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## What Are The Effects Of Inadequate Fetal Nutrition?

- Holocaust in WW II



## What Are The Effects Of Inadequate Fetal Nutrition?

- Dutch Winter Hunger



## WW II - Evidence

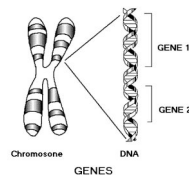
Children developed lifetime health problems  
that were:

- Unique to their genetics
- Passed on to their children



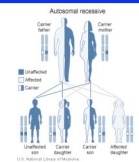
## Epigenetics

- Is a term used to describe the idea that environmental factors can cause an organism's genes to behave (or "express themselves") differently, even though the genes themselves don't change.



## Effects of the Holocaust on the Physical Health of the Offspring of Survivors

- The epigenetic changes brought about by fetal programming are not limited to the fetal period. There is ample proof that they are permanent, last throughout life, and can be passed on to future generations.



Hazani and ShaSha, Perspective, April 2008

### What are these lifetime health problems?

- Type II diabetes
- Hypertension
- Glucose intolerance
- Insulin resistance
- Renal Failure
- Cardiovascular disease
- Hyperlipidemia

### What about cattle?



- This is our paradigm:
  - Our primary concern with the health & well being (performance) begins after calves are on the ground.

### Fetal Programming...application to cattle

- Refers to maternal events during development of the fetus...that have life-time effects on the calf after birth.
- Each trimester appears to be critical



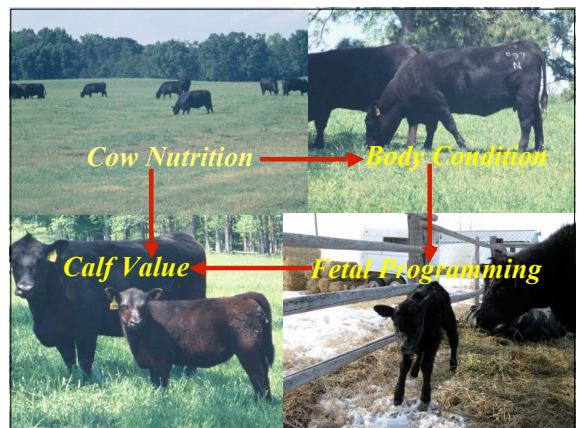
### Fetal Programming In Cows

- The brood cow is the only “managed livestock species” where the industry plans on her to lose weight during gestation.
- Do cows receive consistent nutrition in early, mid and late gestation?
  - Green-up...condition loss
  - Drought...condition loss
  - Winter...condition loss
- “Maternal Hunger” is the norm.



### When is the critical stage?

- Last trimester
  - Over 75% of fetal growth (last 2 months)
  - This has always been the focus
  - Birth weight can be effected
- First 2/3 of pregnancy
  - Overlooked because of supposed less demand for macro nutrients (protein and energy)
  - Placenta develops
  - Organs differentiate (lung, liver, GI tract)
  - Organs grow
  - Muscle cell growth and proliferation



**\$ Is Body Condition  
Important To Overall \$  
Reproductive Success \$  
And Total Value Of The  
Calf From Conception  
\$ To Weaning? \$**



**So Does Nutrient Delivery  
During Pregnancy and Body  
Condition At Calving Matter?**





***EFFECT OF BODY CONDITION SCORE ON THE RETURN TO ESTRUS\****

CROSSBRED GROUP	BODY CONDITION SCORE		
	< 4	5	> 6
Hereford X Angus	10.1%	61.3%	77.0%
Simmental Crossed	36.4%	65.1%	82.8%

**\*Percentage of cows with luteal activity 85 day postpartum.**

Tinker, E.D. et al. 1989. Effect of Cow Type and Body Condition Score on Postpartum Cyclicity of Various Two-Breed-Cross Cows. OSU Agr. Exp. Sta. Res. Rep. MP-127:29-31

***EFFECTS OF BODY CONDITION SCORE (BCS) AT PARTURITION ON POSTPARTUM INTERVAL (PPI)***

BCS	PPI (DAYS)
3.5 – 4.0	88.5
4.5	69.7
5.0	59.4
5.5 – 6.0	51.7
6.5	30.6

BCS\* Condition Scores have been converted to the 1-9 scoring system.

Houghton, P.L. et al. 1990. Effects of Body Composition, Pre and Postpartum Energy Level and Early Weaning on Reproductive Performance of Beef Cows and Prewearing Calf 68:1438-1446

***Body Condition Score - % Showing Estrus and Pregnant By 20, 40, and 60 Days Of Breeding***  
(adapted - Spitzer et. al – J. Anim. Sci. 73:1251-1257)

BCS	% Estrus By Day			% Preg. By Day		
	Day 20	Day 40	Day 60	Day 20	Day 40	Day 60
4	42%	56%	74%	27%	43%	56%
5	54%	80%	90%	35%	65%	80%
6	63%	98%	98%	47%	90%	96%

***First Calf Heifer Calving Difficulty And Initial Body Condition Score***

INITIAL BCS	CALF BIRTH WT.	ASSISTANCE AT CALVING
4	71.6 lbs	22.2%
5	74.7 lbs	12.6%
6	75.5 lbs	13.8%
7	74.1 lbs	15.7%

Coombs et. Al., Body Condition and Winter Supplementation Effect on Weight Change and Reproduction in Spring-Calving Beef Heifers. Louisiana State University Agricultural Center. Bulletin Number 853

***REPRODUCTIVE PERFORMANCE OF FIRST CALF HEIFERS DEPENDENT UPON BODY CONDITION SCORE (BCS) AT CALVING***

BCS AT CALVING	PREGNANCY RATE, %	DAYS TO PREGNANCY
4	64.9%	92
5	71.4%	82
6	87.0%	74
7	90.7%	76

Coombs et. al., Body Condition and Winter Supplementation Effect on Weight Change and Reproduction in Spring - Calving Beef Heifers. Louisiana State University Agricultural Center. Bulletin Number 853

**LEVEL OF NUTRITION AND ITS EFFECT ON CONDITION SCORE, DAYS TO FIRST ESTRUS, WEIGHT LOSS AND CONCEPTION RATE.**

LEVEL OF NUTRITION		
	Moderate	Low
<b>CONDITION SCORE:</b>		
- Initial	5.9	5.8
- Start of Breeding	5.5	4.9
- End of Breeding	5.3	4.9
<b>WEIGHT LOSS – LBS:</b>		
- Initial to Start of Breeding	- 43	- 84
- Initial to End of Breeding	- 134	- 154
Days to First Estrus	52.1	67.1
Conception Rate %	94.9	80.0

**CALF ADG AT 50 DAYS AND MILK PRODUCTION OF BRAHMAN COWS LOSING OR MAINTAINING BODY CONDITION FROM CALVING TO 50 DAYS POSTPARTUM**

GROUP	CALF ADG. LBS	MILK PRODUCTION LBS/4 HR
Cow Losing Weight	1.91	2.42
Cow Maintaining Weight	2.31	2.95

Bastidas, P. et al. 1990. Biological and Immunological Luteinizing Hormone Activity and Blood Metabolites in Postpartum Brahman Cows. J. Anim. Sci. 68: 2771– 2778

**Nutrition Levels And Milk Production**

Energy Intake (Kcal/Metabolic BW)	Time of Peak Lactation	Milk/lbs Per Day At Peak	210 day Total Milk Lbs.
170	8.3 wks	20.2 lbs	2726 lbs
210	9.2 wks	22.7 lbs	3271 lbs
250	10.7 wks	23.8 lbs	3661 lbs
290	10.9 wks	24.2 lbs	3742 lbs

Adapted from Jenkins and Ferrell, Journal of Animal Science 1992:70:1652-1660

**1<sup>st</sup> Calf Heifer Condition and Calf Immunity**

	BCS - 3	BCS - 4	BCS - 5	BCS - 6
Interval from Calving to Standing (Min)	59.9	63.6	43.3	35.0
IgG <sub>1</sub> (mg/dl)	1998.1	2178.8	2309.8	2348.9
IgM (mg/dl)	145.9	157.2	193.1	304.1

1. A newborn calf acquires passive immunity by ingesting immunoglobulins present in colostrum.
2. Passive immunity is a major determining factor of calf health during the early days of life.
3. Failure of passive transfer of colostrum immunoglobulins increases sickness.
4. Predominate immunoglobulins present in colostrum is IgG<sub>1</sub>. IgM also plays a key role in preventing disease in calves

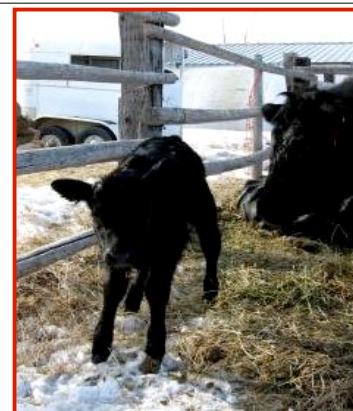
Odde, et al. Colorado State

**Nutrient Restriction And Calves Weaned/Cow Exposed**

Dry Matter Intake (Grams / Day Metabolic Wt)	58 grams	76 grams
Calculated DMI lbs./1200 lb. Cow	14.4 lbs	19 lbs
% of Energy Needed To Maintain BC @ Calving	79%	103%
% Calves / Cow Exposed	70.6%	82.8%

\*Adapted Jenkins and Ferrell. Journal of Animal Science:1994:72:2787-2797. The calculated feed ration was approximately 16% crude protein and 65% TDN.

**What About The Effect Of Fetal Programming On The Cow's Progeny If Retained As A Heifer Or Fed Out As A Steer If Nutrients Were Restricted Versus Supplemented To The Cow?**



## Priority for Nutrients

- **Ranked based on demand in the cow**

- 👉 Basal metabolism
- 👉 Activity
- 👉 Growth (For Heifers Through 3 Year Olds.)
- 👉 Energy reserves, Basic
- 👉 Maintenance of pregnancy
- 👉 Lactation
- 👉 Energy reserves, Additional
- 👉 Cycling & initiation of pregnancy
- 👉 Energy reserves, Excess



## Maternal Nutrition “Programs” The Development Of The Placenta

### Maternal Undernutrition Has An Effect:

- Developing vascular system
- Reduced nutrition and oxygen to the fetus
- Fetal organogenesis
- Progeny structure, physiology, and metabolism
- Lung growth and function
- Response to respiratory disease challenge
- Skeletal muscle development
- Subsequent milk production, colostrum, and calf survival

*Yonnahme. K.A. North Dakota State. Range Beef Symposium. Univ. of Nebraska 2007.*

## Fetal / Developmental Programming

*“A concept that a maternal stimulus or insult at a critical period in fetal development has a long term impact on the offspring” (Dr. Kim Vonnahme, PhD, North Dakota State – Drovers -2/27/2008).*

*“Fetal Programming is the concept that a maternal stimuli during fetal development influence the physiology of the fetus and post natal growth and health” (Barker et al. 1993).*

## Effect of Cow Protein Supplementation During The Last Trimester of Gestation On Heifer Reproduction And Calving

	Supplemented	Unsupplemented
% Cycling at beginning of the breeding season	61%	67%
Calved in first 21 days	77%	49%
Overall Pregnancy, %	93%	80%
Calf Birth Weight, lbs	72.6 lbs	72.6 lbs
Unassisted Births, %	78%	64%

*Adapted from Martin et al. Journal of Animal Science 2007.85:841-847. Supplemented cows fed 1 lb. of a 42% protein during the last trimester of gestation\**

## Fetal Programming of Skeletal Muscle Development In Ruminants

- Nutrition in the fetal phase is important because there is no net increase in the number of muscle cells after birth.
- The lower priority in nutrient partitioning renders skeletal muscle development venerable to fluctuation of maternal nutrition.
- Maternal nutrition during the fetal phase alters muscle fiber number and size, intramuscular adipocyte number and collagen content in offspring muscle – a process called Fetal Programming.

*Du et al. Journal of Animal Science. - published on line August 28, 2009*

## Effects Of Cow Winter Grazing Program and Supplementation On Steer Performance

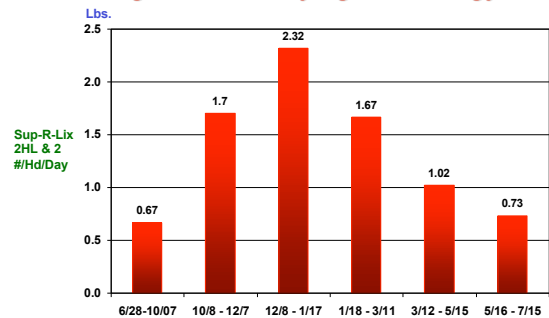
	Winter Range, PS	Winter Range, NS	Corn Residue, PS	Corn Residue, NS
Adj. Calf Wean Wts.	508	482	499	504
ADG, lb/day	3.76	3.65	3.72	3.65
DMI, lb/day	20.0	19.5	20.4	19.8
Treated wean to slaughter	0	12	3	11
HCW, lbs.*	827	785	810	816
Marbling Score	503	457	482	430
Net Return/hd	\$211	\$192	\$212	\$171

*Adapted from Larson et al. Journal of Animal Science 2009.87:1147-1155. Cows were supplemented with 1 lb/hd./day of a 28% protein cake in gestation. HCW were different between the winter range supplemented and unsupplemented cow progeny.*

## What If We Provide Sustained Nutrition To The Cow On A Year Round Basis?

- Can intake and cost be controlled?
- Does it result in any greater performance?
- Is net return greater?

### Running M Ranch – Sustained Nutrition Using Intake Modifying Technology



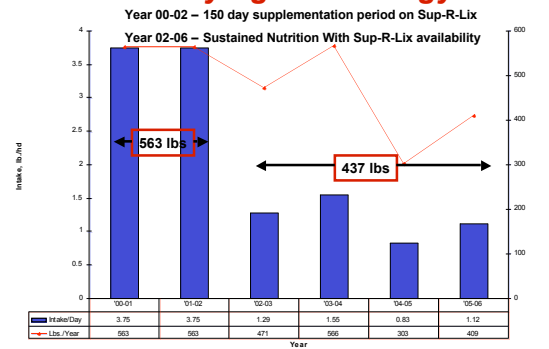
1. Cows began calving mid-December and grass green-up February - March.

### Running M Ranch Sustained Nutrition Using IM Technology

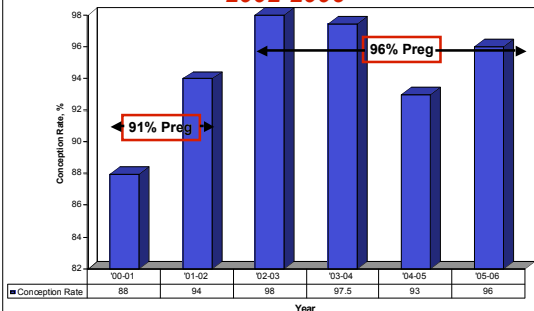
- 121 Cows from 6/28/01 to 7/15/02
- 382 days on Sup-R-Lix
- Intake 1.21 lbs/hd/day
- Pregnancy rate 92% versus previous year of 88%

Year	Weaning Wts.
2001	Steers 592 lbs. Heifers 572 lbs.
2002	Steers 649 lbs. Heifers 596 lbs.

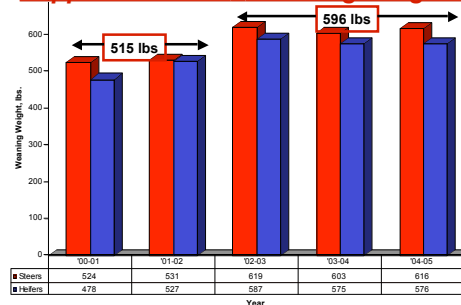
### Sustained Nutrition Using Intake Modifying Technology



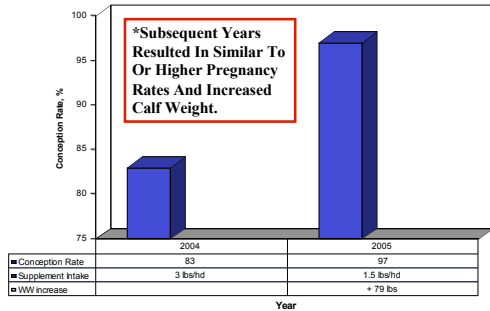
### Conception Rates – 2000-2002 (150 day SRL Use) Vs. Sustained Nutrition With SRL Use in 2002-2006



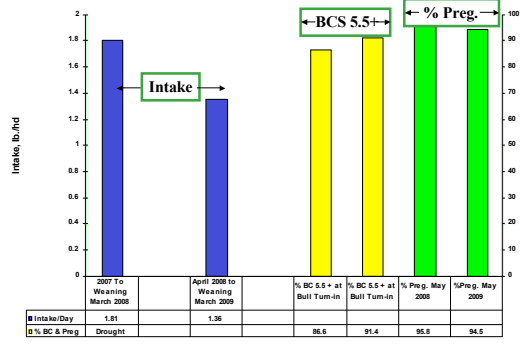
### Sustained Nutrition With SRL Supplementation – Weaning Weights



**Conception Rates – 2004 (150 day Cube Program)  
Vs. Sustained Nutrition With IM Technology 2005**



**18 Pasture Summary – Sustained Nutrition  
Using IM Technology 2007 - 2009**



**Sustained Nutrition And Fetal  
Programming Conclusions**

- The gestational nutrition of your herd this year, imprints the lifetime genetic potential and performance of subsequent generations.



- The performance of a calf is influenced not only by its nutrition before and after birth, but also by the prior fetal nutrition of both its dam and grand dam.

**“They Are What  
Mama Eats!”**

*Beef Magazine – 2/24/2010*