	

[a]See Table 7
** P < .005
* P < .05

TABLE 16

ANALYSIS OF VARIANCE TO TEST BREED OF SIRE (1960)

Source	Degree of Freedom	Mean Square	F (ratio)
Breed of Dam	1	.56	
Age of Dam	2	2.64	
Breed of Sire	3	12.28	4.26**
Type of Birth	4	1.42	
Error	74	2.88	

** P < .01

TABLE 17

ANALYSIS OF VARIANCE TO TEST BREED OF SIRE (1961)

Source	Degree of Freedom	Mean Square	F (ratio)
Breed of Dam	1	1.51	
Age of Dam	2	1.86	
Breed of Sire	3	12.69	2.67
Type of Birth	4	9.58	2.02
Error	53	4.75	

TABLE 18

ANALYSIS OF VARIANCE TO TEST BREED OF SIRE (1962)

Source	Degree of Freedom	Mean Square	F (ratio)
Breed of Dam	1	23.66	7.73**
Age of Dam	2	12.12	3.96*
Breed of Sire	3	4.41	1.44
Type of Birth	4	.66	1.44
Error	49	3.06	

** P < .01
* P < .05

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