Optimizing Reproductive Efficiency in Sheep Production with Strategic Nutritional Management

Presenter:

Richard Ehrhardt, Ph.D.

Sheep and Goat Extension Specialist

Michigan State University

Host/Moderator: Jay Parsons

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This webinar is being offered in cooperation with the American Sheep Industry Association Rebuild the Sheep Inventory Committee.

Overview

- Reproductive efficiency-often untapped opportunity in sheep production
- Nutrition and ovulation rate
- Nutrition and out of season breeding success
- Ewe lamb development programs

Sheep are the most efficient ruminants for meat production:

- Higher reproductive efficiency than cattle
  - ✓Can have up to 4 lambs per ewe per year!
- A ewe can produce close to 2 times her weight in marketable lambs per year
  - ✓Cattle are always <1
- ***This efficiency is explained by greater reproductive efficiency (prolificacy and birth interval), therefore shouldn't we focus on maximizing this in a sustainable way?***
  - ✓***Target areas: genetics and <u>nutrition</u>***

Overview of the nutritional management of reproduction in ewes of breeding age:

- Pre breeding-ovulation rate
- Early pregnancy-embryo survival
- Mid pregnancy-period of placental growth
- Late Pregnancy-fetal growth and development, colostrum supply, mammary development

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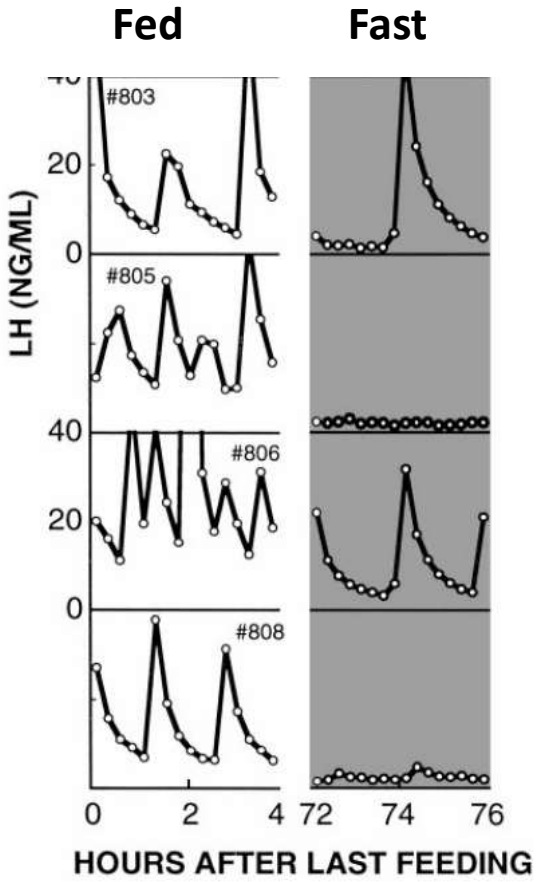
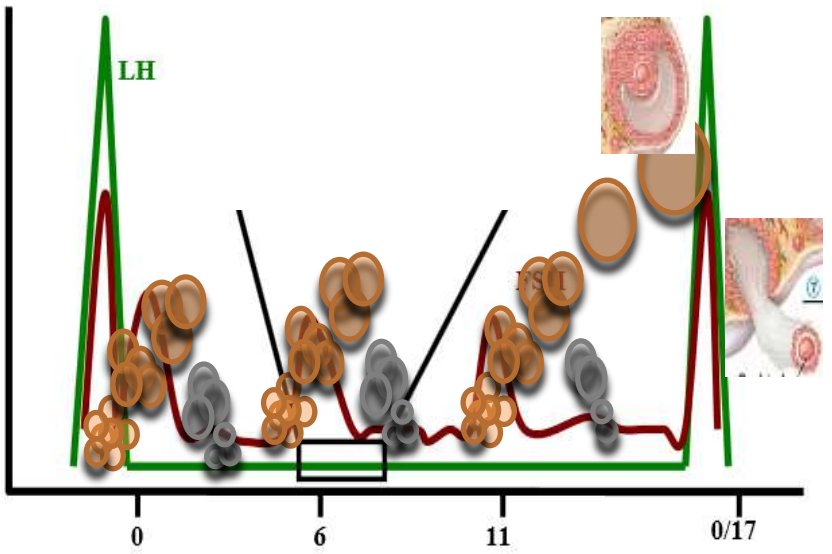
Pre-Breeding/Flushing:

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





Nagatani et al. 2000, Endocrinology 141:3965

Pre-Breeding/Flushing:

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.

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 (loose 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

Pre-Breeding/Flushing:

Nutritional target:

- ~20% increase in energy intake over maintenance (1.2x) for 2-4 weeks.
- Increase in body condition score of 0.5 units over this period, (~5-8 lbs).
- Key is to place sheep 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.)


Ewes flushed by grazing on annual forage strips of BMR sudan grass and forage brassica hybrids (chinese cabbage x turnip)
Crop planted during early July into a killed pasture following pasture lambing and grazed in late August

Nutrition and out of season breeding:

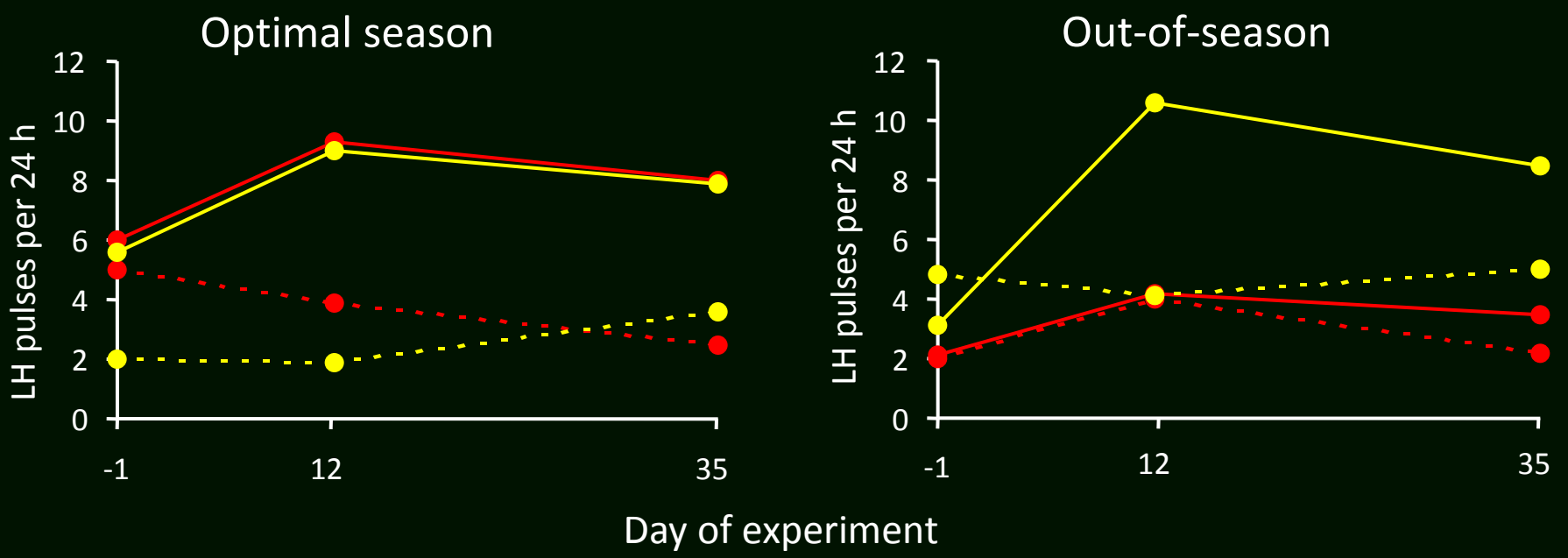
Concept:

- The sheep brain responds to signals indicating that the ewe is well-fed thereby allowing her overcome the seasonal constraint on conception.
- This concept also applies to rams as improved nutrition provides them with greater libido and fertility.

This concept only applies to sheep with the genetic capacity for out of season breeding.

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

Applies to both female and male fertility.



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

Ewe fertility and lambing percentage during October in 2 commercial flocks derived from the same genetics (Finn x Dorset)

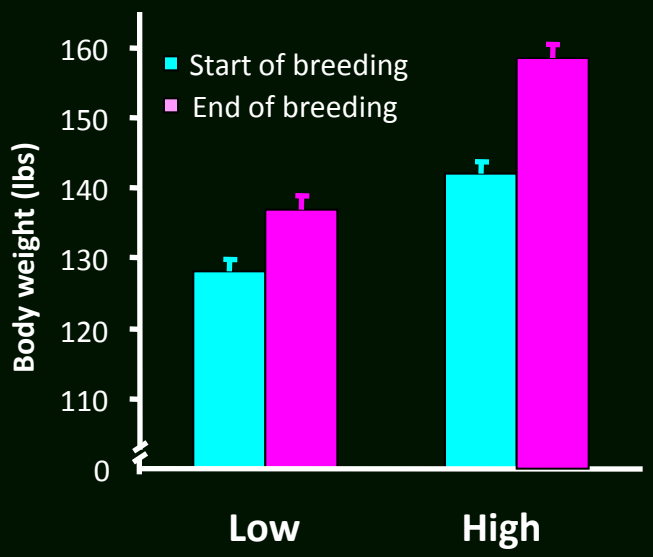
	Low Fertility	*High Fertility*
Fertility[1]:	32%	92%
Lambing Percentage[2]:	133%	206%

[1] Fertility expressed as ewe lambed/ewe exposed x 100%

[2] Lambing Percentage expressed as lambs born/ewe lambed x 100%

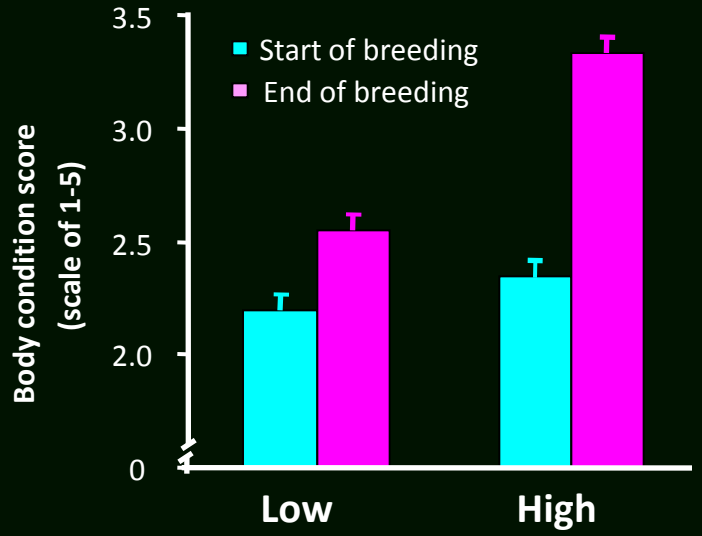
Nutritional status of ewes at the start and end of the breeding season

Body weight



P<0.001 Flock
P<0.001 Time
P<0.001 Flock x time

Body condition score



P<0.001 Flock
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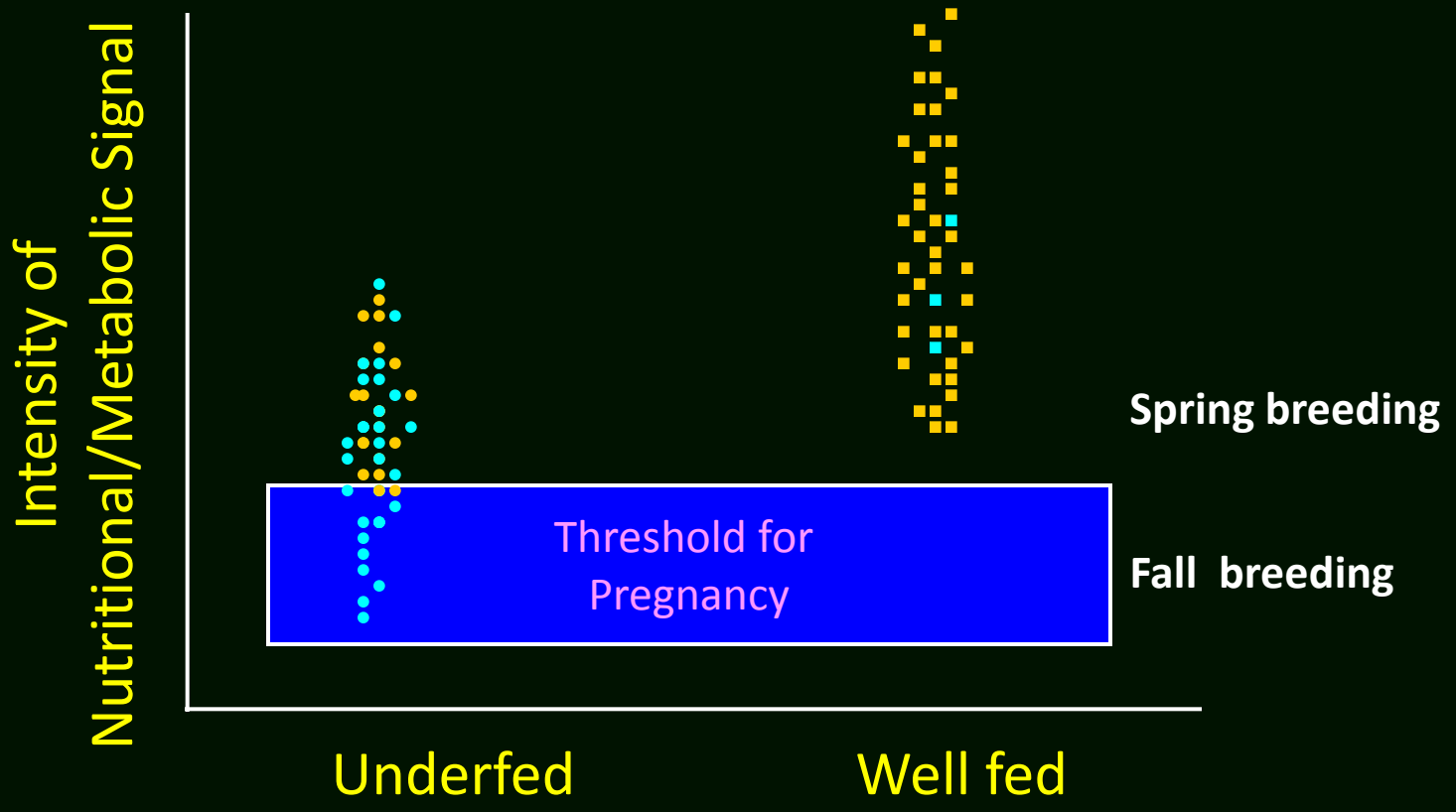
General hypothesis relating nutrition status to aseasonal fertility



Nutrition and out of season breeding:

Responses to expect:

- Not perfectly clear, however field evidence suggests that certain breeds respond to improved nutrition dramatically (2-fold improvement in conception along with greatly improved ovulation rate).
- Improved nutrition provides little to modest improvement in out-of-season conception in breeds constrained by genetics to be largely seasonal breeders.

Nutrition and out of season breeding:

Nutritional Targets:

- Rams:
  - 1.5-2X maintenance for 3-4 weeks pre-breeding

- Ewes:
  - In accelerated systems, the nutritional treatment should begin during late lactation to levels of 2.2x maintenance energy intake (for ewes rearing twins during day 30-60 of lactation).
  - Conduct a 30 day flushing program at 1.4x maintenance energy intake (between weaning and breeding in accelerated production or just prior to mating in annual production).


KUHN
KNIGHT

Nutrition and out of season breeding:

Nutritional targets in formulated diets regarding of breeding season:

- Example feedstuffs might include: high quality grass hay or haylage, corn silage, sorghum or sudan silage, corn grain, high moisture corn, etc.
- Reserve high protein feedstuffs for lactation and moderate protein feedstuffs for late pregnancy.
- Flushing diets often also make good diets for replacement ewe lambs.
- Target [protein]: ~11% crude protein.

Ewe lamb development program overview:

- Breeding ewe lambs-good or bad idea?
- Factors that determine age of puberty in sheep
- Development guidelines for replacement females.

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Cumulative performance over five lambings (2, 3, 4, 5, and 6 years of age) of ewes exhibiting or not exhibiting estrus their first winter

Breed	Estrus first winter	Cumulative performance		
		No. lambs born	Lb. lamb weaned	Lb. wool
Rambouillet	No	5.9	372.5	58.1
	Yes	6.6	417.3	57.6
Targhee	No	6.6	456.9	63.4
	Yes	6.9	480.9	62.5
Columbia	No	6.0	412.7	68.2
	Yes	6.3	454.3	68.4
Average	No	6.2	414.0	63.2
	Yes	6.6	450.8	62.8

Hulet et al. 1969; JAS 28:246

- ~9% more lifetime lbs of lamb produced in ewes able to conceive at 12 months
- Does this hold up for more productive/prolific breeds?

Why do ewes that conceive as lambs have greater lifetime production than those that cannot ?

Hypotheses:

- Mothering experience as a lamb has beneficial impact on mothering later in life
- Genes that control early puberty are linked to those that control ovulation rate
- Genes that control early puberty are linked to those that control other aspects of ewe productivity
  - ✓Mothering
  - ✓Milk Production
  - ✓Embryo survival

Other factors to consider in the decision to breed ewe lambs:

- Feed inventory-do you have quality forages to allocate to growing/pregnant ewe lambs?
- Feed cost vs. returns in productivity:
  - ✓ Feed cost is approx 30% greater to develop ewes to 27 months of age if they lamb first at 12 compared to 24 months of age.
  - ✓ Lamb production increased 1.3-1.4x?
- Are non-productive ewe lambs a dead asset?
  - ✓ Overhead and maintenance costs with no return
- Is there extra labor involved in lambing ewe lambs and if so, is it worth it?
- What is the salvage value of non-fertile ewe lambs compared to non-fertile 2 yr olds?
- Generation interval-breeding ewes lambs reduces it, a must for seedstock producers

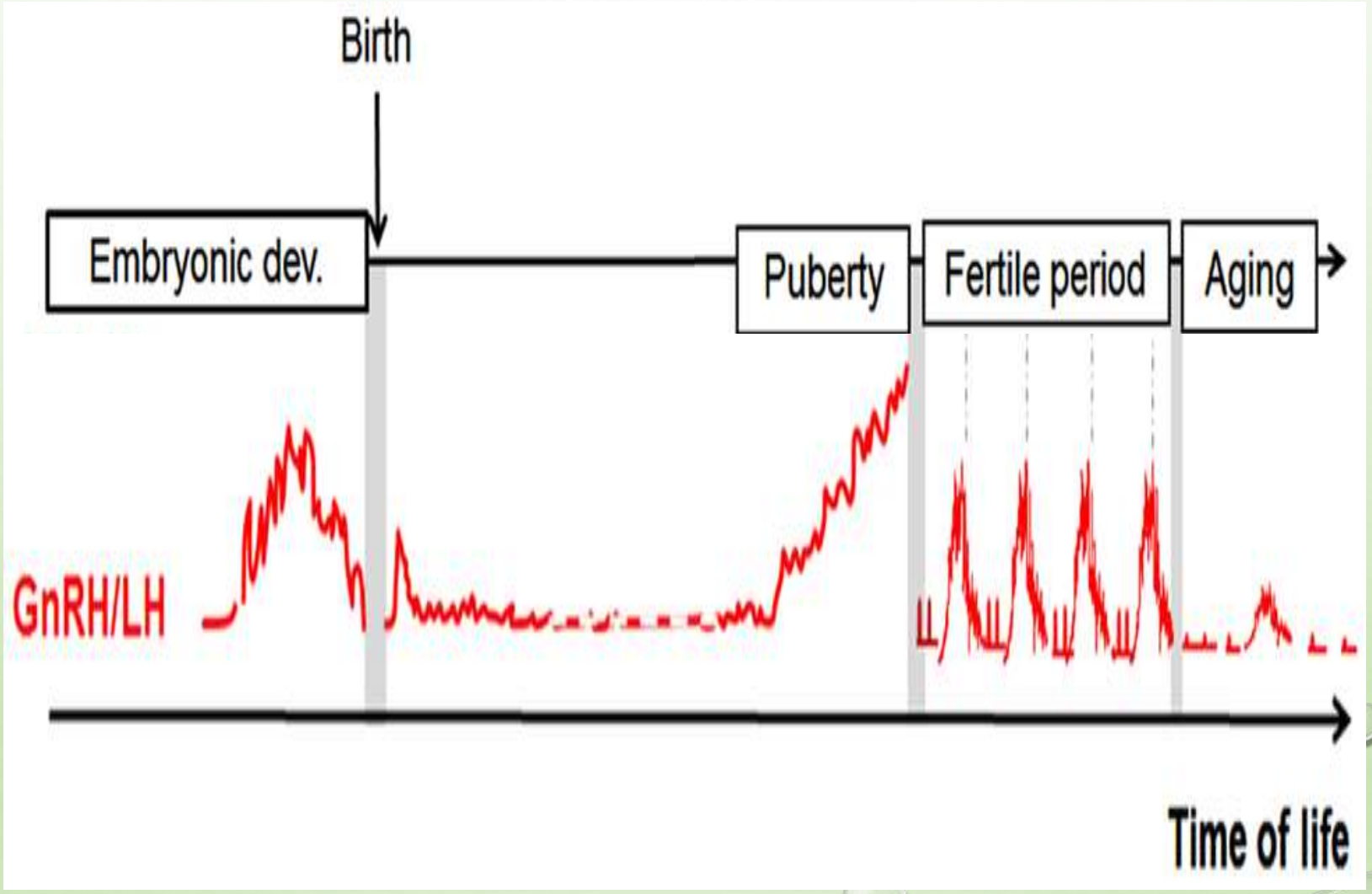
Summary:

- Selection of ewes based on ability to lamb as lambs will favor greater lifetime productivity
- Salvage value of open ewe lambs is very high especially with early pregnancy detection (use of ultrasound)
- Pregnant ewe lambs require careful management for success
  - ✓Feeding
  - ✓Lambing
  - ✓Separate breeding/feeding/rearing group
- Do not expect high productivity out of ewes conceiving < 10 months of age- they will pay for their feed but perhaps not much more
- Breeding ewe lambs is a “no-brainer” in accelerated production and with seed stock producers focused on genetic gain

Factors that regulate the onset of puberty in sheep:

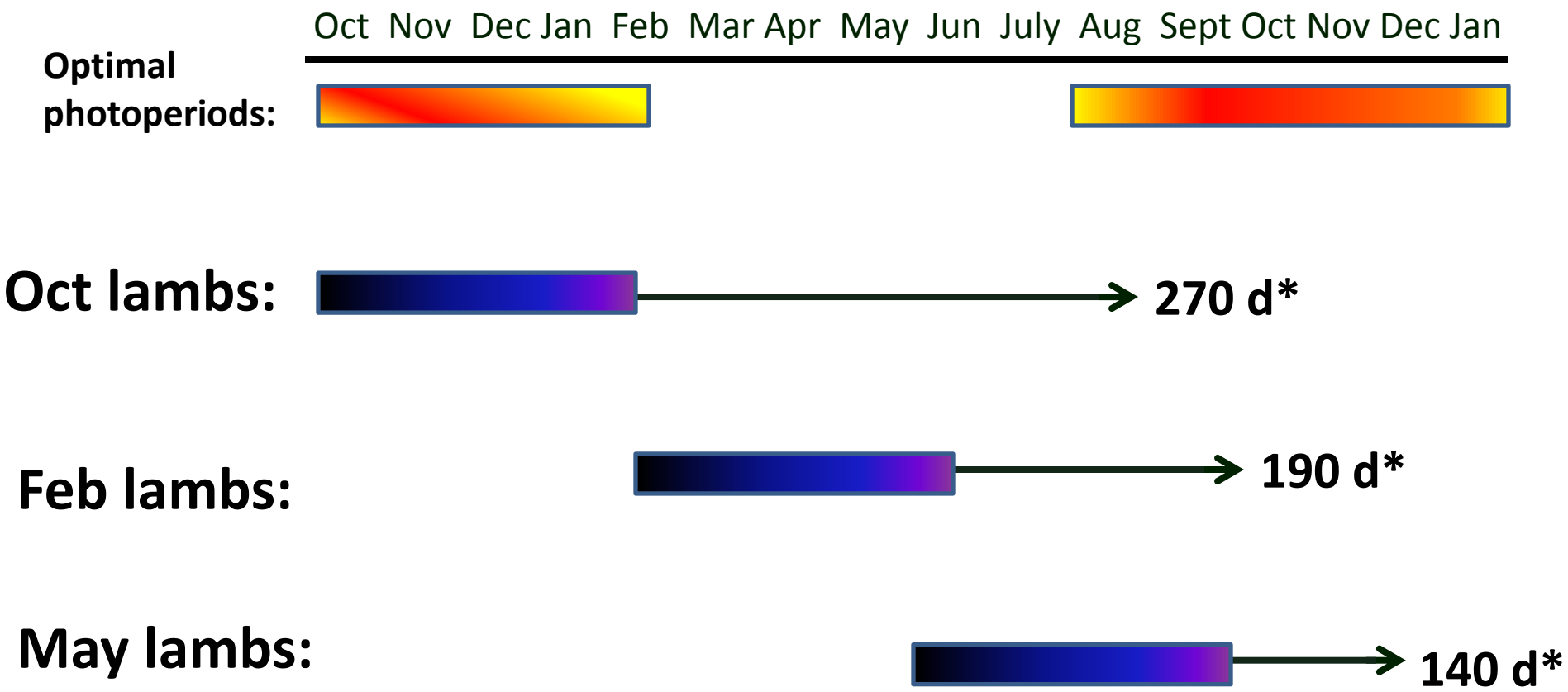
- Season
- Nutrition
- Genetics

ACHIEVING PUBERTY



Franceschini, 2013

Seasonal influences on onset of puberty: working model



* Age at which 50% of lambs reach puberty

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Influence of nutrition on the onset of puberty:

- FinnxDorset Ewe lambs born in May grown either fast (0.55 lb/day) on a grain-based diet or slow (0.29 lb/day) on a forage-based diet (Freer and Ehrhardt, unpublished)

	% reaching puberty by 7 months:
Slow grown (0.29 lb/d)	31%
Fast grown (0.55 lb/d)	100%

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Body fatness of ewe lambs grown fast or slow according to reproductive status:

	Puberty status at 7 mo.: Yes	No
Slow grown (0.29 lb/d)	28%	20%
Fast grown (0.55 lb/d)	33%	

- ***Body fatness to reach puberty estimated at 28%***

Is body weight a good estimator of body fatness and therefore when to breed ewe lambs?

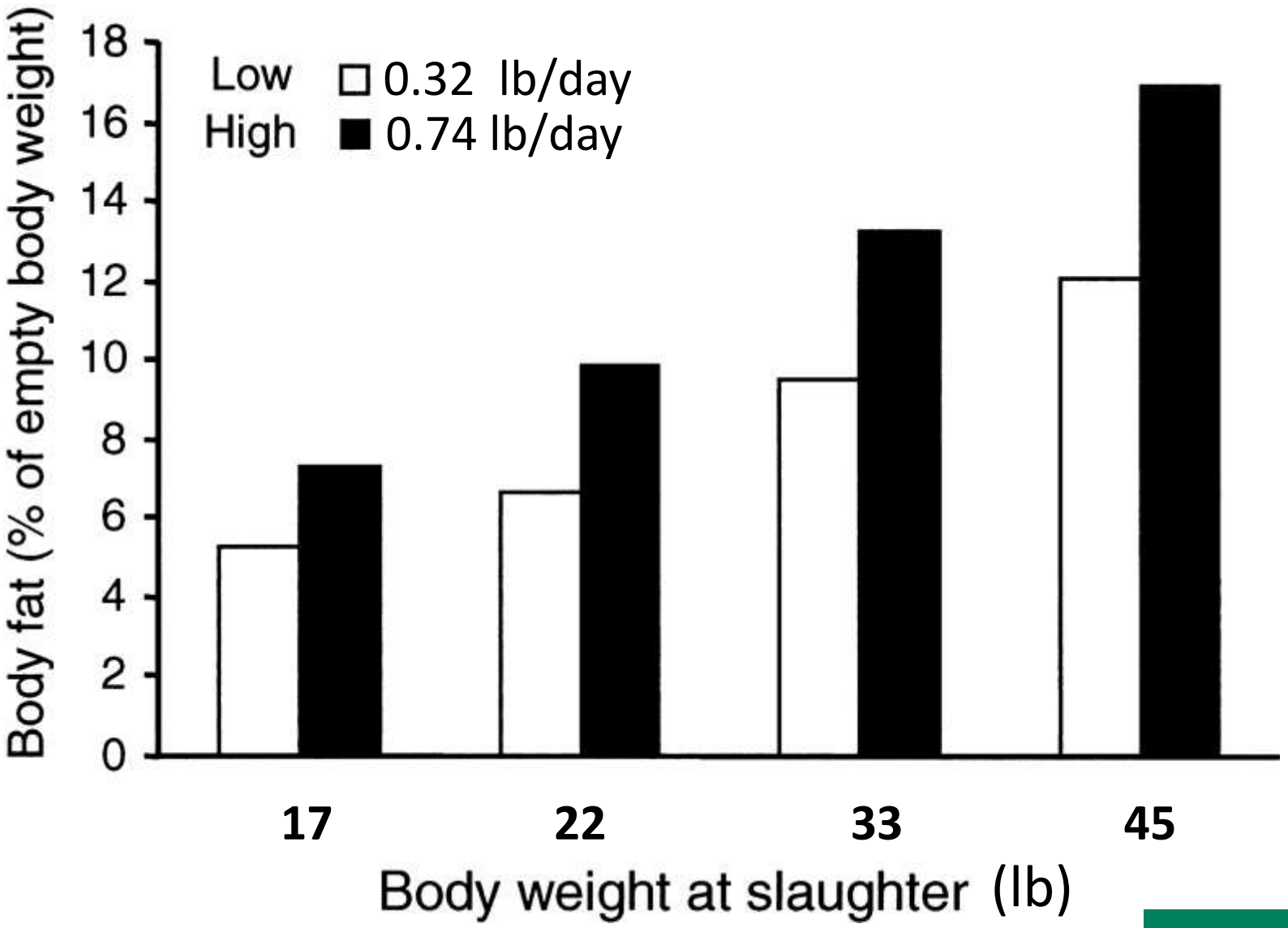
- Sheep vary in mature size
- Sheep vary in their growth curve shape
- Sheep vary in how they are fed

∴ Body weight itself is a poor predictor unless scaled to mature size

What determines body fatness?

- Age: fat% increases over time
- Diet: low vs. high plane of nutrition
- Stage of growth: % of mature size

Lamb growth rate is a good indicator of the rate of fat deposition



Ehrhardt R A et al. J. Nutr. 2003;133:4196-4201

JN THE JOURNAL OF NUTRITION

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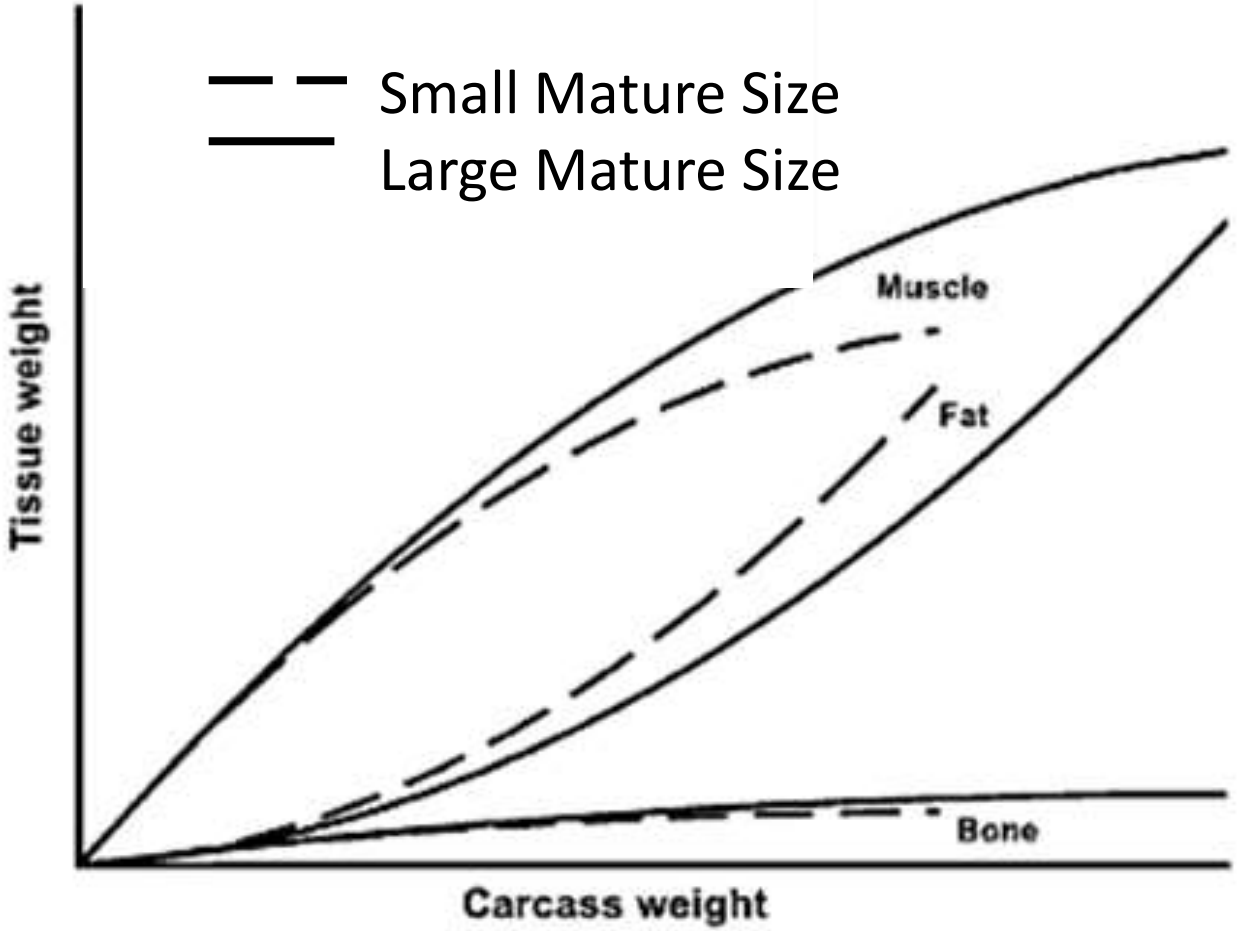
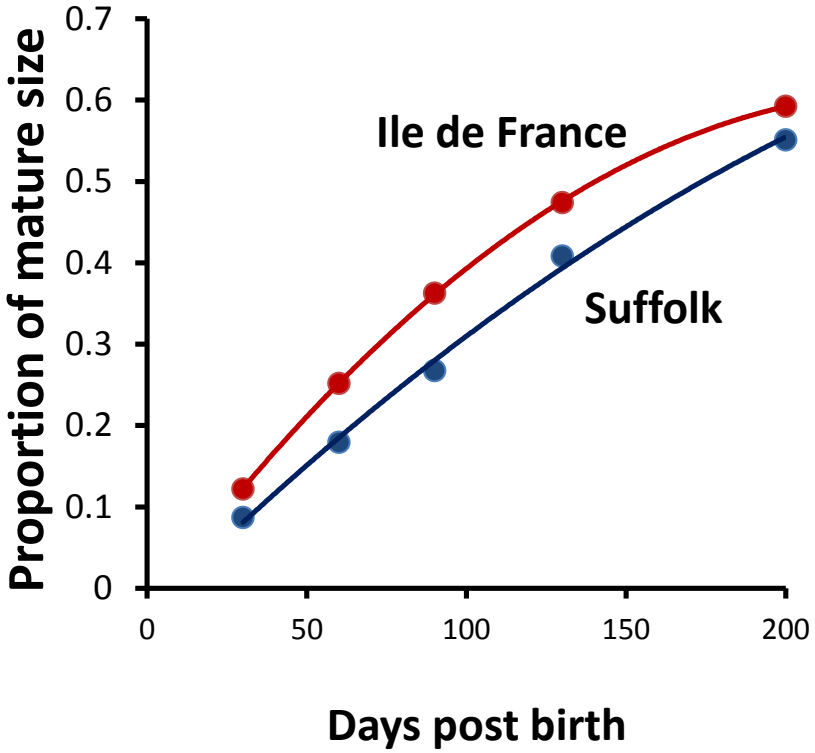
Body composition according to mature size:



Adapted from R. Butterfield "New concepts of sheep growth"
Internet First University Press 1988

- ***Lambs at 70% of maternal mature size have approx. 25% body fat***

Genetics with early growth patterns may also reach puberty earlier



Genetics and puberty:

Puberty:	Early →					Late
Breed category:	Prolific short tailed breeds	Caribbean hair breeds	British down breeds	Mediterranean fine wool breeds	Hill breeds	Long wool Breeds
Example breeds:	Finn Romanov	St. Croix Barbados-Black Belly	Suffolk Hampshire Dorset Oxford Southdown	Rambouillet Merino	Cheviot Scottish-Blackface	Lincoln Romney Leicester

- Cross breeding (heterosis) also influences puberty as crossbred lambs reach puberty earlier than their parent breeds.

Guidelines for developing ewes to conceive as lambs :

- Season of birth, genetics and rate of growth are the key variables

- Ewe lambs born during late spring have the least seasonal barrier to reach puberty and reach puberty the fastest everything else the same

- Establishing a threshold % of mature maternal body weight provides a sound target but may require some adjustment according to season of birth and genetics

Guidelines for developing ewes to conceive as lambs:

- Breed at target of 70% maternal mature size to optimize conception rate (Feb. born, non prolific)

Ewe weight (lbs):	Ewe lamb weight target (lbs):
130	91
140	98
150	105
160	112
170	119
180	126
190	133
200	140
210	147
220	154

Guidelines for developing winter and spring born ewes to conceive as lambs:

❖ Adjustment factors to the 70% rule:

- Season of Birth (northern hemisphere)
  - ✓ March 1-April 15: - 3%
  - ✓ April 16 to May 31: - 6%

- Genetics
  - ✓ 25% Finn/Romanov - 3%
  - ✓ 50% Finn/Romanov -6%

Guidelines for developing ewes to conceive as lambs:

- Scenario:
  - ✓3/8 Finn ewe lambs with mature weight of 170 lb
  - ✓Want to optimize target breeding weight

  - Feb. born lambs to lamb at 12 months of age
    - ✓Adjustsments: -4.5% for Finn genetics
    - ✓170lb x 0.655= **111 lb**
  - May born lambs to lamb at 12 months of age
    - ✓ Adjustments: -4.5% for Finn genetics, -6% for season
    - ✓ 170lb x 0.595= **101 lb**

Further considerations in developing ewes to conceive as lambs:

- It may be wise to breed fall and early season lambs (July to Feb) to lamb at 14-16 instead of 12 months of age
  - ✓ Ewe lambs achieve greater reproductive maturity before breeding as they exhibit more estrus cycles before conceiving
  - ✓ Early dilation syndrome (EDS) has been observed at higher rates in early season lambs giving birth at 12 months of age
  - ✓ EDS largely disappears when the same genetic strain is delayed to lamb for the first time at 14-16 months of age.
- Lower % mature size breeding thresholds can be used but expect conception rate to drop
  - ✓ 10-15 lb of weight difference may decrease conception 30%
- Breed ewe lambs as a separate mating group with higher ram coverage
  - ✓ 3% (1 ram to 33 ewes) as compared to 2% (1 ram to 50 ewes)
- Lambing ewe lambs on pasture may seem counterintuitive but if properly managed, lower human pressure may improve maternal bonding

Is there a penalty for growing ewe lambs too fast other than cost?

- Historically in diary heifers, it has been held that heifers grown fast have impaired mammary development and therefore lower milk production in their first lactation
- Recent evidence indicates that this is mostly explained by age and not body fatness as fast grown heifers are younger at mating than those grown more slowly.
- In sheep, both age and season are likely important for mammary development and milk production, however milk production is often not a limiting in factor as ewe lambs have lower lambing rates.
- Overly fat ewe lambs may however be more prone to both rectal and vaginal prolapse.

Summary on ewe lamb development programs:

- Ewe lambs able to conceive as lambs have higher lifetime lamb production
- Ability to lamb during year one can be a practical selection tool with open ewe lambs identified with ultrasound allowing sale as lambs at high market prices
- Body condition/fatness is a major determinant of the onset of puberty
- Fatness is highly related to body weight scaled to mature size so % mature size is a good predictor for when to breed ewe lambs
- Prolific genetics, Finn and Romanov, reach puberty earlier than other breeds
- Season of birth has a large impact on reproduction and onset of puberty and needs to be considered when developing ewe lamb rearing programs
- Ewe lambs bred as lambs should be managed as a separate group during breeding,pregnancy and lactation for the best outcome

Overall summary on nutrition and reproduction:

- Plane of nutrition has a huge impact on:
  - ✓Ovulation rate
  - ✓Conception, particularly out-of season
  - ✓Age at puberty

- Management of feed resource availability to meet targets
  - ✓Management of stocking rate, forage availability and quality in grazing-based programs
  - ✓Management of forage and concentrate inventory in feeding-based programs

Richard Ehrhardt Ph.D.
Email: **ehrhard5@msu.edu**
Office: (517) 353-2906
Cell: (517) 899-0040