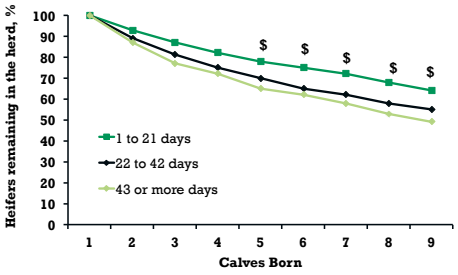
Effects of peri-AI nutritional management on embryo development and pregnancy

George Perry
Department of Animal Science
South Dakota State University

SDSU Extension

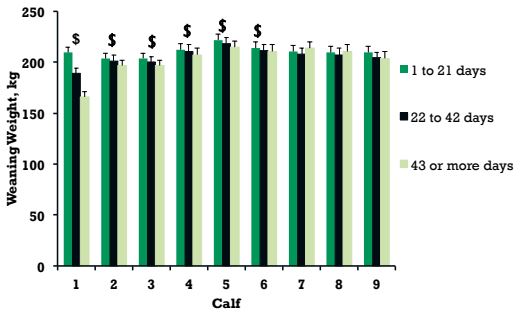
Advantages of calving early as a heifer



Cushman et al., 2013. J. Anim. Sci. 91:4486

iGrow.org

Advantages of calving early as a heifer



Cushman et al., 2013. J. Anim. Sci. 91:4486

iGrow.org

Time course of early bovine embryo development	
Event	**Day**
Estrus	0
Ovulation & Fertilization	1
First cell division	2
8-cell stage	3
Migration to uterus	5-6
Blastocyst	7-8
Hatching	9-11
Maternal recognition of pregnancy	15-17
Attachment to the uterus	19
Placentation	25
Definitive attachment of the embryo to the uterus	42
Birth	285

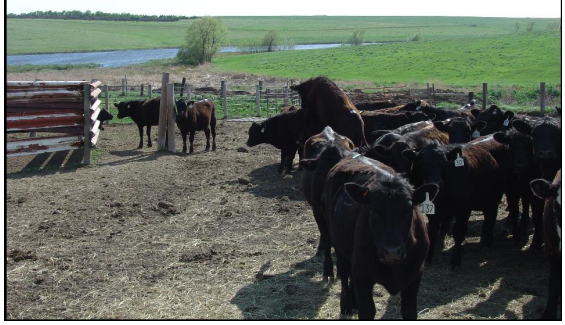
Data adapted from: (Shea, 1981, Flechon and Renard, 1978, Peters, 1996, Telford et al., 1990)

Factors Affecting Embryonic/Fetal Mortality

- Genetic factors.
- Heat stress.
- Asynchrony between the embryo and maternal environment.
- Effect of the sire
- Nutrition
- Shipping stress

iGrow.org

Method of heifer development



Heifer Development - Behavior

- Weaning is the period of time during which animals increased their consumption of forage (Lyford, 1988).
- Young ruminants learn grazing skills from mothers and other adults (Flores et al., 1989a, b, c).
- During the 1st year of life willingness to try novel food declined (Lobato et al., 1980).

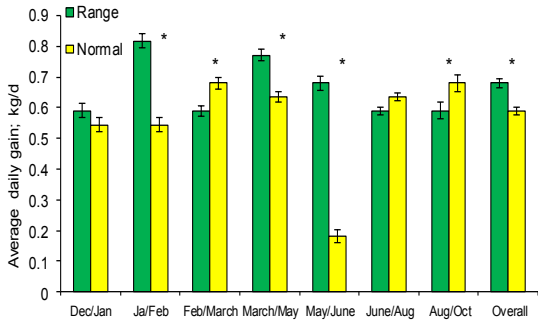
iGrow.org

Heifer Development - Behavior

- This learning resulted in the development of preferences or aversions to plants and in the development of the motor skills necessary to harvest and ingest forages efficiently (Provenza et al., 1987).

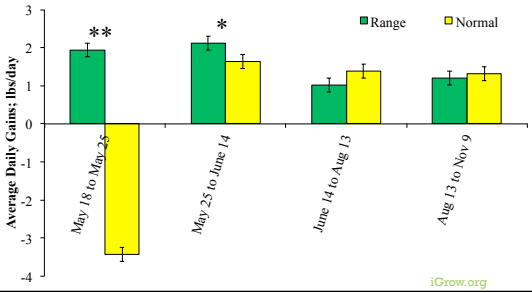
iGrow.org

Forage vs Normal Development



iGrow.org

Forage vs Normal Development



iGrow.org

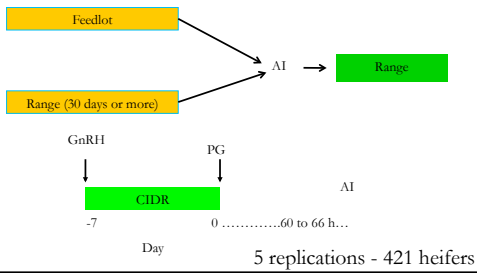
Nutrition Restriction

- A decrease in feed intake from 120% of maintenance to 40% of maintenance resulted in a loss of 56.3 lbs over 2 weeks (4.03 lbs/day), and 60% of heifers becoming anovular within 13 to 15 days of diet change (Mackey et al., 1999).

iGrow.org

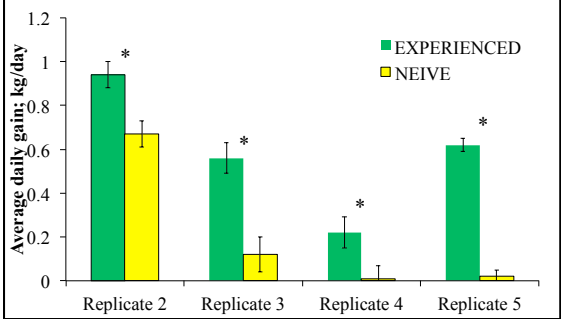
Experimental Design

iGrow.org



5 replications - 421 heifers

Average Daily Gain



Impact of Heifer Development Method on Cycling Status and Pregnancy Success

	LOT	GRASS	P =
Cycling Prior to Breeding Season[a]	97.3%	93.6%	0.93
Pregnancy Success	49.1%	59.4%	0.04

[a]Three replicates.

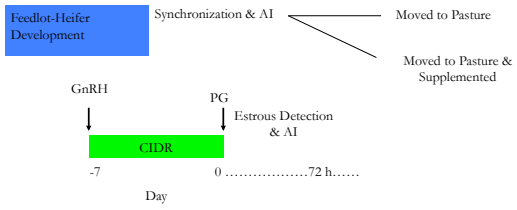
Nutrient Partitioning in the Beef Cow

1. Basal Metabolism
2. Activity
3. Growth
4. Basic Energy Reserves
5. Pregnancy Maintenance
6. Lactation
7. Additional Energy Reserves
8. Estrous Cycles and Pregnancy Initiation
9. Excess Reserves

Impact of Nutrition on the Embryo

- Change in the Uterine Environment
  - Nutritionally mediated changes in components of uterine secretions or by influencing the circulating concentrations of progesterone (Foxcroft, 1997).
  - Heifers fed 85% of maintenance requirements of energy and protein had reduced embryo development on day 3 and day 8 compared to heifers fed 100% maintenance (Hill et al., 1970) indicating decreased embryonic growth.

Experimental Design



Herd 1 n = 144; Herd 2 n = 164

Forage Quality and Quantity

	Herd 1		Herd 2	
	Pasture	Pasture & Supplement*	Pasture	Pasture & Supplement*
Protein	15.9%	13.8%	10.3%	8.7%
TDN	67%	62.1%	63.4%	60%
ADF	30%	34.2%	37%	41.9%
NDF	52.2%	51.4%	60.9%	65.5%
Kg/Hectare	2173	1278	1894	985

*Plus 2.22 kg/hd/d of DDG; 24% CP

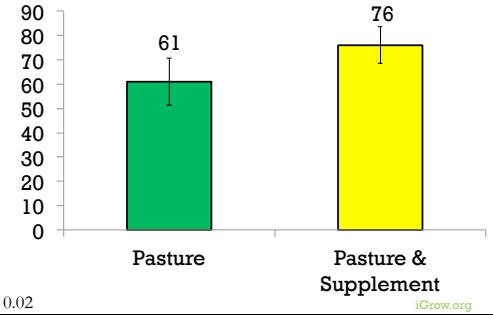
Post-AI supplementation on weight change

Weight change from AI to pregnancy determination on day 42 after AI.

	Location 1		Location 2		Combined	
	PASTURE	PASTURE -SUPP	PASTURE	PASTURE-SUPP	PASTURE	PASTURE-SUPP
Weight at AI (lb)	940 ± 9.9	962 ± 9.7	865 ± 9.9^{y}	919 ± 8.8^{z}	902 ± 7.1^{y}	939 ± 6.6^{z}
Weight at pregnancy diagnosis (lb)	957 ± 8.8	977 ± 8.6	838 ± 8.8^{y}	965 ± 7.7^{z}	897 ± 6.2^{y}	970 ± 5.7^{z}
Weight change (lb)	17 ± 4.0	15 ± 4.0	-37 ± 4.0^{y}	45 ± 3.1^{z}	-5.5 ± 4.0^{y}	32 ± 3.5^{z}

^{xyz}Means within a row and location having different superscripts are different (P < 0.01)

Pregnancy Success

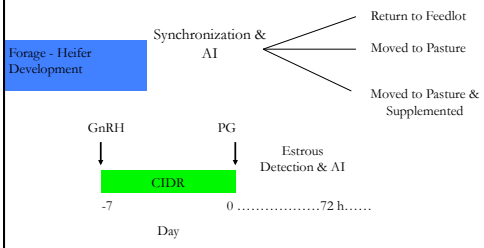


P = 0.02

iGrow.org

Experimental Design

iGrow.org



n = 333

Forage Quality and Quantity

	Pasture	Pasture & Supplement*	Drylot
Protein	11.5%	12.1%	17.7%
TDN	59.6%	60.5%	72.3%
ADF	34.7%	34.1%	24.1%
NDF	62%	59.7%	39.5%
Kg/hectare	205	180	

*Plus 2.22 kg/hd/d of DDG; 24% CP

Body Condition Scores

	Feedlot	Pasture	Pasture & Supplement
Day -7	5.4 ± 0.05	5.4 ± 0.05	5.4 ± 0.05
Day 42*	5.8 ± 0.04	5.4 ± 0.04	5.9 ± 0.04

* P < 0.01

iGrow.org

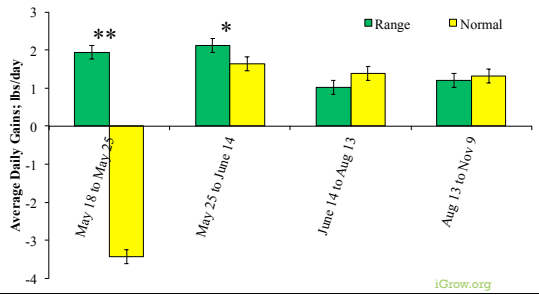
Pregnancy Rates

	Feedlot	Pasture	Pasture & Supplement
AI	56%	59 %	57 %
Final*	86%	89%	88%

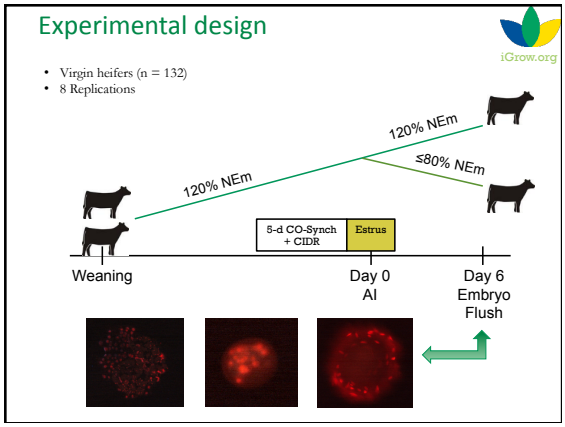
* 28 day bull exposure

iGrow.org

Forage vs Normal Development



Experimental design



Decreased nutrition on embryo quality

Effect of post-AI nutrition on day 6 embryo characteristics

TRT	n[a]	Embryo Recovery (%)	Embryo Stage (n[b])	Embryo Quality (n[c])	Access. Sperm (n)	Dead Cells (n)	Total Cells (n)	Percent Live Cells (%)
GAIN	46	70.8 (46/65)	4.6 ± 0.1	2.0 ± 0.2	22.7 ± 3.8	7.8 ± 0.9	70.6 ± 5.6	83.3 ± 3.0
LOSE	42	62.1 (42/66)	3.8 ± 0.2	2.8 ± 0.2	16.7 ± 3.8	9.7 ± 1.0	48.9 ± 3.9	71.1 ± 4.1
P-value	.	.	< 0.01	0.02	0.64	0.42	0.03	0.01

[a] Defined as embryo number; not heifer with the exception of recovery rate
[b] Stage of development (1-9;1 = UFO; 9 = expanded hatched blastocyst; per IETS Standards)
[c] Quality of embryo (1-5;1 = excellent; 5 = degenerate; per IETS Standards)

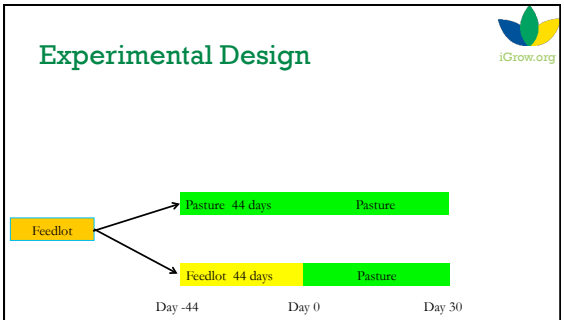
iGrow.org

Heifer Development - Behavior

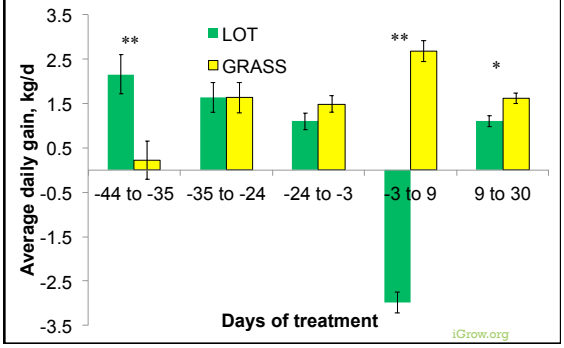
- Young livestock ingest small amounts of novel food and gradually increase the amount ingested if no adverse effects occur (Burritt et al., 1987; Chapple et al., 1986).
- When introduced to novel food livestock may spend significantly more time and energy foraging, but ingest less (Osuji, 1974 Arnold et al., 1977; Curll et al., 1983; Hodgson et al., 1981).

iGrow.org

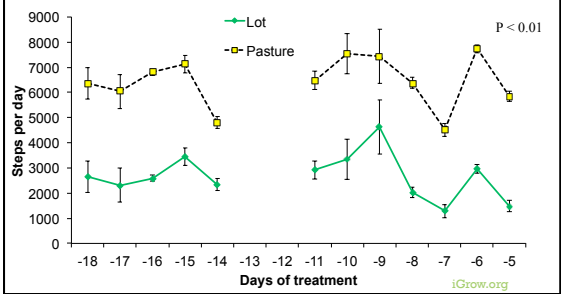
Experimental Design



Average Daily Gain

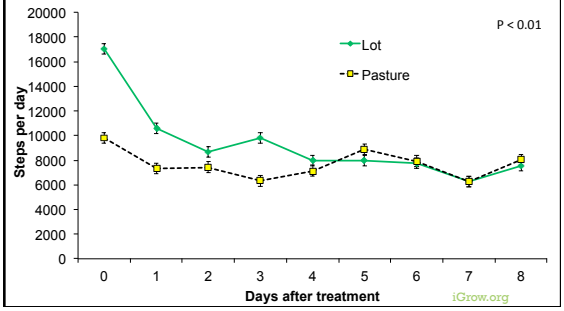


Grazing Behavior Prior to Movement



iGrow.org

Grazing Behavior after Movement



iGrow.org

Dry-Matter intake on Embryo Survival

Treatment	Embryo Survival Rate
Low-Low	70%
Low-High	71%
High-Low	38%
High-High	65%

Low 80%

High 200%

Dunne et al., 1999

iGrow.org

Consistency

iGrow.org

Shipping Stress

Effect of time of transport after insemination on pregnancy rates

	Days after insemination that transportation occurred			
	1 to 4	8 to 12	29 to 33	45 to 60*
Synchronized pregnancy rate	74%	62%	65%	
% pregnancy loss compared to transportation on days 1 to 4		12%	9%	6%*
Breeding season pregnancy rate	95%	94%	94%	

*Loss compared to percent pregnant prior to transportation (pregnancy determined by transrectal ultrasonography)

Data adapted from Harrington et al., 1995, and T. W. Geary unpublished data

iGrow.org

QUESTIONS???


Questions???