Seasonal reproduction in ewes – how to manipulate the breeding season

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Sheep are seasonal breeders in temperate regions, meaning that they experience distinct periods of sexual activity or inactivity annually. Specifically, sheep are short day breeders, breeding at times of the year when the day length is shorter and night time longer. Thus, ewes are normally sexually active (show 17 day oestrous cycles) mid-Autumn into Winter, and sexually inactive (anoestrous) from late winter through to autumn. Seasonality ensures lambs are born at an optimal time, in the spring, when grazing quality increases to support lactation. However, seasonality introduces some issues in modern farming practices when aiming to meet the correct market times for optimal lamb prices, whilst also managing production costs. Therefore, it is necessary to understand the biological background to seasonal reproduction and how to manipulate this for the benefit of farm management.

Seasonal breeding – how is it regulated?

During night time, the hormone melatonin is produced by the pineal gland, in the brain. Melatonin is the main driver of seasonal breeding in many animals, producing an annual rhythm. Following surgical removal of the pineal gland, melatonin secretion is dramatically reduced and ewes become unresponsive to day length. However, external factors have also been suggested to aid in seasonality, such as temperature changes and nutrition.

The increase in melatonin secretion activates the hypothalamo-pituitary-gonadal axis. Gonadotropin-releasing hormone (GnRH) is secreted from the hypothalamus in response to elevated melatonin concentrations. GnRH then subsequently induces secretion of follicle-stimulating hormone (FSH, responsible for follicle development and oestrogen production) and luteinising hormone (LH, responsible for ovulation) from the pituitary gland. These hormones act on the ovary, stimulating follicle growth, oestrogen production and ovulation, and so, initiating reproductive cyclicity.

Towards the end of winter, ewes become resistant to the shorter day lengths and prolonged melatonin secretion subsequently becoming anoestrous. Throughout the summer insufficient melatonin is secreted to instigate the onset of oestrous again, therefore ewes do not return to natural cycling until autumn when day length shortens and melatonin secretion increases.

Manipulation of the breeding season

Extension of the natural breeding season, e.g. inducing ewes to breed earlier (late summer) or inducing ewes to breed for longer (late winter), can be attained through several mechanisms that fall under two concepts: hormonal manipulation or natural manipulation.

Hormonal manipulation:

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A knowledge of the hormones involved in natural control of the oestrous cycle can be exploited to manipulate the breeding season length. The use of several different hormonal methodologies have been researched, with successful stimulants being gonadotropin mixtures (mix of LH- and FSH-like activity; in combination with progesterone treatment) and melatonin. If used during mid-anoestrous, injections of gonadotropin treatment, particularly after 5-9 days treatment of progesterone, advances the natural breeding season and increases lambing rate compared to non-treated ewes still in anoestrous. Melatonin implant treatments used in the late non-breeding season and late breeding season/early anoestrous, increases the number of ewes lambing compared to ewes without oestrous manipulation. Although, the effects of melatonin implants are best utilised to advance the breeding season.

Natural manipulation:

Three mechanisms of natural manipulation have been identified, light, the ram effect and nutrition, with the ram effect being the most widely researched and recognised.

The most obvious solution to altering the breeding season is the use of artificial light manipulation. As ewes become resistant to melatonin secretion towards the end of the winter, it is often necessary to 're-set' their seasonal rhythm which can be completed with a period of artificial long days before either artificially or naturally shortening day lengths. This treatment (combined with the introduction of rams) successfully induces an oestrous response in early anoestrous. Time of light treatment should also be considered. Research has shown that the day should be artificially extended around the natural dusk and dawn to achieve the most promising effects. However, these treatments are expensive through labour time and the need to house animals in light proof buildings.

A more feasible technique to utilise, and perhaps the most established and understood, is the ram effect. However, in highly seasonal sheep this methodology will only extend the breeding season by approximately 1 month either side of the natural state. For the ram effect to take effect, ewes must be segregated from rams for a period before re-introduction. The time length of the segregation appears to vary between breeds, ranging from 2 weeks to a month. The introduction of a sexually active ram to anoestrous ewes either a month before the season starts or month before it is due to end induces a rapid secretion of FSH and LH through a surge in GnRH secretion. This response drives follicular development and maturation and subsequently induces ovulation. The first ovulation is normally seen 50-65 hours post ram introduction, but is accompanied by a silent oestrous (no behavioural acceptance of the ram). Oestrous behaviour and successful mating is typically first seen between 18 and 24 days after initial ram introduction, depending on the ewe's response to the ram effect. The rams must stay with the ewes until all of the flock ovulates and post first ovulation if cyclicity is to be maintained.

So what is it about the ram that stimulates ewes to ovulate? Considerable work has investigated the neuronal aspect of the ram effect and shown that both olfactory and non-olfactory stimuli are necessary. Olfactory stimuli relate to smell (ram pheromones), with wool and wax from around rams' eyes and flanks able to stimulate ovulation. Non-olfactory stimuli, such as ram behaviour are also important. Castrated males that display sexual behaviours (following testosterone treatment) are better at inducing ovulation than those that are relatively inactive. However, the best results are achieved through direct contact between ewes and rams, where both stimuli are utilised. Furthermore, ewe experience has a profound effect. Naïve or young ewes show less response to the ram effect than older experienced ewes, attributed to olfactory learning in relation to neuronal responses within the brain.

Nutrition is widely acknowledged to interact with the seasonality and cyclicity of reproduction in sheep, likely through the central hypothalamic pathway. The use of a short term flush of nutrition can increase follicle development and bring forward ovulation. However, a lack of adequate nutrition can negatively impact mechanisms such as the ram effect, as ewes with a low body condition score (BCS) show less of a hormonal response to the ram effect. Therefore, to ensure reproductive efficiency, the nutrition of the animal should be managed carefully.

Work between Farming Connect and the Innovation site Innovis is investigating the use and benefits of later lambing. Updates will be available on this project through the Farming Connect website soon.

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