

Nutrition During Gestation and Fetal Programming

Kim Vonnahme
2007 Range Beef Cow Symposium

"Healthy Offspring through Optimal Nutrition"
Center for Nutrition and Pregnancy
Department of Animal & Range Sciences
North Dakota State University
Fargo, ND 58105-5727, USA

Vonnahme, 12/12/07

Acknowledgements

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- Collaborators at NDSU
 - ▣ Dr. Joel Caton
 - ▣ Dr. Carrie Hammer
 - ▣ Dr. Greg Lardy
 - ▣ Dr. Justin Luther
 - ▣ Dr. Anna Grazul-Bilska
 - ▣ Dr. Dale Redmer
 - ▣ Dr. Larry Reynolds
- Other collaborators
 - ▣ Dr. Steve Ford– UW
 - ▣ Dr. Bret Hess– UW
 - ▣ Dr. Rick Funston– UNL



NDSU Animal Nutrition and Physiology Center

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Outline

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- What is fetal programming?
- How can fetal programming impact animal agriculture?

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THE ROANOKE TIMES
Monday, September 20, 2004



STEPHANIE KLEIN-DAVIS | The Roanoke Times

Mellisa Williamson, 35, a Bullitt Avenue resident, worries about the effect on her unborn child from the sound of jackhammers.

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Phenotype

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Classic Animal Breeding Example

Phenotype = Genotype + Environment

Eg. Milk production = Holstein genetics + Mastitis

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Phenotype

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Future Animal Breeding Example

Phenotype = Genotype + Environment

Eg. Yield grade = Angus genetics + Uterine environment

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“The concept that life time health is determined in large measure by the environment experienced during development is the single most important story in human and animal health.”

-Dr. Peter Nathanielsz

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Programming

The process through which a *stimulus* or *insult* establishes a *permanent* response

Fetal (or Developmental) programming hypothesis

Exposure during a *critical period* in development may influence later metabolic or physiological functions in adult life

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10 Principles of Fetal Programming

1) During development in the womb, there are critical periods of vulnerability to suboptimal conditions. Vulnerable periods occur at different times for different tissues.

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Bovine Fetal Growth Time Line

Day 0	Ovulation
Day 9-11	Hatching from the zona pellucida
Day 15-18	Critical period for maternal recognition of pregnancy
Day 18-22	Time of conceptus attachment to the uterine wall
Day 21-22	Heart beat apparent
Day 28	Gonadal ridge formed
Days 25-30	Limb development
Day 40-50	Differentiation of the rumen, stomach, formation of the rumen, reticulum, and omasum Cellular differentiation and growth of the pancreas, liver, adrenals, lungs, thyroid, muscle and kidneys
Day 45	Testicular development
Day 50-60	Bone ossification begins Limbs are increasing in length Ovarian development
Day 70	Completion of rumen differentiation Orientation of stomach is complete
Day 80	First detection of adipose cells
Day 120	Marked increase in carotid vascularization and blood flow
Day 150	Completion of carotid arterial vascularization
Day 190	Brown fat is detectable
Last third of gestation	Further cellular differentiation and growth of all tissues

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“Timing is Everything”

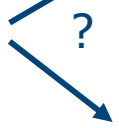
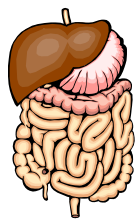


10 Principles of Fetal Programming

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6) Compensation carries a price. In an unfavorable environment, the developing baby makes attempts to compensate for deficiencies. However, the compensatory effort often carries a price.

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The Maternal Environment

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Newsweek

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HEALTH FOR LIFE

Fertility & Diet

HOW WHAT YOU EAT AFFECTS YOUR ODDS OF GETTING PREGNANT

By Dr. Jorge R. Chavarra, Dr. Walter C. Willet and Patricia J. Sherrin

WITH HARVARD MEDICAL SCHOOL

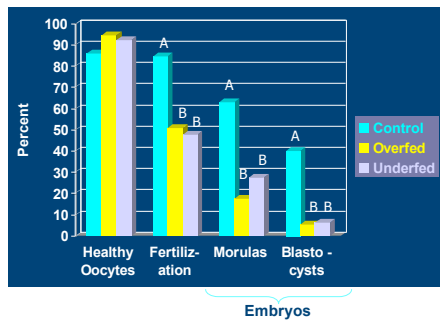


ISSN: 0014-6819
FEB 12 2007
\$4.99

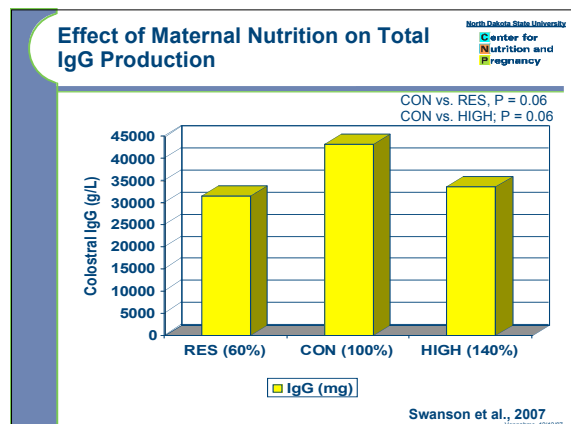
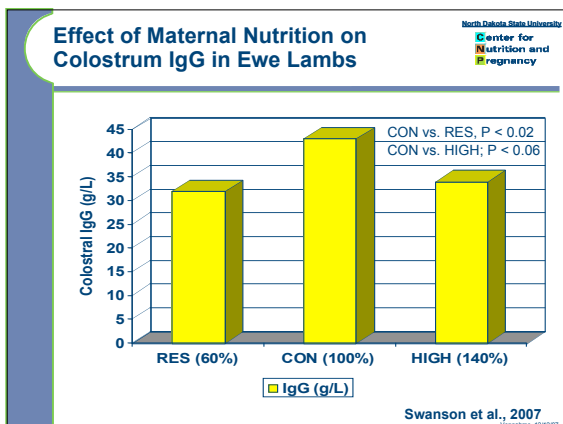
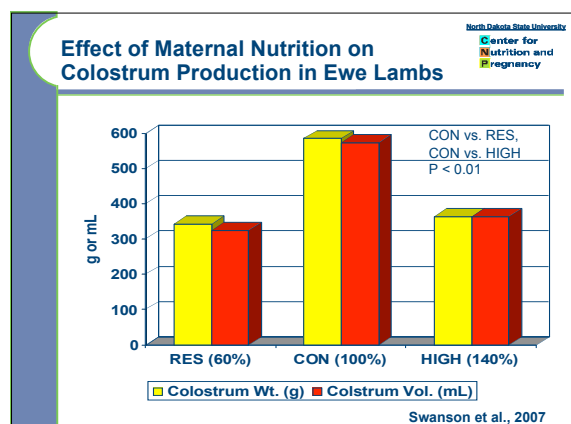
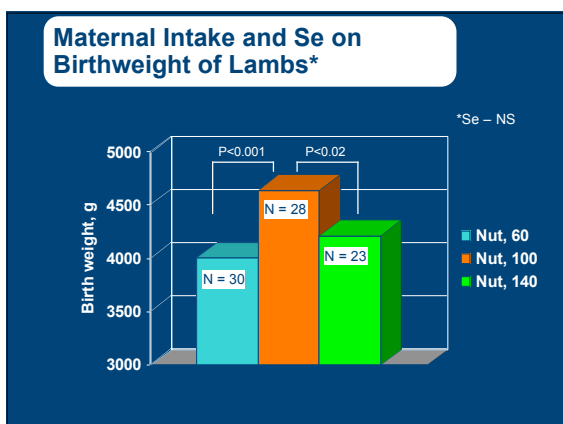
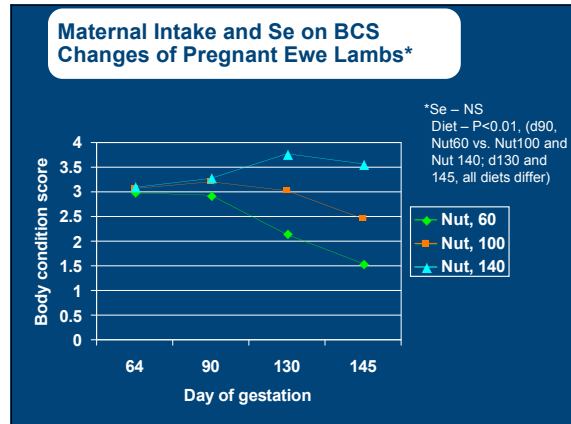
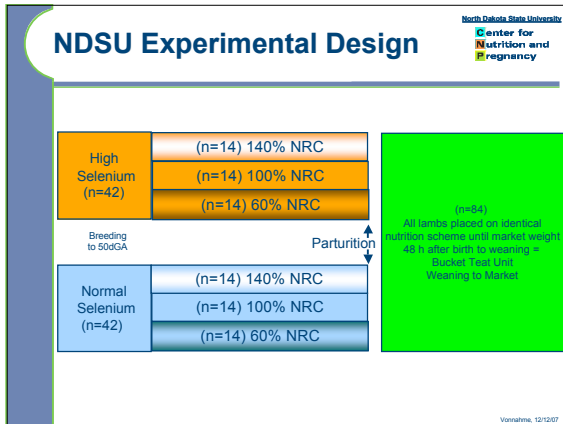
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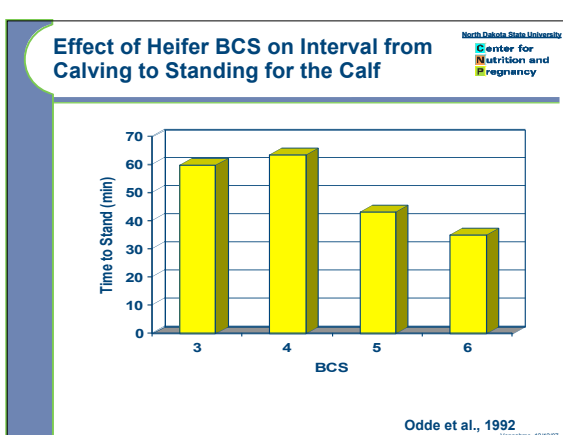
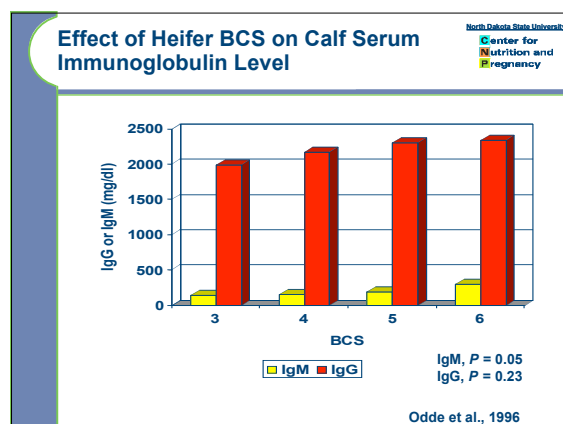
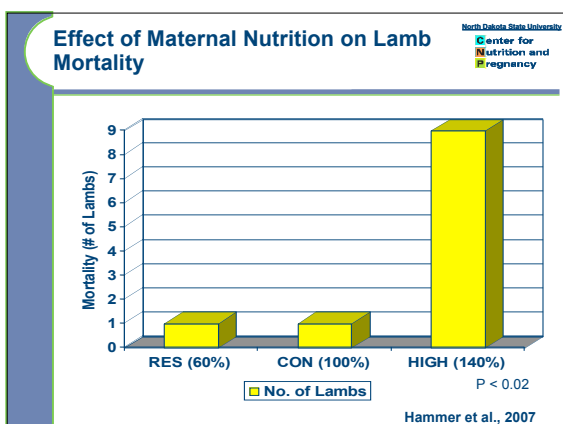
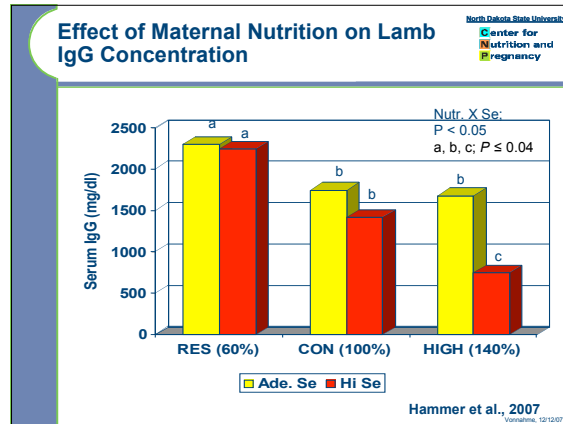
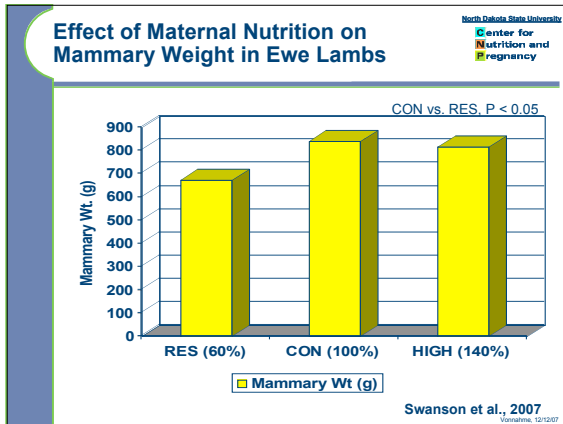
Effects of maternal nutrition before mating on oocyte quality (Grazul-Bilska et al., 2007)

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Effects of dam nutrition on growth and reproductive performance of heifer calves

1 Running head: Maternal nutrition and heifer fertility
2
3
4 Effects of dam nutrition on growth and reproductive performance of heifer calves¹
5
6 J.L. Martin¹, K.A. Vonnahme², D.C. Adams¹, G.P. Lardy¹, and R.N. Funston²
7 ¹University of Nebraska West Central Research & Extension Center, North Platte, NE 69101;
8 ²Dept. of Animal and Range Sciences, North Dakota State University, Fargo, ND 58105

Experiment:

3 yrs: Gudmundsen Sandhills Lab (n=170 heifer calves)

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Growth Performance

Item	Treatment ^b				SEM	P-value	
	Prot	NoProt	Mdw	Hay		LG	EL
Birth date, Julian d	86	84	85	86	1	0.29	0.67
Birth wt, kg	36	35	35	36	1	0.25	0.15
Act. Wn. wt, kg	212	207	212	206	7	0.14	0.09
Adj. 205 d wt, kg	226	218	225	219	7	0.02	0.07
Pre-breeding wt, kg	276	266	272	270	9	0.04	0.70
Weight at pregnancy diagnosis, kg	400	386	391	395	31	0.03	0.56

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Reproductive Performance

Item	Treatment						P-values	
	Prot	NoProt	Mdw	Hay	SEM	LG	EL	
Age at Puberty, d	339	334	341	332	10	0.70	0.48	
Cycling at beginning of breeding season, %	61	67	56	73	-	0.45	0.15	
Calved in first 21 d, %	77	49	63	63	-	0.005	0.89	
Overall pregnancy rate, %	93	80	83	91	-	0.05	0.18	
Calving date, Julian d	71	75	73	73	3	0.15	0.94	
Calf birth wt, kg	33	33	32	33	1	0.94	0.25	
Unassisted births, %	78	64	76	66	-	0.24	0.21	

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Specific areas in which this story is important to animal health and productivity:

- Growth and nutrient transfer.
- Reproductive capacity.
- Aging and lifetime productivity.

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