IMPACT OF NON-GENETIC FACTORS ON GROWTH TRAITS ACROSS TELEORMAN BLACK HEAD, SUFFOLK AND ILE DE FRANCE SHEEP BREEDS

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Abstract

Evaluating the effect of non-genetic factors on growth traits, such as birth weight and weaning weight, is essential for optimizing production within sheep farming systems. Factors such as sex, type of lambing (single or twin), and year of birth can significantly influence lamb development, with direct implications for their growth performance and, consequently, the economic yield of farms.

The aim of this study was to investigate the influence of sex, type of lambing, and year of birth on birth weight and weaning weight in three sheep breeds:Teleorman Black Head, Suffolk, and Île de France, using t-tests and ANOVA.

The results indicate that the studied non-genetic factors have a variable impact on growth traits. Birth weight is significantly influenced by the type of lambing and year of birth in the Teleorman Black Head breed ($p < 0.05$). For Suffolk, the type of lambing and year of birth have significant effects on birth weight ($p < 0.05$), and for Ile de France, the same factors influenced birth weight ($p < 0.05$), while sex did not have a significant impact on birth weight inTeleorman Black Head and Suffolk breeds ($p > 0.05$), but had a significant impact in Ile de France breed ($p < 0.05$).Regarding weaning weight,type of lambing, and year of birth significantly influence this trait in all three breeds ($p < 0.05$), while sex significantly influenced weaning weight ($p < 0.05$)in Teleorman Black Head and Ile de France breeds and insignificanttly ($p > 0.05$) in Suffolk.

These results highlight the importance of non-genetic factors in influencing birth weight and weaning weight, and are relevant for optimizing management strategies in sheep farming.

Key words: ANOVA, sheep, *Teleorman Black Head, Suffolk, Île de France*

INTRODUCTION

Birth weight and weaning weight are two important indicators of growth performance in sheep, having a direct impact on the productivity and profitability of farms. Recent studies highlight the significant role of non-genetic factors such as parity, sex, season, and year of birth in influencing these weights [1-8]. Birth weight is an important early indicator due to its positive correlation with later weights, being essential for the survival and viability of lambs [9,10]. Similarly, weaning weight is recognized as the most important economic trait, significantly influencing economic returns in sheep farms [11,12].

Additionally, several non-genetic factors influence lambs' birth and weaning weights, including the age and body condition score of the mother, nutrition, ram effects, and environmental conditions [13,14]. Previous studies have demonstrated that birth type, parity, and season significantly influence these traits,

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and these variables must be considered in management and selection practices to maximize reproductive performance [15,16].

Understanding the impact of these non-genetic factors provides opportunities for optimizing sheep growth and improving selection strategies by considering the physiological and environmental characteristics that affect productive performance [17,18]. With the increasing demand for lamb meat in the international market, farmers have acquired specialized breeds from other countries for this production, which are considered to enhance traits related to body development and carcass quality. Rams from breeds such as Suffolk and Île-de-France have been introduced for breeding within sheep populations of various indigenous or crossbred mixed production types, such as Țurcana, Țigaia, Teleorman Black Head and Karakul, yielding descendants with better growth and body development performance. However, many farmers have not established a sustainable breeding plan, which will ultimately lead to a decline in the performance of the descendants.

Given that breeds such as Suffolk and Île-de-France are among those considered to be improving breeds regarding meat production traits, it is deemed necessary to study them from both phenotypic and genotypic perspectives. Additionally, the indigenous breed Teleorman Black Head (TBH) shows good performance in body development and carcass quality and can be used in crosses with improving breeds to obtain descendants with superior performance [19].

Therefore, this paper aims to investigate how these factors influence birth and weaning weights in the Cap Negru de Teleorman, Suffolk, and Île-de-France breeds, with the goal of providing relevant data for optimizing sheep farm management and increasing productivity.

MATERIAL AND METHOD

The biological material studied consisted of a total of 120 lambs born between 2017 and 2022 from the sheep breeds Cap Negru de Teleorman, Suffolk, and Île de France, with 40 individuals from each breed, including 20 females and 20 males. These lambs came from ewes included in the Official Performance and Recording Scheme (C.O.P), which implies compliance with a set of rules related to the period and method of breeding and management of rearing. Therefore, the breeding season began in early September and ended in mid-October, with one ram randomly assigned to 30 ewes for breeding, while strictly avoiding inbreeding. Lambing occurred in February and March. Data related to sex, parity, and year of birth were collected from official documents available in the breed genealogical records and through inspections conducted on farms when birth and weaning weights of the lambs from the three breeds were determined.

To assess the significant impact of the fixed factors—sex (Male or Female), type of lambing (Singleton or Twin), and year of birth (YB – 2017 to 2022) on birth weight, an analysis of variance (ANOVA) and t-test were conducted, followed by a Tukey HSD test to identify significant differences between individual groups within each fixed factor. All single-factor ANOVA, t-test, and descriptive statistics were applied to all lamb groups for each non-genetic factor examined. The results were evaluated at a significance threshold of $P < 0.05$. The data analysis for this paper was generated using the Real Statistics Resource Pack software (Release 7.6). Copyright (2013 – 2023) Charles Zaiontz [20].

RESULTS

The descriptive statistical analysis of birth weight (BW) and weaning weight (WW) for the three breeds—Teleorman Black Head (TBH), Suffolk (S), and Île de

France (I)—revealed distinct averages and variabilities(Table 1). Suffolk lambs had the highest mean birth weight at 4.79 kg with the greatest variability (SD = 1.02 kg, V% = 21.34%), indicating a wide range of values in birth weight. Teleorman Black Head lambs showed a mean birth weight of 3.95 kg with lower variability (SD = 0.43 kg, V% = 11.61%), reflecting more consistent values within this breed. Île de France lambs had the lowest mean birth weight (3.66 kg) and moderate variability (SD = 0.46 kg, V% = 12.61%) (Figure 1).

Table 1. Descriptive statistics analysis of birth weight (BW) and weaning weight (WW) for the three breeds

Breed	N	BW				WW			
		Mean ± SD	V%	Min	Max	Mean ± SD	V%	Min	Max
TBH	40	3.95 ±0.43	11.61	3	4.7	28.91±4.60	15.92	21	38.4
S	40	4.79±1.02	21.34	3	7	39.95±12.67	31.72	23.9	56
I	40	3.66±0.46	12.61	2.9	4.6	29.57±5.15	17.42	23.1	39

For weaning weights, Suffolk lambs again displayed the highest mean at 39.95 kg and significant variability (SD = 12.67 kg, V% = 31.72%), suggesting diverse growth potential within this breed. Île de France lambs had a mean weaning weight of 29.57 kg with moderate variability (SD = 5.15 kg, V% = 17.42%), while the Teleorman Black Head breed showed a similar mean weaning weight of 28.91 kg with relatively low variability (SD = 4.60 kg, V% = 15.92%).

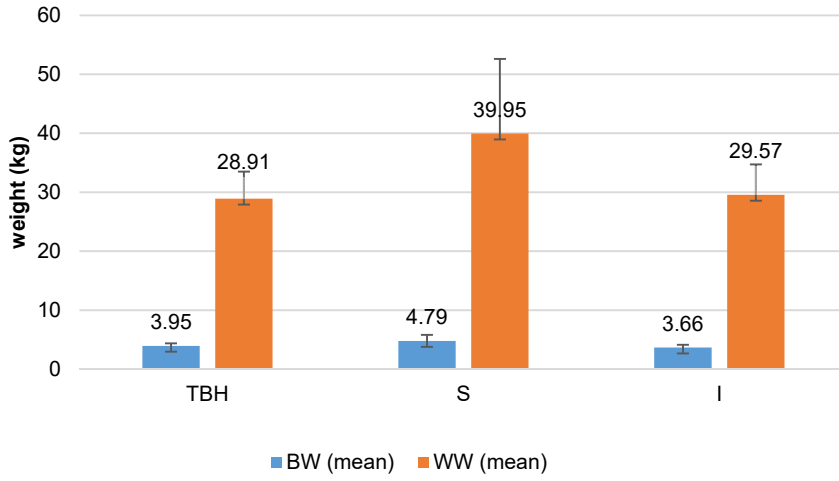

Fig. 1 Comparative means of BW and WW in

Suffolk lambs exhibited the largest body size with the highest variability across both birth and weaning weights. In contrast, the Teleorman Black Head and Île de France breeds showed more uniformity in both measures, suggesting a more consistent growth pattern within these populations.

The effect of type of birth on birth weight (BW) and weaning weight (WW) in Teleorman Black Head lambs shows notable differences for BW but not for WW.

Table 2. Effect of sex type on BW and WW of Teleorman Black Head Lambs

Measure	Sex	Mean	Variance	Observations	t Stat	p-value (two-tail)
BW	F	3.955	0.191	20	0.342	0.734 ns
	M	3.905	0.235	20		
WW	F	25.13	2.407	20	-9.262	<0.001 **
	M	32.695	10.94	20		

*Note: BW -Birth Weight; WW -Weaning Weight; F -Female; M -Male; ns -insignificant; **-highly significant.*

The analysis of the effect of sex on birth weight (BW) and weaning weight (WW) in Teleorman Black Head lambs revealed distinct outcomes for each weight measure. For BW, the mean values were comparable between females (3.955 kg) and males (3.905 kg), with a t-test yielding a p-value of 0.734. This result indicates no statistically significant difference in BW between the sexes, as the p-value exceeds the conventional threshold of 0.05, and thus, the influence of sex on BW can be considered negligible (Table 2).

In contrast, the effect of sex on WW was statistically significant. Females had a mean WW of 25.13 kg, while males had a higher mean WW of 32.695 kg. The t-test for WW produced a highly significant p-value (<0.001), confirming a substantial difference in WW between sexes (Table 2). This suggests that male lambs exhibit significantly greater WW compared to female lambs, possibly due to factors such as growth rate or nutrient utilization efficiency.

Table 3. Effect of type of birth factor on BW and WW of Teleorman Black Head Lambs

Measure	Type of Birth	Count	Mean (kg)	Variance	SS	F-stat	P-Value
BW	S	22	4.18	0.09	3.10	23.45	2.17E-05 **
	T	18	3.62	0.19			
WW	S	22	29.39	23.67	10.98	0.51	0.4787 ns
	T	18	28.33	18.70			

*Note: BW -Birth Weight; WW -Weaning Weight; S -Singleton, T -Twin; ns -insignificant; **-highly significant.*

For BW, single-born (singleton) lambs had a higher mean weight of 4.18 kg compared to twin-born lambs, who had a mean BW of 3.62 kg. The F-test produced a highly significant p-value (2.17E-05) (Table 3), indicating a strong effect of birth type on BW. This suggests that singletons tend to have a significantly greater BW than twins, likely due to less competition for maternal resources in utero.

In contrast, the analysis of WW between singletons and twins did not show a statistically significant difference. The mean WW for singletons was 29.39 kg, while for twins it was 28.33 kg. The F-test yielded a p-value of 0.4787, indicating no significant effect of type of birth on WW (Table 3). This lack of significance suggests that, by the time of weaning, both singletons and twins reach similar weights, potentially due to uniform postnatal nutrition or management practices.

These values shows that the type of birth has a highly significant impact on BW, favoring singletons, but does not significantly affect WW in Teleorman Black Head lambs.

Table 4. Effect of year of birth on BW and WW of Teleorman Black Head Lambs

Measure	Year of Birth	Count	Mean (kg)	Variance	SS	F-stat	P-Value
BW	2017	2	4.3	0	0.88	1.07	0.3869 ns
	2018	9	4.07	0.23			
	2019	9	3.81	0.27			
	2020	9	3.76	0.24			
	2021	11	3.99	0.13			
WW	2017	2	25.75	1.45	270.3	4.26	0.0065 **
	2018	9	32.89	16.08			
	2019	9	28.54	17.45			
	2020	9	29.71	26.29			
	2021	11	25.88	7.55			

*Note: BW -Birth Weight; WW -Weaning Weight; ns -insignificant; **-highly significant.*

For BW, the year of birth does not appear to have a significant effect. The mean BW values varied slightly between years, from 3.76 kg in 2020 to 4.3 kg in 2017, but the F-test yielded a p-value of 0.3869, which is not statistically significant (Table 4). This suggests that the year of birth does not have a meaningful influence on the BW of Teleorman Black Head lambs, with relatively stable birth weights across the years observed.

In contrast, the year of birth significantly affected WW, with an F-test p-value of 0.0065, indicating a highly significant difference. Weaning weights showed more variability among years, with the highest mean WW observed in 2018 (32.89 kg) and the lowest in 2017 (25.75 kg) (Table 4). These fluctuations could reflect environmental or management differences across years, impacting growth rates up to weaning.

While the year of birth did not significantly impact BW, it had a highly significant effect on WW, suggesting that environmental conditions or management practices in specific years may influence postnatal growth in Teleorman Black Head lambs.

Table 5. Effect of sex type on BW and WW of Suffolk Lambs

Measure	Sex	Mean	Variance	Observations	t Stat	p-value (two-tail)
BW	F	4.69	1.133	20	-0.614	0.543 ns
	M	4.89	0.991	20		
WW	F	39.74	164.109	20	-0.102	0.919 ns
	M	40.155	165.433	20		

Note: BW -Birth Weight; WW -Weaning Weight; F -Female; M -Male; ns –insignificant.

The analysis of sex-based differences in birth weight (BW) and weaning weight (WW) for Suffolk lambs shows no statistically significant differences between males and females for either measure.

For BW, the mean weight for females was 4.69 kg, while for males it was slightly higher at 4.89 kg (Table 5). However, the t-test returned a p-value of 0.543, indicating no significant difference in BW between sexes.

Similarly, for WW, females had a mean weight of 39.74 kg and males had a similar mean of 40.16 kg. The t-test yielded a p-value of 0.919, further confirming that there is no significant sex effect on WW in Suffolk lambs.

This suggests that sex does not have a statistically significant impact on either BW or WW in Suffolk lambs. Both birth and weaning weights are comparable across sexes within this breed.

Table 6. Effect of type of birth factor on BW and WW of Suffolk Lambs

Measure	Type of Birth	Count	Mean (kg)	Variance	SS	F-stat	P-Value
BW	S	31	5.19	0.5869	22.08	44.93	6.23E-08 **
	T	9	3.41	0.1336			
WW	S	31	43.88	137.14	2127.88	19.55	7.92E-05 **
	T	9	26.41	2.6286			

*Note: BW -Birth Weight; WW -Weaning Weight; S -Singleton, T -Twin; **-highly significant.*

The analysis of the type of birth factor on birth weight (BW) and weaning weight (WW) for Suffolk lambs shows a highly significant effect for both measures, with singleton lambs consistently outperforming twin lambs in terms of weight.

For BW, singleton lambs had a mean weight of 5.19 kg, while twin lambs had a notably lower mean weight of 3.41 kg (Table 6). The F-statistic for BW is 44.93, with a p-value lower than 0,0001 ($p<0.0001$), indicating a highly significant difference in birth weight based on the type of birth.

Similarly, for WW, singleton lambs had a mean weight of 43.88 kg, compared to 26.41 kg for twin lambs(Table 6).The F-statistic for WW is 19.55, with a p-value lower than 0,0001 ($p<0.0001$) also showing a highly significant difference in weaning weight between singletons and twins.

In summary, the type of birth significantly affects both BW and WW in Suffolk lambs, with single-born lambs being heavier than twins at both birth and weaning stages. This suggests that singleton lambs may have advantages in terms of initial growth, likely due to reduced competition for maternal resources.

Table 7. Effect of year of birth on BW and WW of Suffolk Lambs

Measure	Year of Birth	Count	Mean (kg)	Variance	SS	F-stat	P-Value
BW	2017	1	4.2	-	9.0875	1.95	0.1114 ns
	2018	2	4.6	0.02			
	2019	5	4.1	0.85			
	2020	6	4.15	0.291			
	2021	16	4.94	1.3185			
	2022	10	5.38	0.7796			
WW	2017	1	25	-	2604.62	4.84	0.0019 **
	2018	2	29.05	0.125			
	2019	5	28.32	21.532			
	2020	6	30.92	78.1737			

*Note: BW -Birth Weight; WW -Weaning Weight; ns -insignificant; **-highly significant*

The effect of the year of birth on birth weight (BW) and weaning weight (WW) in Suffolk lambs reveals a non-significant effect on BW but a highly significant effect on WW.

For BW, although there is a variation across years, with a mean ranging from 4.1 kg in 2019 to 5.38 kg in 2022, (Table 7) the differences were not statistically significant. The F-statistic for BW was 1.95

with a p-value of 0.1114, indicating that the year of birth did not significantly impact birth weight in Suffolk lambs.

In contrast, the effect of the year of birth on WW was statistically significant. The WW varied notably, from 25 kg in 2017 to 30.92 kg in 2020, with the F-statistic for WW at 4.84 and a p-value of 0.0019 (Table 7). This highly significant result suggests that environmental or management factors in specific years may have influenced the lambs' growth up to weaning age.

It can be said that the year of birth did not have a significant effect on BW, but it had a highly significant impact on WW in Suffolk lambs, implying that factors associated with specific birth years influenced postnatal growth outcomes.

Table 8. Effect of sex type on BW and WW of Île de France lambs

Measure	Sex	Mean	Variance	Observations	t Stat	p-value (two-tail)
BW	F	3.475	0.153	20	-2.823	0.008 **
	M	3.855	0.21	20		
WW	F	25.465	2.34	20	-8.407	3.3E-10 **
	M	33.67	16.709	20		

*Note: BW -Birth Weight; WW -Weaning Weight; F -Female; M -Male; **-highly significant*

The analysis of the effect of sex on birth weight (BW) and weaning weight (WW) in Île de France lambs shows that sex has a highly significant impact on both measures.

For BW, male lambs had a higher average birth weight (mean = 3.855 kg) compared to female lambs (mean = 3.475 kg) (Table 8). The difference between sexes was statistically significant, with a t-statistic of -2.823 and a p-value of 0.008, indicating a highly significant effect of sex on birth weight.

For WW, the difference between males and females was even more pronounced. Male lambs had a much higher weaning weight (mean = 33.67 kg) compared to females (mean = 25.465 kg). This difference was also highly significant, with a t-statistic of -8.407 and a p-value ($p<0.0001$), strongly suggesting that male Île de France lambs grow faster than females up to weaning age.

In summary, the sex of Île de France lambs significantly affects both birth and weaning weights, with males exhibiting higher values in both cases. These results indicate a clear difference in growth patterns between male and female lambs, likely influenced by genetic and physiological factors associated with sex.

Table 9. Effect of type of birth factor on BW and WW of Île de France lambs

Measure	Type of Birth	Count	Mean (kg)	Variance	SS	F-stat	P-Value
BW	S	20	4.03	0.0696	5.329	67.46	6.00E-10 **
	T	20	3.3	0.0884			
WW	S	20	31.11	26.7073	95.172	3.85	0.0572 ns
	T	20	28.03	22.7651			

*Note: BW -Birth Weight; WW -Weaning Weight; S -Singleton, T -Twin; ns -insignificant; **-highly significant.*

The type of birth's effect on birth weight (BW) and weaning weight (WW) in Île de France lambs reveals significant values for BW but not for WW.

For BW, singleton births (S) showed a notably higher mean birth weight (mean = 4.03 kg) compared to twins (T) (mean = 3.3 kg) (Table 9). This difference was

statistically highly significant, with an F-statistic of 67.46 and a p-value (p<0,0001), indicating a strong effect of birth type on birth weight.

However, for WW, although singletons had a higher mean weight at weaning (mean = 31.11 kg) than twins (mean = 28.03 kg), the difference was not statistically significant (F-statistic = 3.85, p-value = 0.0572) (Table 9). This suggests that the type of birth has a diminishing effect by the time of weaning, possibly due to compensatory growth among twin lambs.

For Île de France lambs while the type of birth significantly impacts birth weight, its effect on weaning weight is minimal, likely due to compensatory growth observed in twins post-partum.

Table 10. Effect of year of birth on BW and WW of Île de France lambs

Measure	Year of Birth	Count	Mean (kg)	Variance	SS	F-stat	P-Value
BW	2018	2	4.3	0.18	1.4788	1.89	0.1344 ns
	2019	10	3.51	0.2054			
	2020	9	3.51	0.1811			
	2021	12	3.8	0.1982			
	2022	7	3.67	0.199			
WW	2018	2	33.55	59.405	219.4	2.35	0.0729 ns
	2019	10	27.07	16.3223			
	2020	9	27.52	8.7694			
	2021	12	30.62	32.1033			
	2022	7	32.83	31.0257			

Note: BW -Birth Weight; WW -Weaning Weight; ns –insignificant.

The analysis of the effect of year of birth on birth weight (BW) and weaning weight (WW) in Île de France lambs indicates that, for both BW and WW, the year of birth does not significantly impact these weights.

For BW, although there are small variations in mean birth weights across the years (ranging from 3.51 kg to 4.3 kg), the differences were statistically insignificantt (F-statistic = 1.89, p-value = 0.1344)(Table 10). This suggests that birth year does not play a critical role in determining birth weight within this breed.

Similarly, for WW, the year of birth shows no significant influence on weaning weight. Although the mean WW values vary by year—from 27.07 kg in 2019 to 33.55 kg in 2018—the variation was not statistically significant (F-statistic = 2.35, p-value = 0.0729)(Table 10). This result implies that environmental or management factors that might vary year-to-year do not strongly affect weaning weights in Île de France lambs.

In summary, the year of birth does not significantly impact either BW or WW in Île de France lambs, indicating stable weights across the studied timeframe.

Previous studies have highlighted the significant influence of the birth year on lamb birth weight. [2] reported significant variations in the birth weight of Dorper lambs depending on the year, with an average weight of 3.4 kg in 2010 and 4.0 kg in 2009 ($p < 0.05$). Similarly, [21] observed a significant effect of the year on birth weight across various sheep breeds ($p < 0.05$). [22] confirmed these findings, reporting a significant variation in birth weight depending on the year of birth in different sheep breeds ($p < 0.05$).

CONCLUSIONS

Based on the data and literature reviewed, we can conclude the following key points regarding the impact of non-genetic factors on lamb birth and weaning weights:

1. Among the three studied breeds (Teleorman Black Head, Suffolk, and Île de France), there were notable differences in average birth and weaning weights, as well as variability. Suffolk lambs demonstrated the highest birth weight average, while Île de France had the lowest, indicating breed-specific growth traits.
2. Consistent with findings from prior research [2, 22] non-genetic factors such as birth year and sex type significantly affect birth weight. For instance, male Île de France lambs showed significantly higher birth weights compared to females, highlighting the importance of adjusting management practices based on these inherent differences.
3. Singleton lambs generally displayed higher birth and weaning weights across the breeds than twins. This distinction suggests that the increased growth potential of single-born lambs could be leveraged to optimize performance when breeding for weight traits.
4. Year-to-year environmental variations contribute significantly to weaning weight differences, reinforcing the importance of annual assessments to adjust breeding and management strategies in response to fluctuating conditions.

These insights underscore the need to account for and manage non-genetic factors to enhance productivity and economic performance in sheep farming, especially as demand for high-quality lamb products increases.

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