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## Factors impacting the seasonality of sheep breeding: A review

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### Abstract

Sheep are a short-day breeder and a seasonally polyestrous species, and they stop cycling when the length of the day increases in the summer. Photoperiod, the primary environmental element responsible for the seasonality of reproduction, has a significant impact on sexual behavior in sheep. Seasonality is also influenced by other factors like as temperature, nutrition, and neuroendocrine control.

**Keywords:** Sheep, season, photoperiod, melatonin, temperature

### Introduction

All sheep breeds that are native to high or mid-latitudes ( $>40^{\circ}\text{N}$ ), where there are significant annual fluctuations in day length, exhibit pronounced seasonal variations in reproductive activity that can be seen in both sexes (Ortavant *et al.*, 1985) [17]. Ewes are either entirely unseasonal or sporadically polyestrous in tropical and subtropical habitats. The sheep is a short-day breeder and a seasonally polyestrous species that is distinguished by the end of cyclicity in the summer as day lengthens. Photoperiod, the primary environmental factor responsible for the seasonality of reproduction in populations at high latitudes, has a significant impact on sexual activity in sheep. (Forcada and Abecia, 2006) [7]. The pineal gland, which secretes melatonin during the period of darkness, translates this environmental signal into an endocrine signal. In the majority of breeds found in high latitudes, long days are linked to decreased gonadotropin secretion and, as a result, less ovarian activity.

### External factors controlling the annual reproductive rhythm

#### a) Photoperiod

The photoperiod primarily controls sheep's seasonal reproduction. However, it is thought that other environmental cues (such as temperature, nutrition, and social connections) can moderate its impact. Periods of sexual activity and anestrus are brought on by alternately having short (8 h of light) and long (16 h of light) days (Chemineau *et al.*, 1988) [1]. It is obvious that short days stimulate and lengthy days hinder activity when they are short in duration. The reproductive status of the ewes is altered by prolonged stimulatory (short days) or inhibitory (long days) photoperiods (Robinson and Karsch, 1984; Robinson *et al.*, 1985) [20, 21]. The pineal gland has a direct impact on how a ewe perceives the photoperiod. The pineal gland gets photoperiodic information from the retina, where it passes via a complex neuronal network and modifies the rhythm of melatonin secretion (Karsch *et al.*, 1984) [11].

#### b) Nutrition

Numerous factors, including age at puberty in both sexes, fertility, ovulation rate, embryo survival, testis growth, and spermatozoa production, are influenced by nutrition in sheep (Smith, 1991; Clarke and Tilbrook, 1992; Rhind, 1992; Robinson, 1996) [23, 3, 19, 22]. Flushing few weeks before the breeding season enhances triplets and increases the number of twin lambs. During the breeding season, flushing ewes is reported to enhance ovulation (Clarke, 2001) [2].

#### c) Temperature

Protecting the ewe from summer heat promotes an earlier start to breeding activity; yet, severely cold temperatures may cause the breeding season to be delayed. Many species'

fecundity can decline as a result of high ambient temperatures. High temperatures have an impact on spermatogenesis and other spermatological characteristics in males (Gundogan *et al.*, 2003) [8].

#### d) Ram effect

The "ram effect" occurs when a ram is introduced to the breeding flock at the start of the breeding season and causes a partial synchrony of ovulation in the sheep few days later. Ram impact is removing rams from the flock of ewes and reintroducing them after two or three months. The reproductive activity of the entire flock is increased by bringing anestrus ewes into cyclicity (Lucidi *et al.*, 2001; Zuniga *et al.*, 2002) [14, 25]. This male-to-female interaction is known to be accompanied by increased LH secretion in the sheep.

### Neuroendocrine control of seasonality in sheep

#### a) Role of melatonin

In sheep, melatonin has a stimulating effect on the reproductive axis. (Karsch *et al.*, 1984) [11]. Malpoux *et al.*; 1996 [15] reported that majority of GnRH neurons are found in the preoptic region of the hypothalamus, which does not appear to be a site of action for melatonin, and very few are found in the mediobasal hypothalamus (MBH), which is a presumed site of action for this hormone. This makes a direct action of melatonin on GnRH neurons appear unlikely. Melatonin controls the production of the hormone thyrotrophin (TSH), causing levels to be high during long photoperiods and low during short photoperiods through high-affinity, G-protein-coupled receptors found in thyrotroph cells in the PT of the pituitary (Dardente *et al.*, 2010) [6]. Melatonin is given to donors used in artificial insemination. Increased ram semen freezability, fertilisation rates, and decreased enzyme leakage across sperm cells upon cryopreservation (Kaya *et al.*, 2001; Kokolis *et al.*, 2000) [12, 13].

#### b) Role of prolactin

Melatonin inhibits the pituitary's production of prolactin in rams. Consequently, prolactin levels are low in sheep throughout the breeding season. (Regisford and Katz, 1993) [18]. Misztal *et al.*; 1997 [16] reported that in Melatonin levels drop in nursing sheep while prolactin levels rise, which are crucial for starting and maintaining lactation. Prolactin has been hypothesised to have a stimulating influence on testicular function in rams. This might be brought on by gonad-level stimulation of testosterone release and spermatogenesis (Regisford and Katz., 1993) [18].

#### c) Role of kisspeptin

Kisspeptin is a neuropeptide that stimulates the release of GnRH and increases the expression of the Kiss1 gene in ewes during breeding season. Kisspeptin neuronal function declines throughout the non-breeding season, and kisspeptin injections in seasonally acyclic females result in ovulation, suggesting a significant role for these neuropeptides in seasonal breeding. (Clarke *et al.* 2009) [4].

#### d) Role of thyroid hormone

The transition from the breeding season to anestrus requires thyroid hormones (Hanon *et al.*, 2008) [9]. Dahl *et al.*; 1995 [5] demonstrated that Due to thyroidectomized sheep prolonged breeding season state, thyroid hormones (T3 and T4) are essential for the transition into anestrus.

#### e) Role of Dopamine

Dopamine is a neuromodulator that helps sheep regulate their reproductive activity throughout the year. Prolactin secretion from the hypothalamus is inhibited by dopamine. In both rams and ewes, dopaminergic neural circuits limit LH secretion when the day is long but not when the day is short. (Tortonesi and lincoln, 1994) [24]. Dopamine is a neuromodulator that contributes in sheep's year-round regulation of their reproductive activity. Dopamine prevents the hypothalamus from secreting prolactin. Dopaminergic neural circuits inhibit LH secretion during long days but not during short days in rams and ewes (Havern *et al.*, 1994) [10]. LH pulse frequency increased in rams given subcutaneous sulpiride injections over the long days (Havern *et al.*, 1994) [10]. Outside of the breeding season, the dopaminergic system is most active.

### Conclusion

For breeds found in mid- and high-latitude regions, seasonality of reproductive activity is a common phenomenon. Both males and females are concerned about the seasonal fluctuations in mating. The ram exhibits less variance in gonadal activity and sexual behavior than the ewe. Seasonal breeding has long been known to be determined by the daily photoperiod, with environmental temperature, nutrition and lactation period acting as modulators. According to photoperiodic control of seasonality, the LH pulse producing system becomes extremely vulnerable to the negative feedback effect of steroids when the anestrus season's long days are present. The mechanisms at play are complex and poorly understood. The hormone melatonin is in charge of translating the information about the length of the day to the reproductive axis by altering the sensitivity of the GnRH pulse generator, which has an impact on the pulsatile secretion of LH. Various neuroendocrinal hormones also controlling seasonality of sheep breeding like kisspeptin, prolactin, dopamine and thyroid hormones.

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