

## Settled and nomadic breeding of Karya sheep

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### Abstract

Records of five settled and five nomadic sheep enterprises in Karya-2, a sub-project of the “National Ovine Breeding by Public” project carried out by the General Directorate of Agricultural Research and Policies of Denizli Province, Turkey, were examined in this study. In nomadic and settled enterprises, birth weights, 90-d live weights, 180-d live weights, 90-d daily live weight increase, and daily live weight increase up to 180 d were different. Birth types were different and the twin birth rates were higher in nomadic enterprises. The Karagoz type was more common. The proportion of male and female newborn lambs was similar. The nomadic breeders tended to separate the sheep in the herd more than the settled sheep; the number of animals devoted to breeding in the nomadic systems was found to be higher than in settled systems. The number of lambs per ewe decreased slightly over time from 2014–2018. Although the number of rams decreased, the number of breeding rams increased. There was no marked change in survival rate during the weaning period. There was an increase in live weight and fertility of Karya sheep from 2014–2018. The production averages of sheep in nomadic enterprises were more profitable and yields of measured parameters were higher than in the settled sheep enterprises.

**Keywords:** Karya, nomadic, settled, fertility, breeding

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### Introduction

Proper reproductive management is a critical factor for the sustainability of the sheep industry worldwide. Ewes can produce two or more offspring annually, yet routinely fall short of this benchmark. Refined management, strategic genetic selection, and consistent supply are priorities for sustainable small ruminant production. Sheep are capable of survival in a wide variety of climates and environments and enhance agricultural production in both developed and underdeveloped regions of the world (Redden & Thorne, 2020).

Türkiye is a country suitable for sheep breeding in terms of its geographical structure and climatic characteristics. Due to their religious convictions, Turkish people meet their animal product needs from cattle, sheep, goats, and poultry. The preference for sheep meat, cheese, and yogurt among Turkish people has emphasized the importance of sheep breeding (Tekin & Akçapınar, 1994; Akçapınar, 2000; Kaymakçı, 2006).

Extensive breeding systems are preferred over intensive systems. Breeders migrate the sheep to various pastures at certain months of the year; they move to more temperate regions in winter and to pastures in spring and summer. Breeders do not give extra feed to their animals; they try make livestock breeding a more profitable activity by feeding very little depending on the conditions of the pasture, pregnancy, and birth status of the animals (Atasoy *et al.*, 2003).

Social structures of group-living farm animals can have important implications for animal welfare and productivity. Understanding which factors have an effect on behaviour is thus important in developing the best management strategies in livestock industries (Ozella *et al.*, 2020). This study considers the behaviour and breeding styles in settled and nomadic sheep breeding systems, the two systems prevalent in Türkiye. Nomadic sheep breeding, which is not very common, is gradually being phased out. Nomadic breeders migrate to the provinces which are warmer and where there are grassy pastures from November–May. Usually, at the end of May, they come to the provinces where they are registered and continue their sheep breeding activities in the highlands. In settled breeding, breeders take their sheep from the barn to the pasture to graze and then bring them back to the barn in summer and winter without moving them anywhere (Dönmez, 2008).

Nomadic sheep farming, from an economic perspective, is a sustainable system, in addition to generating more income. It is a traditional lifestyle that has been adopted by the majority of the population in rural areas in Turkey. With migration and socio-economic changes in big cities, economic problems occur (Yılmaz *et al.*, 2014). Nomadic animal breeding is generally carried out in areas that are not suitable for agriculture. It is important to select suitable regions for the sustainability of nomadic animal breeding (Keskinçilic, 2019). The role of nomadism in livestock farming as a source of income, contribution to the country's economy, and in sustainability of small livestock farming is important and it is a culture that should be taken into consideration (Yılmaz *et al.*, 2020).

The Karya breed, which is considered to have high milk and reproductive efficiency, was obtained from the cross-breeding of the Cine Caparı sheep, which was common in the Aydın region in the past, with Sakız × Kivırcık cross-bred rams. The Karya breed is common in the plains where synthetic-type maintenance and feeding conditions are better. In this breed, the body colour is white, but the eyes, ear tips, and feet are usually black. Depending on the rearing conditions, the average lactation milk yield is 90–150 L and the lactation period is 180 d. The number of lambs at birth varies from 1.33–1.76 (Karaca *et al.*, 1999; Karaca *et al.*, 2000; Karaca & Cemal, 2002). Of the growth characteristics, birth weight is 4 kg, weaning age is 90 d, weaning weight is 40–50 kg, adult weight is 75–90 kg in males, 60–75 kg in females, and age at first breeding is 12 m. In terms of carcass characteristics, daily live weight gain is 217 g, live weight (3–3.5 months) is 40–50 kg, carcass weight (3–3.5 months) is 18–20 kg and carcass yield is 48–50%. Meat quality of the Karya breed is good. The marbling score is 2, which is quite high. This gives the meat flavour, juiciness, and maturity (Anonymous, 2023)

Karya-2, which is the sub-project of the "National Sheep Breeding Project", which is being carried out under the coordination of the General Directorate of Agricultural Research and Policies in various provinces of Turkey, was carried out in the Serinhisar and Tavas districts of the city of Denizli. Since 2014, records related to date of birth, number of lambs, sex of lamb, lamb weight, lamb number, lamb type, and rate of culling have been registered within 12 h. In addition, the project technical staff responsible for the project weighed and recorded the lamb weights with a precision scale based on their average age of 90 d and 180 d.

The current study was conducted in order to determine which of the nomadic and settled systems of Karya sheep breeding was more productive, with the intention of it being more profitable. Knowing the live weight gain of Karya sheep, especially lambs, can inform proper breeding and management to contribute to the country's economy.

## Materials and Methods

In this study, yield records from five nomadic and five settled sheep breeding farms in Denizli province were compared. Birth weights, gender, date of birth, type of birth, stillbirth rate, type characteristics (Capar, Beyaz, Karagoz), lifespan, 3- and 6-m live weights of lambs were recorded on these farms. Previous records of the farms taken between the years of 2011 and 2016 were used and the records of 3517 lambs in the nomadic farms and 3150 lambs in the settled farms for the period 2016–2018 were examined. In the birth certificates provided to the breeders, the sheep number, lamb birth date, number of lambs born, gender of the lamb, lamb birth weight, lamb number, and lamb type were filled in by the breeder within twelve hours of the lamb being born. Birth weight was measured using a hand scales to a precision of 10 g. Twelve hours after the lamb was born, the breeder weighed the lamb and recorded its weight on the birth registration form. The weights of the 90-d and 180-d lambs were recorded using scales with a precision of 50 g. Animals suitable for breeding were selected.

Lambs were taken to the lamb rearing section where smart feeders were located after staying with their mother in the birth rooms for 1–2 d. They were brought together with their mothers for sucking twice a day, once in the morning and once in the evening, and were fed with concentrated feed (barley, corn ready-made feed) and a very small amount of roughage (alfalfa, barley straw) until they reached the slaughter age.

The *t*-test was used for statistical calculations of the independent samples of the groups (nomadic or settled) and for the significance of the differences between the average values of the groups. Regressions were examined and analysed according to the least squares mean method to determine the effects of factors affecting birth weight and live weight in other periods.  $P < 0.05$  and  $P < 0.001$  were considered statistically significant,  $P > 0.05$  was considered not significant. The SPSS 23.0 statistical package program was used for this purpose.

## Results and Discussion

The average birth weight of 3859 lambs in the nomadic sheep breeding farms was found to be  $4.24 \pm 0.01$  kg, and the average birth weight of 2790 lambs in the settled sheep breeding farms was  $4.33 \pm 0.01$  kg. The average weight of 3873 lambs on at 90-d was  $30.40 \pm 0.12$  kg in the nomadic sheep breeding farms and  $29.47 \pm 0.14$  kg in the settled sheep breeding farms. The difference between weaning weights in nomadic and settled sheep breeding farms was found to be significant ( $P < 0.001$ ). The average 180-d weight of 735 lambs in the nomadic sheep breeding farms was found to be  $31.42 \pm 0.23$  kg, and the average 180-d weight of 508 lambs in the settled sheep breeding farms was  $37.88 \pm 0.31$  kg. The difference between lamb birth weights, 90-d, and 180-d weights in the nomadic and settled sheep breeding farms was found to be significant ( $P < 0.001$ ) (Table 1).

**Table 1** The difference between lamb birth weights, 90-d (weaning period) and 180-d live weights in the nomadic and settled sheep breeding farms in Denizli Province, Turkey

Environmental Factors	N	$\bar{x} \pm S\bar{x}$	Minimum	Maximum
Type of Enterprise	***			
Nomadic	3859	4.24+0.0116	1.97	7.38
Settled	2790	4.33+0.0158	2.09	7.51
90-d Live Weights	***			
Nomadic	3873	30.4071+0.1243	15.00	44.95
Settled	2795	29.4722+0.1454	15.00	44.95
180-d Live Weights	***			
Nomadic	735	41.4230+0.2325	26.50	79.10
Settled	508	37.8876+0.3193	21.80	75.70

\*\*\*:  $P < 0.001$

Average daily live weight gain (90-d) of 3851 lambs until weaning was found to be  $0.27 \pm 0.00$  kg in the nomadic sheep breeding farms, and  $0.24 \pm 0.00$  kg in the settled sheep breeding farms. The average daily live weight gain of 732 lambs until 180-d in the nomadic sheep breeding farms was found to be  $0.17 \pm 0.00$  kg and in the settled sheep breeding farms; the average daily live weight gain of 505 lambs up to 180-d was found to be  $0.15 \pm 0.00$  kg. Daily live weight gains up to 90-d and 180-d in the nomadic and settled sheep breeding farms were different ( $P < 0.001$ ) (Table 2).

**Table 2** Daily live weight gains of lambs up to 90-d and 180-d in nomadic and settled sheep breeding farms in Denizli Province, Turkey

Environmental Factors Examined	N	$\bar{x} \pm S\bar{x}$	Minimum	Maximum
90-d Average Daily Live Weight Gain	***			
Nomadic	3851	0.2787+0.0009	0.0929	0.6733
Settled	2786	0.2461+0.001	0.0890	0.5421
180-d Average Daily Live Weight Gain	***			
Nomadic	732	0.1791+0.0014	0.0868	0.3595
Settled	505	0.1550+0.0016	0.0754	0.3195

\*\*\*:  $P < 0.001$

Between 2014 and 2018, the birth rate (54.04%) was higher in the nomadic sheep (more twins by 28.64%) than in the settled sheep (45.96%) (26.16% of them were single births) in 2014  $P < 0.001$  (Table 3). In 2015, the birth rate was 55.59% (more single births by 28.15%) in the nomadic sheep and

44.41% (26.57% of them were single births) in the settled sheep ( $P < 0.001$ ). In 2016, the birth rate was 55.25% (more twin births by 32.87%) in the nomadic sheep and 44.75% (24.00% of them were single births) in the settled sheep ( $P < 0.001$ ). In 2017, the birth rate was 64.75% (more twin births by 33.46%) in the nomadic sheep and 35.25% (10.01% of them were single births) in the settled sheep ( $P < 0.001$ ). In 2018, the birth rate was 60.49% (more twin births by 30.14%) in the nomadic sheep and 39.51% (22.43% of them were single births) in the settled sheep ( $P > 0.05$ ).

**Table 3** Types of births and number of lambs in nomadic and settled sheep breeding farms in Denizli Province, Turkey

Year		Number of lambs				Total	%	Difference
2014	Type	1	2	3	4			***
	Nomadic	334	415	30	4	783		
	%	23.05	28.64	2.02	0.28		54.04	
	Settled	379	264	22	1	666		
	%	26.16	18.22	1.52	0.07		45.96	
2015	Nomadic	322	289	25	0	636		***
	%	28.15	25.26	2.19	0.00		55.59	
	Settled	304	194	10	0	508		
	%	26.57	16.96	0.87	0.00		44.41	
2016	Nomadic	272	426	18	0	716		***
	%	20.99	32.87	1.39	0.00		55.25	
	Settled	311	255	14	0	580		
	%	24.00	19.68	1.08	0.00		44.75	
2017	Nomadic	389	448	22	8	867		***
	%	29.05	33.46	1.64	0.60		64.75	
	Settled	134	303	30	5	472		
	%	10.01	22.63	2.24	0.37		35.25	
2018	Nomadic	424	434	13	0	871		
	%	29.44	30.14	0.90	0.00		60.49	Not Significant
	Settled	323	233	12	1	569		
	%	22.43	16.18	0.83	0.07		39.51	

\*\*\*:  $P < 0.001$ , Not Significant:  $P > 0.05$

From 2014–2018, 2044 female and 1829 male lambs were born out of a total of 3517 lambs on the nomadic sheep farms and 1473 female and 1321 male lambs were born from a total of 3150 lambs on the settled sheep farms (Table 4;  $P > 0.05$ ). Proportions of sexes were similar: 58.09% in the nomadic sheep and 41.91% in the settled sheep ( $P > 0.05$ ).

**Table 4** Difference between the sexes in the nomadic and settled sheep breeding farms in Denizli Province, Turkey

		Female (n)	Male (n)	Total	%	Differences
Type	Nomadic	2044	1829	3517		
	%	30.66	27.43		58.09	Not Significant
	Settled	1473	1321	3150		
	%	22.09	19.81		41.91	

Not Significant:  $P > 0.05$

In the period between 2014 and 2018, the types were different: 58.08% (Karagoz 41.21%) in the nomadic sheep breeding farms and 41.92% (Karagoz 29.80%) in the settled sheep breeding farms ( $P < 0.001$ ) (Table 5).

**Table 5** Proportional difference between the types in the nomadic and settled sheep breeding farms in Denizli Province, Turkey

		Beyaz	Karagoz	Capar	Total	%	Differences
Type	Nomadic	886	2748	239	3873		***
	%	13.29	41.21	3.58		58.08	
	Settled	724	1987	84	2795		
	%	10.86	29.80	1.26		41.92	

\*\*\*:  $P < 0.001$

The characteristics of the sub-types of lambs the farms in the period between 2014 and 2018 were different; the number of Karagoz sheep in the nomadic farms was higher than in the settled farms ( $P < 0.05$ ) (Table 6).

**Table 6** General state of the sub-types in settled and nomadic sheep farms in Denizli Province, Turkey by year from 2014 to 2018

Year	Type	Beyaz	Karagoz	Capar	Total	%	Differences
2014	Nomadic	228	493	62	783		*
	%	15.73	34.02	4.28		54.04	
	Settled	198	446	22	666		
	%	13.66	30.78	1.52		45.96	
2015	Nomadic	179	403	54	636		*
	%	15.65	35.23	4.72		55.59	
	Settled	136	352	20	508		
	%	11.89	30.77	1.75		44.41	
2016	Nomadic	173	504	39	716		*
	%	13.35	38.89	3.01		55.25	
	Settled	150	419	11	580		
	%	11.57	32.33	0.85		44.75	
2017	Nomadic	168	646	53	867		*
	%	12.55	48.24	3.96		64.75	
	Settled	122	334	16	472		
	%	9.11	24.94	1.19		35.25	
2018	Nomadic	138	702	31	871		*
	%	9.58	48.75	2.15		60.49	
	Settled	118	436	15569	1440		
	%	8.19	30.28	1.04		39.51	

\*:  $P < 0.05$

Between 2014 and 2018, the number of lambs allocated for breeding was 596 in the nomadic farms and 455 in the settled farms; more animals were allocated for breeding in nomadic farming (Table 7).

**Table 7** Number of lambs kept for breeding in nomadic and settled sheep farms in Denizli Province, Turkey

	Type	N	%
Animals kept for breeding	Nomadic	596	56.71
	Settled	455	43.29
	Total	1051	100.00

When the rate of culling was analysed by year, 56.29% were culled on nomadic sheep farms and 43.71% on the settled sheep farms in 2014. Culling was more common in the nomadic sheep farms (Table 8).

When the rate of culling was examined by year, culling in nomadic sheep farms was found to be 62.10% in 2017 and 72.78% in 2018. Compared to the other years, more sheep were culled in the nomadic sheep farms from 2017–2018.

**Table 8** Culling of the lambs born in the nomadic and settled sheep farms in Denizli Province, Turkey

Year	Type	N	%	Destroyed	Dead	Sold
2014	Nomadic	474		1	6	467
	%		56.29	0.12	0.71	55.46
	Settled	368		2	1	365
2015	%		43.71	0.24	0.12	43.35
	Total	842	100.00	3	7	832
	Nomadic	534		0	0	495
2016	%		58.62	0.00	0.00	54.34
	Settled	377		0	3	374
	%		41.38	0.00	0.33	41.05
2017	Total	911	100.00	0	3	869
	Nomadic	510		0	0	510
	%		60.93	0.00	0.00	60.93
2018	Settled	327		4	2	321
	%		39.07	0.48	0.24	38.35
	Total	837	100.00	4	2	831
2019	Nomadic	652		0	3	649
	%		62.10	0.00	0.29	61.81
	Settled	398		2	7	389
2020	%		37.90	0.19	0.67	37.05
	Total	1050	100.00	2	10	1038
	Nomadic	393		0	0	393
2021	%		72.78	0.00	0.00	72.78
	Settled	147		0	1	146
	%		27.04	0.00	0.19	27.04
2022	Total	540	100.00	0	1	539

From 2014–2018, a higher rate of culling was seen in the nomadic sheep farms. The number of lambs per ewe was 1.32 and the survival rate during the weaning period was 94.9% in 2014; the number of lambs per ewe was 1.29 and the survival rate during the weaning period was 91.0% in 2015. The number of lambs per ewe was 1.36 and the survival rate during the weaning period was 91.2% in 2016; the number of lambs per ewe was 1.39 and the survival rate during the weaning period was 96.9% in 2017. In 2018, the number of lambs per ewe was 1.26 and the survival rate during the weaning period was 92.3% (Table 9).

Sezenler *et al.* (2013) found that the average birth weight of the lambs raised in multiplier and base sheep flocks of Karacabey Merino Sheep from 2007–2009 was 3.51, 3.58, 3.70 and 3.95 kg, respectively. Ceyhan *et al.* (2007) found birth weights of Kıvrıcık, Gökçeada, and Chios lambs was 4.09, 3.52 and 3.93 kg, respectively. These findings were different from the findings of the current study. This might be because of the differences between the breeds. Yılmaz (2008) found a birth weight of 3.99 kg in singles and 3.16 kg in twins in a study conducted at two different times in breeder conditions, which was similar to the current study.

In the study conducted by Yakan *et al.* (2012), 42 Akkaraman, 28 Awassi, and 25 Kıvrıcık sheep and their lambs were used. The mean of least squares of birth weights of lambs in the same genotype were found to be 4.50, 4.40, and 4.34 kg, respectively ( $P > 0.05$ ). Esenbuğa & Dayıoğlu (2002) found the birth weight of Morkaraman lambs to be 4.03 kg in their study in Morkaraman herds, showing

similarities with the current study. In the study performed by Yaralı (2004) on Kıvırcık lambs, an average of 3.36 kg lamb birth weight was found, which is different from the current study. This might be because of the differences of the breeds.

Ceyhan *et al.* (2009) found an average birth weight of 4.01 kg in the lambs of Blackhead Merino (German Blackhead Meat × Karacabey Merino G1) meat-type ewes. Canatan *et al.* (2012) found the birth weight of the lambs obtained from Dağlıç ewes fertilized by Dağlıç, Hasmer, and Hasak rams from 2010–2011 as  $3.30 \pm 0.03$ ,  $4.23 \pm 0.04$ , and  $4.09 \pm 0.03$  kg, respectively. In the study carried out by Ağıdacı (2013), the average birth weights were found to be 4.088, 3.764, 4.198, 3.477, 4.244, and 4.121 kg in Pırlak sheep raised on six different farms. These findings were similar to the findings of the current study.

In the study conducted by Akbulut *et al.* (2012), the average birth weight of Dağlıç lambs raised under extensive conditions was found to be  $3.30 \pm 0.04$  kg. Özbey & Akçan (2003) found the birth weights of Morkaraman, Kıvırcık × Morkaraman, and Chios × Morkaraman crossbred lambs to be 3.25 kg, 3.25 kg, and 3.26 kg, respectively. These findings in the literature are different from the findings of the current study. This might be due to the different breeds used in the studies.

In the study conducted by Bayar (2015), the least square averages for daily average milk yield, lactation duration, and lactation milk yield were determined as 615.11 g, 168.01 days, and 103.08 kg, respectively. The averages for birth weight, weaning live weight, and average daily live weight gain, which were examined as lamb growth characteristics, were found to be 4.13 kg, 19.30 kg, and 197.35 g, respectively. The determined results were compatible with the study conducted.

In another study conducted in Aydın province, the least square means and standard errors of birth weight, weaning live weight, and average daily live weight gain for Karya and Kıvırcık were  $3.53 \pm 0.025$  kg and  $3.66 \pm 0.030$  kg;  $22.67 \pm 0.177$  kg, and  $22.28 \pm 0.28$  kg, respectively. It was obtained as 0.215 kg and  $201.06 \pm 1.936$  g and  $196.48 \pm 2.354$  g, which is similar to the study conducted by Yaman (2022).

In a study conducted by Suliman *et al.* (2021) in Arabia Awassi, Harri, and Najdi races, 45 lambs of similar weight and age were raised for 90 d under similar conditions. All the experimental animals started the growth period that extended for 90 d with an initial live weight of approximately 24.56 kg. It was determined that the 90-d live weights of lambs were lower than the study conducted due to breed differences.

In a study conducted by Ayichew (2019) in Ethiopian Dorper and indigenous sheep, researchers found that under on-farm conditions, body weight at different ages was significantly higher in 50% Dorper crosses than their 25% and 75% counter parts. On-station birth weight of Dorsers (3.39–3.8 kg) were better than crossbreeds (3.0–3.24 kg) and local sheep (2.36–2.77 kg), respectively; the mean weaning (14–16 kg) and yearling weights (26.95–32.43) of 50% Dorper crossbreeds were better than indigenous sheep breeds. Lower results were obtained in the current study due to breed differences.

Sezenler *et al.* (2013) found the 90-day average body weights of Karacabey Merino Sheep raised in multiplier and base sheep flocks were 28.03, 26.53, 26.31, and 27.65 kg, respectively, in 2007–2009. Ceyhan *et al.* (2009) found the average weaning weight of the Blackhead Merino (German Blackhead Meat × Karacabey Merino G1) meat-type lambs was 30.29 kg, which is similar to the findings of the current study.

Yakan *et al.* (2012) found the mean of the least square weaning weights of 42 Akkaraman, 28 Avesi, and 25 Kıvırcık sheep and their lambs of the same genotype were 25.85, 25.19 and 23.79 kg ( $P > 0.05$ ), respectively. Örkiz *et al.* (1984) found the average weaning weights of single and twin lambs of Kangal type, Akkaraman ewes were  $23.22 \pm 0.78$  kg and  $19.95 \pm 0.63$  kg in male lambs, respectively and  $22.40 \pm 0.42$  kg and  $18.61 \pm 0.9$  kg in female lambs, respectively. These findings were different from the findings of the current study, possibly due to differences in breeds and feeding styles.

Özbaşer & Akçapınar (2011) found the average weaning weight of Acipayam lambs was 22.5 kg. Akbulut *et al.* (2012) found that weaning weights of lambs in Dağlıç sheep raised under extensive conditions were  $11.92 \pm 0.12$  kg in males and  $12.78 \pm 0.14$  kg in females. These findings in the literature are different from the findings of the current study, possible due to the different breeds used in the studies.

**Table 9** Some Fertility Characteristics in All the Farms in the Project by Years

Year	NEFR	NRB	NETL	Number of Lambs Born	Number of Born Lambs (Kept for Breeding)		Birth Weight (kg)					Weaning/Marketing (kg)					NLET L	Mean Difference between the Males Selected for Breeding and the Other Males in the Flock (Kg)	Survival Rate in the Weaning/Marketing Period (%)	
							N	Min.	Max	$\bar{x} \pm S\bar{x}$	VK (%)	N	Min.	Max	$\bar{x} \pm S\bar{x}$	Age				VK (%)
2014	6062	238	5547	7364	E (n)	3680	3638	1.70	7.15	4.32±0.014	20.35	2633	10.00	61.25	28.37±0.188	91.0	34.02	1.32	3.39	94.9%
					D (n)	3684	3629	1.45	6.68	4.10±0.013	20.02	2612	10.00	54.40	25.22±0.153	90.0	31.05			
2015	6062	238	5366	7039	E (n)	3489	3432	1.36	7.38	4.37±0.015	20.50	2340	10.00	57.65	27.85±0.207	95.0	35.87	1.29	6.97	91.0%
					D (n)	3550	3493	1.08	6.98	4.06±0.014	20.29	2368	10.00	52.10	25.47±0.170	96.0	32.54			
2016	6062	238	4974	6800	E (n)	3400	3360	1.19	7.14	4.20±0.014	20.05	2278	10.00	62.10	27.67±0.210	91.0	37.27	1.36	7.94	91.2%
					D (n)	3400	3352	1.09	6.94	4.04±0.013	19.40	2252	10.00	51.10	25.43±0.177	92.0	33.03			
2017	6033	267	5367	7504	E (n)	3737	3703	1.27	8.17	4.28±0.014	20.29	3078	10.00	66.20	30.34±0.207	96.1	37.83	1.39	5.94	96.9%
					D (n)	3767	3730	1.46	7.87	4.07±0.013	19.98	3104	10.00	59.40	26.85±0.164	96.4	34.12			
2018	6033	267	5597	7905	E (n)	3895	3845	1.35	7.89	4.29±0.014	21.20	3372	10.00	73.45	32.13±0.217	97.0	39.25	1.26	5.86	92.3%
					D (n)	4010	3973	1.17	7.92	4.10±0.013	20.62	3521	10.00	75.20	27.92±0.164	97.0	34.79			

NRB: Number of rams for breeding, NLET L: Number of lambs per ewe that lambs  
 NEFR: Number of ewes fertilized by a ram, NETL: Number of twin lambs



Canatan *et al.* (2012) found the weaning weight averages of lambs obtained from Dağlıç ewes fertilized by Hasmer and Hasak rams in the years 2010–2011 were  $14.14 \pm 0.11$ ,  $16.69 \pm 0.13$ ,  $17.53 \pm 0.11$  kg, respectively. These findings were similar to the findings of the current study.

In the study carried out by Ağdacı (2013), the least square means of the weaning weights of Pırlak breed sheep raised on six different farms were  $23.710 \pm 1.420$ ,  $21.639 \pm 0.851$ ,  $20.446 \pm 0.775$ ,  $20.050 \pm 0.824$ ,  $25.926 \pm 0.621$ , and  $20.828 \pm 1.023$  kg, respectively. Özbey & Akçan (2003) determined the average weaning weights of Morkaraman, Kıvırcık × Morkaraman, and Chios × Morkaraman crossbred lambs were 16.05 kg, 16.09 kg, and 15.99 kg, respectively. These findings were different from the findings of the current study. This might be due to the different breeds used in the studies. In a study conducted by Yaralı (2004), the average weaning weight of the Kıvırcık lambs was 21.9 kg, which is different from the current study and may be due to the different breeds used in the studies.

Yılmaz (2008), in a study carried out at two different times in breeder conditions, found the averages of the live weights of the lambs (weaning period) in the first and second years were 27.20 kg and 31.29 kg, respectively. This finding was similar to the finding of the current study.

Yakan *et al.* (2012) found the least square means of live weights of 42 Akkaraman, 28 Avesi, and 25 Kıvırcık ewes and their lambs at 180-d for the same genotype were 37.88, 36.65, and 33.86 kg ( $P < 0.01$ ), respectively. Ceyhan *et al.* (2007) found the average live weight at 180-d of Kıvırcık, Gökçeada, and Chios lambs were 43.14, 35.57, and 34.64 kg, respectively. These findings were similar to the findings of the current study.

Özbaşer and Akçapınar (2011) found that the 180-d average live weight of Acıpayam lambs was 28.0 kg. Canatan *et al.* (2012) found that the 180-d average live weight of lambs obtained from Dağlıç sheep fertilized by Dağlıç, Hasmer, and Hasak rams was  $23.54 \pm 0.13$ ,  $26.68 \pm 0.14$ , and  $27.62 \pm 0.13$  kg, respectively. These findings are different from the findings of the current study and may be due to breed differences.

In their study conducted to determine the fattening, slaughtering, and carcass characteristics of Kıvırcık and Karya lambs, Altın *et al.* (2005) found the starting fattening weight was 16.84 and 17.54 kg and the final fattening weight was 34.70 and 29.92 kg, respectively. These findings were similar to the findings of the current study.

Yaralı & Karaca (2011) found the daily average live weight gain during fattening was 174.08 g in males and 153.93 g in females, with 133.28 g, 173.07 g, and 185.63 g in the respective groups. Ağdacı (2013) found that the least square means of the daily live weight gains in Pırlak lambs on six different farms were  $0.170 \pm 0.011$ ,  $0.156 \pm 0.006$ ,  $0.156 \pm 0.006$ ,  $0.151 \pm 0.006$ ,  $0.200 \pm 0.004$ , and  $0.149 \pm 0.007$  kg, respectively. These findings are different from the findings of the current study and may be due to breed differences.

Altın *et al.* (2005) found a daily average live weight gain of 250 g 181 g in Kıvırcık and Karya lambs, respectively. Örkiz *et al.* (1984) found that daily live weight gains in Kangal type Akkaraman lambs until weaning were 222.5 g and 177.0 g in single and twin born male lambs, respectively, and 201.3 g and 165.9 g in single and twin born female lambs, respectively. These findings were similar to the findings of the current study. Esenbuğa & Dayıoğlu (2002) found the daily live weight gain of 0.145 kg in Morkaraman lambs until weaning. This is similar to the findings of the current study.

Koyuncu & Akgün (2018) found the rates of single and twin births in Kıvırcık sheep were 71.2%, and 28.8%, respectively. In the current study, the number of lambs per ewe was 1.29. The survival rate of the lambs at weaning (–90 d) was 83%. The number of lambs per ewe in the studies were similar but the weaning survivability rates were different. The reason for this is the differences in the care and feeding conditions and the different species used in the studies.

Sezenler *et al.* (2013) found the average lamb yield per ewe in Karacabey Merino sheep raised in multiplier and base sheep flocks from 2007–2009 was 1.33, 1.17, 1.29, and 1.20 lambs, respectively. This finding is similar to that of the current study.

In the research conducted by Tüfekçi (2023), the birth weight of Akkaraman lambs was 3.71 kg, while the live weight on the 60th, 90th, 120<sup>th</sup>, and 150th days was 15.54 kg, 23.30 kg, 31.08 kg, and 38.85 kg, respectively. The difference in the study is due to the difference in breed.

Tekerli *et al.* (2002) calculated the mean number of lambs at one birth to be 1.33, 1.33, and 1.38 in Akkaraman; 1.00, 1.06, and 1.31 in Dağlıç; 1.46, 2.14, and 2.50, in Chios; and 1.2, 1.08, and 1.47 in Awassi sheep. The survivability of all lambs at 1 m, 3 m and only the females in at 6 m and 1 y was 100%, 100%, 100%, 100% in Akkaraman; 96.55%, 96.55%, 94.11%, 94.11% in Dağlıç, 71.43%, 71.43%, 68.42%, 68.42% in Chios; and 96.55%, 89.66%, 100%, and 100% in Awassi sheep. These findings are different from the findings of the current study. Yakan *et al.* (2012) conducted a study on 42 Akkaraman, 28 Awassi, and 25 Kıvırcık sheep and their lambs. The number of lambs per birth in Akkaraman, Awassi, and Kıvırcık ewes was 1.19, 1.13, and 1.10, respectively, and the survival rate of Akkaraman, Awassi, and Kıvırcık lambs at weaning (90-d day) was found to be 97.67%, 88.89, and

90.91%, respectively. These findings are different from the findings of the current study and might be due to the breeds.

Yilmaz *et al.* (2011) found an average of 89% in survivability in the period from birth to weaning in lambs born in 95 multiplier and base sheep flocks in the Aydın and Denizli provinces. Ceyhan *et al.* (2007) found the lamb yield in Kıvrıkcık, Gökçeada, and Chios lambs was 1.26, 1.24, and 1.83, respectively, with survival rates of 97%, 94.7%, and 92.2%, respectively. Ökiz *et al.* (1984) determined the number of lambs per birth in Kangal type Akkaraman ewes as 1.21. The survival rate of the lambs until weaning (90 days) was found to be 90% in singles and 79% in twins. These findings are similar to the findings of the current study.

Ceyhan *et al.* (2009) found that the number of lambs born per ewe was 1.46 in Blackhead Merino (German Blackhead Meat × Karacabey Merino G1) meat-type ewes. The twin birth rate in Morkaraman sheep was 1.05 (Kayalık & Bingöl, 2015).

Canatan *et al.* (2012) found the survival rate at 90 d in lambs from Dağlıç sheep fertilized by Dağlıç, Hasmer, and Hasak rams as 98.99%, 98.31%, and 97.41%, respectively. This finding is different from the finding of the current study. The biggest reason for this is the breed, followed by the difference in care and feeding conditions.

Ağdacı (2013) found the least squares means of survivability of Pırlak sheep on six different farms were  $0.929 \pm 0.076$ ,  $0.923 \pm 0.043$ ,  $0.995 \pm 0.041$ ,  $0.986 \pm 0.044$ ,  $0.960 \pm 0.033$ , and  $0.912 \pm 0.051$ , respectively. These findings are similar to the findings of the current study.

Yaralı (2004) found an average 68% survival rate in Kıvrıkcık lambs until the marketing period and this is different from the current study. This is due to the different breeds used in the studies. Yilmaz (2008) found that the number of lambs born per ewe was 1.06 and 0.66, and the survivability up to 100 d was 71.58% and 62.04%, respectively, in a study conducted at two different times under breeder conditions. The finding related to the number of lambs per ewe is similar to the finding of the current study and the finding related to the survivability is different from the survivability in the current study.

## Conclusion

In the current study, the yield data obtained from the nomadic and settled sheep breeding farms involved in Karya-2, which is the sub-project of the "National Sheep Breeding Project" carried out under the coordination of the General Directorate of Agricultural Research and Policies (TAGEM), were statistically analysed and some yield characteristics of the lambs raised in the nomadic and settled farms were compared. Fertility in Karya sheep and pre-weaning live weights and daily body weight gains of their lambs were found to be close to the values obtained from native breeds in Turkey.

Birth weights, weaning (90-day) weights, 180-day live weights, 90-day (until weaning) daily live weight gains, and daily live weight gains up to 180 d were different in nomadic and settled farms. Nomadic farm averages were more profitable in terms of the examined characteristics and the examined yields were higher. Since nomadic sheep rely on pasture, this is more advantageous in terms of feed costs.

Differences in birth types between the farms were substantial ( $P < 0.001$ ), twinning was more common in the nomadic farms, the difference between the phenotypes of the lambs born was significant ( $P < 0.05$ ), the Karagoz type was more common, and sex proportions of lambs were similar. More culling was performed on the nomadic farms (destroyed, died, or sold) and the number of animals allocated for breeding in nomadic farming was higher than in settled farming. Between 2014 and 2018, there was a slight decrease in the number of lambs per sheep, a decrease in the number of sheep fertilized by a ram, and an increase in the number of breeding rams. There was no marked change in the survival rate during the weaning period. There has been an increase in live weight and reproductive efficiency of Karya sheep and there is potential for breeding. The breeders in the region, who have witnessed the breeding activities in Karya sheep in Denizli, buy lambs to be raised as rams or female lambs/ewes for breeding from these flocks. This increases the productivity level of local livestock and sets an example for more conscious breeding. Karya sheep breeding is becoming widespread in other provinces. Raising sheep of specific breed is more efficient and more profitable.

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## Conflict of Interest Declaration

The authors declare that they have no conflict of interest.

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