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# Effect of live weight and age of Akkaraman ewes at mating on multiple birth rate, growth traits, and survival rate of lambs

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**Abstract:** This study was performed in order to determine the effect of live weight (LW) and age of Akkaraman ('White Karaman', WK) ewes at mating on the multiple birth rate (MBR), growth traits, and survival rate (SR) of lambs in breeder flocks. In the trial, data of 4452 head of ewes and 5324 head of lambs obtained from 16 WK breeder flocks in Konya Province were used. One week before the mating season ewes were weighed and separated into 5 groups according to their LW. In the research, the differences of MBR, the SR of lambs until days 60 and 120, the birth weight (BW), and the average LWs at days 60 and 120 between the groups were found to be statistically significant. It was determined that the MBR, the SR of lambs, the BW, and the average LWs at days 60 and 120 increased directly proportional to the LW increase of WK ewes at mating. Ewe's age affected MBR significantly and the MBR of ewes of ages 2 and 3 was lower ($P < 0.01$) than those of other age groups. However, ewe's age did not affect SR up to days 60 and 120, BW, or growth of lambs.

**Key words:** White Karaman ewe, multiple birth rate, growth, survival rate

## 1. Introduction

High lambing rate is the biggest contributor to get more profits from sheep farms. However, lambs' survivability is an important issue in highly fecund sheep flocks (1). Various studies have reported likely factors affecting survival rate (SR), such as live weight (LW) and age of ewes, breed, sire, birth rank, and birth weight (BW) (2,3). It was observed that the LW of the ewe at mating has an important effect on the consequent number of lambs and productivity of sheep (4,5). It was reported that ewes with high LWs at mating showed better performance than the other ewes in terms of reproductive traits (6–8). As LW at mating increased in Manchega breed sheep, the probability of twin births increased (9). Gaskins et al. (10) reported that the weight of 1-year-old ewes at breeding had a positive effect on fertility and prolificacy in Columbia, Polypay, Rambouillet, and Targhee breeds, and increasing weight at breeding increased ($P < 0.004$) the probability of multiple births.

Growth and development in animals is analyzed in 2 parts, prenatal and postnatal, and postnatal growth is further divided into 2 parts, the suckling period and the postweaning growth period (11). It is known that the effect of factors such as genotype, birth type, lamb's sex, ewe's age, LW of the ewe and ram, and maintenance and feeding of the ewe have significant influence on the birth and weaning weights (12,13). However, the absolute effects of LW have greater impact than ewe's age on sheep reproduction efficiency (14,15). Body condition score (BCS) and LW of the ewes during the lambing period are important factors affecting their growth performance in the postnatal period (16).

In a study conducted with the purpose of determining the effect of BCS, LW, and age on the reproduction performance of Afshari sheep by Aliyari et al. (15), the number of lambs born per lambing in ewes with weights of 74 to 80 kg was highest. Effect of BCS and LW of ewes on weaning weight was significant ($P < 0.05$) and following ewes' weight increases, lambs' weaning weights increased. Ray and Smith (14) found that the heaviest ewes at mating produced lambs that weighed 9% and 20% more at birth and weaning, respectively, than ewes in the lightest weight group.

Combined productive native sheep breeds in terms of milk and meat that are resistant to harsh climatic and poor pasture conditions can be raised successfully in the central and eastern regions of Anatolia in Turkey. There are about 25 million head of sheep in Turkey and the Akkaraman ('White Karaman', WK) sheep breed constitutes the biggest share of this population at 44% (17).

This study was carried out with the purpose of determining the effect of LW and age of WK ewes at mating on multiple birth rate (MBR), SR, and growth traits of lambs in breeder flocks.

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## 2. Materials and methods

### 2.1. Animal material

The study was carried out in the Karakaya and Divanlar villages of Karatay District of Konya Province in Turkey (37°54′N, 32°53′E, 1020 m a.s.l.). In this study, data of 4452 WK sheep and their 5324 lambs were used from a project entitled "The improvement of White Karaman sheep in breeder conditions".

### 2.2. Feedstuffs and feeding

Except for the snowy winter period, WK sheep, which were the animal material of the study, were fed on the pasture. During the winter, the ewes were fed with a diet that consisted mostly of hay and, to a small extent, grains. After birth, starting with the month of April, the sheep were grazed on the pasture and in the stubbles after the harvest period. After the stubble period, the sheep were grazed on insufficient pastures until the snowfall. Some breeders used, in addition to wheat straw, dry legume hay such as common vetch and sainfoin hay in small amounts, and occasionally corn silage. The sheep were given concentrate feed stuff that contained barley and cottonseed meal in the amount of 300 g during the last phase of pregnancy and in the amount of around 1 kg after birth until the start of the pasture period. Breeders do not have much of a tendency to use standard feed mill feeds.

Lambs were suckled twice a day up to the weaning (day 75). As supplemental feedstuff, the lambs were usually given daily a mixture of 300 g of concentrate feedstuff that contained barley and cottonseed oil meal. After 2 months, lambs were grazed in the pastures close to the sheepfolds as separate flocks from the ewes.

### 2.3. Method

Except for 2 flocks, insemination was carried out in the improvement flocks on which the study was conducted, in the form of uncontrolled mating. In the study flocks, mating was started on the same date (20 August), and insemination was completed in a total of 60 days. LWs of the ewes were measured 1 week before the mating (10–15 August) using a digital scale sensitive to 100 g. All newborn lambs were tagged on the ear; their birth records were kept and the BWs of the lambs were determined. The lambs were weighed every 60 days on average after the date of the birth and their 60 and 120 day adjusted LWs were calculated using interpolation. To determine SR, data from the lambs that survived until around days 60 and 120 were used.

### 2.4. Statistical analysis

In order to study the relationship between ewe's LW, ewe's age, MBR, and SR, logistic regression analysis was used. Simple regression analysis was also performed to examine the relationship between LW of ewe and BW with the LW of lambs. The effect of LW and age of ewes at mating, lamb's sex, and birth type on the lambs' BW and LWs at 60 and 120 days was analyzed using the least squares method (generalized linear model). Significant differences between the averages were compared using the Tukey test. For statistical analysis, Minitab (18) software was used.

## 3. Results

LWs of WK ewes at mating are given according to the ewe's age in Table 1 and LWs of 1.5- and 2.5-years-old ewes were found significantly lower than LWs of older ewes ($P < 0.01$). Pearson correlation of ewe's age and LW at mating was 0.196 ($P < 0.01$).

Number of animals, MBRs, and SRs are given in Tables 2 and 3. Logistic regression tables for the effect of ewe's age and LWs at mating on the MBRs and SRs are given in Tables 4–6. It was observed that the MBR increased with the ewe's LW at mating and that ewes with weights of ≥65 kg had the highest level of MBR (Table 2). Differences between the LW groups in terms of MBR were significant ($P < 0.01$, Table 4). Ewe's age also affected MBR significantly ($P < 0.01$), but only the MBR of 2-year-old ewes was lower significantly ($P < 0.01$) than those of other age groups, and the MBRs of other groups were similar (Tables 3 and 4).

The differences between the lowest and highest LW groups in terms of SRs at 60 and 120 days were significant ($P < 0.01$, Tables 5 and 6), while no significant differences were observed for other pairs of LW groups. The average LWs for the birth adjusted at 60 and 120 days of the lambs grouped based on the ewe's LW and age at mating are given in Table 7.

**Table 1.** Live weights of White Karaman ewes at mating (kg).

| Age | 1.5 | 2.5 | 3.5 | 4.5 | ≥5.5 | Overall | P |
|---|---|---|---|---|---|---|---|
| Number of ewes | 777 | 942 | 1361 | 1137 | 235 | 4452 | |
| LSM | 53.6[c] | 57.2[b] | 59.0[a] | 59.3[a] | 58.8[a] | 57.6 | 0.01 |
| SE | 0.29 | 0.23 | 0.19 | 0.21 | 0.55 | 0.14 | |

[a, b, c]: Values shown with different letters in the same row differ significantly ($P < 0.01$).
LSM: Least squares means, SE: standard error of mean.

**Table 2.** Number of animals, multiple birth rates, and survival rates by weight of ewes.

| LW groups | ≤49 | 50–54 | 55–59 | 60–64 | ≥65 | Overall |
|---|---|---|---|---|---|---|
| Number of lambing ewes | 799 | 1146 | 1036 | 739 | 732 | 4452 |
| Number of multiple lambings | 67 | 162 | 214 | 203 | 226 | 872 |
| Multiple birth rates, % | 8.4 | 14.1 | 20.7 | 27.5 | 30.9 | 19.6 |
| Number of born lambs | 866 | 1308 | 1250 | 942 | 958 | 5324 |
| No. of lambs at 60 days | 802 | 1231 | 1176 | 888 | 928 | 5025 |
| No. of lambs at 120 days | 759 | 1147 | 1106 | 835 | 879 | 4726 |
| Survival rates up to 60 days, % | 92.6 | 94.1 | 94.1 | 94.3 | 96.9 | 94.4 |
| Survival rates up to 120 days, % | 87.6 | 87.7 | 88.5 | 88.6 | 91.8 | 88.8 |

**Table 3.** Number of animals, multiple birth rates, and survival rates by age of ewes.

| Age | 2 | 3 | 4 | 5 | ≥6 | Overall |
|---|---|---|---|---|---|---|
| Number of lambing ewes | 777 | 942 | 1361 | 1137 | 235 | 4452 |
| Number of multiple lambings | 78 | 172 | 309 | 261 | 52 | 872 |
| Multiple birth rates, % | 10.0 | 18.3 | 22.7 | 23.0 | 22.1 | 19.6 |
| Number of born lambs | 855 | 1114 | 1670 | 1398 | 287 | 5324 |
| No. of lambs at 60 days | 786 | 1043 | 1588 | 1336 | 272 | 5025 |
| No. of lambs at 120 days | 744 | 981 | 1485 | 1256 | 260 | 4726 |
| Survival rates up to 60 days, % | 91.9 | 93.6 | 95.1 | 95.6 | 94.8 | 94.4 |
| Survival rates up to 120 days, % | 87.0 | 88.1 | 88.9 | 89.8 | 90.6 | 88.8 |

**Table 4.** Logistic regression tables for the effect of ewe's age and LW at mating on the multiple birth rate.

| Predictor | Coeff. | SE coeff. | Z | P | Odds ratio |
|---|---|---|---|---|---|
| Ewe's LW | | | | | |
| Constant | –1.2373 | 0.0813 | –15.21 | 0.000 | |
| 50–54 | 0.4330 | 0.1010 | 4.29 | 0.000 | 1.54 |
| 55–59 | 0.8218 | 0.0998 | 8.24 | 0.000 | 2.27 |
| 60–64 | 1.1927 | 0.1042 | 11.45 | 0.000 | 3.30 |
| ≥65 | 1.3021 | 0.1039 | 12.53 | 0.000 | 3.68 |
| Ewe's age | | | | | |
| Constant | –1.0765 | 0.0823 | –13.08 | 0.000 | |
| 3 | 0.5419 | 0.1021 | 5.31 | 0.000 | 1.72 |
| 4 | 0.7853 | 0.0939 | 8.37 | 0.000 | 2.19 |
| 5 | 0.7063 | 0.1018 | 6.94 | 0.000 | 2.03 |
| ≥6 | 0.7752 | 0.1609 | 4.82 | 0.000 | 2.17 |

**Table 5.** Logistic regression tables for the effect of ewe's age and LW at mating on the lambs' survival rate at 60 days.

| Predictor | Coeff. | SE coeff. | Z | P | Odds ratio |
|---|---|---|---|---|---|
| Ewe's LW | | | | | |
| Constant | 2.7726 | 0.1443 | 19.21 | 0.000 | |
| 50–54 | –0.2489 | 0.1788 | –1.39 | 0.164 | 0.78 |
| 55–59 | –0.0068 | 0.1876 | –0.04 | 0.971 | 0.99 |
| 60–64 | 0.0285 | 0.2012 | 0.14 | 0.887 | 1.03 |
| ≥65 | 0.6582 | 0.2350 | 2.80 | 0.005 | 1.93 |
| Ewe's age | | | | | |
| Constant | 2.5972 | 0.1411 | 18.41 | 0.000 | |
| 3 | 0.2057 | 0.1890 | 1.09 | 0.276 | 1.23 |
| 4 | 0.2120 | 0.1709 | 1.24 | 0.215 | 1.24 |
| 5 | 0.2536 | 0.1915 | 1.32 | 0.185 | 1.29 |
| ≥6 | 0.6512 | 0.3870 | 1.68 | 0.092 | 1.92 |

**Table 6.** Logistic regression tables for the effect of ewe's age and LW at mating on the lambs' survival rate at 120 days.

| Predictor | Coeff. | SE coeff. | Z | P | Odds ratio |
|---|---|---|---|---|---|
| Ewe's LW | | | | | |
| Constant | 1.9605 | 0.1033 | 18.99 | 0.000 | |
| 50–54 | –0.0049 | 0.1331 | –0.04 | 0.970 | 1.00 |
| 55–59 | 0.0861 | 0.1362 | 0.63 | 0.527 | 1.09 |
| 60–64 | 0.0848 | 0.1453 | 0.58 | 0.559 | 1.09 |
| ≥65 | 0.4616 | 0.1569 | 2.94 | 0.003 | 1.59 |
| Ewe's age | | | | | |
| Constant | 1.9270 | 0.1076 | 17.91 | 0.000 | |
| 3 | 0.1984 | 0.1433 | 1.38 | 0.166 | 1.22 |
| 4 | 0.1024 | 0.1282 | 0.80 | 0.424 | 1.11 |
| 5 | 0.1982 | 0.1438 | 1.38 | 0.168 | 1.22 |
| ≥6 | 0.4608 | 0.2688 | 1.71 | 0.086 | 1.59 |

It was found that the effect of ewe's LW at mating on the birth and the 60 and 120 day LWs of the lambs was significant ($P < 0.01$). The highest birth and 60 and 120 day LWs were observed in the lambs born to ewes with LWs of ≥65 kg at mating, and lambs born to sheep with LWs of ≤49 had the lowest values for the same properties. It was also determined that the birth and 60 and 120 day LWs of the lambs increased with the increase in the ewe's LW at mating.

It was also found that that with a 1 kg increase in the LWs of the ewes, increases of 6.4, 161, and 198 g could be obtained for the birth and 60 and 120 day LWs of the lambs, respectively, and that with a 1 kg increase in the BW of the lambs, increases of 1.86 and 2.84 kg could be obtained for the 60 and 120 day LWs of the lambs, respectively.

In the present study, BWs and LWs of lambs at 60 and 120 days were not affected significantly by the ewe's age (Table 7).

**Table 7.** The effects of ewe's age and LW at mating, lamb's sex, and birth type on the growth of lambs.

| Factors | Birth weight | | Day 60 | | Day 120 | |
|---|---|---|---|---|---|---|
| | n | LSM ± SE | n | LSM ± SE | n | LSM ± SE |
| Ewe's LW | | | | | | |
| ≤49 | 866 | 3.97 ± 0.020[d] | 802 | 14.6 ± 0.12[d] | 759 | 29.5 ± 0.21[e] |
| 50–54 | 1308 | 4.02 ± 0.017[cd] | 1231 | 15.6 ± 0.10[c] | 1147 | 30.6 ± 0.18[d] |
| 55–59 | 1250 | 4.06 ± 0.017[c] | 1176 | 16.4 ± 0.10[b] | 1106 | 31.8 ± 0.18[c] |
| 60–64 | 942 | 4.13 ± 0.019[b] | 888 | 16.9 ± 0.11[b] | 835 | 32.6 ± 0.20[b] |
| ≥65 | 958 | 4.22 ± 0.019[a] | 928 | 19.0 ± 0.11[a] | 879 | 34.8 ± 0.20[a] |
| P | | 0.001 | | 0.001 | | 0.001 |
| Ewe's age | | | | | | |
| 2 | 855 | 4.04 ± 0.020 | 786 | 16.1 ± 0.12 | 744 | 31.4 ± 0.21 |
| 3 | 1114 | 4.09 ± 0.016 | 1043 | 16.4 ± 0.10 | 981 | 31.8 ± 0.17 |
| 4 | 1670 | 4.08 ± 0.012 | 1588 | 16.6 ± 0.07 | 1485 | 31.9 ± 0.13 |
| 5 | 1398 | 4.10 ± 0.016 | 1336 | 16.6 ± 0.10 | 1256 | 32.0 ± 0.17 |
| ≥6 | 287 | 4.07 ± 0.037 | 272 | 16.7 ± 0.22 | 260 | 32.2 ± 0.39 |
| P | | 0.191 | | 0.241 | | 0.143 |
| Lamb's sex | | | | | | |
| Female | 2680 | 4.02 ± 0.013 | 2498 | 15.9 ± 0.08 | 2351 | 30.4 ± 0,13 |
| Male | 2644 | 4.14 ± 0.013 | 2527 | 17.1 ± 0.08 | 2375 | 33.3 ± 0.13 |
| P | | 0.001 | | 0.001 | | 0.001 |
| Birth type | | | | | | |
| Single | 3240 | 4.30 ± 0.011 | 3100 | 17.2 ± 0.07 | 2954 | 32.9 ± 0.12 |
| Twin | 2084 | 3.86 ± 0.014 | 1925 | 15.9 ± 0.08 | 1772 | 30.9 ± 0.15 |
| P | | 0.001 | | 0.001 | | 0.001 |
| Overall | 5324 | 4.08 ± 0.009 | 5025 | 16.5 ± 0.06 | 4726 | 31.9 ± 0.10 |

[a, b, c, d, e]: Values shown with different letters in the same column differ significantly (P < 0.01).

The effects of lamb's sex and birth type on the lamb's BW and LWs at 60 and 120 days were significant (P < 0.01). In all periods, the LWs of the male lambs were higher than those of female lambs and the LWs of singletons were higher than those of twins.

## 4. Discussion

### 4.1. Multiple birth rate

In present study, MBR increased in proportion to the ewe's LW at mating (Table 4), and the ewes with the highest LWs (≥65 kg) had the highest MBR (30.9%, Table 2). The results of the present study were similar to the findings of Molina et al. (9), Gordon (4), and Vatankhah and Salehi (5), where subsequent offspring number and sheep efficiency was affected by the increase in the LWs of the ewes. Similarly, it was found that MBR increased in proportion to LW increases in the Afshari breed and that the highest rate of increase, 37%, was in the heaviest (74–80 kg) group (15). In another study, it was reported that Awassi sheep with LWs of 51–55 kg had the highest rate of twin births and that the twin birth rate was lower in groups with weights above this range (7).

In this research, ewe's age affected MBR significantly, but only the MBR of 2-year-old ewes was significantly lower than those of other age groups, and the MBRs of other groups were close to each other. A similar outcome was reported in a different study where MBRs of 2- and 3-year-old ewes were lower than those of 4-year-old ewes (19).

**4.2. Survival rates**

In the present study, the differences between the lowest and highest LW groups in terms of SRs at 60 and 120 days were significant ($P < 0.01$, Tables 5 and 6), while no significant differences were observed for other pairs of LW groups.

Various studies (2,3) reported that SRs of lambs were affected by LWs of ewes. The reason for this may be that milk yield of heavier ewes may be higher than that of ewes with lower LWs due to higher abdominal fat sources. As a result of this, lambs of heavier ewes can suck more milk. This may also increase the SR. Another reason may be that BW has an important impact on the ability of the lamb to survive (4,20). The mortality of lambs weighing less than 2.5 kg at birth is extremely high; it improves steadily for each additional 0.90 kg at birth, but the rate tends to increase with lambs weighing more than 6 kg (20). The BW of the lambs born to the ewe group with the lowest LW (≤49 kg) was lowest in our study.

In this study, although ewe's age did not significantly affect the SR of lambs at 60 and 120 days, SRs of lambs born to 2-year-old ewes were lower than those of other groups. Similar results were reported in different studies (3,19). Similarly, Morris et al. (2) reported that survival rate was consistently lowest in lambs of 2-year-old ewes at birth, while survival was lower among lambs of 2- and 5-year-old ewes and higher in lambs of 3- and 4-year-old ewes at preweaning.

A reason for this may be that although the average litter size of 2-year-old ewes is much smaller than that of adult ewes, the mortality rate of their lambs is greater. Two-year-old ewes generally have a poorer maternal instinct and do not always take care of their lambs immediately, leading to hypothermia (20).

**4.3. Live weights of lambs**

In this study, it was found that 60 and 120 day LWs of the lambs increased in proportion to the increase in LWs of ewes and that the highest lamb LW was observed in the lambs born to ewes with LWs of ≥65 kg. These findings were similar to the results of Ray and Smith (14) and Aliyari et al. (15). Those researchers reported that the increase in LWs of ewes resulted in parallel increase in the weaning weights of the lambs.

In this study, it was found that the ewes in the heaviest group produced lambs that weighed 6.3%, 30.1%, and 18.0% more in terms of BW and 60 and 120 day LWs, respectively, compared to the ewes in the group with the lowest weight. These values were 9% lower than the values reported by Ray and Smith (14) and 20% higher than the values reported by them for weaning weight. It was also found that a 1 kg increase in the LW of the WK sheep resulted in 6.4, 161, and 198 g increases in the BW and 60 and 120 day LWs of the lambs, respectively. The increase in the rate of growth for the lambs as a result of the increase in LW in WK ewes was found to be 100 g higher than that reported by Ray and Smith (14). In this study, lambs that had BWs equal to 7.08% of the LW of the ewes (57.6 kg) were produced and this value was similar to that (6.5%–10.6%) found by Donald and Russell (21) for ewes with LWs of 100 kg. From the ewes in the group with the highest LWs (≥65 kg), the lambs with the highest BWs were produced (4.22 kg). These results were similar to the results of the studies by Ray and Smith (14) and Aliyari et al. (15), which reported that ewes with the highest LWs produced the lambs with the highest BWs. Likely, the reason for this phenomenon was body fat source degradation for more milk production in heavy ewes.

In the present study, BWs and LWs of lambs at 60 and 120 days were not affected significantly by ewe's age. The results of some previous studies were similar (15,22,23) However, LWs of lambs born to 2-year-old ewes were significantly lower than others (14,15). The reason for this may be that mammary gland development of 2-year-old ewes is not sufficient to produce enough milk for their lambs.

**4.4. Lamb's sex and birth type**

The effects of a lamb's sex and birth type on the lamb's BW and LWs at 60 and 120 days were found to be highly significant ($P < 0.01$). Numerous studies have reported the superiority of male and single lambs in birth and weaning (24–27).

In conclusion, the results of this study showed that MBR, BW, and LWs of the lambs at 60 and 120 days were influenced by the LW of the ewe at mating in WK ewes, and these features were improved in proportion to the ewe's LW. We can also say that heavier ewes in most instances produce heavier lambs per ewe than lighter ewes at weaning in the WK breed. Therefore, to increase profitability in WK flocks, it can be recommended that the LWs of ewes at mating should be in a range of 60–70 kg. The maximum MBR can be expected in 4.5-year-old ewes weighing over 65 kg at mating in WK flocks in the conditions of Konya Province.

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