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Birth Characteristics of Lambs from Crossbreeding of Dorper and Awassi Rams with Texel Cross Ewes

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ABSTRACT

Crossbreeding is an effective strategy to enhance sheep productivity under tropical conditions. This study evaluated the birth characteristics of lambs resulting from crossbreeding Dorper and Awassi rams with Texel cross ewes in Indonesia's tropical environment. The experiment was conducted from April to November 2023 at CV Kambing Burja, Malang Regency, East Java, Indonesia. A total of 125 Texel cross ewes aged 1.5 to over 3 years were naturally mated with 71 Dorper and 54 Awassi rams using a controlled colony mating system at a ram-to-ewe ratio of 1:25. The study employed complete enumeration, including all ewes that successfully lambed during the observation period. Sire groups comprising two to three rams per breed were rotated every 45 days to ensure equal mating opportunities and prevent exhaustion. Estrus synchronization followed a two-step hormonal protocol, including the administration of Conceptase ($PGF_{2}\alpha$, 2.5 mL/ewe) intramuscularly to induce luteolysis, followed 48 hours later by PG600 (1.5 mL/ewe) containing eCG and hCG to stimulate follicular development and ovulation. Mating behavior was observed daily, with successful copulation indicated by restlessness, vocalization, and receptivity. Measured parameters included birth weight, litter size, and sex ratio. Results showed no significant differences in mean litter size or birth weight between Dorper × Texel cross and Awassi × Texel cross lambs, although Awassi crosses exhibited more uniform birth weights. Birth weight decreased as litter size increased, and sex ratios remained balanced in both groups. These findings suggest that both Dorper and Awassi rams are suitable for enhancing the reproductive performance of Texel cross ewes under tropical management systems, highlighting the importance of integrating hormonal synchronization and controlled breeding for sustainable sheep production in Indonesia.

Keywords: Awassi sheep, Birth weight, Dorper sheep, Litter size, Sex ratio, Texel cross sheep

INTRODUCTION

Sheep play an important role in supporting the livelihoods of smallholder farmers in Indonesia, particularly on the island of Java, which accounted for more than 92% of the national sheep population in both 2022 and 2023, with the majority raised under traditional smallholder farming systems (Badan Pusat Statistik, 2024). Domestic mutton consumption, as reflected by national production, reached 50,702.06 tons in 2021, 52,162.30 tons in 2022, and 52,998.80 tons in 2023, based on livestock slaughter data (Ditjen PKH, 2024). However, the national sheep population in Indonesia has experienced a notable decline, from 17.83 million head in 2019 to 15.62 million head in 2022, primarily due to genetic limitations, traditional management practices, and limited access to modern breeding technologies (Badan Pusat Statistik, 2023). This population decline highlights the urgent need for effective genetic improvement strategies to enhance sheep productivity in Indonesia, such as the implementation of systematic crossbreeding programs to improve genetic potential while maintaining adaptation to local environmental conditions.

Crossbreeding with exotic breeds, particularly Dorper and Awassi sheep, has emerged as a promising approach for genetic improvement in Indonesia. Dorper sheep, developed from Dorset Horn and Blackhead Persian crosses, are known for their superior growth rates and carcass quality. Adult Dorper rams can reach weights of up to 130 kg, while ewes typically weigh between 80 and 110 kg (Milne, 2000; Jannah et al., 2025). Their reproductive performance is notable, with single birth weights averaging around 3.54 ± 0.9 kg for Dorper lambs and 2.99 ± 0.9 kg for F1 Garut × Dorper crossbreds (Jannah et al., 2025). Similarly, Awassi sheep from the Middle East offer valuable multipurpose traits, producing an average of 91 liters of milk per 100-day lactation period even under challenging conditions (Haile et al., 2017). The breed's adaptability to tropical environments and ease of handling make Awassi sheep particularly suitable for crossbreeding programs (Üstüner and Oğan, 2013).

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Crossbreeding Dorper and Awassi rams with other sheep breeds has been shown to produce progeny with superior traits, including faster growth rates and improved feed efficiency (Wahyudi et al., 2023; Mudawamah, 2024). One of the key aspects of lambing characteristics is birth weight. Previous studies have indicated that lamb birth weight is influenced by genetic and environmental factors, including maternal nutrition during gestation (Boujenane et al., 2015; Magotra et al., 2022; As et al., 2025). Genetic factors such as breed group and heritability play important roles (Amarilho-Silveira et al., 2018; Hagan et al., 2022), while environmental factors such as season and birth type also have significant effects (Hagan et al., 2022). Maternal nutritional supplementation can enhance birth weight and postnatal productivity (Elnageeb and Abdelatif, 2013; McCoard et al., 2017). The birth characteristics of lambs resulting from Dorper rams crossed with Texel ewes demonstrate significant potential for enhancing sheep productivity in Indonesia. By harnessing the genetic advantages of both breeds, farmers can produce sheep with better adaptability and meat quality traits that are highly sought after in the Indonesian sheep industry (Wahyudi et al., 2023; Mudawamah, 2024).

In recent years, Indonesia has actively imported Dorper and Awassi sheep as part of crossbreeding programs aimed at improving the performance of local sheep breeds. In East Java, the majority of the sheep population consists of Local Texel and Texel cross types, which are currently being used in crossbreeding with Dorper or Awassi rams to produce offspring with enhanced productivity traits. Although the benefits of strategic crossbreeding have been well-documented in numerous studies (Getachew et al., 2016; Tesema et al., 2020), limited research has examined the specific interactions between dam age and reproductive parameters in Dorper and Awassi crosses under tropical conditions. For instance, recent field observations suggest differing sex ratio patterns among progeny, including Dorper crossbreeding tends to yield a male-biased ratio (58.5%), whereas Awassi crosses tend to produce more females (56.9%) when mated with Texel Cross ewes (Hudori et al., 2022). However, the combined effects of these genetic factors on key production traits such as birth weight, litter size, and sex ratio remain poorly understood, especially in tropical environments.

These initial observations underscore the complex interactions between genetic factors and physiological responses influenced by sire breed, highlighting the need for more comprehensive research to inform livestock production and management strategies. Therefore, the present study aimed to evaluate the effects of crossbreeding on lambing characteristics, specifically focusing on birth weight and litter size of Texel cross ewes mated with Dorper and Awassi rams under tropical conditions.

MATERIALS AND METHODS

Study location

The study was conducted at CV Kambing Burja, located in Bedali Village, Lawang Subdistrict, Malang Regency, East Java, Indonesia (7°50'20" S, 112°37'50" E). This location was purposefully chosen due to its active sheep breeding programs involving Texel cross ewes and purebred Dorper and Awassi rams. The study was carried out from April to June (dry season) for the mating period, and from September to November (rainy season) for the lambing period. The farm is situated at an altitude of approximately 550 meters above sea level, characterized by a tropical wet climate with an average temperature of 25-30°C and rainfall of 100-200mm per month.

Experimental animals

This study involved 125 crossbred Texel ewes obtained from the breeding flock at CV. Kambing Burja, a commercial sheep farm located in East Java, Indonesia. The sample size represented the entire population of ewes that successfully lambed during the observation period (September-November 2023) and met the inclusion criteria, thereby employing a complete enumeration approach. Due to the limited number of ewes that lambed within this period, random sampling was not applied; instead, all eligible individuals were included in the study. The ewes were between 1.5 and over 3 years of age and were stratified according to parity before being randomly allocated to treatment groups.

Two mature breeding rams were used, including a purebred Dorper ram (± 80 kg, > 2 years old) assigned to 71 ewes, and a purebred Awassi ram (± 80 kg, > 2 years old) assigned to 54 ewes. To maintain breeding efficiency and ensure ram welfare, multiple rams of the same breed were managed under a rotational colony system. Each breeding group comprised 2-3 rams of the same sire line with approximately 25 ewes per pen. Rams within each sire group were rotated every 45 days to provide adequate rest between breeding cycles, ensuring an effective ram-to-ewe ratio, minimizing fatigue, and maintaining high conception rates. Within each parity group, ewes were randomly allocated to either the Dorper or Awassi sire group before estrus synchronization.

Estrus synchronization followed a two-step hormonal protocol to coordinate breeding activity. Conceptase® (cloprostenol sodium, $PGF_{2}\alpha$; Agrovet Market, Peru) was administered intramuscularly at a dose of 50 µg or 2.5mL/ewe to induce luteolysis (Arroyo-Ledezma et al., 2015; Ramírez et al., 2018). After 48 hours, ewes received PG 600® (MSD Animal Health, USA), containing equine chorionic gonadotropin (eCG; 80 IU/mL) and human chorionic gonadotropin (hCG; 40 IU/mL), at a dose of 1.5 mL/ewe, to stimulate follicular development and ovulation (Habeeb et al., 2019). This protocol promoted uniform estrus expression across the flock, enabling efficient natural mating within the 45-day breeding period. Mating behavior was monitored daily, and ewes exhibiting estrus signs (restlessness, vocalization, mounting behavior, and receptivity to the ram) were observed for successful copulation.

Management and feeding practices

The flock was managed intensively using a colony housing system with raised wooden floors designed for optimal ventilation and sanitation. The diet consisted of fresh Pakchong grass (Pennisetum purpureum cv. Thailand) offered at 10% of body weight per day, supplemented with a formulated concentrate feed containing 14% crude protein and approximately 3100 kcal/kg of metabolizable energy. The concentrate was composed of locally available ingredients such as cassava cobs, coffee husks, corn, kapok seeds, cassava peels, coconut meal, corn gluten feed (CGF), soybean meal (SBM), distillers dried grains (DDGS), soy sauce residue, iodized salt, lime, sheep premix, molasses, fermented mother liquor (FML), sodium bicarbonate, and pollard. Feed composition was adjusted according to sex and physiological status. Clean drinking water was provided *ad libitum*, and flock health was monitored biweekly.

The mating program followed standard farm procedures with a ram-to-ewe ratio of 1:25. Rams underwent a minimum seven-day conditioning period prior to mating. Both rams and ewes were groomed (hair and hoof trimming) before being placed in mating pens. To enhance reproductive performance, rams received nutritional supplementation with sprouts on day 7 and a traditional herbal mixture (*jamu*) on day 10 of the mating period. The herbal mixture (Indonesia) was formulated in-house by CV Kambing Burja (partner farm) using locally sourced ingredients, including palm sugar, native chicken eggs, garlic, honey, and vitamin E-selenium. Additionally, vitamin supplements were administered to both sexes every 10-14 days during the 45-day mating period. At the end of the mating period, rams were removed and returned to rest pens.

Pregnancy diagnosis was performed by transabdominal ultrasonography at 60- and 75-days post-mating. Confirmed pregnant ewes were transferred to lactation pens, while non-pregnant ewes were re-enrolled in the next breeding cycle. All breeding activities, including mating start and end dates, were systematically recorded.

Data collection

The reproductive traits were measured, including lamb birth weight, litter size, and sex ratio. Birth weights were obtained within 24 hours post-partum using a calibrated digital scale with 0.01 kg precision. Litter size was recorded for each ewe and classified into three categories include single, twin, or triplet births. Lamb sex was determined by visual examination immediately following birth. Meteorological data, including ambient temperature and relative humidity, were collected throughout the study period to evaluate potential environmental influences on reproductive parameters.

Statistical analysis

The observed variables included sex, litter size, and birth weight of lambs from Dorper × Texel cross and Awassi × Texel cross matings. Data were analyzed using Microsoft Excel and SPSS version 26. Descriptive statistics, including mean, standard deviation, and coefficient of variation, were calculated for all variables. Spearman correlation test and Analysis of Variance (ANOVA) with a significance level of $\alpha = 0.05$ were performed to examine the correlation and differences between birth weight and litter size, with differences between treatments further analyzed using the Games-Howell post-hoc test. Independent sample t-tests were conducted to analyze differences in lamb litter size from crossbreeding, birth weight from crossbreeding, and birth weight based on sex. Additionally, a chi-square test was used to evaluate sex ratio distribution among the crossbred progeny.

RESULTS AND DISCUSSION

Litter size

The phenotypes of the Dorper × Texel cross and Awassi × Texel cross progeny are shown in Figure 1. Statistical analysis (Table 1) indicated no significant difference in litter size between Dorper × Texel cross (1.51 ± 0.65) and Awassi × Texel cross (1.56 ± 0.60, $p > 0.05$). The high coefficients of variation were observed between crosses (43.26% and 38.83%, respectively)

Although not statistically significant, the slightly higher litter size observed in Awassi × Texel cross compared to Dorper × Texel cross may reflect breed-specific reproductive characteristics. Awassi sheep have demonstrated superior adaptability and reproductive performance in tropical environments (Haile et al., 2017), whereas Dorper sheep are primarily selected for growth rate and carcass traits rather than prolificacy (Milne, 2000). The litter sizes observed in both crossbreeds exceeded those reported for purebred Dorper (1.40 ± 0.05), Texel (1.25 ± 0.05), and Awassi (1.16 ±

0.01) sheep (Wolf et al., 2014; Gavojdian et al., 2015; Al-Najjar et al., 2022). Comparative studies on Dorper crossbreeding with Indonesian local sheep breeds have shown considerable variation in litter size, ranging from 1.35 to 2.1 across different genetic backgrounds and management systems. The highest litter sizes were observed in Garut sheep × Dorper crosses (1.7-2.1, Lusi et al., 2022) and Javanese local crossbreds (1.92, Hudori et al., 2022), while intermediate values were reported for thin-tailed sheep crosses in Sedan village (1.82, Najmuddin and Nasich, 2019) and West Java (1.79, Najmuddin and Nasich, 2019), fat-tailed sheep crosses (1.61, Sodiq et al., 2011), and Batur sheep crosses (1.55, Sodiq et al., 2011). Lower litter sizes of 1.44 and 1.35 have also been documented in some local sheep crosses (Hudori et al., 2022; Pratama and Siswoyo, 2024).

The average litter size of Texel cross in the current study was lower than that reported by Hakim et al. (2019) for Texel cross sheep in Wonosobo, Central Java, Indonesia (1.45), and by Talebi et al. (2023) for Texel × Moghani F1 sheep in Iran (1.42). It was also lower compared to the findings of Najafabadi et al. (2020) for Texel cross × Romney sheep in New Zealand, which ranged from 1.9 to 2.2. The high coefficients of variation may be influenced by several factors, including dam age, nutritional status, and the genetic potential of individuals within the studied population. Previous studies have reported that dam age and parity affect litter size, with younger ewes more likely to give birth to singletons, while older ewes have a greater likelihood of delivering twins or more (Gavojdian et al., 2013). In addition, environmental factors, such as feed availability and reproductive management, can also impact lambing outcomes (Tesema et al., 2020).

Figure 1. Phenotypic color variations in various sheep crossbreeds in Indonesia. **a:** A Texel cross ewe with white wool and a long tail pattern. **b:** A one-day-old Dorper x Texel cross lamb with a solid black or black-and-white pattern on its head, a pure white body, and a long tail similar to the Texel cross ewe. **c:** A one-day-old Awassi x Texel cross lamb with cream-colored wool, distinctive light brown patches on the head and face, and a long tail pattern resembling the Texel cross ewe (Designed by Authors).

Table 1. Average litter size from crossbreeding Dorper and Awassi rams with Texel cross ewes in Indonesia

Crossbreeding	Number of Ewes	Mean Litter size ± SD	CV (%)[1]
Dorper × Texel cross	71	1.51 ± 0.65	43.26
Awassi × Texel cross	54	1.56 ± 0.60	38.83

[1]CV: Coefficient of Variation, expressing the ratio of the standard deviation to the mean as a percentage, indicating the relative variability of litter sizes within each group. SD: Standard deviation

The crossbreeding program has influenced the genetic variation in reproductive traits, as indicated by the high coefficients of variation (CV) in litter size, ranging from 38.83% to 43.26%. The CV was calculated at the individual ewe level based on litter size per lambing. The reproductive physiology of sheep in tropical environments may differ from that in subtropical regions, potentially affecting hormone secretion patterns and ovulation rates independently of dam age (Notter, 2008; Abdoli et al., 2013). These findings suggest that, under optimal management conditions, the effect of maternal age on reproductive performance may be less pronounced than previously assumed. This highlights the importance of adopting a comprehensive approach in sheep breeding programs that integrates genetic, physiological, and environmental factors.

The high CV observed in this study might be attributed to several interacting factors, including dam age, nutritional status, and the inherent genetic potential of individuals within the population (Ptáček et al., 2017; Kuźnicka et al., 2020; Gaur et al., 2022). Previous studies have reported that parity influences maternal behavior, litter size, and lamb survival, with multiparous ewes exhibiting more nurturing behaviors that lead to better lamb survival rates. Previous studies have reported that dam age and parity significantly influence litter size, with younger ewes more likely to produce single lambs, while older ewes have a higher probability of multiple births (Gavojdian et al., 2013; Lv et al., 2016). Moreover, environmental conditions such as feed quality, reproductive management, and climate stress can further influence lambing outcomes (Safari et al., 2005; Tesema et al., 2020). Overall, the results indicate that crossbreeding Dorper and Awassi rams with Texel cross ewes produces comparable litter sizes but with a high degree of variability. Therefore, strategic breeding design combined with optimized nutritional and reproductive management is essential to enhance reproductive efficiency and improve sheep production performance under tropical conditions in Indonesia. Birth weight. The statistical analysis (Table 2) showed no significant difference in overall birth weight between the two crossbreeding groups, Dorper × Texel and Awassi × Texel ($p > 0.05$). The high CV (36.93% and 30.39%) indicates considerable variability in birth weight within both crossbreeding types.

Table 2. Average birth weight from crossbreeding Dorper and Awassi rams with Texel cross ewes in Indonesia

Crossbreeding	Number of Lambs	Mean Birth Weight (kg) ± SD	CV (%)[1]
Dorper × Texel cross	107	2.26 ± 0.84	36.93
Awassi × Texel cross	84	2.46 ± 0.75	30.39

[1]CV: Coefficient of Variation, expressing the ratio of the standard deviation to the mean as a percentage, indicating the relative variability of litter sizes within each group. SD: Standard deviation

The comparison of average birth weights from crossbreeding Dorper and Awassi rams with Texel cross ewes provides insight into lamb growth performance. Studies by McGovern et al. (2020) and Abebe et al. (2023) revealed that lamb birth weight varies due to genetic factors, management practices, and climatic conditions. The study by Athifa et al. (2022) on post-weaning growth of lambs from Garut ewes crossed with Dorper rams indicated that Dorper genetics contribute positively to growth traits, reflected in both birth weight and average body weight (ABW). Environmental factors indeed influence growth traits in both Dorper and Awassi sheep. Studies have shown that factors such as year of birth, birth season, maternal effects, and management practices significantly affect growth performance in these breeds (Aljubouri et al., 2020; Besufkad et al., 2023; Jannah et al., 2025; Haddad et al., 2025). Getahun et al. (2019) and Kao et al. (2022) investigated the effects of heterosis in crossbred sheep, finding that hybrid vigor contributed to higher birth weights compared to weaning weights in various Awassi crossbreeding scenarios.

In the present study, lambs from Awassi crosses showed a higher birth weight (2.46 ± 0.75 kg) than those from Dorper crosses (2.26 ± 0.84 kg) when bred with Texel cross ewes (Table 2). This difference reflects the genetic characteristics of Awassi sheep, which exhibit superior maternal traits and enhanced fetal growth potential. Although Dorper sheep possess genetic advantages for post-natal growth and meat production, they tend to produce lower birth weights compared to Awassi sheep (Athifa et al., 2022), possibly due to breed-specific differences in placental development and maternal resource allocation (Özyürek, 2020; Daş et al., 2022).

The lower CV observed in Awassi crosses (30.39%) compared to Dorper crosses (36.93%) indicates more uniform birth weights in lambs from Awassi crosses. This greater uniformity reflects the consistent reproductive performance and enhanced maternal capacity of Awassi sheep under optimal management conditions (Alamer and Al-Hozab, 2004; Talafha and Ababneh, 2011).

Al-Thuwaini and Al-Hadi (2022) highlighted the critical role of maternal body condition in lamb growth, pointing to the need for further studies in sheep farming under tropical conditions. Several interconnected factors within the production system may explain the lack of statistically significant differences. Controlled feeding practices at the research site, regular provision of Pakchong grass (10% of body weight) and concentrate feed (14% crude protein) likely ensured equivalent nutritional status across all crossbred groups and age classes. These ideal nutritional conditions allowed younger ewes to overcome physical limitations, thereby supporting fetal development as effectively as older ewes.

The relatively high CV reflects the genetic diversity present in the Texel crossbred population. The controlled farming conditions, an elevation of 550 meters, ambient temperatures between 25-30°C, and carefully timed breeding (mating during the dry season from April to June, and lambing during the rainy season from September to November) provided an optimal environment for all ewes regardless of age. Under these favourable conditions, young ewes may compensate for their physical immaturity through more efficient nutrient utilization, better environmental adaptability, and optimal placental development, aligning with the findings of McGovern et al. (2020) regarding the interaction between environmental factors and maternal physiology.

Birth weight based on litter size

Based on the data presented in Table 3, single births produce the highest birth weight, followed by twin births and triplets. Additionally, there are differences in lamb birth weights based on litter size from crossbreeding Dorper and Awassi rams with Texel cross ewes. In the Dorper × Texel cross, birth weights of lambs with litter sizes 1 and 2 show no significant difference ($p > 0.05$), but both differ significantly from litter size 3, which has a lower birth weight ($p < 0.05$). A similar pattern was observed in the Awassi × Texel cross, where birth weights of lambs with litter size 1 differ significantly from both litter sizes 2 and 3 ($p < 0.05$).

Table 3. Average birth weight based on litter size, average litter size from crossbreeding Dorper and Awassi Rams with Texel cross ewes in Indonesia

Crossbreeding	Litter size	Mean birth weight (kg) ± SD	Number of lambs	CV (%)[1]
Dorper × Texel cross	1	2.58 ± 0.77[a]	41	30.03
	2	2.30 ± 0.53[a]	48	22.92
	3	1.45 ± 0.15[b]	18	10.12
Awassi × Texel cross	1	2.95 ± 0.62[a]	27	20.91
	2	2.36 ± 0.28[b]	48	11.90
	3	1.49 ± 0.19[c]	9	12.83

[1]CV: Coefficient of Variation, expressing the ratio of the standard deviation to the mean as a percentage, indicating the relative variability of litter sizes within each group. [a,b,c] Different superscript letters within the same column indicate significant differences ($p < 0.05$). SD: Standard deviation.

The coefficient of variation (CV), ranging from 10.12% to 30.03%, indicates moderate to high variability in the birth weight of lambs resulting from these crossbreeding programs. Birth weights based on litter size show a significant negative correlation in both Dorper × Texel cross and Awassi × Texel cross groups ($p < 0.05$). Birth weight demonstrates a decreasing trend with increasing litter size, where lambs from single births exhibit the highest average birth weight, followed by twins, and triplets showing the lowest birth weight. This inverse relationship, where single-born lambs are significantly heavier than twins and triplets, is consistent with the findings of Şahin et al. (2022), Al-Janabi et al. (2023), and Aksoy et al. (2023) ($p < 0.05$). This pattern is primarily attributed to intrauterine nutrient competition, as emphasized by Gaur et al. (2021). Single-born lambs benefit from greater placental resource allocation, resulting in higher birth weights. Studies conducted in various tropical regions consistently show an inverse relationship between litter size and birth weight. Pinheiro et al. (2020) in Brazil reported that single births resulted in higher birth weights compared to multiple births due to reduced competition for maternal resources. Furthermore, the relationship between litter size and birth weight has been widely studied, with findings indicating that as litter size increases, the average weight of individual lambs tends to decrease because of the shared maternal resources during gestation (Mellado et al., 2016).

The findings of the current study, which show a clear difference in birth weight between single and multiple births (2.58 ± 0.77 kg vs. 2.30 ± 0.53 kg in the Dorper cross), are in line with the study of Rather et al. (2020). That study demonstrated that lambs born as singletons had significantly higher birth weights compared to twins or triplets. In the present study, single and twin births differed significantly from triplet births in terms of birth weight ($p < 0.05$), reinforcing that litter size is a major factor influencing birth weight and early growth performance. In a comparative context, Prakash et al. (2017) noted that although the average litter size in their study was lower than in the present findings, they also observed a decrease in birth weight with increasing litter size, supporting the generalizability of this trend across different breeds and environments. Additionally, the study by Momoh et al. (2013) emphasized that birth type, whether single or multiple, significantly affects both birth weight and subsequent growth performance, which corroborates the results of the present study. Moreover, Chay-Canul et al. (2019) highlighted those environmental conditions and maternal health significantly influence birth outcomes.

The tropical climate plays a crucial role in birth weight patterns. Robertson and Friend (2022) demonstrated that high temperatures and heat stress can impair fetal development, reduce lamb birth weight, and increase perinatal lamb mortality. Heat stress above 32°C can significantly impact reproductive performance, including increased embryonic mortality and reduced birth weight. Gemiyo et al. (2014) and Oke et al. (2021) further noted that higher temperatures intensify the effects of intrauterine competition in multiple pregnancies, highlighting the critical relationship between climate and reproductive outcomes in tropical livestock production. Multiple factors influence lamb birth weight beyond litter size, including maternal nutrition, maternal characteristics, and environmental conditions. Boujenane and Diallo (2017) found that single lambs benefit from enhanced nutrient access throughout pre- and postnatal development. Habtegiorgis et al. (2022) identified additional factors, including ewe parity, management practices, and seasonal variations, noting increased litter sizes during dry seasons and higher birth weights during rainy seasons. Long-term selection programs have proven effective in improving both litter size and birth weight across generations (Habtegiorgis et al., 2022; Jimma et al., 2025), emphasizing the importance of proper management and adequate feeding, particularly for high-parity ewes and multiple births.

Birth weight based on sex

Based on the data in Table 4, the chi-square analysis of the sex ratio in crossbred lambs showed a χ^2 value of 0.234 ($p = 0.234$) for Dorper × Texel cross (52% male; 48% female) and χ^2 value of 0.762 ($p = 0.762$) for Awassi × Texel cross (45% male; 55% female). While these differences were not statistically significant ($p > 0.05$), the contrasting patterns between the two crossbreeds warrant further discussion. The Dorper crosses' tendency toward male offspring and Awassi crosses' inclination toward female offspring may be attributed to several underlying factors related to breed characteristics and physiological mechanisms.

Table 4. Average birth weight based on sex from crossbreeding Dorper and Awassi rams with Texel cross ewes in Indonesia

Crossbreeding	Sex	Number of lambs (%)	Mean birth weight (kg) ± SD	CV (%)[1]
Dorper × Texel cross	Male	56 (52%)	2.22 ± 0.79	38.38
	Female	51 (48%)	2.30 ± 0.88	35.7
Awassi × Texel cross	Male	38 (45%)	2.42 ± 0.66	27.14
	Female	46 (55%)	2.49 ± 0.82	32.96

CV: Coefficient of Variation, expressing the ratio of the standard deviation to the mean as a percentage, indicating the relative variability of litter sizes within each group. SD: Standard deviation.

In the Dorper crossbreeding program, the higher proportion of male offspring (52%) aligned with the findings of Zülkadir and Karabacak (2013), who reported a similar male-biased sex ratio in meat-type sheep breeds. This bias may be linked to the selection history of the Dorper breed for meat production traits, which could influence sex determination mechanisms (Zonabend König et al, 2017; Selala and Tyasi, 2022). The larger body size and higher muscle mass typical of Dorper rams may affect sperm motility patterns or the survivability of Y chromosome-bearing spermatozoa. Similar observations were reported by Al-Thuwaini and Al-Hadi (2022), who noted a correlation between ram breed type and offspring sex ratio in meat-focused breeding programs.

In contrast, the tendency for Awassi crossbreeding to produce a higher proportion of female offspring (55%) presents an interesting contrast that may be associated with its characteristics as a dairy breed. This pattern has been observed in other dairy sheep breeds as well, as reported by Boujenane and Diallo (2017), who found a slight female bias in crossbreeding programs oriented toward milk production. The physiological basis for this bias may involve differences in placental development, maternal recognition of pregnancy, or hormone profiles typical of dairy breeds. However, it is important to note that the differences in sex ratios observed in the present study were not statistically significant ($\chi^2 = 0.762$, $p > 0.05$), indicating that other factors may be influencing sex determination.

Variations in sex ratio distribution patterns may also be influenced by environmental and management factors (Gootwine, 2011; Casellas et al., 2023). Temperature, nutrition, and breeding season have been shown to affect the sex ratio in sheep, as documented by Thompson et al. (2021). The timing of mating during the dry season (April–June) may interact differently with the physiological characteristics of Dorper and Awassi rams, potentially affecting sex ratio outcomes. Additionally, factors such as ram age, semen quality, ejaculation frequency, and scrotal circumference may also contribute to these patterns, as suggested by Martínez-Velázquez et al. (2003).

A review of previous studies revealed inconsistent findings regarding breed-specific sex ratios in sheep. While some researchers have reported similar breed-based patterns (Al-Thuwaini and Al-Hadi, 2022), others have found no consistent relationship between breed type and offspring sex ratio (Casellas et al., 2023). This variability suggests that sex determination is a complex trait influenced by genetic, environmental, and management factors. Studies show low heritability for sex ratio in sheep breeds, indicating limited genetic influence (Kumar et al., 2021), though selecting sires with sex-specific tendencies may help skew ratios. Environmental conditions significantly impact sex ratios. Ewes fed diets high in omega-6 fatty acids have been shown to produce a higher proportion of female offspring, suggesting that dietary composition can directly influence lamb sex ratios (Laleva et al., 2022). In addition, seasonal variations have also been reported to affect these outcomes (Casellas et al., 2023). Future research should focus on larger sample sizes and multiple breeding seasons to better understand these mechanisms. The practical implications of these findings for breeding programs should be carefully considered. Although the observed differences in sex ratios were not statistically significant, understanding breed-specific tendencies may help farmers better plan their breeding strategies, especially when a specific sex ratio is desired for production or flock replacement purposes. However, further studies are needed to confirm whether these patterns can be consistently reproduced across different environments and management systems.

CONCLUSION

This study demonstrated that crossbreeding Dorper and Awassi rams with Texel cross ewes can enhance sheep productivity by optimizing birth weight and litter size. Although litter size did not differ significantly between the two crossbreeds, lambs from Awassi × Texel cross had higher and more uniform birth weights than those from Dorper × Texel Cross. A negative correlation was observed between litter size and birth weight, indicating that birth weight decreased as litter size increased. The sex ratio analysis showed contrasting tendencies, with Dorper producing more males and Awassi more females, though differences were not statistically significant. These findings highlight the need to optimize breeding strategies and management practices in Indonesia's smallholder systems to improve reproductive efficiency through selective mating and targeted nutrition for pregnant ewes. Future studies should investigate multi-generational performance, sex ratio mechanisms, economic viability, genotype and environment interactions, and nutritional interventions to enhance lamb survival and productivity.

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Availability of data and materials

The data to support the present study's findings are available upon reasonable request to the corresponding author.

Ethical considerations

This study was prepared according to the guidelines of the WVJ journal and is free from plagiarism and has not been submitted to any other journal. The authors did not use any AI applications during conducting the study, performing the procedures and finally writing the manuscript.

Authors' contributions

Asrullah As, Suyadi, Tri Eko Susilorini, and Kuswati conceptualized the study, developed the methodology, provided resources, and supervised the study. Asrullah As, Ari Ardiantoro, Rafika Febriani Putri, and Muhamad Jayfa Gilang Pratama conducted the investigation and visualized the data. Asrullah As and Suyadi wrote the original manuscript. Wike Ande Septian and Chairdin Dwi Nugraha revised the manuscript. All authors agreed to the final version of the manuscript. No AI was used to conduct the current study.

Competing interests

The authors declare that there are no conflicts of interest regarding the publication of this article.

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