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To the Graduate Council:

I am submitting herewith a thesis written by Radhi K. Abdallah entitled "Statistical Analysis of Birth Weight in Awassi Sheep in Iraq." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

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STATISTICAL ANALYSIS OF BIRTH WEIGHT IN AWASSI SHEEP IN IRAQ

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee

Radhi K. Abdallah

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ABSTRACT

In the Awassi flock raised at the Hammam Al-Alil Experiment Station, Mosul University, Iraq, 336 single and 62 twin births were recorded over the years 1968-1972. The environmental factors, year of birth, sex of lamb, age of dam, weight of dam, month and type of birth were assessed with respect to their influence on birth weight, and repeatability of birth weight was estimated.

Month of birth, sex of lamb, type of birth and weight of dam were highly significant effects ($P < .01$). However, in this study, year of birth appeared to have less significant ($0.1 < P < 0.25$) influence on birth weight of lambs since all lambs were born in the same season of each year and feeding and management were quite similar in all years.

The phenotypic correlation between birth weight of lamb and weight of dam was 0.32, and repeatability of birth weight as a trait of the dam was estimated to be 0.23.

The results provide a good illustration of the general level of management and environment prevailing in the ewe flock, with birth weight as indicator.

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CHAPTER I

INTRODUCTION

It has been reported in the literature that lamb birth weight has a positive relationship with subsequent weights, and estimates of heritability of this trait average about 0.25. Thus, selection based on birth weight should be effective. However, both induced and natural environmental factors operate to conceal differences in genetic merit, confusing the breeder and obstructing his efforts to select lambs having the greatest breeding value. Birth weight of lamb is known to be influenced by some non-genetic sources of variation. Factors known to predominate in determining variation in this trait are year of birth, sex of lamb, age and weight of dam and type and month of birth.

Intraclass correlation has been advanced by Lush (1945) as an expression of repeatability. It measures the extent to which the individual animal approaches having the same performance over successive measurements of a trait, and it tests the degree to which individuals will show the same relative ranks in performance for a trait measured at different times. Therefore, the estimate of repeatability provides information on the importance of permanent differences, both genetic and environmental, relative to total variation. It is thus useful for predicting the increase in lifetime production which can be achieved through early selection and also in deciding whether such selection should be based on one record or on the mean of several. It should be stressed that predictions from repeatability

refer only to lifetime production in the current flock and give no information about the relative value of individual records or means of records for predicting production in the next generation. Such predictions involve consideration of heritability rather than repeatability.

This study was undertaken to evaluate some environmental factors affecting birth weight of Awassi lambs, to estimate the repeatability of birth weight (as a trait of the dam) from adjusted data and also to calculate the phenotypic correlation between birth weight of lamb and weight of dam after parturition.

CHAPTER II

LITERATURE REVIEW

I. ENVIRONMENTAL FACTORS AFFECTING BIRTH WEIGHT

Effect of Year of Birth

It has been stated in the literature many times that year of birth had an influence on birth weight of lambs. Bogart *et al*. (1957) reported that the environmental conditions which differ from year to year affected birth weight of lambs.

Blackwell and Henderson (1955), Eloksh *et al*. (1962), Sidwell *et al*. (1964), Smith and Lidvall (1964), Eltawil *et al*. (1970), Sidwell and Miller (1971) and Chopra and Acharya (1971) observed a highly significant effect of year of lambing on birth weight of lambs.

One exception was the study of Cassard and Weir (1956) in which it was found that there was no effect of year of birth on birth weight of Suffolk lambs. Webb (1963) found that season of birth significantly affected birth weight of Hampshire lambs in Tennessee. Eltawil (1965) reported that year of birth could affect many lamb traits at birth, including birth weight, through the amount of feed their dams are able to get, amount of rain and management practices.

McLaren *et al*. (1968) found that differences in average birth weight between years were highly significant. They observed that lambs born in 1957 were the heaviest (9.1 lb) at birth and the lambs born in 1954 were the lightest (7.8 lb). These differences result from variation in management, level of feeding and general health of

the ewes. Fahmy et al. (1969) also observed that lambs born in the first season of the years 1961-62 and the last season of the years 1965-66 were significantly heavier than lambs born in the other three seasons studied. However, Dass and Acharya (1970) found a nonsignificant effect of year of birth. They concluded that this was due to lambs being born in the same season in all years and that conditions of management and the feeding procedures for the pregnant ewes were more or less the same in all years. Juma and Faraj (1966) found a highly significant effect of year on birth weight of Awassi lambs. They further stated that the fluctuation in birth weight observed between years may be due to changes in environmental conditions, especially feed. Eliya (1969) also found a highly significant effect of year of lambing on birth weight of lambs, reporting that the birth weights were 10.54 lb, 9.97 lb and 10.36 lb in 1966, 1967 and 1968, respectively. Ghoneim et al. (1973) found that year of birth had a highly significant effect on birth weight. Kazzal (1973), using similar data from the same flock, found that year of birth had a significant ($P < .01$) effect on birth weight. Many other workers have reported similar results with respect to the effect of year of birth (Ali, 1952; Harrington et al., 1958; Karm, 1959; Gjedrem, 1967; Srinivasan, 1969; and Vesely and Robinson, 1970).

Effect of Sex

It is generally agreed that males in different breeds of sheep are born heavier than females. Such effect of sex on birth weight has been reported by some workers to be significant (Gregory et al.,

1950; Santiago and Neto, 1954; Belic and Ognjanovic, 1955; Jakubec, 1959; Karm, 1959; Frederiksen et al., 1967; and Chopra and Acharya, 1971).

The effect of sex on birth weight was studied also by Nelson and Venkatachalam (1949) in a study of five breeds. They found that a significant portion of the variation in birth weight of lambs was due to sex differences. In the same study they found also that females weighed 5 percent less than males at birth. Ali (1952) found that male lambs were 0.05 pound heavier than female lambs. Blackwell and Henderson (1955), in an analysis of the birth weight of 2,186 lambs kept under farm flock conditions, found that males exceeded females by 0.54 pound at birth. Starke et al. (1958), working with Merino and Blackhead Persian sheep, observed a difference of 5.1 percent, with male lambs heavier at birth than female lambs. Bichard and Cooper (1966) reported also that males are about 5 percent heavier than females. Dalton (1962) observed in Welsh mountain sheep a difference of 0.5 lb in birth weight between male and female lambs.

Sidwell et al. (1964), studying data from Hampshire, Shropshire, Southdown and Merino breeds of sheep, found that males were heavier at birth by 0.51 lb than females. Frederiksen et al. (1967) studied effects of environmental factors on Rambouillet lambs and showed that the ram lambs were significantly heavier than ewe lambs in birth weight. McLaren et al. (1968) reported a difference of 0.61 pounds in favor of males. Fahmy et al. (1969) reported that male lambs were 69 grams heavier at birth than females in Hungarian Merino sheep. Dass and Acharya (1970) found in Bikaneri sheep that male lambs were,

on the average, 0.18 kg heavier than female lambs at birth. Eltwail et al. (1970) stated that sex difference in three analyses was responsible for 1.6, 3.5 and 27.9 percent of total variability in birth weight of Navajo lambs. In a study of some pure breeds and crosses, Sidwell and Miller (1971) found that in all of them, sex had a significant effect on the traits studied and found that males were heavier by 0.26 kg than females at birth. In Bikaneri sheep, Chopra and Acharya (1971) found the effect of sex on birth weight to be significant ($P < .01$). Slight differences between the two sexes in birth weight were reported in Shropshire, Suffolk and crossbred lambs by many other workers (Sojetado, 1952; Cassard and Weir, 1956 and Bogart et al., 1957). Ghoneim et al. (1957) made a detailed study of the growth of lambs of the Ossimi and Rahmani breeds. Birth weights (kg) of males and females were 3.3 and 3.0 and 3.5 and 3.4 kg for Ossimi and Rahmani breeds, respectively. In this case, as in all others, males were significantly heavier at birth than females.

Asker (1964) found birth weight of Awassi lambs in Iraq to be not appreciably affected by sex, male lambs and female lambs weighing 9.8 and 9.5 lb, respectively. Juma and Faraj (1966) indicated that the average weight advantage of single male lambs over single female lambs was 0.23 lb ($P < .01$), and twin males were 0.69 lb heavier at birth than twin females ($P < 0.01$). Eliya (1969) also studied the effect of sex on birth weight of Awassi lambs and, showed that single male lambs were born heavier than single female lambs at the three locations studied. Twin male lambs on one farm were heavier at birth than twin female lambs and, on the average overall, male lambs were

heavier by 0.52 lb ($P < .01$) than female lambs at birth. Ghoneim *et al*. (1973) reported also that male lambs were heavier by 0.16 kg, at birth than females ($P < .01$). Kazzal (1973) observed that the effect of sex of lamb on birth weight was significant ($P < .01$). The average birth weights of the Awassi lambs in his study were 4.56 and 4.32 kg for male and female lambs, respectively, with a difference of 0.24 kg in favor of male lambs.

A number of other workers have reported similar results with respect to sex influence. Karam *et al*. (1949), Harrington *et al*. (1958), Brown *et al*. (1961), Webb (1963), Datta *et al*. (1963), Smith and Lidvall (1964), Sabin and Brown (1969) and Vesely and Robinson (1970) found no significant difference in weight between males and females at birth.

Effect of Type of Birth

Type of birth has an influence on birth weight of lambs. Phillips and Dawson (1937) found that single lambs were heavier at birth than twins. Ali (1952) reported that single lambs exceeded twins by 1.75 pounds at birth. A difference of 1.85 pounds between singles and twins in favor of singles was obtained by Blackwell and Henderson (1955). Nelson and Venkatchalam (1949), Starke *et al*. (1958) and Bichard and Cooper (1966) found that single lambs were, respectively, 22 percent, 16 percent and 20 percent heavier at birth than twin lambs. The effect of type of birth on birth weight has been found by several other workers to be significant (Karam *et al*., 1949; Domanski, 1954; Belic and Ognjanovic, 1955; Cassard and Weir, 1956;

Neville et al., 1958; Jakubec, 1959; Eltawil et al., 1970; Sidwell and Miller, 1971 and Gould and Whiteman, 1971).

Many other workers have observed the same influences of type of birth on birth weight in various breeds (Santiago and Neto, 1954; Palian, 1957; Karm, 1959; Sidwell et al., 1964 and Frederiksen et al., 1967). Ray and Smith (1956), studying birth weight of lambs, showed that twin lambs weighed 0.76 kg less than single lambs at birth. Bogart et al. (1957) stated that singles were from 1.92 to 2.40 lb heavier at birth than were twins. Smith and Lidvall (1964) found that single lambs were 1.58 lb heavier than twins at birth. Datta et al. (1963) reported also that single lambs were heavier than twins. The respective weights of singles and twins were 4.12 and 3.43 kg. McLaren et al. (1968) found that lambs born as singles were 1.1 lb heavier ($P < .01$) than lambs born as twins in different breeds. Labban and Radwan (1969) found also that single lambs were 0.43 kg heavier than twin lambs at birth. Fahmy et al. (1969) reported also that single lambs were about half a kilogram heavier than twins in Hungarian merino sheep.

In Awassi sheep, Asker (1964) found that single lambs and twin lambs weighed 10.1 and 8.9 pounds, respectively. Juma and Faraj (1966) studying the same breed, reported also that type of birth affected birth weights significantly ($P < 0.01$), single male and single female lambs being 1.1 lb heavier at birth than twin male and female lambs. Eliya (1969) found also that single lambs were heavier by 1.97 lb than twin lambs. Ghoneim et al. (1973) stated that lambs born as singles were heavier at birth by 0.80 kg ($P < .01$) than twins.

Kazzal (1973) found also that single Awassi lambs were 0.62 kg heavier at birth than twins. Similar results with respect to effect of type of birth on birth weight were obtained by many other researchers (Asker et al., 1952; Ragab et al., 1953; Srinivasan, 1969; Trail and Sacker, 1969).

Effect of Age of Dam

Age of dam has been reported by many workers as an important factor influencing birth weight of lambs (Belic and Ognjanovic, 1955; Blackwell and Henderson, 1955; Goreckii et al., 1958; Narayan et al., 1959; Datta et al., 1963; Smith and Lidvall, 1964; Sidwell et al., 1964; Frederiksen et al., 1967 and McLaren et al., 1968). They found that growing ewes produced smaller lambs at birth than did adult ewes. Kincaid (1943) reported that an average annual increase of 0.63 lb in birth weight of crossbred lambs was attained as ewes increased in age from 2 to 6 years. Nelson and Venkatchalam (1949) stated that age of dam significantly affected birth weight of five breeds of sheep at Michigan State College. They reported further that lambs from mature ewes were 10 percent heavier than lambs from two-year-old ewes. Ali (1952) reported that lambs from mature ewes were 0.67 pounds heavier than those of young ewes. Many research workers have reported significant differences due to effect of age of dam on birth weight (Brown et al., 1961; Bennett et al., 1963; Webb, 1963; Gjedrem, 1967; Srinivasan, 1969; Vessly and Robinson, 1970 and Eltawil et al., 1970). Frederiksen et al. (1967) found that lambs from mature dams were heavier at birth than lambs from two-year-old dams. Cassard and

Weir (1956), in a single exceptional report, indicated that age of dam had no effect on birth weight of Suffolk lambs, but Ray and Smith (1966), Karm (1959) and Dalton (1962) reported that lambs from mature ewes were heavier than lambs from two-year-old ewes.

Bichard and Cooper (1966) observed that lambs from one-year-old dams were 25 percent lighter than lambs from mature ewes, and those from two-year-old dams were 10 percent lighter than lambs from mature ewes. Sidwell and Miller (1971) reported that age of dam had a highly significant ($P < .01$) effect on birth weight; however, mature ewes had lambs which were only slightly heavier than lambs from ewes two and three years of age, as contrasted to the larger differences reported by other workers.

Eliya (1969) studied the effect of age of dam on lamb birth weight and found that birth weights were 9.90, 10.39, 10.28, 10.75, 10.33 and 10.16 pounds in first, second, third, fourth, fifth and sixth lambings, respectively. They indicated from this finding that increases in birth weight occurred with increasing age of dam up to 6 years, and after that age, birth weight decreased. However, some workers have reported that age of dam appeared to have no significant influence on birth weight (Juma and Faraj, 1966 and Kazzal, 1973).

Effect of Month of Birth

Month of birth seems to have an influence on birth weight of lambs. Sanchez Belda and Esteban Munoz (1960) and Eliya (1969) indicated that lambs born during the last weeks of the lambing season weighed more than those born earlier in the season. Smith and Lidvall (1964) found that the differences between lambs born during different

months of the year were highly significant ($P < .01$), and lambs born during January, February and March were significantly heavier at birth than lambs born during other months.

Juma and Faraj (1966) reported a significant effect of time of lambing on birth weight of Awassi lambs born in Iraq, lambs born earlier and later in the lambing season being heavier than lambs dropped in mid-season.

McLaren *et al.* (1968) also showed that month of birth had a significant ($P < .05$) effect on average birth weight, lambs born in January being 0.5 pounds heavier at birht than lambs born in December, and the average birth weight of lambs born in February and March tended to be close to the overall mean and not significantly different from that of lambs born in either December or January.

Month of birth was reported to have a significant ($P < .01$) effect on birth weight of lambs also by Kazzal (1973) who studied similar data from the same flock which supplied the data for the present study.

Effect of Weight of Dam

Heavier ewes produced heavier lambs, according to Sanchex Belda and Esteban Munoz (1960), who showed that ewes weighing 51 to 54 kg produced lambs that were 0.96 kg heavier at birth than lambs from ewes weighing 26 to 30 kg. Hamada (1954) reported an increase of 1.0 pound in birth weight for each seventeen-pound increase in body weight of dam.

Phillips *et al.* (1940) and Ensminger *et al.* (1943) found low correlations between birth weight of lamb and weight of ewe in Columbia, Corridale and Rambouillet sheep.

Ray and Smith (1966) also showed that the heaviest ewes (59.5 to 63.6 kg) produced heavier lambs at birth than did other ewes.

Juma and Faraj (1966) found a significant ($P < .05$) positive correlation between birth weight of lamb and live weight of dam ($r = 0.28$). When dams were grouped into eight classes according to body weight, they found dam weight to have a significant ($P < .05$) effect on the birth weight, and dams weighing 126 to 135 pounds gave birth to the heaviest lambs.

Eliya (1969), studying data from Awassi sheep, also found a significant ($P < .05$) positive correlation between weight of dam and birth weight of lamb. The correlation coefficients obtained were 0.35 for single and 0.27 for twin lambs. When the dams were grouped into eight weight classes, significant differences in birth weight between classes was found, with dams weighing 151 pounds having the heaviest lambs.

II. REPEATABILITY

Repeatability is a measure of the extent to which repeated observations on the same animal tend to resemble each other. It is an intraclass correlation between records of the same individual (Lush, 1945). As normally defined, repeatability is the fraction of the variance in repeated observations due to the effects of the genotype of the individual plus any permanent effects of environment, that is, environmental effects that are alike on all repeated observations. Thus, repeatability can be represented as follows:

$$\text{Repeatability } (\mu_I) = \frac{\sigma^2 H + \sigma^2 PE}{\sigma^2 H + \sigma^2 PE + \sigma^2 TE}$$

where: $\sigma^2 H$ is the variance due to the effect of genotype,

$\sigma^2 PE$ is the variance due to permanent environmental differences,

$\sigma^2 TE$ is the variance due to temporary environmental effects on each record.

In this case estimations should be made on a group of sheep of the same age and sex which have been run together for the period during which observations are made. Usually, observations are made annually (fleece weight, lambing record and so on).

An estimate of repeatability is useful in a breeding program, as it indicates the extent to which selection practiced at any stage will affect the subsequent population average in later records. It is an upper limit of heritability. It is useful also to indicate the relative value of having one record or more than one record per animal when predicting future performance relative to the population average. These aspects are considered in some detail by Lush (1945).

Estimates of repeatability reported by a limited number of investigators for lamb birth weights are quite few and quite variable. The major differences may be due to specific factors involved at variable locations, breeds, number of observations used and different methods used to make adjustments in the determination of this parameter.

Blackwell and Henderson (1955) estimated repeatability of birth weight as a trait of the ewe in Corriedale, Hampshire, Shropshire and Dorset sheep to be 0.199. MacNaughton (1956) reported estimates of

repeatability of birth weight in Rambouillet and Corriedale sheep to be 0.27 to 0.36, respectively. Gregory et al. (1950) reported estimates of repeatability of birht weight, ranging from 0.11 to 0.24 in beef cattle. Taylor et al. (1957) obtained 0.18 as an estimate of the same parameter. Using range Hereford cattle, Botkin and Whatley (1952 and 1953) also found a repeatability estimate of 0.18 for birth weight in beef cattle.

CHAPTER III

MATERIALS AND METHODS

Data Used

Birth records for 398 Awassi lambs born between 1968 and 1972 to 176 ewes were obtained from the University of Mosul sheep flock in Iraq.

The herd was established in 1965 by purchasing 100 ewes and 10 rams from the Abu-Braid Station. Each breeding season began about mid-June to late August. Ewes were "flushed" for about two weeks prior to the breeding season by providing additional feed in the form of concentrate and fresh-cut alfalfa. Ewes lambed in a closed lambing barn and were placed in temporary flexible lambing pens after lambing. Lambs were identified by both tattoo and metal tag within a few hours after birth.

The following information was recorded in addition to the birth weight for each lamb:

1. Date of birth
2. Type of birth
3. Various body measurements
4. Sex of lamb
5. Sire's age
6. Age of dam
7. Weight of dam after parturition.

Feeding, breeding and management practices were described in detail by Kazzal (1973).

Statistical Analysis

An initial analysis of variance was performed first to study the environmental effects, including year of birth, sex of lamb, age and weight group of dam, type and month of birth as fixed environmental factors. Because of disproportionate subclass numbers, the least-squares analysis of variance procedure as described by Harvey (1960) was used in all analyses.

The linear model used to describe each observation of birth weight was as follows:

$$Y_{ijklmno} = \mu + Y_i + S_j + t_k + a_l + b_m + g_n + e_{ijklmno}$$

where $Y_{ijklmno}$ is the birth weight of the ijklmnoth lamb,

μ is the overall mean of lambs,

Y_i is the effect of the ith year of birth,

S_j is the effect of the jth sex of lamb,

t_k is the effect of the kth type of birth,

a_l is the effect of the lth age of dam,

b_m is the effect of the mth month of birth,

g_n is the effect of the nth group of dam, (weight groups) and

$e_{ijklmno}$ is the random error forming a part of each individual observation.

The data were adjusted only for the significant ($P < .05$) environmental effects. The adjustment was performed by using the least-squares estimates of the effects.

Repeatability of birth weight was estimated from the adjusted data as the intraclass correlation between the birth weights of two

lambs from a ewe or the ratio of

$$\sigma^2 E \text{ to } \sigma^2 E + \sigma^2 w,$$

where $\sigma^2 E$ is the between-ewe component of variance and

$\sigma^2 w$ is the error mean square or variance among lambs from the same ewe.

The standard error of the repeatability estimates was computed by the formula given by Becker (1968).

An estimate of phenotypic correlation between birth weight and weight of dam was calculated according to the method of Hazel (1943) by the following formula:

$$r_p = \frac{Cov_{pxy}}{Spx\ Spy}$$

where r_p = estimate of phenotypic correlation

Cov_{pxy} = the phenotypic covariance between trait X and Y

Spx = the phenotypic standard deviation of trait X

Spy = the phenotypic standard deviation of trait Y

CHAPTER IV

RESULTS AND DISCUSSION

I. ENVIRONMENTAL FACTORS AFFECTING BIRTH WEIGHT

Year of Birth

Although the effect of year of birth on birth weight was not significant at the conventional 5 percent probability level as shown in Table 1, it was significant ($.05 < P < .25$). Lambs born during the 1968 lambing season were heavier than those born during any other year. The lightest lambs were born in 1970 (Table 2). Kazzal (1973), using some of these data, found that lambs born in 1967 were 0.97 kg heavier at birth than lambs born in 1970. He stated further that in 1970 the ewes were faced with a very dry season and gave the lightest lambs. Eltawil (1965) also reported that year of birth could affect lamb birth weight through year-to-year variation in the amount of feed available to ewes. Many other workers reached the same conclusion with respect to year effect (Ali, 1952; Borgart *et al.*, 1957; Harrington *et al.*, 1958; Webb, 1963; Juma and Faraj, 1966; McLaren *et al.*, 1968; Vesely and Robinson, 1970 and Sidwell and Miller, 1971). In a few investigations, year of birth effects were not found to be a significant factor. Cassard and Weir (1956) reported that there was no effect of year on birth weight of Suffolk lambs, and Dass and Acharya (1970) also stated that lambing was in the same season in all years and that conditions of management and the feeding procedures for the pregnant ewes were more or less the same for all years. The similarity of results of the present study to those of

TABLE 1

ANALYSIS OF VARIANCE OF
BIRTH WEIGHT

Source of Variation	Degrees of Freedom	Sum Squares	Mean Squares
Year of birth	3	3.55	1.18
Month of birth	1	4.95	4.95**
Sex of lamb	1	4.53	4.53**
Type of birth	1	33.57	33.57**
Age of dam	5	7.57	1.51*
Weight of dam	4	15.21	3.81**
Error	383	143.13	0.37
Total	398	311.40	

*$P < .05$.

**$P < .01$.

TABLE 2

LEAST-SQUARES MEANS OF BIRTH WEIGHT

Effect	Number of Observation	Birth Weight (kg)	Constant
Overall mean	398	4.17 ± 0.07	4.17
Year of Birth			
1. 1968	102	4.30 ± 0.09[a]	0.13
2. 1969	112	4.23 ± 0.09[a]	0.05
3. 1970	98	4.01 ± 0.09[a]	-0.16
4. 1971	86	4.15 ± 0.09[a]	-0.02
Month of Birth		**	
1. November	319	4.03 ± 0.07[a]	-0.14
2. December	79	4.32 ± 0.09[b]	0.14
Sex of Lamb		**	
1. Male	209	4.28 ± 0.07[a]	0.11
2. Female	189	4.07 ± 0.07[b]	-0.11
Type of Birth		**	
1. Single	336	4.59 ± 0.06[a]	0.42
2. Twin	62	3.75 ± 0.09[b]	-0.42
Age of Dam		*	
1. 2-year	63	3.96 ± 0.11[a]	-0.21
2. 3-year	108	4.04 ± 0.08[a]	-0.13
3. 4-year	80	4.14 ± 0.08[a]	-0.04
4. 5-year	50	4.20 ± 0.11[b]	0.03
5. 6-year	54	4.44 ± 0.10[b,c]	0.27
6. 7-year	43	4.26 ± 0.11	0.09
Weight of Dam		**	
1. 30-39 kg	10	3.23 ± 0.20[a]	-0.94
2. 40-49 kg	83	4.14 ± 0.08[a]	-0.04
3. 50-59 kg	182	4.35 ± 0.06[b]	0.17
4. 60-69 kg	110	4.44 ± 0.07[b]	0.27
5. 70 and above	13	4.71 ± 0.18[b,c]	0.54

[a,b,c]Least-squares means followed by the same letter within column and subclass do not differ significantly ($P > .05$). All others differ significantly ($P < .05$) or ($P < .01$) as indicated above each group of means.

*$P < .05$.

**$P < .01$.

Dass and Acharga (1970) is not surprising, because data of the present study were collected under the same conditions as theirs.

Month of Birth

As Table 1, page 19, shows, the influence of month of birth on birth weight was highly significant ($P < .01$). Lambs born during December were heavier than those born in November. The difference in weight was .28 kg in favor of those born late in the lambing season (Table 2). This result agrees with those of Kazzal (1973) who stated that Awassi lambs born in December, January and February were heavier at birth than lambs born in November and March. It agrees also with the results obtained by Sanchez Belda and Esteban Munoz (1960) in Marchia sheep and Eliya (1969) in Awassi lambs. However, Juma and Faraj (1966) and McLaren *et al*. (1968) found that lambs born earlier and later in the lambing season were heavier than lambs born during the middle weeks of the lambing season.

Sex of Lamb

The effect of sex of lamb on birth weight (Table 1) also was highly significant ($P < .01$). Males weighed 4.28 kg, on the average, which was higher than females weights by 0.21 kg (Table 2). McLaren *et al*. (1968) reported a difference of 0.61 pounds in favor of males. Kazzal (1973) found about the same difference due to sex influence. He found that the average birth weight of Awassi lambs was 4.56 and 4.32 kg for males and females, respectively. Many workers have reported similar small differences in favor of males (Ali, 1952; Asker *et al*., 1952; Blackwell and Henderson, 1955; Harrington *et al*., 1958; Sabin

and Brown, 1962; Webb, 1963; Datta et al., 1963; Sidwell et al., 1964; Smith and Lidvall, 1964; Juma and Faraj, 1966; Srinivasan, 1969; Eliya, 1969; Vesely and Robinson, 1970; Eltawil et al., 1970; Sidwell and Miller, 1971). However, Bogart et al. (1957) and Trail and Sacker (1969) reported that sex of lamb did not significantly affect birth weight.

Type of Birth

Type of birth significantly affected birth weight ($P < .01$) as shown in Table 1, page 19. Least-squares means showed that single lambs weighed 4.50 kg while twin lambs weighed 3.75 kg, a difference of 0.84 kg in favor of single lambs. This result is very similar to the findings of Nelson and Venkatachalam (1949), Asker et al. (1952), Ragab et al. (1953), Cassard and Weir (1956), Bogart et al. (1957), Karm (1959), Brown et al. (1961), Bennett et al. (1963), Webb (1963), Juma and Faraj (1966), Gjedrem (1967), Frederiksen et al. (1967), McLaren et al. (1968), Srinivasan (1969), Trail and Sacker (1969), Eliya (1969), Eltawil et al. (1970) and Sidwell and Miller (1971). Ghoneim et al. (1973) found that lambs born as singles were 0.80 kg heavier at birth than twins which was highly significant ($P < .01$). Kazzal (1973), using similar data from the same flock, found that single lambs exceeded twins by .62 kg in birth weight.

Age of Dam

Difference in birth weight of lambs due to differences in age of dam were significant ($P < .05$), as shown in Table 1. It appeared that lamb birth weights increased with increasing age of

dams (Table 2, page 20). These results were in close agreement with many other research workers who also reported significant differences due to the effect of age of dam (Brown et al., 1961; Webb, 1963; Gjedrem, 1967; McLaren et al., 1968; Eliya, 1969; Srinivasan, 1969; Vesely and Robinson, 1970; Eltawil et al., 1970 and Sidwell and Miller, 1971). However, Cassard and Weir (1956), Juma and Faraj (1966) and Kazzal (1973) reported no significant differences in lamb birth weight due to differences in age of dam.

Weight of Dam

Effect of weight of dam on birth weight of lambs was highly significant ($P < .01$) as indicated in Table 1, page 19. This effect seems to be in the same direction and of about the same magnitude as the effect of age of dam. The product-moment correlation between birth weight and weight of dams after parturition was 0.32. Elyia (1969) reported a significant ($P < .05$) positive correlation between weight of dam and birth weight, the correlation coefficient obtained being 0.35 for single lambs and .26 for twin lambs. This agrees with many research workers (Ostgard, 1957; Senchex Belda and Esteban Munoz, 1960; Juma and Faraj, 1966). Phillips et al., 1940; Ray and Smith, 1966 and Ensminger et al., 1943 found low but significant ($P < .05$) correlation between the variables.

II. REPEATABILITY OF BIRTH WEIGHT

Repeatability was calculated from the intraclass correlation of all records for each ewe having at least two records. The result

is given in Table 3. The estimate of repeatability of birth weight was 0.23.

Dalton (1962) found the same value for birth weight in Welsh Mountain sheep. Blackwell and Henderson (1955) reported repeatability estimates of birth weight in four breeds of sheep to be 0.199. Mason and Dass (1954), working with Langhe sheep data, observed repeatability of birth weight to be 0.32 and 0.79 for adjusted and unadjusted records, respectively. MacNaughton (1956) found that the estimates of repeatability of birth weight were 0.27 and 0.36 for Rambouillet and Corriedale ewes, respectively.

The fact that published estimates of repeatability vary widely is not surprising to anyone familiar with differences in amount of control over environmental variations exercised in various situations. It appears that repeatability of birth weight is low, indicating the need for an average of several records from a ewe if birth weight is to be a criterion of selection. However, since repeatability is an upper limit of heritability, estimates of repeatability can be considered rough indicators of heritability in flocks where data appropriate for estimating heritability are not available, as is the case in the flock contributing the data for the present study. On this basis, it seems likely that, in spite of great environmental variation found in this and other studies, birth weight is slightly heritable.

Perhaps most of the value of a study of birth weight such as that conducted here is that the results may be used as an index or "barometer" of the general level of management or environment prevailing in the ewe flock.

TABLE 3

ESTIMATION OF REPEATABILITY OF BIRTH WEIGHT

Source of Variation	Degrees of Freedom	Sum Squares	Mean Squares	Expected Mean Squares
Analysis of Variance				
Total	306	168.753		
Among Ewes	114	86.791	0.761	$\sigma_W^2 + k^a\sigma_E^2$
Within Ewes	192	81.961	0.427	σ_W^2

Components of Variance and Repeatability

$\hat{\sigma}_E^2 = 0.125$

$\hat{\sigma}_W^2 = 0.427$

$k^a = 2.667$

$$\text{Repeatability} = \frac{0.125}{0.125 + 0.427} = 0.23$$

[a]Average number of records/ewe.

CHAPTER V

SUMMARY

In the Awassi flock raised at the Hammam Al-Alil Experiment Station, Mosul University, Iraq, 336 single and 62 twin births were recorded over the years 1968-1972. The environmental factors, year of birth, sex of lamb, age of dam, weight of dam, month and type of birth were assessed with respect to their influence on birth weight, and repeatability of birth weight was estimated.

Month of birth, sex of lamb, type of birth and weight of dam were highly significant effects ($P < .01$). However, in this study, year of birth appeared to have less significant ($0.1 < P < 0.25$) influence on birth weight of lambs since all lambs were born in the same season of each year and feeding and management were quite similar in all years.

The phenotypic correlation between birth weight of lamb and weight of dam was 0.32, and repeatability of birth weight as a trait of the dam was estimated to be 0.23.

The results provide a good illustration of the general level of management and environment prevailing in the ewe flock, with birth weight as indicator.

LITERATURE CITED

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Ali, K. T. 1952. The heritability of, and the effect of some environmental factors on the birth weight, the weaning weight, and the grease fleece weight of sheep. Ph.D. Dissertation. University of Minnesota, St. Paul, MN.

Asker, A. A. 1964. Some economic characters of Awassi sheep in Iraq. J. Anim. Prod. U.A.R. 4:1.

Asker, A. A., M. T. Ragab and M. R. Kadi. 1952. The influence of some environmental factors affecting weight of Ossimi and Rahmani sheep. Bul. Fac. Agric. 19:25. Fouad I University. Cairo.

Becker, W. A. 1968. Manual of procedures in quantitative genetics. Washington State University Press, Pullman, Washington.

Belic, J. and A. Ognjanovic. 1955. Fertility in Tsigai sheep. A.B.A., 24:372.

Bennett, J. A., D. H. Matthews and M. A. Madsen. 1963. Utah Exp. Sta. Bul. 442.

Bichard, M. and M. McG. Cooper. 1966. Analysis of production records from a lowland sheep flock. Anim. Prod. 8:401.

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

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

Botkin, M. P. and J. H. Whatley, Jr. 1952. Repeatability of production in range beef cows. J. Anim. Sci. 11:737 (Abstr.).

Botkin, M. P. and J. H. Whatley, Jr. 1953. Repeatability of production in range beef cows. J. Anim. Sci. 12:552.

Brown, C. J., C. A. Baugus and S. Sabin. 1961. Evaluation of factors affecting the growth of spring lambs. Ark. Agric. Exp. Sta. Bul. 646.

Cassard, D. W. and W. C. Weir. 1956. Hereditary and environmental variation in the weights and growth rates of Suffolk lambs under farm conditions. J. Anim. Sci. 15:1221.

Chopra, S. C. and R. M. Acharya. 1971. A note on non-genetic factors affecting body weights of Bikaneri sheep. Anim. Prod. 13:349.

Dalton, O. C. 1962. Characters of economic importance in Welsh mountain sheep. Anim. Prod. 4:269.

Dass, G. S. and R. M. Acharya. 1970. Growth of Bikaneri sheep. J. Anim. Sci. 31:1.

Datta, I. C., K. L. Sahani, R. K. Bhatnagar and A. Roy. 1963. Studies on certain aspects of sheep and goat husbandry. II. Birth-weight, live-weight growth and rearing lambs and kids. Indian J. of Vet. Sci. and Anim. Husb. 33:71.

Domanski, A. 1954. A comparative study on the growth before weaning of single and twin lambs of the Merino-Precoce breed. A.B.A., 24:266.

Eliya, J. 1969. Studies on some economic characteristics in Awassi sheep. M. S. Thesis. University of Baghdad, Iraq.

Eloksh, H. A., T. M. Sutherland and V. B. Swanson. 1962. Birth weight and measurements as aids to selection of lambs. J. Anim. Sci. 21:663 (Abstr.).

Eltawil, E. A. 1965. Genetic and environmental factors of sheep under arid conditions. Ph.D. Dissertation. Iowa State University, Ames.

Eltawil, E. A., L. N. Hazel, G. M. Sidwell and C. E. Terrill. 1970. Evaluation of environmental factors affecting birth, weaning and yearling traits in Navajo sheep. J. Anim. Sci. 31:823.

Ensminger, M. E., R. W. Phillips and R. G. Scott. 1943. Measuring performance of progeny of rams on a small flock. J. Anim. Sci., 2:157.

Fahmy, M. H., E. S. E. Galal, Y. S. Ghanem and S. S. Khishin. 1969. Genetic prarmeters of Barki sheep raised under semi-arid conditions. Anim. Prod. 11:361.

Frederiksen, K. R., D. A. Price and R. L. Blackwell. 1967. Environmental factors affecting rate and efficiency of gain and other traits in Rambouillet lambs. J. Anim. Sci. 26:667.

Ghoneim, K. E., A. Taha, M. R. Taka, R. K. Abdallah and N. T. Kazzal. 1973. Some economic characters of Awassi sheep in north of Iraq. Bull. No. 22, Mosul University, Iraq.

Ghoneim, A., M. A. Raafat, A. K. Abouraua and El-Samman. 1957. Mutton production from Egyptian sheep. I. Growth studies during the suckling period. II. Growth studies from weaning up to one year old. A.B.A. 29:442.

Gjedrem, T. 1967. Phenotypic and genetic parameters for weight of lambs at five ages. Acta. Agric. Scandinavica. 17:199.

Goreckii, S. P., S. V. Gumakovskaja and M. V. Zamjatina. 1958. The effect of the age of fine wooled- coarse wooled ewes on the quality of their progeny. A.B.A., 28:421.

Gould, M. B. and J. V. Whiteman. 1971. Association of certain variables with the performance of spring vs. fall-born lambs. J. Anim. Sci. 33:531.

Gregory, K. E., T. Blunn and M. L. Baker. 1950. A study of some of the factors influencing the birth and weaning weights of beef calves. J. Anim. Sci. 9:338.

Hamada, M. K. O. 1954. A study of birth weight in British mutton breeds. A.B.A., 23:49.

Harrington, R. B., J. V. Whiteman and R. D. Morrison. 1958. Estimates of some source of variation of the body weights of crossbred lambs at different ages. J. Anim. Sci. 17:743.

Harvey, W. R. 1960. Least squares analysis of data with unequal subclass numbers. A.R.S. 20-8, U.S.D.A.

Hazel, L. N. 1943. Genetic basis for selection indices. Genetics 28:476.

Jakubec, V. 1959. A standard growth rate of crossbred Valachian x Texel sheep. A.B.A. 27:314.

Juma, K. H. and M. Faraj. 1966. Factors affecting birth weights of Awassi lambs. J. Agric. Sci. 67:169.

Karam, H. A. 1959. Birth, weaning and yearling weights of Rahmani sheep. I. Effects of some environmental factors. II. Heritability estimates and correlations. Empire Journ. Exper. Agric., 27:313.

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. Anim. Sci., 8:606 (Abstr.).

Kazzal, N. T. 1973. Evaluation of some genetic and environmental factors affecting growth and development of Awassi sheep in Iraq. Ph.D. Dissertation, University of Tennessee, Knoxville.

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

Labban, F. M. and A. Radwan. 1969. A study of some economic characters of an imported Merino flock. J. Anim. Prod. U.A.R., 2:303.

Lush, J. L. 1945. Animal breeding plans. Iowa State College Press, Ames, Iowa.

MacNaughton, W. N. 1956. Repeatability and heritability of birth, weaning and shearling weights among range sheep in Canada. Ph.D. Dissertation. Iowa State University, Ames, Iowa.

Mason, I. L. and P. Dassat. 1954. Milk, meat and wool production in the Langhe sheep of Italy. Z. Tierz. Zucht Biol. 62:197.

McLaren, J. B., H. J. Smith, G. Srinivasan and E. J. Chapman. 1968. Performance of spring lambs in Tennessee. Tenn. Agric. Expt. Sta. Bul. 444.

Narayan, N. L., S. Narayan and N. C. Khandekar. 1959. Influence of age of dam on birth weight of Chokla sheep. A.B.A., 28:147.

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

Neville, W. E., A. B. Chapman and A. L. Pope. 1958. Comparison of lambs from western (Columbia - Rambouillet) ewes and sired rams of four down breeds. J. Anim. Sci., 17:763.

Ostgard, O. 1957. Gestation period, birth weight and sex ratio in sheep. A.B.A., 26:61.

Palian, B. 1957. Differences in the growth of twin and single Pramenk lambs at Kupres in the suckling period. A.B.A., 26:59.

Phillips, R. 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. American Anim. Prod. 296.

Phillips, R. W., J. A. Stoehr and G. W. Brier. 1940. Growth in Corriedale and Rambouillet sheep under range conditions. Amer. Soc. Anim. Prod. 33rd Ann. Proc.

Ragab, M. T., A. A. Asker and A. A. Youssef. 1953. Comparative study of body weight and measurements of Ossimi and Rahmani sheep. No. 27. Cairo University.

Ray, E. E. and L. S. Smith. 1966. Effects of body weight of ewes on subsequent lamb production. J. Anim. Sci. 25:1172.

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.

Sanchez Belda, A. and C. Esteban Munoz. 1960. A study of lamb birth weight and some factors which determine it. Anim. Breed. Abstr. 31:70.

Sanitago, A. A. and L. P. Neto. 1954. Suffolk sheep in Sao Paulo. A.B.A., 23:389.

Sidwell, G. M. and L. R. Miller. 1971. Production in some pure breeds of sheep and their crosses. II. Birth weights and weaning weights of lambs. J. Anim. Sci. 32:1090.

Sidwell, G. M., D. O. Everson and C. E. Terrill. 1964. Lamb weights in some pure breeds and crosses. J. Anim. Sci. 23:105.

Sojetado, R. M. 1952. The growth and habits of lambs. A.B.A., 22:323.

Srinivasan, G. 1969. A comparison of heritability estimates obtained by different methods. Ph.D. Dissertation. University of Tennessee, Knoxville.

Starke, J. S., J. B. Smith and D. M. Joubert. 1958. The birth weight of lamb. Anim. Breed. Abst. 27:63.

Taylor, J. C., R. C. Carter, J. A. Gaines and C. M. Kincaid. 1957. Repeatability of performance in the beef cow. J. Anim. Sci. 16:1025 (Abstr.).

Trail, J. C. M. and G. D. Sacker. 1969. Growth of crossbred Dorset Horn lambs from East African Blackheaded sheep. J. Agri. Sci. 73:239.

Vesely, J. A. and O. W. Robison. 1970. Genotype-sex interactions in sheep. J. Anim. Sci. 31:273.

Webb, C. E. 1963. Factors and their effects on birth weight, average daily gain and 120-day weight of purebred Hampshire lambs. M.S. Thesis. University of Tennessee, Knoxville.

VITA

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