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Abstract: Many sheep producers have experienced the frustration of ultrasound scanning a ewe flock in mid-pregnancy with high expectations, only to find later that the lambing percentage doesn't match the scanning results. Where do those "missing lambs" go? Research on embryonic and fetal loss in sheep provides important lessons about management, nutrition, and why conditions and events in the first trimester of pregnancy matter so much.

Keywords: sheep reproduction, breeding, pregnancy loss

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THE PROBLEM

Many sheep producers have experienced the frustration of ultrasound scanning a ewe flock in mid-pregnancy with high expectations, only to find later that the lambing percentage doesn't match the scanning results. Where do those "missing lambs" go? Research on fetal loss in sheep provides important lessons about management, nutrition, and why conditions and events in the first trimester of pregnancy matter so much.

OVERVIEW OF FETAL DEVELOPMENT

Sheep pregnancy lasts about 147 days, and understanding its stages can help producers support ewe and lamb health. The embryonic stage occurs in the first weeks following conception, the process in which the oocyte, or egg, is fertilized. The embryo implants into the uterus and vital systems begin forming. During this time, the nervous system, heart, and limb buds develop rapidly; any stress, poor nutrition, or illness can cause embryo loss. By day 40, the pregnancy transitions to the fetal stage, where organs continue to grow and mature. Between days 40 and 80, the lungs, liver, kidneys, and digestive tract take shape, while the skeleton begins hardening. From day 80 onward, the fetus gains most of its weight and organs such as the lungs and brain mature, preparing for life outside the womb. Because early losses are difficult to

detect, maintaining optimal nutrition and stress-free conditions throughout pregnancy—especially during early development—is key to maximizing embryonic, fetal, and newborn lamb survival (Table 1).

EARLY PREGNANCY: FACTORS CONTRIBUTING TO SUCCESS AND FAILURE

Successful pregnancy in sheep requires more than fertilization; it depends on a precise cascade of molecular signals between the embryo and the ewe's reproductive system. Failure at any step can result in embryo loss.

Hormones, including progesterone, and immune factors, including interferon tau (IFN- τ) and vascular endothelial growth factor (VEGF), regulate the early establishment of pregnancy. In the first 12–15 days after conception, the embryo secretes IFN- τ , a protein that instructs the ewe's uterus to maintain the pregnancy (Figure 1). IFN- τ prevents release of prostaglandin F $_{2\alpha}$, a natural compound that would otherwise cause the corpus luteum (CL)—the structure on the ovary that produces the hormone progesterone—to regress. Progesterone is essential for supporting the uterine lining and early embryo survival. If stress, poor nutrition, or sudden environmental changes

Table 1. Timeline of embryonic and fetal loss in sheep pregnancy.

Gestation days	Key biological events	Risk of loss	Notes for producers
0–14	Fertilization, cleavage, and first embryo–maternal signaling. Embryo secretes interferon tau (IFN- τ) to maintain corpus luteum and progesterone.	High	Many losses occur here; stress, poor nutrition, or health problems disrupt signaling and cause resorption (O'Connell et al., 2016).
15–29	Implantation and placental development begin. VEGF promotes uterine vascular growth.	High	Most embryonic losses occur before d 29; up to 20–40% of embryos lost during this stage (Dixon et al., 2007; Rickard et al., 2017; Reader and Juengel, 2025).
30–45	Transition from embryonic to fetal stage. Heart, lungs, liver, and skeleton begin to develop.	Moderate	Still vulnerable to nutritional or environmental stress. This is a critical management window.
45–90	Organ growth and fetal development continue; fetuses detectable via ultrasound.	Low to moderate	Ultrasonography most reliable in this window for fetal counting; scanning percentages often exceed lambing percentages (Allworth et al., 2017).
90–term (\approx 147 d)	Rapid fetal growth; lungs and brain mature in preparation for birth.	Low	Further losses uncommon unless ewe faces disease, undernutrition, or severe stress (Yotov, 2012).

disrupt this communication, the result is often early embryo death. During this early stage of pregnancy, the immune factor VEGF promotes blood vessel growth in the uterus and embryonic tissues that will become the placenta, a process crucial for implantation and the establishment of a healthy blood supply to the fetus.

During the first 20–45 days of gestation, embryos must implant, establish a placenta, and initiate proper hormonal signaling, making this a vulnerable phase (Figure 1). Research shows that 20–40% of potential lambs are lost in the first month of gestation, often before pregnancy can even be detected (Dixon et al., 2007; Reader & Juengel, 2025). Much of this early loss is linked to developmental problems in the embryo, including genetic errors, chromosomal abnormalities like mosaicism or abnormal chromosome numbers, in addition to the mentioned imbalances in the ewe’s reproductive hormones (Chundekkad et al., 2020). More refined tools, like transrectal ultrasound, confirm that most embryo losses occur before day 29 (Rickard et al., 2017), with O’Connell et al. (2016) showing that many are lost even earlier, before day 14.

In commercial settings, producers first assess pregnancy using flank (transabdominal) ultrasonography between

days 45 and 90. This window offers the highest accuracy for fetal counting but also captures only those pregnancies that have survived the critical early stages.

Early scanning results, therefore, often overestimate lambing percentages, since some fetuses detected at 45–70 days will not survive to term (Allworth et al., 2017). Although pregnancies stabilize around 45–60 days, further losses are possible if the ewe experiences disease, severe undernutrition, or major stressors (Yotov, 2012). Meeting animal health and nutrition requirements and minimizing stress during gestation can help reduce the gap between scanning percentage and lambing percentage.

In sheep, not every pregnancy loss means the ewe loses the whole litter. Many losses are partial, where one lamb is lost but others survive to birth. Research has shown this is fairly common. For example, Dixon and colleagues (2007) found that more than a third of ewes that experienced loss only lost a single fetus; far fewer lost the entire litter. More recent work reported that about 18% of twin- or triplet-bearing ewes had partial litter loss, with survival often correlated to the mix of males and females—litters with more male fetuses were more likely to lose one or more lambs before birth (Alon et al., 2023). Other studies

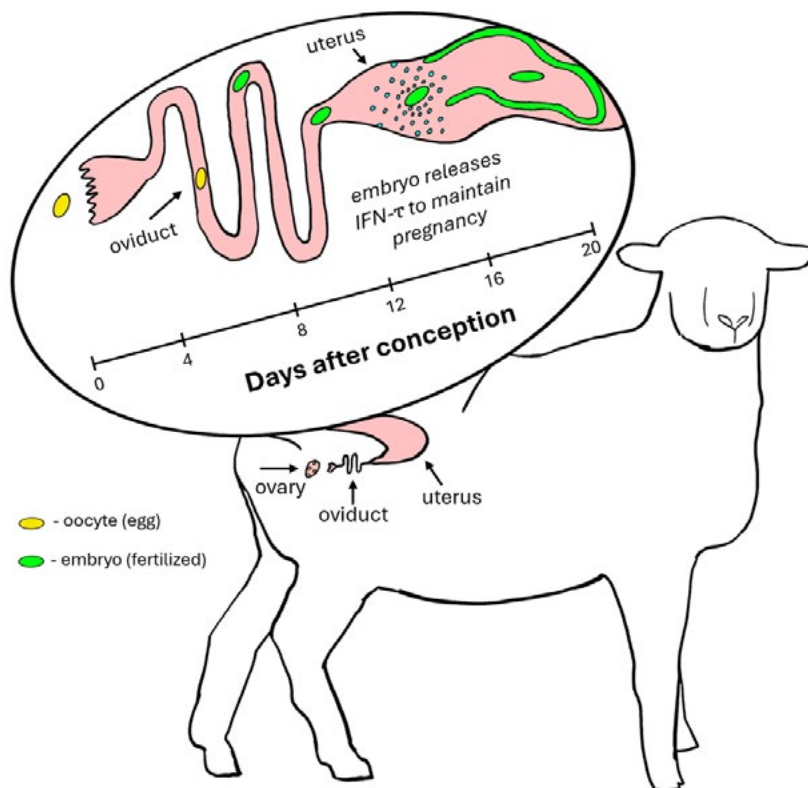


Figure 1. Maternal recognition of pregnancy occurs in the first trimester, around days 12–15 of gestation, in response to embryonic secretion of interferon tau (IFN- τ). Adapted from *Pathways to Parturition*, 3rd ed. P.L. Senger. Current Conceptions Inc., 2012.

have shown that some rams sire pregnancies where partial loss is more common, while others are more likely to sire pregnancies that either hold or lose the entire litter (Holler et al., 2014). Taken together, these findings show that some fetal loss in sheep, due to non-stress causes, can reduce litter size rather than causing complete pregnancy failure, which helps explain why a ewe may scan with twins but only lamb a single.

Undernutrition is a common risk during drought or periods of low forage quality, lowering pregnancy rates by reducing early embryonic survival, a North Dakota State University study showed (Grazul-Bilska et al., 2012). The researchers found that both under- and over-nutrition harm reproductive success in ewes. After being fed at 60% of maintenance for eight weeks prior to sampling, ewes weighed less and had lower body condition. Although they produced a normal number of oocytes, the quality of those oocytes was reduced. Fewer oocytes cleaved (progressed developmentally) after fertilization, and far fewer developed to the morula and blastocyst stages, key steps for pregnancy establishment. While overfeeding also impaired embryo development, it is rare in rangeland grazing contexts.

FLOCK HEALTH STRATEGIES TO MINIMIZE FETAL LOSS

Good hygiene, avoiding known vectors, maintaining a veterinary health plan with vaccinations, and confirming diagnoses early are all key to reducing the risk of infectious reproductive losses. Using a standard quarantine protocol prior to introducing new breeding stock to the flock and following proper biosecurity practices with neighbors and guests also helps mitigate disease risk.

In the final trimester (gestational days 105–147), it is natural for sheep producers to worry about losing lambs they counted earlier in gestation. While most fetal losses are sporadic, certain infectious agents can cause abortion storms or clusters of mummified fetuses—especially in naïve (haven't been exposed to the disease) or poorly vaccinated flocks. Producers should work with a veterinarian to determine what vaccinations are appropriate for their operation.

The most common pathogens include *Toxoplasma gondii*, *Chlamydia abortus*, *Coxiella burnetii* (Q fever), and viruses like border disease virus (Menzies et al., 2011). In flocks where the pathogen is endemic, these agents may cause abortion in 5% or fewer ewes, often going unnoticed.

But in outbreak conditions, abortion rates can exceed 20% and in severe cases of *C. abortus*, rates as high as 60% have been reported (Tirosh-Levy et al., 2022).

These infections may also lead to the mummification of one or more fetuses, particularly when fetal death occurs in the second or third trimester. After approximately 50 days, once the fetal skeleton has developed, complete resorption of a dead fetus becomes unlikely. If death occurs at this stage or later, the surrounding fluids may be reabsorbed, but the fetus itself often dehydrates and forms a mummified structure. These mummified fetuses are typically expelled at parturition, either alone or along with healthy lambs. However, when fetal death happens very early in pregnancy, before bones have formed, the entire fetus—including tissues and fluids—may be fully reabsorbed with no trace remaining. In rare cases where a mummified fetus is retained, manual or surgical removal may be necessary to prevent complications (Lefebvre, 2015; Vikram et al., 2020).

According to the USDA's National Animal Health Monitoring System (NAHMS), reproductive loss—including abortion—accounts for a notable portion of lamb mortality, though national abortion rates aren't always clearly reported. Still, in most veterinary contexts, an abortion rate over 2–3% is considered significant and typically warrants investigation. Controlled challenge studies have shown *C. abortus* can cause abortion in up to 33% of unvaccinated ewes, compared to just 0–14% in vaccinated animals (Livingstone et al., 2025). Similarly, *T. gondii* outbreaks in naïve flocks have produced abortion rates as high as 41.7% (Silva et al., 2022). These results underscore the importance of following a proper vaccination regime.

NUTRITIONAL MANAGEMENT STRATEGIES TO MINIMIZE FETAL LOSS

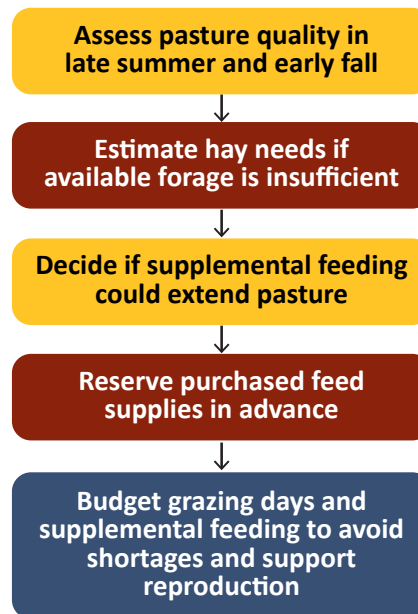
The most practical management strategy to reduce fetal loss under extensive rangeland conditions is to ensure adequate nutrition from the pre-breeding phase to mid stages of gestation.

Flushing, or giving ewes extra feed for a short period before breeding, improves reproduction by acting directly on the ovaries. In practical terms, this happens in three ways: 1) quick response (acute effect), 2) gaining response (dynamic effect), and 3) condition response (static effect) (Scaramuzzi et al., 2006).

The acute effect occurs when short-term supplementation, such as feeding a supplement for only a few days before

Figure 2. Schematic of planning for early pregnancy success.

Plan Feed Resources for Pregnancy Success in Ewes



breeding, increases the number of ovulatory follicles even before body weight changes are noticeable. This occurs because as ewes eat more, their blood levels of glucose, insulin, and leptin increase. These signals tell the ovaries to grow more medium and large follicles, which contain oocytes and are supportive of higher ovulation rates. This enhanced communication between the reproductive tract and the brain results in more lambs born per ewe.

The dynamic effect, or “gaining response,” happens when ewes are actively gaining weight in the lead-up to and during mating—for example, when flocks are moved from dry summer pasture onto lush green feed or are offered a flushing ration, leading to a rapid improvement in energy balance and a boost in ovulation rate.

The static effect reflects the benefit of long-term good nutrition: ewes maintained at consistently high body condition scores (3.5–4.0) on quality feed already have an elevated baseline ovulation rate, even without recent weight gain, leading to better reproductive outcomes.

PREPARING TO MAINTAIN BODY CONDITION

It is important to plan feed resources carefully to support pregnancy success in ewes. Keeping animals off breeding

and winter pasture, or stockpiling the standing forage resource, until the critical reproductive stages ensures that ewes can be selective to meet their nutritional requirements. Effective planning begins with assessing pasture quality in late summer and early fall to determine whether available forage will be adequate. If not, producers should decide whether additional hay will be needed to substitute for pasture shortfalls, and whether strategic supplemental feeding could extend pasture availability by slowing the rate of utilization.

For example, a 640-acre winter pasture may provide 180 grazing days for 500 ewes in a normal year. But during drought, when production drops from 1,200 lbs to 500 lbs per acre, that same pasture may support just 75 grazing days—a deficit of more than 100 days. Sheep are highly selective grazers and initially consume the most nutrient-rich plant parts. As grazing continues, both forage quantity and quality decline, even when biomass appears adequate. To prevent deficits, producers should either rotate pastures more frequently or increase supplementation as quality drops. Without proactive management, ewes can face nutritional stress throughout pregnancy, increasing the risk of reduced conception rates and pregnancy loss.

It is also important to ask early whether purchased feed reserves should be secured in advance to avoid shortages

later in the season. Remember, when sheep first enter a pasture, they selectively consume the most palatable and nutrient-rich plant parts; over time, both forage quantity and quality decline. Budgeting grazing days and aligning supplemental feeding strategies to maintain a steady, sustained level of nutrition not only prevents abrupt feed shortages but also supports consistent reproductive performance and overall flock health (Figure 2).

ANIMAL HANDLING AND STRESS FACTORS THAT INFLUENCE FETAL LOSS

One of the most overlooked factors in reproductive success is maintaining a low-stress environment during breeding and early pregnancy. Environmental, nutritional, and social stress elevates blood cortisol to the detriment of ovulation and hormone production in the establishment and maintenance of pregnancy (Tada et al., 2025).

Environmental factors influence reproductive success. Research shows that photoperiod (day length) and sociosexual signals converge on the brain and reproductive axis, influencing the release of key hormones such as gonadotropin-releasing hormone (GnRH), luteinizing hormone (LH), and follicle-stimulating hormone (FSH) that regulate ovulation and pregnancy establishment. Sociosexual cues include the “male effect,” where the introduction of rams can trigger ovulation in anestrus ewes, as well as the “female-female effect,” where the presence of ewes in heat helps stimulate ovulation in flock-mates. Even dominance hierarchies matter, as dominant females often respond more quickly to ram introduction than subordinates.

Handling events that elevate stress—such as aggressive dogs, frequent gathering, or restricted access to feed and water—can disrupt the delicate balance between the hormonal and immune systems that is critical for early pregnancy recognition and establishment. For the same reason, vaccination should be avoided at the onset of breeding and during the first 45 days afterward, as immune activation and related stress in this period can compromise embryo survival (Mutinati et al., 2006). Similarly, “white” dewormers like albendazoles should not be administered during early gestation. They can interfere with embryonic cell division and organ development, posing a risk of teratogenicity and embryo loss during this highly sensitive period (Cristofol, et al., 1995).

Inclement weather can also induce stress in a gestating ewe, shifting energy metabolism away from pregnancy and fetal development. Sheep are generally resilient to cold weather, especially when in full fleece. However, Wyoming production systems often require ewes to breed, conceive, and maintain a pregnancy during the mid- and late-winter months when temperatures are coldest and forage resources are least abundant and of the lowest quality. Meeting minimum dietary requirements for energy and protein leading into the breeding season and the first 50 days of gestation is critical to keep the ewe in adequate body condition and allow her to sustain her maintenance and reproductive functions.

Shearing often takes place during mid-gestation in Wyoming production systems. This handling event is another potential source of stress on ewe and fetus. Although a Montana study found that typical versus late shearing showed no effect on ewe body weight or feed intake and there were no differences in lamb birthweights (Murphy et al., 2018), care should always be taken to avoid unnecessary stress or roughness when gathering, handling, and processing pregnant ewes at shearing. Furthermore, avoiding exposure to inclement weather post-shearing, to the extent possible, and providing supplemental energy in wet and cold conditions improves resilience to stress. A 30% increase in total feed allocation is recommended in the period immediately before and after shearing and in response to extreme cold temperatures.

Importantly, these environmental factors interact, meaning that stress can diminish the positive influence of sociosexual cues. In practice, successful reproductive management depends on maintaining both a low-stress physical environment and a stable social environment to minimize early losses and maximize flock fertility.

CONCLUSION: BRIDGING THE SCAN-TO-LAMBING GAP

Not every fertilized oocyte becomes a lamb on the ground. But understanding why—whether it is early embryonic loss, infection-induced fetal loss, or the effects of nutrition and hormonal signaling—helps Wyoming producers make more informed management decisions. Protecting the first 50 days of pregnancy, particularly by optimizing flock health, adequately meeting nutritional requirements, and minimizing stress, can close the gap between scanning and lambing percentages and put more lambs on the ground come spring.

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