**Today's Overview**

1. Nutrients and diet formulation
   - dietary protein and urea nitrogen
   - control of body condition score
   - altering dietary fats / fatty acids
   - high starch (insulin-stimulating) diets
   - organic mineral sources
   - trace mineral / vitamin injections
   - hypocalcemia and ketosis

2. Intake of harmful substances
   - water analysis
   - high molybdenum soils
   - molds and mycotoxins

**Nutrition and Repro Overview**

- Reproduction is extremely multifactorial
  - moderate relationship between nutrition and reproductive performance
  - very difficult outcome to research

- This is a review principles of dairy nutrition and reproductive management
  - you make the applications to AI programs

- No magic bullets

**Crude Protein and Urea Nitrogen**
High Crude Protein and Impaired Fertility

- Strongest nutrition/repro relationship
- Ruminally degradable protein (RDP) is the most crucial protein fraction
  - interacts with ruminally soluble carbohydrate, expressed as non-fiber carbohydrates (NFC)
- High RDP/low NFC results in high urea nitrogen (UN)
- High UN is associated with infertility

Fertility Reduction Due to High UN

- Excessive negative energy balance
  - energy cost of NH₃ detoxification
  - can consume 5 to 10% of net energy
  - repro is extremely sensitive to energy balance
- Direct effects of high UN on uterine environment?

Monitoring Program for UN

- UN data are commonly ignored
  - especially herd-level bulk tank MUN's
- UN data must be interpreted in light of sampling time relative to feeding
  - particularly important if ET donors or recipients are component-fed
- UN levels peak ~3 hours after a protein meal
- Need to monitor at consistent times relative to feeding

Figure 1. BUN and MUN Variations after Feeding

- Either BUN or MUN can be monitored
- Can use bulk tank, string samples, or individual cow samples
- Wet chemistry preferred over NIRS
  - milk plant and DHI testing are done by NIRS
  - NIRS calibration errors before ~2000 flawed research conclusions
  - I send milk samples to Marshfield Labs
**Monitoring Program for UN**

- Optimum is 9 to 12 mg/dl
  - clear repro impairment if >20 mg/dl
- Expect slightly higher values if higher DMI

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**Body Condition Score and Fertility**

- Too fat or too thin increases risk for infertility
  - >4.0 is too fat and is the greater concern
  - ≤2.5 is too thin
- BCS is too simplistic an approach
  - negative energy balance is the real key
- Fatter cows experience more profound NEB

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**Value of Body Condition Score**

- Best measure that we have
  - correlates well to actual body fat
  - poorer correlation to body fat at lower scores, where body protein is now being lost
- Overconditioning is the main challenge
  - very thin ET donors and recipients are not so common

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**Preventing Overconditioned Cows**

- Especially if cattle have long lactations or long dry periods
- Must be proactive and aggressive!
  - nutritionists want to make small changes
  - think big (3 to 7 lb changes in feed amounts)
- Add lots more forage (chopped straw, etc.)
- Take out lots of grain

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**Control of Body Condition Score**

- Expect slightly higher values if higher DMI

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**Preventing Overconditioned Cows**

- Do not limit-feed groups
  - dominant cows will still get / stay fat
- Continue to feed to normal feed refusals
  - 2 to 5% of feed offered
Managing Overconditioned Cows

- Do not attempt to reduce BCS just before using donors or recipients
- Maintain or increase energy balance once ET is planned
- This is a long-term, proactive exercise!

Altering Dietary Fats

Added Fats and Fertility

- Added fats often increase fertility
- Effect is inconsistent, not fully understood
- May improve oocyte quality and embryo development
- Mechanisms involved:
  - Attenuation of NEB?
  - Blunted by ↓ DMI, especially in early lactation

Specific Fatty Acid Supplementation

- Polyunsaturated fatty acids
  - Some n-3, some n-6 have shown benefits
- Flaxseed (high n-3 content)
  - Equivocal effects at best from research
  - Do not expect too much from this

High Starch (Insulin Stimulating) Diets

- Increases proportion of cows ovulating by 50 DIM
  - Converse is true – high fat (low starch) diets reduce the proportion of cows ovulating
- Practical limitations
  - Cannot be high starch and high fat

Insulin-Stimulating Diets

**Effects of Nutrition and Metabolic Diseases on Reproduction**
Garrett R. Oetzel, DVM, MS 11/5/13

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**Proposed Two-Stage Feeding**
- Phase 1 – high starch (insulin-stimulating) until cycling activity begins
  - early lactation / before VWP
- Phase 2 – higher fat (insulin-depressing) once breeding begins
  - better production response to fat feeding after peak milk anyway

**Other Practical Concerns**
- High starch diets increase the risk for ruminal acidosis
- High starch diets increase ruminal propionate production
  - propionate will ↑ satiety and ↓ DMI
- Starch is expensive

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**Organic Mineral Sources**

**Organic Minerals and Fertility**
- Improved bioavailability
- Improved response at tissue level?
- Research results – mildly positive
  - meta-analysis for organic Ca, Cu, Mn, and Zn showed improved reproductive performance
  - organic Se – modest improvement in one study, no improvement in another

**Organic Minerals and Fertility**
- Do not overdose trace minerals!
  - watch for multiple sources
  - Se, Cu most likely to be toxic
- Cannot create a ‘supra-physiological’ state
  - can correct deficiencies / remove bottlenecks

**Trace Mineral / Vitamin Injections**

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Advani et al., J. Dairy Sci. 93:4239, 2010

Adapted from UBC SoilWeb http://www.landfood.ubc.ca/soil200
Trace Mineral / Vitamin Injections

- Very limited evidence of benefit
  - one large study with injectable Cu, Mn, Se, and Zn reported no effect or slightly reduced odds for pregnancy
- Injections could certainly correct deficiencies
  - but deficiencies should be uncommon

Vanegas et al., J. Dairy Sci. 87:3665, 2004

Trace Mineral / Vitamin Injections

- Fat-soluble vitamins are stored in adipose tissue for months
- Beware of Se toxicity
- Impact of local inflammatory responses:
  - some formulations are more irritating
  - aqueous formulations are less irritating
  - energy cost of inflammatory response? (risk of impairing energy balance before ET?)

Preventing Hypocalcemia and Ketosis

Plasma Ca Around Calving

Fresh cows with (n=8) or without (n=19) milk fever

Kimura et al., J. Dairy Sci. 89:2588, 2006

Subclinical Hypocalcemia and Reproductive Performance

- Multi-site, multi-institution study
  - 2,365 cows in 55 Holstein herds, US and Canada
  - weekly blood samples around calving

Chapinal et al., J. Dairy Sci. 94:4897, 2011
Chapinal et al., J. Dairy Sci. 95:1301, 2012

Multi-Site Study Design
**Ketosis and Fertility**

- BHBA > 1.4 mmol/L in first two weeks (Ontario herds, late 1990's)
  - ↓ 1st service CR by 50%
  - ↓ overall CR by 20%
  - ↑ days open by 16 days

- Other studies (more recent, larger, TMR herds)
  - little to no effect of ketosis on fertility
  - do sync programs moderate the effect?

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**Multi-Site Study Results**

- Overall 1st service conception rate:
  - 26 to 29% if hypocalcemic (by any of the 4 thresholds)
  - 35 to 36% if not hypocalcemic

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**Intake of Harmful Substances**

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**Water Analysis**
**Water Analysis**
- Reasonable to monitor water analysis
  - Key concerns – nitrates, iron, and sulfates
- Experts do not agree on upper safe limits
  - Nitrate-nitrogen range of 10 to 100 ppm
  - Iron range of 0.2 to 0.4 ppm
  - Sulfates range of 250 to 1000 ppm
- Very minimal research data for repro effects
- Mitigation of water systems is expensive

**High Molybdenum Soils**
- Plant tissue takes up soil Mb
- High Mb interferes with Cu
- Functional Cu deficiency impairs fertility

**Molds and Mycotoxins**
- Minimal research data
  - Ruminants degrade most mycotoxins
- Feed refusal should be the first clinical sign
  - Secondary negative energy balance could cause infertility
  - Beware of making a mold/mycotoxin diagnosis without feed refusal problems
- Do look for visible mold
  - Separate and discard this feed
- Testing is difficult
  - High cost of tests
  - Localization in silos or hay stacks
  - Unclear maximal safe levels
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Molds and Mycotoxins
- Mold (and yeast) counts are nearly worthless
  - keep samples cool
  - plate the same day
  - use good laboratory procedures
  - modest relationship to mycotoxin content
- Mycotoxin binders?
  - very little research data
  - generally do no harm

Conclusions
- Dairy cow fertility is very multifactorial
- Nutrition plays a moderate role

Questions?

www.vetmed.wisc.edu/dms/fapm