# Estimate the effect of non-genetic factors on the reproductive traits of Afec-Assaf strain in Bani Naim Farm, Palestine

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## ABSTRAK

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Tujuan dari penelitian ini adalah untuk mengevaluasi penampilan reproduksi pada galur Afec-Assaf di peternakan intensif. Penelitian dilakukan di Bani Naim, kota Hebron, Palestina. Data yang dikumpulkan dari 450 betina dan 1660 domba yang lahir dari 2019 hingga 2022, digunakan untuk menyusun data untuk penelitian ini. Model linier dengan efek tetap digunakan untuk mengestimasi pengaruh tahun kelahiran dan paritas terhadap ukuran serasah lahir hidup (LS), ukuran serasah saat penyapihan (LSAW), dan interval beranak (LI). Komponen yang paling berpengaruh pada LS adalah paritas yang menghasilkan rata-rata 1,81  $\pm$  0,9. Terdapat perbedaan yang nyata antara ukuran anakan yang lahir pada paritas pertama dan keempat, dengan anakan terkecil lahir pada paritas pertama (1,75 $\pm$ 0,04) dan yang terbesar lahir pada paritas keempat (2,25 $\pm$ 0,14). LSAW rata-rata 1,75 $\pm$ 0,82 domba. LSAW secara signifikan dipengaruhi oleh paritas (P<0,05). LI adalah rata-rata 250,60 $\pm$ 77,59 hari. Tidak ada hubungan yang signifikan (P>0,05) antara paritas dan LI. LI terpanjang diamati pada paritas ketiga (251,56 $\pm$ 6,15 hari). Menurut temuan, jenis kelahiran anak domba secara signifikan dipengaruhi oleh paritas. Variabel non-genetik berdampak besar pada keragaman sifat reproduksi di Afec-Assaf.

Kata Kunci: Afec-Assaf, Litter Size, Lambing Interval, Parity, Domba

#### ABSTRACT

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The aim of the study was to evaluate the reproductive performance of the Afec-Assaf strain in intensive farming. The research was carried out in Bani Naim, Hebron city, Palestine. Data collected from 450 ewes and 1660 lambs born over the period 2019 to 2022 were used to compile the data for this study. Linear models with fixed effects were used to estimate the influence of year of birth and parity on litter size born alive (LS), litter size at weaning (LSAW), and lambing interval (LI). The most influential component in LS was parity, which resulted in an average of  $1.81 \pm 0.9$ . There was a significant difference between the size of litters born in the first and fourth parities, with the smallest litters born in the first parity ( $1.75\pm0.04$ ) and the largest born in the fourth ( $2.25\pm0.14$ ). LSAW lamb averaged  $1.75\pm0.82$ . The LSAW was significantly influenced by parity (P<0.05). LI was  $250.60\pm77.59$  days on average. There was no significant (P>0.05) relationship between parity and LI. The longest LI was observed at third parity ( $251.56\pm6.15$  days). According to the findings, the birth type of a lamb is significantly affected by the parity. Nongenetic variables have a substantial impact on the diversity of reproductive traits in Afec-Assaf.

Key Words: Afec-Assaf, Litter Size, Lambing Interval, Parity, Sheep

#### **INTRODUCTION**

Sheep are one of the most important animals because their high production and reproduction rates have a direct impact on the economy and other industries in different regions (Jalal et al. 2015; Gebreselassie et al. 2020; Hameed et al. 2022). In Palestine, one of the most common methods of earning a living from the livestock industry is raising sheep. Sheep are an important source of revenue and food for rural people, which allows them to maintain their standard of living (meat and milk).

As of October 1, 2021, the total number of sheep in Palestine had reached 771,168 heads. In Palestine, the sheep were divided up according to the different strains. There were 363,759 heads counted under the category of "local" or "Awassi", 283,651 heads counted under the category of "Asaf", 118,150 heads counted under the category of "hybrid" Afec-Awassi and Afec-Assaf, and 5,608 heads counted under the category of "other." There was a total of 322,239 heads raised using an intensive method (41.8%), while 448,929 heads were raised using a semi-intensive method (58.2%). Regarding the distribution of sheep in Palestine according to the primary reason for their raising, there were 88,592 heads (11.5%) only for meat, 99,132 heads (12.8%) mainly for meat, with some milk, 99,436 heads (12.9%) only for milk, 484,008 heads (62.8%) mainly for milk with some meat (Palestinian Central Bureau of Statistics 2022). There has not been enough research done to determine the reproductive capacity of sheep in Palestine, despite the importance of sheep in the region.

Breeding of the highly prolific Afec-Assaf strain began in 1986 when the Booroola mutation (B) at the BMPR1B gene was introduced into the Assaf breed by combining Assaf ewes with Booroola Merino (Gootwine 2014). This resulted in the introduction of the Booroola mutation into the Assaf breed. Because the B allele is present in the Afec-Assaf strain, it is inherited in a nearly dominant form, which contributes to the strain's exceptionally high rate of prolificacy (Seroussi et al. 2017). The average prolificacy of Awassi sheep is 1.30 LB/EL, while that of Assaf sheep is 1.65 LB/EL. To identify Booroola mutation carriers during backcrossing and intercrossing, researchers first tracked the frequency of forced ovulation in sheep lambs and then used direct genotyping of the FecB locus. This was carried out throughout the time that the mutation was being transmitted from one generation to the next. The breeding efforts resulted in the creation of the very productive Afec Awassi and Afec Assaf strains. Both of these strains carry the Booroola mutation and typically yield around 1.9 and 2.5 LB per embryo litter, respectively (Gootwine 2014; Gootwine 2020).

Sheep's "litter size" is one of their most valuable economic characteristics (Schmidová et al. 2014; Al-Thuwaini et al. 2020; Farrell et al. 2022; Abuzahra et al. 2023), which means the average number of lambs born to a single ewe during lambing season (Ziadi et al. 2021; Tao et al. 2021) Prolificity, also known as litter size, is the indication of sheep's reproductive efficiency that has been subjected to the most research. Prolificity is defined as the average number of lambs born from each pregnancy (Ahlawat et al. 2016; Ayele and Urge 2019; Hernández et al. 2019; Medina-Montes et al. 2021).

Sheep litter sizes also differ by breed, with the Texel and Suffolk having single births and the Booroola Merino having multiple births per litter (Ajafar Majeed Hameed et al. 2022). In contrast to more prolific breeds like the Finnsheep and the Romanov, which frequently give birth to triplets, Awassi breeds are mono ovulatory (Iber & Geyter 2013) and have very low incidences of twinning (Kridli et al. 2007). Sheep litter sizes can be affected by both genetic and environmental factors (Kumar et al. 2017).

The age of the dam has a significant impact on the amount of the litter. Once the animal reaches five years of age or reaches its fourth parity, the litter size should begin to decline (Amer & Hazzaa 2009). Peak prolificacy is typically reached between the ages of 4 and 8 years old, although other studies find an increase in litter size with increasing parity and greater litter size at the fifth parity (Assan 2020; Canché et al. 2016). Larger litter sizes are a direct effect of genetic improvement, which leads to higher meat production per flock (Assan 2020). The Afec Assaf is known as one of the most prolific strain, along with Finnsheep, Booroola Merino and Barbados Blackbelly (Kutluca Korkmaz & Emsen 2016; Mohamed et al. 2016). A Assaf breed sheep with Booroola srtain has been practiced in Middle East to increase prolificacy (Ahmed & Abdallah, 2013; Gootwine 2014; Gootwine et al. 2008; Reicher et al. 2012; Seroussi et al. 2017).

Litter size, lamb survival and lambing interval have been the objective of many studies. (Canché et al. 2016; Deribe et al. 2021; Tera et al. 2021; Kabalin et al. 2022), most notably in regions where traditional methods of husbandry are still widely used. Therefore, the aim of this study is to evaluate the reproductive performance of the Afec-Assaf strain, specifically focusing on traits such as litter size, litter size at weaning, and lambing interval. By examining these parameters, the study aimed to contribute to the understanding of the reproductive capacity and efficiency of the Afec-Assaf sheep starin, which is of significant importance in Palestine's livestock industry.

### MATERIALS AND METHODS

#### Animal management

The research was carried out at a fattening Afec-Assaf farm in Bani Naim-Palestine, located at latitude 31° 30' 53.51 N and longitude 35° 9' 55.23 E. The flock was maintained using an intensive production technique that featured fast lambing and constant mating of the animals. One of the objectives of the breeding program was to increase the number of rams and ewe lambs suitable for breeding, in addition to the production of lambs for slaughter with a final body weight of approximately 45-60 kg. Ewe lambs were combined with rams into breeding groups when they reached the age of six months or a body weight of 45 kilograms. These groups consisted of 20–30 females and one male. During the whole course of observation, this breeding arrangement, which consisted of the same group of ewes and rams, was preserved. The ewes, lambs, and rams were selected at random, which resulted in the development of four distinct breeding groups. The sheep spent the daytime hours housed within vast barnyard pens. During the night, sheep were kept in separate pens according to their respective breeding groups. The ewes were split into smaller individual pens before the beginning of the lambing process. After a few days, the ewes and their newborn lambs were brought back to the breeding group. At the age of sixty days, the lambs were weaned. Every single sheep received a parasite prevention vaccine and was treated for parasites regularly. Because there was no grazing, all animals were given 300 grams of barley and 1.5 kilograms of hay ad libitum. During the final stage of pregnancy, they were gradually given 1.5 kg of concentrated feed, salt stones, and molasses until birth. The farms tried to achieve an average lambing interval of eight months, which would be equivalent to having 1.5 lambs per ewe per year, by having three lambs produces per ewe every two years.

### Recording and the definition of variables

Individual records of 450 Afec-Assaf ewe and 1660 of lambing were used for this study from 2019 to 2022. The database was consulted to ascertain the birth year, the lambing parity, and the number of offspring produced. Immediately after the birth of the lambs, the number of newborns in the litter was counted. The lambing interval (LI) that followed each parity was determined by counting the number of days that had gone by since the previous set of lamb births. It was determined that the litter size at weaning (LSAW) should be taken into account when calculating, the LI (LI after the first parity is the number of days from the date of the first lambing to the date of the second lambing). For this study, the following categories of factors were specified: the year of birth (2019–2022), the parity of lambing (1-4), and the litter type (singleton->4).

Statistical analysis Linear regression models with fixed effects were used to estimate the effect of nongenetic factors on the LS, LSAW and LI. Analyses were performed using IBM SPSS in the statistical program version.

The model used to analyze LS was:

$$Y_{ijkl} = \mu + A_i + P_i + e_{ij}$$

where  $Y_{ijkl}$  is observation on litter size,  $\mu$  is overall population mean,  $A_i$  is fixed effect of the i<sup>th</sup> year of lambing,  $P_j$  is fixed effect of the lth parity and  $e_{ij}$  is residual error.

The model for LI was:

$$Y_{ij} = \mu + A_i + P_i + e_{ij}$$

where Yij is observation on lambing interval,  $\mu$  is overall population mean, Ai is fixed effect of the i<sup>th</sup> year of lambing, P<sub>j</sub> is the effect of j<sup>th</sup> parity (j=1,2,3 and 4) and e<sub>ij</sub> is residual error.

Because the ram and the season did not have a substantial impact on the phenotypic value of growth traits, we did not include them in our analysis. The data were provided with the mean together with the standard error (SE), with a significance level of P<0.05 for statistical significance and P<0.001 for extremely significant significance. An ANOVA was carried out to determine whether or not fixed factors had a significant influence, and the reproductive performance of ewes with different litter sizes and parities was analyzed using means and standard errors. On the SPPS spreadsheet, the obtained information was loaded and saved after it was obtained. After that, the data were examined by utilizing the SPSS application. Tukey's HSD was used to do the comparison between the means. Statistically significant values were P<0.01 and P<0.05.

#### **RESULTS AND DISCUSSION**

During this study, the reproductive performance of the Afec-Assaf strain in Palestine was evaluated, as well as the impact of non-genetic factors on these characteristics has been calculated and analyzed. Table 1 provides a presentation of descriptive statistical parameters on reproductive characteristics for the entire population. The overall mean  $\pm$  and standard deviation for LS and LSAW were ( $1.81\pm0.9$ ,  $1.75\pm0.82$ ) respectively. This study found that the average LI was  $250.60\pm77.59$  days. On the other hand, the absolute variability of LI was significantly lower (SD = 59.3 days), in comparison to the current study findings (SD = 77.59 days) in Table 1.

The year of lambing and parity were found to have a significant influence on the LS (P<0.05) in Table 2. It is commonly known that LS rises as ewe parity advances. Both the parity of the ewes and the year in which they lambed had a significant influence (P<0.001) on LSAW in Table 2. The current study found that the litter sizes of ewes that were having their first lambing had the lowest average. On the other hand, ewes that were in their fourth parity were shown to have the largest litter in Table 1. The effect of parity was favourable to dams in their earlier parities, which suggests that the characteristics necessary for consecutive litter bearing may have been well developed in such a dam. The results of the Chisquare test on the relationship between parity and litter size, as well as the relationship between parity and type of birth, are reported in Tables 3 and 4, respectively.

A greater mean and standard deviation in LS was obtained by the Afec-Assaf strain and recorded by (Gootwine 2014) ( $2.55\pm0.05$ ), (Seroussi et al. 2017) ( $2.50\pm1.00$ ), (Reicher et al. 2012) (1.92) and (Gootwine et al. 2008)( $1.68\pm0.06$ ) in genotype  $\geq 31/32$  Assaf, however for litter size born alive (Gootwine et al. 2008) found that the LS were ( $1.58\pm0.06$ ,  $2.05\pm0.04$  and  $1.98\pm0.07$ ) for genotypes ++, B+ and BB respectively, The similarities between these findings and our own are striking. (Gootwine et al. 2008)reported claim that the LS of the Afec-Assaf strain is 2.5, which is a larger number

Reproductive trait	Descriptive statistics				
	Ν	Means	SD	Min.	Max.
LS (born alive)	913	1.81	0.9	1.00	5.00
LSAW	913	1.75	0.82	1.00	5.00
LI (days)	458	250.60	77.59	145	750

Table 1. Descriptive statistics for litter size, litter size a weaning and lambing interval in Afec-Assaf strain

LS= Litter size, LSAW= Litter size at weaning, LI= lambing interval, SD= standard deviation

Table 2. Variance analysis of litter size, litter size a weaning and lambing interval in Afec-Assaf strain

Variable	Fixed factor	Degree of freedom	Mean square	F value	P value
	Year of lambing	3	5.53	4.028	< 0.001
LS	Parity	3	4.346	5.435	< 0.001
	Year of lambing	3	7.539	6.366	< 0.001
LSAW	Parity	3	1.783	2.226	< 0.05
	Year of lambing	-	-	-	-
LI	Parity	2	4029.501	0.749	<0.474

LS= Litter size, LSAW= Litter size at weaning, LI= lambing interval, SD= standard deviation, F Values= Mean±SE, SE= Standard Error of mean.

**Table 3.** Least square means  $\pm$  standard error by the factor for litter size, litter size at weaning and lambing intervalin Afec-Assaf strain

Fixed factor	Level of		LS	<u>*</u>	LSAW		LI
	factor	Ν	LSM±SE	Ν	LSM±SE	Ν	LSM±SE
Year of	2019	63	1.63±0.13	63	1.46±0.09 <sup>b</sup>	-	-
lambing	2020	187	$1.62\pm0.08$	187	1.53±0.07 <sup>b</sup>	-	-
	2021	327	1.81±0.06	327	$1.77{\pm}0.06^{ab}$	-	-
	2022	336	1.96±0.06	336	1.9±0.06 <sup>a</sup>	-	-
Parity	1	444	$1.75 \pm 0.04^{b}$	444	1.71±0.03 <sup>b</sup>	-	-
	2	272	$1.80{\pm}0.05^{b}$	272	1.74±0.05 <sup>b</sup>	279	250.80±4.5
	3	138	$1.85{\pm}0.07^{b}$	138	$1.76 \pm 0.06^{b}$	137	$251.56{\pm}6.15$
	4	59	$2.25{\pm}0.14^{a}$	59	2.03±0.12 <sup>a</sup>	42	236.57±9.58
	χ2	22.8	43ª, P <0.05	29.7	83 <sup>a</sup> , P<0.01		

LS= Litter size, LSAW= Litter size at weaning, LI= lambing interval, N= Total lamb born, SD= standard deviation, Values= Mean±SE, SE= Standard Error of mean; ab superscript significant effect (P<0.05)

than what our research has revealed. This finding is comparable to those obtained by (Sodiq et al. 2011), in which the litter size of Batur sheep at the time of birth was 1.55 and 1.36 lambs after they were weaned.

Vlahek et al. (2022) recorded an improvement in LS from 1.77 in 1st parity ewes to 2.21 in 5th parity ewes, whereas, in Afec-Awassi in Palestine, LS continually expanded gradually to 5th parity.(Ahmed & Abdallah 2013) Similar trends were observed in Romanov (Murphy et al. 2020), Batur (Sodiq et al. 2011), Rajshahi (Jalal et al. 2015), Awassi (Al-Najjar et al. 2022), Bonga (Tera et al. 2021), Pelibuey (Canché et al. 2016) and Romanov crossbred sheep (Freking & Murphy 2021). This is consistent with the findings to a certain extent, as LS was found to increase to fourth parity. (2.25±0.14) in Table 3.

The result demonstrated that the Afec-Assaf strain was substantially different P<0.05, Afec-Assaf strain increased as a result of increasing parities, and this indicated that the age of the sheep was significant. The findings of the chi-square test in Table 4 showed that the parity had a significant influence on the type of birth P<0.05. moreover, the relationship between litter size and its type of birth had a significant effect P<0.001 in Table 4. The physiological development of ewes and does results in an increase in litter size as parity increases.(Deribe et al. 2014) It is well recognized that ewes' reproductive effectiveness improves with age, which leads to larger litters. This improvement is due to an enhanced ovulation rate, larger uterine capacity, and more maternal features (Assan 2020).

Sources	Number of borns (n, %)
Overall	1660 (100%)
Type of birth	
Single	392 (24%)
Double	706 (43%)
Triplets	330 (20%)
Quadruplets	232 (14%)
$\chi^2 = 24$	447.212ª, P<0.001
Parity	
1	781 (47%)
2	490 (30%)
3	256 (15%)
4	133 (8%)
$\gamma^2 -$	2/ 220ª P-0.05

**Table 4.** Litter size by type of birth and Parity of Afec-Assaf strain

n= number of borns. <sup>a</sup>superscript significant effect (P<0.05)

The reduced prolificacy of primiparous ewes may be attributed to immature reproductive traits required for successive litter bearing compared to multiparous does who had attained physiological maturity (Sodiq et al. 2011). The results for Afec-Awassi and Afec-Assaf in neighboring countries such as Jordan and Syria as well as the outcomes of our study indicate that there is a high potential for improvement of the prolificacy of these breeds through introgression of the mutation into sheep breeds in Palestine. This should be economically appealing given the significant increase in the price of lamb over the past few years. Models for LS analyses frequently incorporate lambing year (Canché et al. 2016; Al-Najjar et al. 2022; Vlahek et al. 2022). In the current investigation, the total impact of lambing season on LS was found to be statistically significant P<0.05 in Table 2. Ewes lambing in 2022 had statistically significant P <0.05 larger litters in Table 2, which may have been caused by the high percentage of ewes who were having their fourth lambing in that year.

During the lambing season of 2021, a greater number of LSAW were documented in Table 3. However, LSAW were found during 2019 at the commencement year of the selection program which was  $1.46\pm0.09^{b}$  litter/ewes. The percentage of LSAW outcomes that were similar to LS increased steadily throughout the selection. Similarly, (Habtegiorgis et al. 2022) stated a trend toward improvement in litter size characteristics as a result of the ongoing breeding of Bonga and Horro sheep. The influence of the lambing year on LSAW has also been documented by other researchers. (Hanford et al. 2005; Sodiq et al. 2011; Habtegiorgis et al. 2022) in Doyogena, Karacabey and Batur sheep, (Tesema et al. 2020) for Dorper x Tumele sheep breeds, and (Deribe et al. 2021) for Dorper crossbred lambs. (Habtegiorgis et al. 2022) stated the litter size at born 1.57 and weaning was 1.50. Other researchers stated the litter size at born and weaning were 1.422 and 1.35 respectively, for Karacabey Merino ewes, (Hanford et al. 2005) stated litter size at birth and weaning of Rambouillet sheep were 1.39 and 0.88 lambs, respectively. The current study of Afec-Assaf ewes obtained larger litter sizes at birth and weaning than the reports listed above on sheep, both when the lambs were born and when they were weaned.

The significant range in LI that was observed in this research might have been the result of intentional mating (continuous mating). The likelihood ratio (LI) was not significantly affected by any of the tested factor's P>0.05 in Table 2. After the second and third parities, the LI that was reported as being the longest (250.80±4.5 and 251.56±6.15 days) was significantly longer than the LI that was recorded after the fourth parities in Table 3. This is in agreement with the findings of (Vlahek et al. 2022) in Romanov sheep, (Ahmed & Abdallah 2013)in Afec-Awassi and improved Awassi, (Tera et al. 2021) in Bonga sheep and (Jalal et al. 2015) in Rajshashi sheep. (Ahmed & Abdallah 2013) informed non-significant P>0.05 differences in the first, second and third LI of Afec-Awassi ewes with different parities. same results were found by (Jalal et al. 2015). The average lambing interval for semi-intensive and intensive feeding systems was found to be 338 days (Ahmed and Abdallah 2013) but the current result was found to be shorter (250.60±77.59). Assuming a 60-day ideal post-lambing oestrus interval, a 90% first-service conception rate, and a gestational period of 150 days, the ideal time between lambing is approximately 210 days. It is possible to double the number of sheep produced in the country in just over one and a half years if the lambing interval can be shortened by optimizing the breed, age, parity, and management practices used in this study (Vlahek et al. 2022). It was hypothesized and discussed that a higher rate of milk production in multiparous ewes might be one of the factors contributing to the longer LI in ewes that have had more than one litter.(Ahmed and Abdallah 2013) reported milk production of 169.0 (43.7), 197.0 (61.3) and 196.7 (77.1) kg in total milk yield to 150 days in Afec-Awassi, Assaf and Awassi x Assaf sheep respectively.

## CONCLUSION

The study found a significant increase in litter size at birth and weaning during the fourth parity. Parity did not have a significant impact on the lambing interval. Reproductive performance varied among the ewes, primarily due to non-genetic factors. Parity played a crucial role in determining litter size at birth and weaning. These findings are valuable for evaluating the reproductive efficiency of the Afec-Assaf breeding program and proposing breeding strategies for improvement. Further research on body weight during delivery and weaning, particularly considering different birth techniques, can provide economic insights for fattening farms. The introduction of the Booroola FecB gene resulted in increased prolificacy in the Assaf population, suggesting its potential to enhance the reproductive performance of sheep breeds in Palestine.

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