

Impact of nutrition, genetics and season on reproductive outcomes in sheep.

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Genetics and Prolificacy

- Maternal lines vary from 100-350%
- European short-tailed breeds are highly prolific and have influenced many composite breeds
 - Finn sheep, 250-300%
 - Romanov, 300-350%
- Polypay (USA) and Rideau Arcott (Canada) are composites now fixed as breeds and well adopted as prolific breeds in intensive sheep farming systems in North America, 200-220%
- Many also create their own crosses using Finn and Romanov germplasm as a critical ingredient
- Booroola F/B gene-single gene (BMP-15 point mutation),
 - ✓ 2-3X greater ovulation for Bb vs. BB
 - ✓ Must match B gene with traits for litter survival ("uterine capacity", milk production, etc.)

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European short-tailed breeds of great influence on prolificacy in North America



Finn

Imported to North American in 1966



Romanov

Imported to North American in 1980

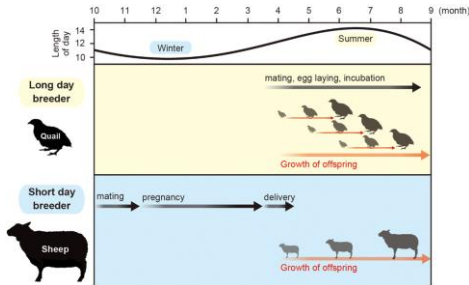
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Genetics and mating interval/aseasonality

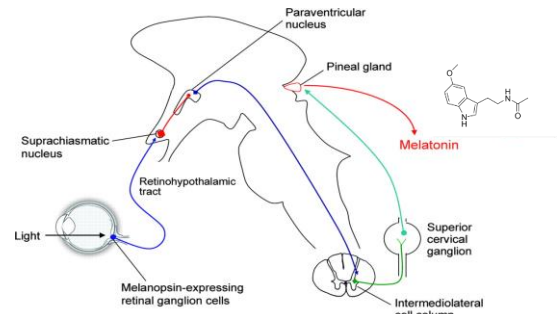
- **Breeds with shorter, shallower(?) anestrus period:**
 - Horned Dorset
 - Polled Dorset*
 - Rambouillet
 - Merino
 - Romanov
 - Finn
 - Polypay
 - Many "hair" breeds
- **Aseasonal fertility is inversely related to the latitude unless selection pressure was exerted (i.e. Finn, Romanov, Dorset).**

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Seasonal breeders are animal species that successfully mate only during certain times of the year.

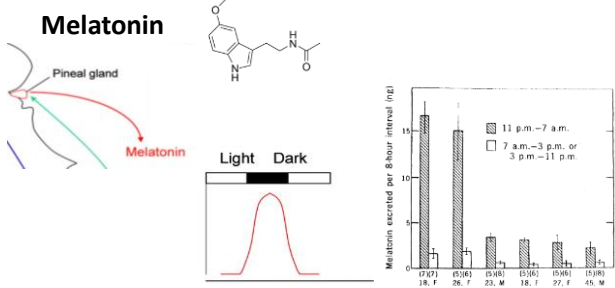


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Photoperiod control of reproduction in sheep is directed by changes in the level of melatonin secreted by the pineal gland

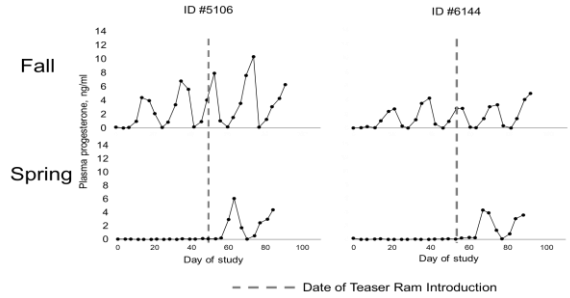
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Daily Rhythm in Human Urinary Melatonin
 Author(s): H. J. Lynch, R. J. Wurtman, M. A. Moskowitz, M. C. Archer and M. H. Ho
 Source: *Science, New Series*, Vol. 187, No. 4172 (Jan. 17, 1975), pp. 169-171

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Many "aseasonal" breeds only exhibit estrus cycles in response to ram presence



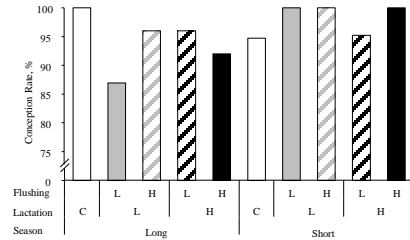
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Conception and lambing rates according to breeding season in a flock of commercial ewes (Dorset x Finn x Ile De France, n~4000, parity ≥2) in an accelerated program with natural mating.

Breeding month	Conception rate, %	Lambing rate, %
January	91	192
March	81	182
May	75	176
July	83	180
September	95	212
November	96	220

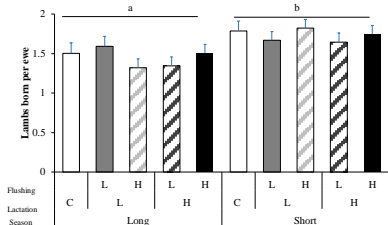
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Conception rate is typically lower during Spring (long days) but only by a small fraction in well managed, moderately aseasonal ewes.



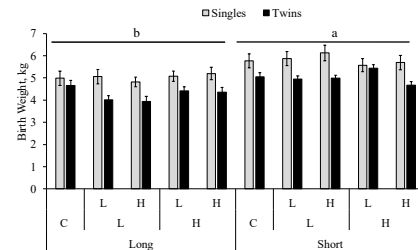
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Litter size is greater in ewe bred in the Fall (short days) compared to ewes bred in the Spring (long days)



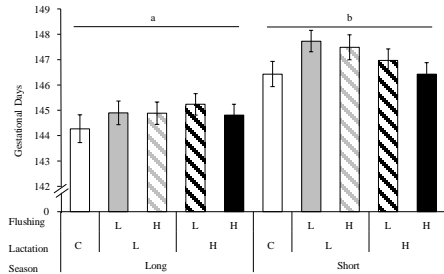
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Birth weight is lower in Spring mating/Fall lambing but survival to weaning is not different



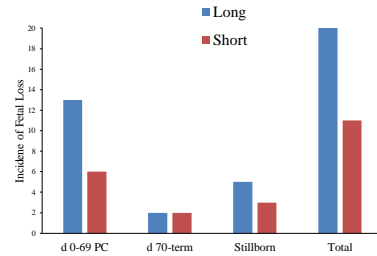
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Ewes bred in Spring (long days) and shorter gestations than those bred in Fall (short days)



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Fetal loss is elevated in Spring mating (long days) compared to Fall mating (short days)



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Summary on seasonality and its impact on reproductive outcomes:

- Some breeds are “moderately” aseasonal and can be induced into estrus by exposure to rams
- Many breeds are more seasonal and require photoperiod therapy or hormonal therapies to breed out of season
- Conception rate can be high in well managed, moderately aseasonal ewes during Spring but is always lower than in the optimal season.
- Ovulation rate/litter size, fetal loss, pregnancy length and fetal weight are lower in optimal mating periods



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Nutrition and out of season breeding:

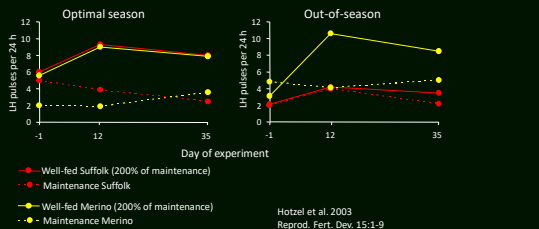
Theory:

- The sheep brain responds to signals indicative of energy status to overcome the seasonal constraint on fertility.
- Positive energy balance also improves embryonic survival which may be more important during the suboptimal breeding season



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Optimal nutritional management will only improve aseasonal fertility in genetics capable of responding to it.



Hotzel et al. 2003
Reprod. Fert. Dev. 15:1-9

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Impact of pre-breeding energy intake on reproduction in an accelerated lambing system during optimal (early Winter) and suboptimal (Spring) breeding seasons

Treatments :

- Energy intake altered during the 21 day period between weaning and the onset of the breeding period (ewes fed a common diet at 115% maintenance during the 5 week breeding period).
- 8 month accelerated system (5 months pregnancy, 2 months lactation, 1 month prebreeding/breeding)

% of maintenance energy

- 50% Restricted TMR (66% TDN; 0.9 lb TDN, 0.18 lb CP per 176 lb ewe)
- 100% Limited TMR (66% TDN; 1.8 lb TDN, 0.36 lb CP per 176 lb ewe)
- 200% Unlimited high energy TMR (73% TDN, 30% NDF; 3.6 lb TDN, 0.75 lb CP per 176 lb ewe)

Animals:

- 99 multiparous Dorset x Polypay ewes, n=33/ treatment;
- Mature Polled Dorset rams used at 3% coverage, ram rotated daily

Seasons:

- Spring: April 24-May 27
- Early winter: Dec 23- Jan 25

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Results:

Spring mating:

	50%	100%	200%	PSE ¹
% Maintenance energy requirements				
Body weight change, lbs	-21.6 ^a	-4.2 ^b	10.8 ^c	1.3
Litter size (by ultrasound)	1.26 ^a	1.22 ^a	1.68 ^b	0.1
Conception rate (by ultrasound) ² , %	82	82	94	

¹ Pooled standard error of the mean
² The number of ewes confirmed pregnant by ultrasound scanning as a percentage of the total number exposed
 Different subscripts denote statistical difference at p<0.05

Early winter mating:

	50%	100%	200%	PSE ¹
% Maintenance energy requirements				
Body weight change, lbs	-14.2 ^a	-4.2 ^b	6.8 ^c	1.1
Litter size (by ultrasound)	1.59 ^a	1.56 ^a	2.04 ^b	0.1
Conception rate (by ultrasound) ² , %	100	89	100	

¹ Pooled standard error of the mean
² The number of ewes confirmed pregnant by ultrasound scanning as a percentage of the total number exposed
 Different subscripts denote statistical difference at p<0.05

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What have we learned?

- Flushing has a huge impact on lambing percentage regardless of season, ≈30-40% increase in an accelerated system.
- Continuation of a high energy diet during mating is not necessary and may even high negative effects on conception.
- Flushing has a large return on investment (≈\$1 investment pays \$20).
- Body condition at the beginning of flushing is also an influential factor in determining lambing percentage.

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Critical management areas to improve reproductive outcomes year-round

- Breeding management
- Ram fertility screening
- Ram and ewe nutrition prior to mating

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Ensuring Ram fertility throughout the year is critical to out of season breeding success:

- **Genetics**-only certain breeds are both fertile and active breeders in the Spring
- **Temperature**-a key environmental factor to control as lack of shade exposure in Summer can drastically reduce semen quality
- **Nutrition**-providing a high plane of nutrition will improve fertility and sex drive of aseasonal rams
- **Screening**-reduce the number of infertile rams in a breeding group
- **Light**- light priming has been shown to help on all breeds but requires specialized ram housing



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Ensuring Ram fertility:

Nutrition:

- Feed rams 2.0 times maintenance for 4 weeks pre-breeding
 - Total diet TDN 66-70%
- Target BCS 3.5
- Group rams according to nutritional needs
 - Growing rams: especially those under 12 mo old (↑ energy and protein)
 - Mature rams: 2 yrs and older (↑energy, 12% CP)
 - Terminal rams vs Maternal rams?
 - Mature size of terminal rams may be 50% greater so they need more and better feed



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Ensuring Ram fertility:

- Perform breeding soundness exam (BSE) ***or at bare minimum, palpate testicles and do a general health exam***
 - ✓ BSE documents fertility but are all fertile rams active breeders (have high libido)?
 - ✓ Service tests on young rams can help but are not very practical to apply (ID ewes in heat with teasers and then join them with young rams)
 - ✓ Monitor libido by recording mating activity with a marking harness.
 - ✓ Avoid using unproven rams in spring




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Minimal Breeding Exam: palpation

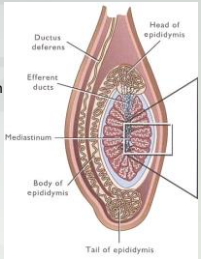
- Testes should be evaluated for
 - Tone and consistency
 - Symmetry
 - Presence of adhesions
 - Areas of swelling or induration



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- Epididymides should be palpated for
 - Symmetry
 - Evidence of pain or inflammation



Senger, 2012

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Why do a BSE exam?

- About 75% of problem rams are identified by testicular palpation and general soundness exam.
- ***Finding the remaining 25% requires a BSE***
- Gross sperm motility alone tells you a lot and accounts for most of the failed exams
- Defective sperm account for about 10% of failed exams and are often associated with other problems.

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Breeding management:

- Ram to ewe coverage needs to be greater during the spring breeding season
 - 3-4% coverage with no estrus synchronization
 - Keep service less than 6 ewes per ram per 24h
- Use ram fertility screening methods to remove subfertile/nonfertile rams
- Grouping strategy?
 - Most successful flocks breed in large groups with rams screened by BSE, or at a minimum by palpation



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What is the ram effect?

- Induces estrus in females **“on the edge”** or ones **“lightly”** in anestrus
- Acts to **synchronize ewes**
- Coverage should be at least 2% for **best** effect.
- Isolate females from males 30 days prior to exposure
- Introduce vasectomized males and remove 14 days later, females will exhibit estrus in two modes either 17-18 or 22-23 days following initial male exposure.
- **Does not work on genetics that have a strong seasonal anestrus**

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Why is the ram effect important in breeding Feb 15 to Aug 15?

- It is hard to find **truly aseasonal ewes** that cycle equally well throughout the year
- Most ewes stop cycling in early March and begin again in late July
- Adding rams to ewes not exposed to rams previously will get many of the **modestly aseasonal ewes** cycling for at least a few cycles.
- **Seasonal ewes** will not cycle at all even with ram exposure
- Many use the ram effect to breed ewes using fertile rams only.
 - Most ewes show behavioral estrus on the second heat.
 - Will using teasers improve conception and lambing percentage in these flocks?

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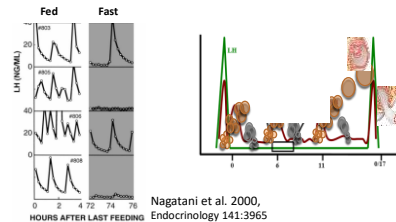
Summary on ram/breeding management:

- During the mid winter to mid summer, active mating behavior is critical to induce estrus and active and fertile rams are needed to settle cycling ewes.
- Managing ram power through feeding, lights, screening and proper coverage will help ensure out-of-season breeding success
- Don't rely on seasonal terminal sires to breed your ewes during to suboptimal season unless you take special measures to ensure fertility/libido such as light priming.

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Pre-Breeding/Flushing:

- **Concept:** the sheep brain responds to signals indicating that the ewe is well-fed by increasing ovulation rate (viable eggs produced).



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Flushing protocols:

Factors to consider:

- Short and long term nutritional both play a role in determining ovulation rate (fatness and current feeding).
- Increased nutrition (primarily energy) for as little as 4-5 days can improve ovulation in under-fed ewes.
- Ewes in positive energy balance (actively gaining weight) will ovulate at higher rates.
- Fat ewes (C.S. >4) show little response.

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Pre-Breeding/Flushing:

Nutritional target:

- ~2 times increase in energy intake over maintenance for 2-3 weeks.
- 65-73% TDN, 11% CP, unlimited intake (2.7-3.6 lb TDN per 176 lb ewe)
- Increase in body condition score of 0.5 units over this period, (~5-10 lbs).
- Key is to place animals in positive weight gain
- Increase or decrease length of flushing program based on condition score
- Can be done with grazing systems with correct stocking rate and forage quality
- Can be done precisely in feeding programs with energy supplement (corn, barley, quality forage, etc.)

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Pre-Breeding/Flushing:

Responses to Expect:

- Increases of 25% are typical, increases up to 57% have been observed in thin ewes
- Flushing response may be lost if ewes go into negative energy balance (lose weight!) in early pregnancy due to embryonic loss
- Maintenance or slightly better feeding (1.1x maintenance) is needed during early pregnancy or gains during flushing may be lost via enhanced embryonic loss.
- Continuing a high energy diet during the breeding season will not improve litter size and may have negative consequences

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Summary

- Ram management and nutritional management are the keys to profitable lamb production regardless of production system.
- Flushing defined by feeding to achieve significant positive weight gain before breeding (state of positive energy balance) is needed to optimize ram activity and ewe lambing percentage regardless of season.
- Creating a strong ram effect and increasing coverage of active, fertile rams during Spring mating are key in obtaining good conception rates in moderately aseasonal ewes.
- Highly seasonal breeds require light and/or hormone therapy to breed out of season

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Extended day protocol:

- 60 days of 24 hrs light followed by 60 days of ambient lighting condition - turn in rams.
- 100 lux (10 FC) at ewe eye level (3.5 FC minimum)
- How I do it:
 - ✓ Bring ewes in from winter pasture on Jan 5.
 - ✓ Set lights to come on at dusk and off at dawn starting Jan 5.
 - ✓ Ewes lamb Jan 25 - Feb 20
 - ✓ Turn lights off on March 5, natural light thereafter
 - ✓ Put in rams May 5.

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Extended day: under evaluation...

Field application in 2008 with 300 ewe flock:

- No change of spring conception rate in aseasonal ewes (Finn x Dorset x Ile de France, n=140-182).
 - ✓ 92% natural light (3 yr average [2005-7], n=132-186)
 - ✓ 94% extended day (2008, n=182)
- Huge change in spring conception rate in seasonal ewes (purebred and ¾ suffolk ewes,).
 - ✓ 0% natural light (2 yr average [2006-7], n=13-17)
 - ✓ 92% extended day (2008, n=16)

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Extended day:

- Cost of \$1.60/ewe/year for electricity use
- Bulbs cost \$0.25/ewe/year
- Barn was lighted during winter lambing which created a stable environment for ewes and nice atmosphere for the shepherd
- *Will it overcome the negative effect of sub-par nutrition on spring conception?*

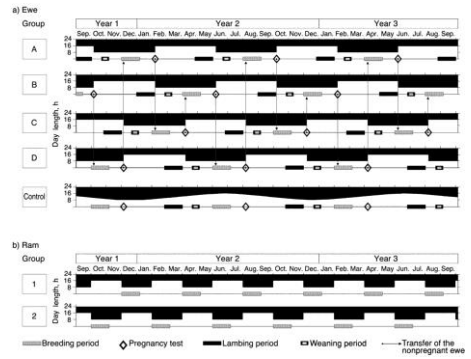
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Ensuring Ram fertility:

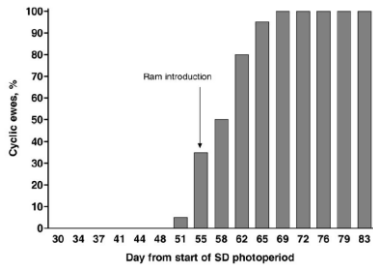
- Light priming: works well on all genotypes
 - ✓ 120 day protocol: 30 d (16h L/ 8h D); 30 d (8h D/ 16h L), 30 d (16h L/ 8h D); 30 d (8h L/ 16 D) then introduce rams.
 - ✓ Ensures high libido and fertility even in seasonal genetics
 - ✓ It has been indicated that rams remain robustly fertile at any time point after 4 months of protocol duration if the protocol is maintained.



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Cameron et al. 2010, Journal of Animal Science 88: 3280-90

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