A GUIDE FOR SHEEP AND FARM LIFE

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Embryonic Mortality: Unnecessary Losses

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Ovulation loss and embryo mortality are a significant source of economic loss that sheep breeder should be aware of. Even though the tools available for the breeder to eliminate or reduce these losses are limited, it is worthwhile understanding the physiological nature and environmental causes of these losses, as well as the implications and what can be done to reduce them.

Many breeders don't have a clear estimate of how extensive the loss due to failure in fertilization and early embryonic mortality may be. They can only notice mortality occurring at later stages of gestation because the outcome is obvious, either abortion or stillbirth, both are measurable. Other results of early mortality or failure of fertilization are, the returns of some ewes to service that extend the lambing intervals and, in prolific breeds, reduction in litter size from their genetic potential. Both cause important economic loss to the breeder. The extent of embryonic mortality, including failure to fertilize the ova shed has been estimated to range between 0 and 85%. However it is widely acknowledged that the mean figures lie between 20 and 30%. A certain proportion of this loss occurs through natural selection. Embryos with genetic defects that affects fitness and survival would eventually perish, but the question of why many seemingly perfect embryos fail to develop into viable lambs at birth still eludes scientists. Even though it is well established that several factors appear to influence the extent of embryonic death, no one factor or a combination of factors eliminates the problem. Scientists agree that there is "a more universally active factor" involved. But little progress has been made into our understanding of the problem despite the concentrated efforts. As it stands now, while associations could be found between prenatal mortality and several physiological and environmental factors, apart from loss caused by genetic deformity, the remaining loss could not be partitioned among those factors. Therefore, the reasons for the loss of morphologically normal embryos remain obscure.

When does this loss occur?

Accurate information on when the embryos do actually die is difficult to find because part of the loss is due to fertilization failure while the rest is the actual embryonic mortality, and the breeder is not in a position to tell which is which. To further complicate the situation, in prolific sheep, ewes with multiple ovulations experiencing partial loss would not return to estrus and this loss would go unnoticed.

1. Ova Loss and Fertilization Failure

Fertilization rates are usually high, between 85 to 95% given suitable fertile rams and favorable management conditions. That means the initial loss of 5 to 15% of the ova shed is lost before they materialize into embryos. Extensive experiments in New Zealand Romney sheep showed that fertilization failure was estimated at 13%, which falls within the range mentioned earlier.

Before fertilization there are two general important factors influencing ova fertilization: the male, through semen characteristics and the female, through maturation and production of ova and provision of the uterus. It is important to use fertile rams for mating, for the obvious reason, infertile rams don't produce progeny. And even fertile rams when over-worked end by producing poor quality semen. That is why it is very important to have a good male to female ratio to make sure that the rams are not producing just seminal fluids void of viable sperms. It is important to test the quality of semen of the rams selected for breeding, the lamb crop of the following lambing depends to a great extent on choosing the right rams. Failure of sperm transport and fertilization is usually associated with cervical mucus characteristics, particularly when sperm have been thawed or the ewes have been exposed to pasture of or including estrogenic species. The breeders have little control on the females maturation and production of ova and much less on the provision of the uterus. However all breeders know that flushing the ewes before the breeding season increases ovulation rate and subsequently litter size. The effect of nutrition will be explained further later.

Hot climates are quite effective in reducing fertilization rates. Artificial manipulation to increase ovulation rate, such as by hormone treatments, may interfere with fertility due to estrogenic imbalance and failure of sperm transport. In a study of ewes synchronized with progestogen and stimulated with 750 IU pregnant mare serum gonadotrophin (PMSG), fertilization rates decreased from 93% for untreated controls to 80 for treated ewes in season and 58% for ewes treated out of season.

2. Embryo Loss

The best estimate of embryo loss varies between 6 to 48% for all zygotes (past the fertilization failure stage), with a mean rate of between 20 to 30%. The timing of embryo mortality has been intensively studied because it may provide clues as to the physiological reasons for mortality. For viable embryos, it is universally recognized that most embryonic loss takes place before 30 days of gestation. In the New Zealand study mentioned earlier, the 13% fertilization failure by day two was followed by 23% embryonic mortality by day 18 and further 19% mortality at day 30 of gestation. This level of loss seems to be similar in several studies conducted worldwide. However, there are exceptions, for example an unusually high rate of embryonic mortality was found in a flock of fine wool Merino sheep in Australia. Despite ovulation rates of 1.27 and 1.73 for maiden and adult ewes, respectively, fertility was 17% for maidens and 73% for adults at day 60. Embryonic mortality accounted for 53 and 82% of this loss of ova; failure to mate 32 and 18%; and failure of fertilization 15 and 0%, respectively. Embryonic mortality rates after correction for fertilization failures were 76% for maidens and 37% for adults.

Extensive studies in western Australia involving Merino ewes with ovulation rates of 1, 2, and 3, confirmed that most embryo loss occurred before day 20 with higher rates of loss found in twins.

Pregnancy failure estimated by means of real time ultrasound was less than 7% from days 20 to 70. Higher figures (20 to 26%) have been obtained and losses of 11 to 23% were also observed in ewes bred by artificial insemination. So there remains controversy over the nature and timing of sheep embryonic mortality. No data within these reports is helpful in determining a physiological cause.

What Factors Contribute to the Loss?

Embryo loss share with the other reproductive traits low heritability esti-

mates. This means the environment plays a greater role in determining the loss than genetics. Both the effects of genetics and environment will be briefly described.

1. Genetics

Studies in different countries and on different breeds showed that losses due to genetically abnormal embryos are relatively constant at about 15% which is of course significant. However, little if anything a breeder or a scientist can do about that loss, which may be regarded as nature's way of controlling undesirable genotypes.

It is established that the genotype of the embryo is less important than the genotype of the dam in accounting for the observed variation in embryo mortality. The case of the Booroola Merino sheep can illustrate this. The high fecundity of this breed is caused by the presence of a major single gene that influences ovulation rate. Ovulations can vary between one and ten (average 4.2) and the number of lambs born varies between one and seven (average 2.5). There are three genotypes according to how many copies of the gene present. A ewe can be homozygous carrying two copies of the gene, heterozygous carrying only one copy or non-carrier. Let's designate, FF, F+ and ++ for the three genotypes, respectively. Studies indicated that embryo mortality rises with multiple ovulation, and embryo losses of the three genotypes average 41, 19 and 9%, respectively. Research also indicated that ovulation rate exceeding three results in little increases in litter size. Also when three embryos were implanted in ++ ewes, little size showed almost no difference. Examining the hormonal profile of the three genotypes of Booroola ewes revealed that the level of progesterone does not increase with ovulation rate, and progesterone administration does not improve the survival of embryos in the FF genotype.

2. Environment

a. Temperature

Sheep can normally endure extremes of temperature, they survive and thrive under extreme heat in the tropics and extreme cold in northern Europe. However, it was confirmed that exposure to high ambient temperatures around breeding not only affects of libido but also affects fertilization and embryo survival. It is generally agreed that early stages of pregnancy, especially before implantation, are the most sensitive and total loss of fertilized eggs can occur. It was also observed in some studies that the occurrence of abnormal embryos increased when ewes were exposed to high temperatures just after fertilization. Adaptation to heat stress can reduce the effect of heat on embryo mortality, but conditions resulting in an increase of 4-5 degrees Fahrenheit above normal deep body temperature can be fatal. Experiments on the other extreme indicated that low temperature may induce abnormalities in sheep eggs during maturation, resulting in higher embryo mortality. However in general, the effect of cold is less dramatic than the effect of heat.

b. Nutrition and Body Condition

The relationship between nutritional regimens and embryo loss is a subject widely researched. The regimens investigated included rising and declining planes of nutrition, extreme cases of under feeding and overfeeding, and pre- and post-mating feeding practices.

Growth and embryo survival in sheep, like in other species, are determined or greatly affected by extremes of nutrition regimens. Over feeding can cause heat stress whereas under-feeding may result in a disturbance in amino acid composition of uterine fluid, or reduction in glucose secretion. Either cause can result in a partial embryo loss, smaller litter size and of course lighter lambs at birth. Under feeding affects more the embryos of young ewes, and older ewes in poor condition at mating, than adult ewes and ewes that already built adequate body energy reserve. Losses caused by poor nutrition are more evident in ewes ovulating twins or triplets than in those ovulating only one egg. Restricting feeding at an early stage of pregnancy can retard lamb development and result in lambs of small size at birth, which run a greater risk of post-natal mortality. Thanks to body energy reserve, ewes in good condition can tolerate a severe period of under nutrition before this regimen can cause reduction in embryo growth and survival. On the other hand, ewes in good condition can suffer if over-fed, ovulation rate may increase and subsequently embryo survival would be lower.

c. Management Practices

Several management practices that are essential to proper sheep husbandry can cause death of the unborn embryos if they were not performed properly or performed during the critical periods of fertilization, implantation and early stages of embryo development. Rough handling during shearing, drenching, dipping, long-term transportation, especially under crowded conditions, as well as exposing the ewes to stress in any way or form (physical or emotional, such as fear) can cause fertilization failure and embryo loss. Sheep is a highly social animal, isolation or introduction to different flocks may cause them unnecessary stress. And because the survival of the fetus and the embryo is controlled to a great extent by the proper hormonal balance, any management treatment that causes hormonal unbalance can have a negative effect on the pregnancy. Therefore, breeders should avoid exposing the animals during the critical first two weeks to any management treatment that can affect the progress of pregnancy. The same is also true during the last phase of pregnancy.

In conclusion, under normal conditions, embryonic mortality should be considered as an unfortunate constant loss of 20 to 30% of eggs in sheep. In practice, though it causes economic loss, embryo mortality may not present a serious problem as nonpregnant ewes would return to service and be rebred. In prolific sheep, prolificacy may suffer, however, if there is a significant multiple ovulation, the ewe would remain pregnant, but produces smaller litters. Embryo loss consists of fertilization failure, and post-fertilization loss. Most loss occurs before day 13, but under some conditions, significant loss may occur between days 13 and 30. In general, individual embryos are lost independently, but twin embryos are subject to a lower chance of survival, probably due to migration between uterine horns. Body condition and the level of nutrition influences the circulating concentrations of progesterone, but unless they are extreme, have little influences on embryo mortality. The interaction between the embryo and the uterine environment may be responsible for embryo loss, and it has been suggested that deficiencies in either a certain protein or progesterone may be the underlying cause. Treatment with these substances, while positive in some respects, does not present a practical method of eliminating this loss of productivity. Knowledge of the effect of certain husbandry practices on embryo loss can help breeders avoid such loss by adopting better and sound management.