



Reproductive performance and evaluation of pregnancy diagnosis techniques in Horro sheep under station management in western Ethiopia

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Abstract

This study evaluated the reproductive performance of Horro sheep and compared pregnancy diagnosis techniques under station management conditions in western Ethiopia. A total of 142 ewes and 13 rams were monitored over two breeding seasons at Bako Agricultural Research Center. Reproductive traits assessed included conception, fertility, lambing rate, litter size, gestation length, lamb survival, and ram reproductive characteristics. Pregnancy diagnosis methods evaluated were traditional observation, seed germination, and ultrasonography. Conception, fertility, and lambing rates were 81%, 69%, and 91.5%, respectively, with a mean litter size of 1.32 lambs per ewe. 87% of ewes conceived after a single service, with an average of 1.17 ± 0.04 , per conception. The average gestation time was 151.2 ± 6 days, lamb birth weight was 2.22 ± 0.20 kg, and weaning survival was 59.6%. Ultrasonography detected pregnancy better than observation, but seed germination performed worse. Early pregnancy has reduced ultrasonographic detection rates. The results show that Horro sheep have moderate reproductive performance and that ultrasonography is the best pregnancy test.

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INTRODUCTION

Sheep production is an important component of Ethiopia's mixed crop–livestock farming systems, contributing to household income, food security, manure, skins, savings, and socio-cultural functions. Their short generation interval, high reproductive potential, adaptability to diverse agro-ecological conditions, and ability to thrive under low-input management systems make sheep particularly valuable to smallholder farmers and pastoral communities in developing countries (Mesele & Hadgu, 2024; Getaneh et al., 2024; Wana, 2024). Ethiopia possesses one of the largest sheep populations in Africa, consisting mainly of

indigenous breeds adapted to diverse agro-ecological environments (CSA, 2021). These genetic resources are essential for sustaining rural livelihoods and improving livestock productivity under changing production environments.

Among Ethiopian indigenous breeds, the Horro sheep are widely distributed in western Ethiopia and are well adapted to the subhumid, mid-altitude agroecologies of the region. The breed is characterized by good adaptability, growth potential, and prospects for genetic improvement under smallholder production systems (Abegaz et al., 2010; Kibebew et al., 2026). However,

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productivity remains below its potential due to constraints related to nutrition, health management, and reproductive inefficiency (Yousuf et al., 2025).

Reproductive performance is a major determinant of sheep flock productivity and profitability. Traits such as conception rate, fertility, litter size, lamb survival, and weaning rate directly influence the number of lambs produced and genetic progress within a flock (Getaneh et al., 2024; Kleemann et al., 2026). Poor nutrition, illnesses, environmental stress, and reproductive management often limit reproductive efficiency in tropical agricultural systems (Mesele & Hadgu, 2024). In particular, ewe body condition and nutritional status affect estrus expression, ovulation rate, conception, embryo survival, and lambing performance, while ram reproductive attributes like libido, mating ability, and semen quality significantly affect flock fertility.

Tropical sheep production systems lose money due to pre-weaning mortality; therefore, lamb survival is crucial to reproductive efficiency. Low birth weight, limited milk supply, illnesses, poor mother conduct, and unfavorable environmental circumstances increase mortality (Ayele & Urge, 2019). Recent research shows that birth weight, mother nutrition, health management, and environmental factors greatly affect lamb survival, underlining the need for better flock production management (Mesele & Hadgu, 2024).

Effective pregnancy detection helps reproductive managers identify pregnant and non-pregnant sheep and make timely feeding, culling, regrouping, and breeding decisions. Modern techniques such as ultrasonography and pregnancy-associated glycoprotein assays provide accurate information on pregnancy status, fetal viability, and litter size, thereby improving reproductive efficiency and resource utilization (Ott et al., 2025; Younis & Hatif, 2024). However, studies evaluating and comparing alternative pregnancy diagnosis techniques in indigenous sheep breeds remain scarce, particularly under Ethiopian production conditions. Limited information is available on the accuracy, reliability, and practical applicability of traditional pregnancy diagnosis methods compared

Sci. Technol. Arts Res. J., July –Sep, 2026, 15(3), 188-196 with modern approaches such as ultrasonography. Generating evidence on affordable, accurate, and field-applicable pregnancy diagnosis techniques is therefore essential for improving reproductive management and flock productivity.

Therefore, the present study was conducted to evaluate the reproductive performance of Horro sheep and compare the efficiency of traditional and ultrasonographic pregnancy diagnosis techniques under controlled breeding conditions at Bako Agricultural Research Center, western Ethiopia.

Statement of the Problem

Accurate and timely pregnancy diagnosis is a key component of efficient sheep reproductive management. Failure to identify pregnant and non-pregnant ewes at an early stage results in poor nutritional management, reduced reproductive efficiency, and economic losses. Although traditional methods of pregnancy detection are widely used, their accuracy is often limited, particularly during early gestation. Ultrasonography may be more accurate; however, data on its diagnostic efficacy in Ethiopian sheep production is lacking. Thus, enhancing reproductive management and flock productivity requires assessing pregnancy detection accuracy and efficacy at different gestational stages.

Research questions

1. What are the diagnostic accuracy, sensitivity, and specificity of real-time ultrasonography compared to traditional pregnancy diagnosis methods in Horro ewes at different stages of gestation?
2. How do maternal nutritional status and ewe body condition score (BCS) during the breeding and early gestation periods directly influence the conception rates, litter size, and subsequent pre-weaning lamb survival rates of Horro sheep?
3. What is the practical and economic feasibility of integrating modern ultrasonographic scanning into the low-input smallholder sheep production

MATERIALS AND METHODS

Study area

Bako Agricultural Research Center, western Ethiopia, 320 km west of Addis Ababa on the Nekemte road, hosted the study. The center is at 9°06' N latitude and 37°09' E longitude, 1650 m above sea level. The area has a moderate sub-humid climate with bimodal rainfall distribution, 1200–1500 mm of annual rainfall, and 18°C–28°C mean annual temperatures. The National Meteorological Agency of Ethiopia provided this study's climate data (NMA, 2016).

Experimental animals and management

The study used 142 Horro breeding ewes and 13 rams. Annual breeding seasons were June–July and November–December, each 42 days. Mating groups of 20–25 ewes were assigned to seven breeding rams. For two weeks before mating, ewes were flushed with extra grain and dewormed to improve body condition and fertility. Breeding ewes from first to third parity averaged 26 kg and 3.00 body condition. Pre-mating weight, age, and bodily condition score were recorded. During mating, skilled enumerators watched mounting and service daily.

All animals were housed and fed similarly. Males and females were held indoors during mating, and rams were separated from ewes at night for rest. Animals were fed hay and a concentrate mixture of Noug cake (*Guizotia abyssinica*), crushed maize, and salt twice daily. We got water twice a day.

Lambs, dams, and sires were identified by ear tags and postpartum ewe and lamb birth weights. Ewes and lambs were kept in small groups for the first month after birth to improve mother–young bonding and prevent trampling mortality. Newborn lambs were allowed to receive colostrum immediately after birth, and weak lambs were assisted to suckle, while all lambs were allowed unrestricted suckling during this period. Gradual adaptation to grazing began two weeks after

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lambing. From about 30 days of age, lambs were separated from their dams during the daytime, and the ewes were brought back to the barn twice daily to allow the lambs to suckle. During the pre-weaning period, the lambs were supplemented with concentrate feed and Rhodes grass hay. Lambs were fully weaned at 90 days of age.

Breeding Animal Management and Data Collection

Data collected include conception rate, fertility rate, lambing rate, litter size, gestation length, abortion rate, lamb survival, birth weight, weaning weight, and pre-weaning growth rate. To improve body condition and stimulate ovulation, ewes were flushed with supplementary feed for two weeks before mating. Breeding rams' reproductive performance, including libido, mounting attempts, ejaculation frequency, scrotal circumference, and body weight, was also recorded.

Lambs were ear-tagged immediately after birth and recorded for sex, birth type, and birth weight. Lamb body weight was measured biweekly until weaning at 90 days of age using a digital fixed scale sensitive to 100 g. Ewes' postpartum weight was measured immediately after placental expulsion and subsequently at monthly intervals. Breeding season, lambing season, gestation length, abortion incidence, number of lambs born, and number of lambs weaned were recorded to evaluate reproductive and survival performance.

Breeding females were randomly assigned to mating pens based on parity, age, body condition score, and live body weight using a ram-to-ewe ratio of 1:25. Each breeding ram was paired with approximately 25 ewes. Breeding rams spent eight hours a day with ewes for two to three estrous cycles during the 42-day mating period. Breeding rams were separated from the ewes during the nighttime, mainly to make them get enough rest. Trained attendants closely monitored and recorded mating activities, including unsuccessful mounting attempts, successful mountings, mating frequency, libido, and number of ejaculations for each ram.

Statistical analysis

A total of 142 breeding females were initially included at the beginning of the breeding season. However, five ewes were later excluded from the analysis due to mortality or removal from the breeding flock, leaving the final dataset for evaluation. A binary logistic regression model (logit model) was employed to evaluate the effects of factors such as parity, body condition score, and breeding season on fertility, birth type, abortion rate, and lamb survival. Fertility outcomes were coded as 0 for those who did not lamb and 1 for those who lambled, while birth type was coded as 1 for single birth and 2 for multiple birth. Lamb survival was coded as 0 = dead and 1 = alive. Quantitative traits, including birth weight, scrotal circumference, scrotal size, body condition score, lamb birth weight, and weaning weight, were analyzed using SAS software (Version 9) PROC GLM procedures. Statistical significance was declared at $P < 0.05$.

RESULTS AND DISCUSSION**Results****Reproductive performance of Horned Sheep
Reproductive Performance of Horro
Ewes**

The average number of services per conception was 1.17 ± 0.04 . Approximately 87% of ewes conceived after one service, while 8% and 5% needed two and three. The high conception rate after one service suggests good reproductive efficiency under regulated breeding settings. Conceptions were 81%, mostly during the first estrous cycle. Body condition score significantly impacts conception rate ($P < 0.05$), with moderately conditioned ewes outperforming over-conditioned ones in reproductive performance. This supports previous research showing that ewe body condition at mating affects conception rate, litter size, embryo survival, and flock productivity, with optimal reproductive outcomes at moderate body condition scores (Kenyon et al., 2014; Vatankhah, 2012).

Average fertility was 69%, and lambing 91.5%. The average litter size was 1.32 lambs per ewe

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lambing, indicating a 32% twinning rate. The litter size matches Ethiopian indigenous sheep breeds and verifies local sheep populations' moderate prolificacy under traditional and semi-intensive production techniques (Getaneh et al., 2024; Mesele & Hadgu, 2024). The 14.3% abortion rate was mostly late-term. High abortion rates may be due to dietary hardship, infectious infections, or environmental factors during pregnancy. The gestation period ranged from 136 to 171 days, with an average of 151.2 ± 6 days, which is within the typical range for sheep. Nutrition, litter size, breed, and environment affect gestation length (Getaneh et al., 2024; Balch, 2024).

The mean lamb birth weight was 2.22 ± 0.20 kg. One-born lambs were heavier than twins, and male lambs were heavier. Production strategies for sheep consistently show these variances. Due to prenatal growth and endocrine regulation differences, male lambs have higher birth weights than females, while single-born lambs are heavier than twins due to reduced competition for uterine space and maternal nutrients. Twin-born lambs have lower birth weights than single-born lambs because maternal resources must be shared. These patterns have been extensively studied in Ethiopian indigenous sheep communities and are key non-genetic determinants impacting pre-weaning growth and survival (Getaneh et al., 2024).

Lamb weaning survival was 59.6%, compared to 40% pre-weaning mortality. Mortality was higher in the first 30 days following delivery and during wet season. The high mortality in this study shows poor newborn treatment and illness issues. In Horro sheep, birth weight, birth type, management method, and health interventions affected lamb survival, with death concentrating in the early stages. Average daily gain was 130 g/day for the first 60 days and decreased near weaning. According to reports, Horro lambs grow fastest before weaning and are affected by birth weight, sex, birth type, season, and management conditions (Bekana et al., 2022).

Reproductive performance of rams

The average body weight, scrotal length, and circumference of breeding rams were 39.76 ± 1.99 kg, 11.26 ± 0.34 cm, and 26.92 ± 0.63 cm, respectively. Since scrotal circumference and body weight are important indicators of testicular development, sperm production capacity, and reproductive potential in rams, these measurements indicate reproductive soundness under current management conditions. Scrotal circumference is important because it predicts semen quality and fertility. The average daily libido was 29.78 ± 3.33 mounting attempts, and the daily ejaculation frequency was 1.57 ± 0.23 . Fatigue, diminished sexual stimulation, and repeated mating exposure may have reduced libido and ejaculation frequency during breeding season. Rams show similar declines in sexual activity and mating performance during prolonged breeding due to physiological exhaustion, temporary sexual motivation reductions, and adaptive endocrine responses to repeated mating. Thus, scrotal measures, libido, and mating activity are crucial to breeding soundness evaluation and practical markers of ram fertility and reproductive efficiency in natural mating systems (Alhamada, 2017).

Evaluation of Different Pregnancy Detection Techniques

Table 1 shows the odds ratio of detecting pregnancy in Horro sheep using different diagnostic methods at different stages. Odds ratio analysis was performed to compare the reliability of several

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pregnancy detection methods in Horro sheep to the traditional method. Ultrasound and seed germination were tested. Ultrasound had a higher pregnancy detection rate than traditional methods (Table 1) (OR = 1.822, $p = 0.0002$). Ultrasound was 1.8 times more likely to identify pregnant ewes than traditional methods. Ultrasound's ability to directly examine embryonic and fetal tissues and analyze uterine contents during gestation makes it a better diagnostic tool. Recent research suggests ultrasonography is the most accurate and reliable approach for early pregnancy identification in sheep due to its high sensitivity and specificity (Alhamada et al., 2017). In sheep production systems, ultrasonography surpassed indirect pregnancy detection approaches in diagnostic accuracy and early pregnancy identification. Real-time ultrasonography can detect sheep pregnancies with high accuracy, with diagnostic accuracy increasing as embryonic and fetal structures become more distinct and identifiable (Kharche & Kouamo, 2015; Alvarez Balaro et al., 2022). Ultrasonography is one of the most reliable and feasible procedures for small ruminant pregnancy detection and reproductive surveillance.

Compared to the traditional method, the seed germination methodology had considerably reduced probabilities of pregnancy detection (OR = 0.434, $p < 0.0001$). A lower odds ratio shows seed germination was less reliable for diagnosing pregnancy in Horro sheep under current experimental settings.

Table 1

Odds ratio of pregnancy detection in Horro sheep using different diagnostic techniques at different stages of pregnancy

Diagnostic technique	Pregnancy stage	Odds Ration	Chi-Square P-Value
Seed germination technique	Early pregnancy	1.184	0.9014
Seed germination technique	Mid-pregnancy	1.263	0.7214
Traditional method	Early pregnancy	0.773	0.7668
Traditional method	Mid-pregnancy	0.773	0.7668
Ultrasonography	Early pregnancy	0.282	0.0251
Ultrasonography	Mid-pregnancy	0.667	0.6602

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Plant-based bioassays and urine-dependent pregnancy detection methods have been investigated as low-cost alternatives, but environmental factors, seed type, urine composition, and testing conditions affect their diagnostic performance, making them inconsistent and inferior to ultrasonographic methods. Thus, small ruminant pregnancy diagnosis is best with ultrasonography. The effect of urine collected from ewes at different gestation stages on seed germination was also evaluated. Early and mid-pregnancy stages were compared with late pregnancy, which served as the reference category. The chi-square analysis (Table 1) indicated that urine collected from ewes during early, mid, and late pregnancy did not significantly affect seed germination ($p > 0.05$). It should also be noted that late pregnancy served as the reference category in the odds ratio analysis; therefore, no separate p-value was generated for this group.

Discussions

The reported p-values indicate only whether early or mid-pregnancy differed significantly from late pregnancy. Although the odds ratios were numerically greater than one, indicating slightly higher germination under urine from early and mid-pregnant ewes, these differences were not statistically significant. However, seed germination tended to be relatively higher under urine from early and mid-pregnant ewes compared with urine from late-pregnant ewes. This suggests a possible influence of pregnancy stage on the germination response, although the effect was not statistically supported. Similar inconsistencies have been reported for indirect biological and urine-based pregnancy detection methods, whose performance may be affected by variations in hormone concentrations, urine composition, environmental conditions, and experimental procedures. Consequently, indirect bioassays generally exhibit lower reliability and reproducibility than modern diagnostic techniques such as ultrasonography for pregnancy detection in small ruminants (Alvarez Balaro et al., 2022).

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This variation may be associated with physiological and endocrine changes occurring during gestation. In sheep, progesterone concentrations increase rapidly after conception and remain elevated throughout most of pregnancy to support embryonic and fetal development, placental function, and uterine quiescence (Abecia et al., 2020). Consequently, changes in the hormonal and biochemical composition of ewe urine during different stages of gestation may have contributed to the variation observed in seed germination response. In particular, the relatively lower germination tendency observed under urine from late-pregnant ewes may be associated with higher concentrations of pregnancy-related metabolites and hormones during advanced gestation. However, because the differences in germination among pregnancy stages were not statistically significant, any biological influence of gestational hormones on seed germination remains speculative and requires further experimental investigation. Similar caution has been recommended when interpreting indirect biological assays for pregnancy diagnosis because multiple physiological and environmental factors may influence test outcomes.

The effectiveness of the traditional pregnancy detection method across different stages of gestation was also evaluated using late pregnancy as the reference category (Table 1). Pregnancy detection using the traditional method during early and mid-pregnancy did not differ significantly from detection during late pregnancy ($p > 0.05$). Although the odds ratios were below one, suggesting numerically lower detection efficiency during early and mid-pregnancy compared with late pregnancy, the observed differences were not statistically significant. Nevertheless, the tendency toward higher detection rates during late pregnancy may be attributed to the more pronounced physiological and anatomical changes associated with advanced gestation, which are generally easier to identify using conventional observation-based methods. Similar observations have been reported in small-ruminant reproductive studies, where pregnancy detection accuracy tends to improve as

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gestation progresses because pregnancy-related changes become increasingly evident.

The relatively improved numerical detection during late pregnancy may be explained by the appearance of more obvious physical and behavioral signs of pregnancy as gestation advances. Enlargement of the abdomen, mammary gland development, and the absence of estrous behavior become increasingly evident during advanced gestation, thereby facilitating pregnancy diagnosis through traditional observational methods (Abecia et al., 2020). These physiological changes are more pronounced during late pregnancy and can improve the effectiveness of visual and management-based pregnancy assessment.

Table 1 shows the effect of pregnancy stage on ultrasound-based pregnancy detection in Horro sheep, using late pregnancy as the reference. The chi-square analysis showed that early pregnancy ultrasonography detection was less effective than late pregnancy (OR = 0.282, $p = 0.0251$). Early pregnancy detection by ultrasonography was much less likely than late pregnancy detection. The small embryo and restricted fetal and uterine fluid accumulation can make ultrasonographic testing difficult, reducing diagnostic performance in early pregnancy.

Ultrasound use during mid-pregnancy had lower odds of pregnancy detection than late pregnancy (OR = 0.667), although the difference was not statistically significant ($p = 0.6602$). This shows that diagnostic accuracy improved from early to mid-gestation, but not enough to be statistically significant.

The results show that ultrasonography works better in late pregnancy than in early and mid-pregnancy. Recent studies in small ruminants show that ultrasonographic pregnancy diagnosis improves as gestation progresses because fetal structures, placentomes, fluids, and uterine landmarks become more distinct and easier to identify. Ultrasound during late pregnancy performs better due to improved fetal visibility and reproductive structure distinction, which improves pregnancy confirmation. Since late pregnancy was

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the reference category, no p-value was calculated for this group. The p-values (Table 1) only compare early and mid-pregnancy to late pregnancy.

CONCLUSION

Under regulated breeding conditions, Horro sheep had good conception and lambing rates. Body condition score strongly affected conception rate, stressing the necessity of breeding ewe nutrition. Lamb growth was good, but pre-weaning mortality was significant, especially in the first month, indicating a need for better neonatal care and health management. Body weight, scrotal measures, libido, and ejaculation frequency indicated reproductive health in breeding rams. Ultrasonography outperformed traditional and seed-germination pregnancy detection methods. Increasing gestation enhanced ultrasonographic accuracy but did not alter seed germination or traditional procedures. Thus, ultrasonography is the best way to diagnose and treat Horro sheep pregnancies.

Recommendations

Replace unreliable traditional and seed germination methods with ultrasonographic scanning. Perform scans in later stages of gestation to maximize accuracy, enabling reliable detection of single vs. multiple pregnancies and accurate lambing projections.

Closely monitor and manage the BCS of ewes before the breeding season, as it directly governs conception and lambing success. Group and feed ewes according to their nutritional needs to ensure they reach optimal body condition prior to introducing rams.

Focus intensive care, hygiene, and monitoring on lambs during their first month of life, where pre-weaning mortality is highest.

Implement immediate colostrum feeding post-birth, maintain clean and sheltered lambing pens, and execute routine veterinary checks to reduce neonatal losses.

CRedit Author Statement

Berihun Mulatu: Conceptualization, Data curation, **Temesgen Jembere:** Investigation,

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Formal analysis, writing the original draft. **Ayant**
Mekonnen: Methodology, Validation. **Gemed**
Duguma: Visualization, Project administration

Declaration of Competing Interest

The authors declare no institutional, financial, or personal conflicts of interest related to this study.

Ethical Approval

Not applicable

Data Availability Statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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