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Performance of village sheep flocks in Central Anatolia II. Fertility and productivity of ewes*

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Abstract: Performance data on fertility of ewes, pre-weaning mortality of lambs and productivity were collected during two years from 24 village flocks in Central Anatolia. The data included flocks with sheep from the Akkaraman and Merino breeds and their crosses. The overall means for lambing rate, weaning rate, twinning rate and pre-weaning lamb mortality were 92.1%, 89.8%, 4.8% and 6.9%, respectively. The fertility traits were significantly affected by genetic group, area where the flock was located and age of ewe and the lamb mortality by the first two effects. Merino ewes had a significantly higher fertility and twinning rate than the Akkaraman breed. Three types of productivity indices relating the litter weight at weaning to the weight of the dam were calculated and analyzed by the least-squares method. Systematic effects of flock, sex of litter and age of dam were highly significant ($p < 0.001$) for all three indices. Despite their higher fertility the productivity of Merino ewes was not significantly different from Akkaraman or crossbred. Highly significant productivity differences between flocks from the same area indicate influence of management and feeding and opportunities for an effective extension programme to reduce these differences.

Key Words: Lambing rates, Pre-weaning lamb mortality, Weaning rates, Productivity

Orta Anadolu'da köy sürülerinde koyunların performansları II. Anaç koyunlarda döl verimleri ve verimlilik

Özet: Orta Anadolu'da iki yıl boyunca 24 köy sürüsünden anaç koyunların verimleri, döl verimleri ve sütten kesimden önce kuzu ölümleri konusunda performans bilgileri toplanmıştır. Bu bilgiler Akkaraman ve Merinos ırkı koyunlar ve onların melezlerinden oluşan sürülerden alınan bilgileri oluşturmaktadır. Ortalama kuzulama oranı, sütten kesim oranı, ikizlik oranı ve sütten kesimden önce kuzu ölümleri oranı sırasıyla %92.1, %89.8%, %4.8 ve %6.9'dur. Döl verimliliği denemelerinde genetik grubun, sürünün bulunduğu bölgenin ve ananın yaşının etkisi önemlidir. Kuzu ölümleri de ilk ikisinden etkilenmiştir. Merinos anaların Akkaramanlardan daha yüksek döl verimliliği ve ikizlik oranları vardır. Sütten kesimdeki kuzu ağırlığı, ananın canlı ağırlığı ile ilgili olarak üç çeşit verimlilik bilgileri hesaplandı ve en küçük kareler (Least-square method) metodu ile analiz edildi. Sürünün yönetimiyle ilgili etkiler, doğan yavrunun cinsiyeti ve ananın yaşı gibi etkiler her üç konu için de önem taşımaktaydı. ($p < 0.001$). Merinos koyunların yüksek döl verimliliğine rağmen verimleri Akkaraman ve melezlerinin verimlerinden önemli bir fark göstermiyordu. Aynı bölge sürüleri arasında önemli verim farklılıklarının oluşu sürü yönetiminin ve beslenmenin etkisini anlatırken bu farklılıkların azaltılması için etkili bir eğitim ve yayım hizmetinin gerekliliğini belirtmektedir.

Anahtar Sözcükler: Kuzulama oranı, Sütten kesim öncesi kuzu ölümü, Sütten kesim oranı, verimlilik

Introduction

The identification of factors which are limiting productivity is an important step in the development of sheep production systems. Good fertility largely contributes to high productivity and is influenced by the conception rates, the litter size and mortality rates of lambs. The combination of fertility and pre-weaning growth performance in a productivity index provides good opportunity to judge different sites and production systems. Data on growth performance and description of the production systems from a pilot study in village flocks of the Konya and Karaman provinces were reported in an

earlier paper (1). This paper reports on the fertility and overall productivity in the same flocks. The results are relevant for the improvement of sheep production in large areas of the Central Anatolian Highland.

Materials and Methods

Fertility data were collected during two years from 24 village flocks with a total number of 2856 ewes. The flocks represent five areas and three genetic groups of sheep (Akkaraman, Merino and crosses between the two). With the exception of one additional flock from the

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Center area, the flocks were identical to those described earlier (1). All ewes of the flocks under study were ear-tagged and age was determined by examination of teeth. Recording of lambing dates was carried out by the farmers and controlled by the extension staff during fortnightly visits. Weaning weight of lambs and weight of ewes were taken by the extension staff close to the time when milking of ewes started. The lambing season in the study area spreads from December to April and age at first lambing is two years. All flocks under study used their own rams for mating. Fertility performance was calculated by including all ewes which were present in the flocks both during the mating and the lambing seasons of the respective years. The fertility traits examined were lambing rate, the number of lambs born per ewe mated, weaning rate, twinning rate and pre-weaning mortality rate of the lambs. Mortality rates were calculated from the difference between lambs born and lambs weaned. The differences between the results for the genetic groups, the areas within the Akkaraman flocks, the ewes with different age and the two recording years were evaluated by χ^2 -test.

For a sub-sample from 21 flocks, three types of productivity indices were calculated, considering that income in the studied production systems is mainly from sale of young lambs. The productivity indices were formulated as follows:

Index 1: Litter weight at 2 months of age (calculated for all ewes present during the lambing season)

Index 2: Index 1 * weight of dam at weaning⁻¹

Index 3: Index 1 * metabolic weight of dam at weaning (weight^{0.73})⁻¹

The weight of lambs at 2 months of age was calculated from the recorded weaning weights and the individual pre-weaning growth rate of the lamb. Indices for individual animals were zero for ewes not lambing or when lambs died before weaning. Productivity indices were analyzed by the least-squares method (2) with a mixed model. Effects of genotype and area were combined into a group of factors. Flock effects were considered random and nested within the group of factors. The models used for analysis of productivity indices were as follows:

$$Y_{ijklmn} = \mu + G_i + F_{ij} + A_k + M_l + S_m + e_{ijklmn}$$

Where Y_{ijklmn} = estimated value, μ = population mean, G_i = fixed effect of genotype-area-group, F_{ij} = random

effect of flock nested within group, A_k = fixed effect of age of ewe (2, 3, 4, 5 > 5 years), M_l = fixed effect of season of birth (until Dec., Jan., Feb., March and later) S_m = fixed effect of sex (male, female) and e_{ijklmn} = random error.

The average litter size of the three genetic groups was very different. Litter size was therefore considered as a distinct characteristic of the respective genetic groups and not included in the model. Both sex codes were evenly allocated for barren ewes and for those with bisexual litter. Differences within variables were evaluated by t-test.

Results

Lambing Rates

The average lambing rate from the recorded flocks was 92.1%. There were significant influences of genotype, area and age of ewe on lambing rates, but none of year (Table 1). Merino ewes had the highest average lambing rate (97.8%), followed by the crossbred (92.2%) and Akkaraman (91.7%) ewes. There were clear differences between areas and within areas between individual flocks (Figure 1). Possible reasons for the poorer lambing rates in the Center area are larger flock size and the late mating season. The lowest performance (88.0%) was recorded for the first lambing ewes. With increasing age of ewe, lambing rates improved until the age of 5 years, but decreased again for the older ewes.

Litter Size

The litter size is characterized by the twinning rate and the ratio between ewes mated and lambs born (Table 1). The systematic influences of genotype, area and age of ewe were highly significant ($p < 0.01$) for both traits. Twins were rarely born from Akkaraman ewes (2.4%), but at significantly higher rates from Merino (25.8%) and crossbred ewes (27.1%). The distinctly higher twinning rates from Akkaraman ewes in the Center-West (8.6%) and West (9.3%) areas demonstrate the effects of intensive management. Age of ewe effects on twinning rate were in the same direction as for lambing rate, resulting in a clear and significant influence of age of ewe on the number of lambs born.

Pre-weaning Lamb Mortality

The average pre-weaning mortality rate from 3529 lambs, born during the study period was 6.9%. There were distinct differences between the areas (Table 1) and between the flocks within areas (Figure 2). Similar to the results for lambing rate, the flocks in the Center and East areas had the poorest performance. Losses from

VARIABLE	PER 100 EWES MATED				PREWEANING	
	EWES MATED	EWES LAMBING	LAMBS BORN	LAMBS WEANED	TWINNING RATE%	MORTALITY RATE%
GENERAL MEAN	3656	92.1	96.5	89.8	4.8	6.9
GENOTYPE						
- Akkaraman	3298	91.7 ^a	93.9 ^a	87.8 ^a	2.4 ^a	6.5a
- Crossbred	128	92.2 ^a	117.2 ^b	100.0 ^b	27.1 ^b	14.7b
- Merino	230	97.8 ^b	123.0 ^b	113.0 ^c	25.8 ^b	8.1a
AREA (Akkaraman only)						
- Center	1544	90.3 ^a	90.9 ^a	83.4 ^a	0.7 ^a	8.3a
- South	387	94.8 ^b	96.9 ^b	93.8 ^b	2.2 ^b	3.2b
- East	827	91.9 ^{ab}	93.1 ^a	86.6 ^c	1.3 ^{ab}	7.0ab
- Center-West	468	93.8 ^b	101.9 ^c	98.3 ^d	8.6 ^c	3.5b
- West	72	88.9 ^{ab}	97.2 ^{ab}	95.8 ^{bd}	9.3 ^c	1.4b
AGE OF EWE						
- 2 Years	458	88.0 ^a	88.2 ^a	84.1 ^a	0.2 ^a	4.6
- 3 Years	502	91.6 ^{ab}	95.2 ^b	89.2 ^{bc}	3.9 ^b	6.3
- 4 Years	1138	93.1 ^b	98.5 ^c	91.4 ^c	5.8 ^b	7.2
- 5 Years	943	94.2 ^b	100.2 ^d	93.0 ^c	6.4 ^b	7.2
> 5 Years	615	90.7 ^{ab}	94.5 ^b	86.7 ^{ab}	4.2 ^b	8.3
YEAR		n.s.	n.s.	n.s.	n.s.	n.s.
- 1990	2858	92.4	96.5	89.6	4.4	7.2
- 1991	798	91.0	96.5	90.6	6.0	6.1

Table 1. Fertility traits of village sheepflocks in Central Anatolia (Means and Significance of X²-Test)

Means with no common letter are significantly different (p<0.05) by X²-Test, Significance levels: n.s. not significant, * p<0.05, ** p<0.01

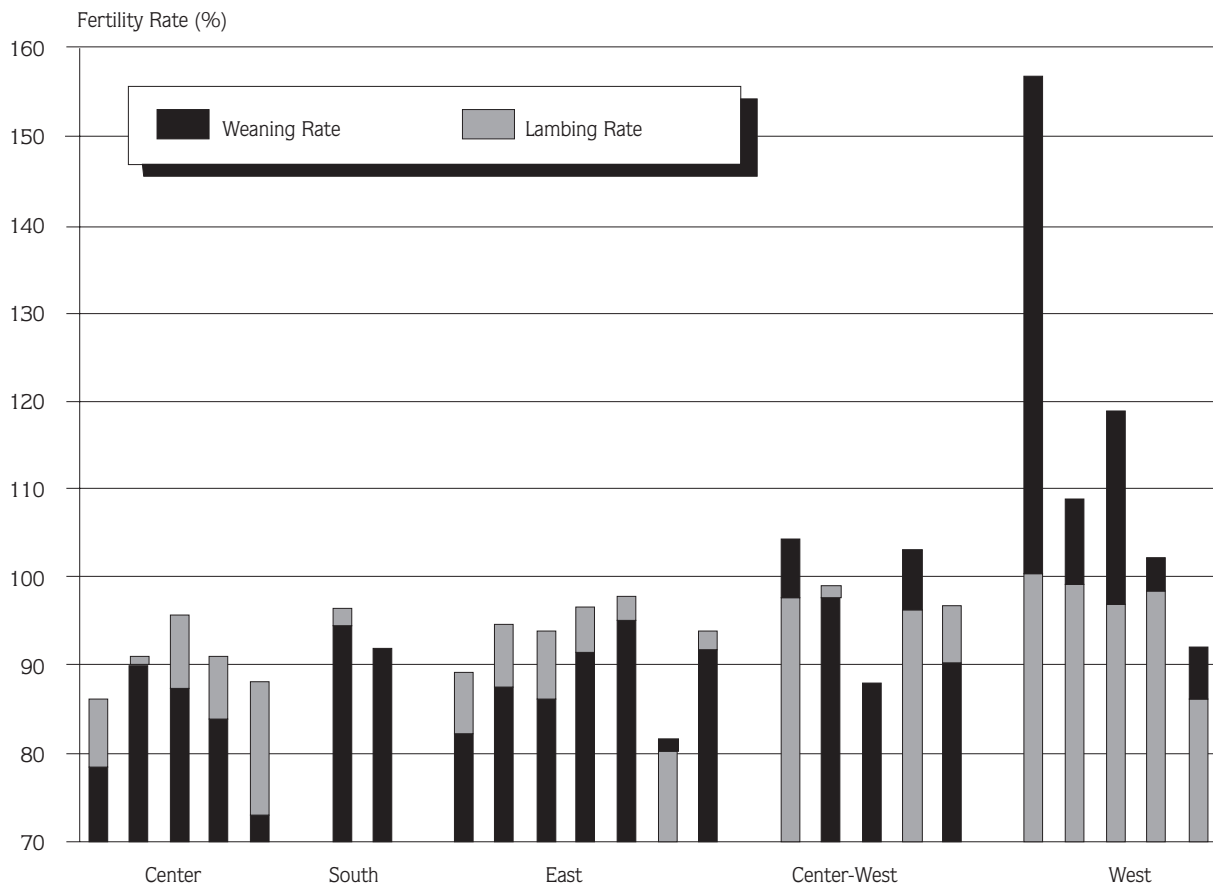


Figure 1. Fertility traits in flocks from different areas

Akkaraman lambs were lowest (6.5%) followed by Merino (8.1%) and lambs out of crossbred ewes (14.7%). The higher losses for the last group, however are mainly the result of two problem flocks which may bias the results. There were seasonal influences on mortality rates, causing higher losses in December (8.4%) and January (8.5%) than in February (6.2%) and March (6.8%). Type of birth had a highly significant ($p < 0.01$) effect on mortality, with losses from multiple lambs being higher (11.8%) than those from single lambs (6.6%). It was not possible to investigate the influence of sex on perinatal losses, because information about sex of dead lambs was usually not recorded. There were, however no sex differences for postnatal losses.

Weaning Rate

The weaning rate is a combination of the fertility traits discussed before. The average weaning rate in the studied flocks was 8.9%. There were highly

significant ($p < 0.01$) influences of genotype, area and age of ewe with similar direction, but greater magnitude than for lambing rate. Weaning rates for Akkaraman, crossbred and Merino ewes were 87.8%, 100% and 113%, respectively. The highest fertility was achieved by the five years old ewes (93.0%), the lowest by those lambing for the first time (84.1%). Apart from age effects, culling of the unproductive animals may have contributed to the better performance of the older ewes. The better performance in the flocks from the Center-West and West areas (Figure 2) were partly caused by Merino and crossbred ewes, but as shown by the results for the Akkaraman ewes (Table 1) also by better management. Sheep production in the Center and East areas is practiced with larger flocks and lower intensity, while the opposite is true for the western parts of the Konya province. The fertility levels clearly reflect these different approaches.

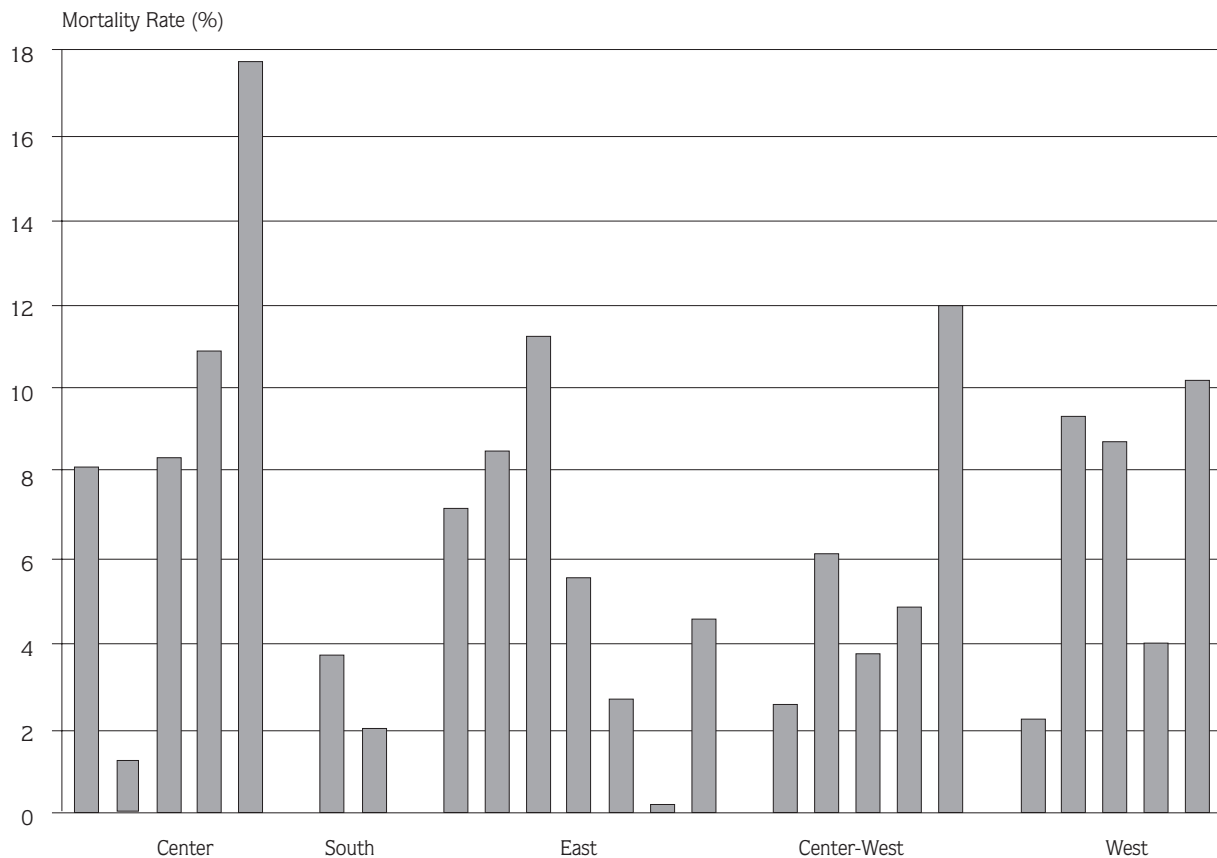


Figure 2. Prewaning mortality in flocks from different areas

Productivity

Analysis of variance results for the three productivity indices and estimated least-squares means are given in Table 2. Adjusted values for indices I, II and III were 16.0 kg, 0.364 and 1.008. Effects of flock, age of ewe and sex of litter were highly significant for all three indices. The grouped influences of area and genotype were not significant, although there were large differences between the groups for Index 1. The large superiority of the Merino and crossbred ewes expressed in the Index'1 is completely lost when weight of ewe is being considered in the two other indices. The best overall productivity was recorded from the flocks with good fertility and low bodyweight of ewes in the southern area, the lowest from the large flocks in the Center area. The influences of age of ewe and sex of litter were consistent for all three indices. The best performance was achieved with ewes between three and five years of age, while those of younger and older ewes were significantly lower. Ewes with male litter always had a better productivity. The

season of lambing had no significant influence on productivity indices. There were large differences between the unadjusted means for ewes with different types of parturition. Ewes giving birth to twins had between 48.7% (Akkaraman, 1.58 vs. 1.06) and 66.1% (Merino, 1.61 vs. 0.97) higher Productivity (Indices 3), than the ewes with one lamb.

Discussion and Conclusions

All investigated fertility traits of the selected village flocks show a high performance level. The observed lambing rates were as good or better than the results reported for Akkaraman and Merino sheep from Government farms in Central Anatolia and a private farm in northern Anatolia (3, 4, 5, 6). They also compare favorably with results from other sheep producing countries with similar environmental conditions (7, 8, 9). Ewes which left the flock between the mating and lambing season were not included in the calculation of

VARIABLE	N	Index 1 (kg)		Ewe Weight	Index 2		Index 3	
		$\mu+c$	s($\mu+c$)	($\mu+c$)	($\mu+c$)	s($\mu+c$)	($\mu+c$)	s($\mu+c$)
GENERAL MEAN	1886	16.0	1.37	43.5	0.364	0.0209	1.008	0.0651
AREA-GROUP		n.s.		***	n.s.		n.s.	
- Center	416	12.4	3.69	34.8 ^a	0.349	0.0559	0.915	0.1745
- South	233	15.3	3.06	37.2 ^b	0.408	0.0468	1.085	0.1454
- East	484	13.1	1.79	35.4 ^a	0.375	0.0277	0.977	0.0856
- Center-West	400	16.6	2.27	44.1 ^c	0.371	0.0350	1.034	0.1085
- West	73	17.5	2.34	51.0 ^d	0.338	0.0390	0.975	0.1163
- Crossbred	105	17.5	1.87	47.3e	0.340	0.0309	1.003	0.0930
- Merino	175	19.5	2.65	54.8f	0.367	0.0411	1.069	0.1269
AGE OF EWES		***		***	**		***	
- 2 Years	236	14.0 ^a	1.43	39.9 ^a	0.338 ^a	0.0234	0.920a	0.0708
- 3 Years	224	16.6 ^b	1.43	43.0 ^b	0.384 ^b	0.0234	1.065b	0.0708
- 4 Years	594	16.8 ^b	1.38	45.0 ^c	0.373 ^b	0.0216	1.039b	0.0664
- 5 Years	528	17.2 ^b	1.39	45.5 ^c	0.380 ^b	0.0218	1.060b	0.0670
> 5 Years	304	15.4 ^c	1.41	44.2 ^d	0.344 ^a	0.0228	0.958a	0.0069
SEX OF LITTER		***		n.s.	***		***	
- Male	926	16.7 ^a	1.37	43.5	0.381 ^a	0.0213	1.054a	0.0659
- Female	960	15.3 ^b	1.37	43.5	0.347 ^b	0.0213	0.963b	0.0658
SEASON OF LAMBING		n.s.		**	n.s.		n.s.	
≤ December	137	16.6	1.51	43.9 ^{ab}	0.357	0.0266	1.004	0.0781
- January	436	15.5	1.40	42.7 ^b	0.357	0.0226	0.988	0.0687
- February	817	15.7	1.38	43.1 ^b	0.365	0.0218	1.006	0.0669
≥ March	496	16.2	1.41	44.3 ^a	0.377	0.0228	1.036	0.0694
FLOCK: GROUP		***			***		***	

Means within variables having no common letters are significantly different ($p < 0.05$).

Significance levels: n.s. not significant, ** $p < 0.01$, *** $p < 0.001$

Table 2. Results from analysis of variance and LSQ-means for weight of ewes (kg) and productivity indices (for definition of indices see text)

fertility traits and it is possible that some of them were barren. However, this factor could have had only a marginal effect on the calculated fertility rates, because the total number of such ewes was small. The very high lambing percentage for the Merino ewes results from small flocks which feed a high amount of concentrates (1). They are also those flocks which achieve the highest twinning percentage (Figure 1). Twinning in the Akkaraman breed is low and normally not wanted by the farmers in the study area. The average twinning percentage of 2.4 for the Akkaraman ewes of the selected flocks was even lower than earlier reported for other Akkaraman flocks (3, 10). The significantly higher twinning performance for the Akkaraman ewes in the western district of Konya show the effect of higher management levels on this trait. Although none of the investigated flocks practiced planned supplementary feeding during the mating season (flushing), it is known that higher ewe live weight and better body condition can also increase ovulation rate (11) and thus the chances for multiple births. Earlier reports about twinning rates of Anatolian Merino show a considerable variation between flocks (4, 5, 12). With the exception of one flock, the twinning results for Merino and crossbred from this investigation were at the lower end of the range of earlier results. Conception rates and litter size of the ewes in the village flocks increased until the age of five years and dropped again with higher ages. Age of ewe effects on the studied fertility traits were also observed in other studies (4, 7, 8, 9, 12). The average pre-weaning mortality rate of lambs from the villages was slightly higher than those reported from Government farms in Türkiye (4, 13, 14). No single main cause could be identified for the pre-weaning lamb mortality. However, it is very likely that the large variation in mortality rates of lambs between the individual flocks (Figure 2) is

caused by a combination of different management practices and/or knowledge of the responsible flock owners or shepherd. Productivity indices comparable to this study have not yet been reported from other Turkish sheep flocks. For Index I, results from other countries with similar production conditions are either close (7, 8) or substantially lower (9) than in the studied flocks. In the two studies with the similar production level age of ewe effects on productivity were also highly significant and showed the same trend as in this investigation (7, 8).

The study clearly shows that age of ewe and flock effects have the greatest influence on fertility and productivity traits of Central Anatolian village sheep flocks. According to the results it seems not advisable to maintain ewes beyond the age of five years. The highly significant differences between flocks from the same area indicate influences of management and feeding and opportunities for an effective extension programme to reduce these differences. Although the fertility for Merino ewes under the studied conditions was significantly higher, keeping sheep of this breed does not increase productivity. If a large proportion of the necessary higher feed inputs has to come from expensive concentrates maintaining Merino may even be a disadvantage unless the lambs could be sold at a substantial higher price per kilogram of live weight. Any further promotion of Merino sheep in Central Anatolia should therefore carefully considered.

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