Impacts of nutrition, behavior and other stressors on pregnancy success

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What is Stress?

- Sum of all reactions of an animal to factors that potentially influence its homeostasis (Moberg, 2000)
  - Physiologic stress – disease
  - Physical stress – injury
  - Psychologic stress – fear
- Body responds similarly to different types of stressors in an effort to maintain or restore homeostasis (Selye, 1973)
  - Sympathetic nervous system
  - Hypothalamic-pituitary-adrenal (**HPA**) axis

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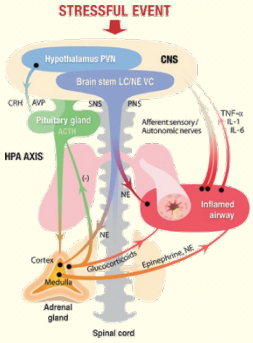
What is Stress?

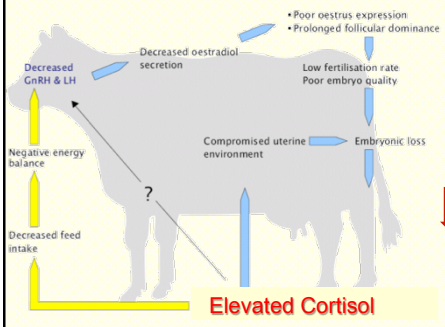


Sympathetic response
- Nervous pathways
- Rapid and acute
- Epinephrine/Norepinephrine

HPA response
- Endocrine pathways
- Not as rapid but chronic
- Glucocorticoids = **Cortisol**

Biological outcomes
- Restore homeostasis
- Increase nutrient availability
- **Detriment of other systems**

Stress/HPA and reproduction



Ovulation success
+
Luteal development
+
Pregnancy maintenance
=
Reproductive failure

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Stress/HPA and reproduction

Proof of concept: cortisol concentrations at timed-AI

Stress/HPA and reproduction

Prevent and/or alleviate stressor are critical for optimal reproductive efficiency of beef operations

- Many stressors come from management
- Recognize stressors
  - Physical
  - Physiological
  - Psychological
- Alternatives to mitigate stressors
  - Viable management alternatives

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Stress/HPA and reproduction

- Elevated stocking density (heifers)
  - Raised on pasture, drylot or pasture after weaning
  - Sudden change in environment
    - Excessive confinement + lack of exercise
    - Not in homeostasis = **psychological** STRESS

6 acres/heifer

160 square feer/heifer

Schubach et al., 2017

Stress/HPA and reproduction

- Elevated stocking density (heifers)

Item	Pasture	Drylot	SEM	*P* =
Heifer growth				
Weaning BW, lbs	464	466	6	0.82
Breeding BW, lbs	783	787	10	0.84
ADG, lbs/day	1.70	1.72	0.05	0.82
Heifer activity				
Steps/week	19,709	3,148	628	< 0.01
HSP72 mRNA	3.48	2.77	0.18	0.04

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Schubach et al., 2017

Stress/HPA and reproduction

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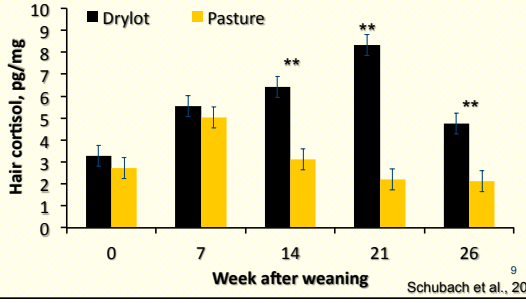

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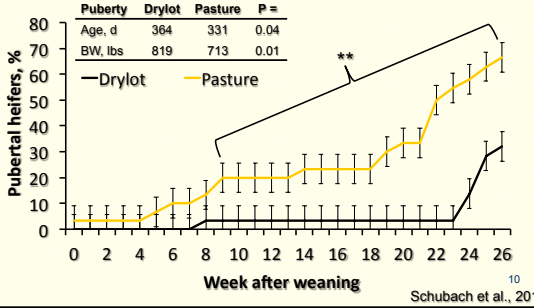
Schubach et al., 2017

Stress/HPA and reproduction

- Elevated stocking density (heifers)

Puberty	Drylot	Pasture	P =
Age, d	364	331	0.04
BW, lbs	819	713	0.01



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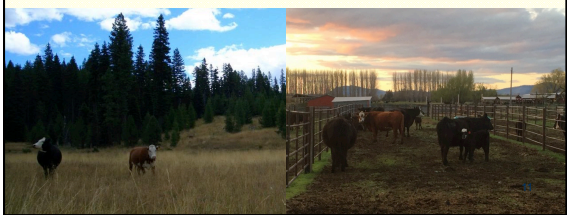
Schubach et al., 2017

Stress/HPA and reproduction

- Elevated stocking density (heifers)
  - Lessons learned
  - Avoid sudden changes in environment
  - Carefully consider stocking density



Stocking Density

College experience

Stress/HPA and reproduction

- Nutrition can be a **physiological** stressor
  - Change in diet = change in homeostasis
  - Lack of nutrients = change in homeostasis
    - **Added deleterious NUTR and STRESS effects**

Perry et al., 2013

Stress/HPA and reproduction

- Nutrition can be a **physiological** stressor
  - Post-AI supplementation programs
  - Optimize pregnancy establishment success
  - Several nutrients to be considered
    - Trace minerals, sugars, amino acids, progestogens

- Ca-salts of soybean oil (**CSSO**)
  - 39% linoleic acid (n-6) and 3% linolenic acid (n-3)
  - Rumen-inert source (avoid extensive modification)
  - Breeding season supplement (AI protocols)
    - 100 g/cow daily, mixed with low-intake CP supplement

Beef cow reproduction

Post-AI nutritional management

CSSO supplementation - Pregnancy rates to AI

Beef cow reproduction

Post-AI nutritional management

Item	CSSO	CON	SEM	P-Value
Cow variables				
N of cows	383	388	-	-
Days post-partum, d	66.3	67.2	3.6	0.86
Performance variables				
BCS, d 0 (AI)	5.21	5.16	0.13	0.78
BCS, d 30	5.34	5.30	0.15	0.81
Reproductive variables				
Estrus patch, %				
Activated	43.9	40.9	3.7	0.59
Pregnancy rate, %	60.2	51.7	4.2	0.01

Brandão et al., 2017

Beef cow reproduction

Post-AI nutritional management

CSSO supplementation – Pregnancy Physiology

Beef cow reproduction

Post-AI nutritional management

Item (mRNA expression)	CSSO	CON	SEM	P-Value
Conceptus				
Interferon-tau	21.3	12.1	3.4	0.05
Prostaglandin E synthase	2.22	2.50	0.48	0.69
Endometrium				
Cyclooxygenase-2	4.88	5.11	1.32	0.89
Prostaglandin E synthase	5.76	7.40	1.10	0.30
Blood cells				
ISG15	43.1	29.8	4.6	0.04
MX2	20.2	20.1	2.7	0.98
OAS1	26.8	18.3	2.7	0.03

Brandão et al., 2017

Stress/HPA and reproduction

- Overall: heifer and cow nutrition
  - Major dietary changes also perceived as stress
    - *Avoid major changes in diet/environment peri-breeding*
  - Targeted nutrition to enhance pregnancy success
  - Prevent/correct deficiencies **and** excesses

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Stress/HPA and reproduction

- Relocation / transportation stress
  - Cows moved during early pregnancy
    - Change in environment = **psychological** STRESS
    - Extreme exercise = **physical** STRESS
    - Handling/transport = (**both**) STRESS

Item	Pregnancy rate to AI, %
Experiment 1 (Harrington et al., 1995)	
Transport (d 1 to 4)	74%
Transport (d 14 after AI)	62%
Experiment 2 (Geary et al., 2010)	
Control (no handling)	72%
Handling (d 10 -15 after AI)	66%

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Stress/HPA and reproduction

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Lesson learned:

Avoid handling, transporting cattle from **7 to 21 days after AI**, as well as any other source of stress

Pregnancy Recognition/Establishment Period

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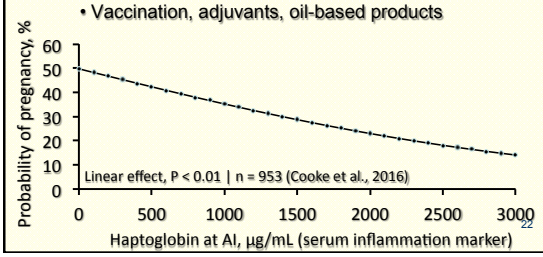
Stress/HPA and reproduction

- Disease and inflammation peri-AI
  - Classical **psychological** STRESS
  - Inflammation elicited in healthy cows
    - Vaccination, adjuvants, oil-based products



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Stress/HPA and reproduction

- Disease and inflammation peri-AI
  - Classical **psychological** STRESS
  - Inflammation elicited in healthy cows
    - Vaccination, adjuvants, oil-based products

Lesson learned:

Health management also impacts cattle reproductive efficiency via stress pathways

Fertility parameters

Pregnancy Recognition/Establishment Success

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Stress/HPA and reproduction

- Excitable temperament
  - Aggressive/fear responses near humans
  - Not in homeostasis = **psychological** STRESS

- Temperament assessment
  - Chute score and exit velocity
  - Temperament score (1 to 5)
  - Temperate type
    - **Adequate** temperament (TS ≤ 3)
    - **Excitable** temperament (TS > 3)

Stress/HPA and reproduction

- Assessed at beginning of breeding season
  - Fixed-time AI + 50-d bull breeding

Item	EXC	ADQ	SEM	P=
Breeding season variables	n = 109	n = 324	-	-
Plasma cortisol at AI, ng/mL	22.7	17.8	0.8	< 0.01
Pregnancy rate, %	88.7	94.6	1.9	0.03
Pregnancy loss, %	3.8	2.8	1.3	0.63
Calving rate, %	85.0	91.8	2.2	0.04
Weaning variables				
Calf weaning BW, lbs	544	545	10	0.71
Weaning rate, %	83.9	89.9	2.4	0.09
Calf weaned/cow exposed, lbs	455	490	12	0.08
@150/ctw weaned calf	↓ $52 per cow			

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Stress/HPA and reproduction

- Excitable temperament
  - Aggressive/fear responses near humans
  - Not in homeostasis = **psychological** STRESS

- Lessons learned
  - Excitable temperament is detrimental to reproductive performance of females
    - Across breed types (*B. indicus* and *B. taurus* cattle)
  - Considered as selection criteria
    - Culling aggressive and unproductive females
    - Maintain "some" temperament in the herd

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Stress/HPA and reproduction

Overall conclusions

- Stress had direct implications on reproduction
  - Cortisol **vs**. ovulation and pregnancy physiology
  - Independent of stress nature
    - Physical, physiological, and psychological
- Many stressors = routine management
  - Stocking density, nutrition, transport, temperament
    - Several others not mentioned, similar pathway/outcome
- Alternatives to prevent or mitigate stressors
  - Optimal reproductive efficiency in beef operations

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Thank you for your attention

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