Fertility in Beef Cows

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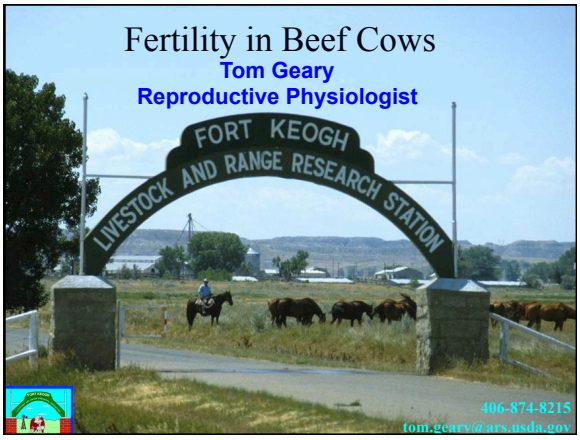

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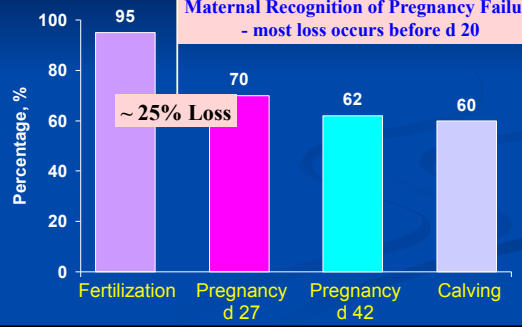
Fertility of a Single Service: Beef Cattle

Early Embryonic Loss
Maternal Recognition of Pregnancy Failure
- most loss occurs before d 20



Annual Cost of Early Embryonic Loss to U.S. Beef Industry

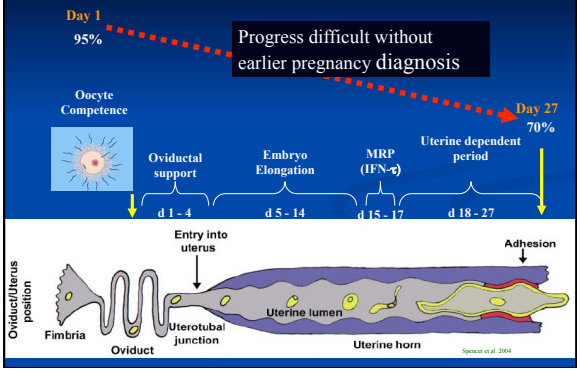
40,000,000	Beef cows & heifers
x 25%	20 d later pregnancy
10,000,000	calve 20 d later
x 3 lb/d	calf gain lost
600,000,000	lbs lost gain
6.25%	40 d later pregnancy
150,000,000	lbs lost gain
1.5%	60 d later pregnancy

Dairy Industry Loss:
$ 600,000,000

787,500,000 lbs
x $1.10/lb
$ 866,250,000

LOSS IS TO COW/CALF PRODUCER!

Why / Where is pregnancy failing?

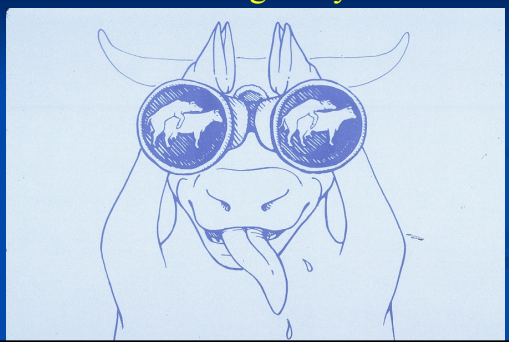


Nutrient Partitioning

1. Maintenance
2. Activity
3. Growth
4. Milk production
5. Body reserves (FAT)
6. Reproduction

Proper nutrition is obligatory to reproductive success, but not focus of presentation.

Reproductive Measures that Result in Pregnancy



Single most important measure of fertility for cow/calf producer?

Each bull is expected to contribute to the production

Limitations: Fertility measure on that given day
Only about 1/3 of the "Fertility Picture"

Importance of Bull Fertility on Breeding Season Pregnancy Rate

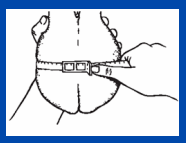
Year 1

	BSE + % Normal Sperm	
	Control	> 80%
No. Cows	572	656
Pregnancy Rate	86%	93%

Year 2

	BSE + % Normal Sperm		
	Control	> 80%	> 70%
No. Cows	1,179	522	769
Pregnancy Rate	85%	90%	91%

Wiltbank et al., 1983



Effect of Social Dominance on Percentage of Calves Sired

Bull	Year 1	Year 2	Year 3	Year 4	Year 5
A Age	10	11	12	13	14
Percent					
B Age	4	5	6	7	8
Percent					
C Age	3	4	5	6	7
Percent					
D Age	2	3	4	5	6
Percent					

Effect of Social Dominance on Percentage of Calves Sired

Bull	Year 1	Year 2	Year 3	Year 4	Year 5
A Age	10	11	12	13	14
Percent	70				
B Age	4	5	6	7	8
Percent	17				
C Age	3	4	5	6	7
Percent	7				
D Age	2	3	4	5	6
Percent	6				

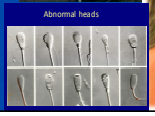
Effect of Social Dominance on Percentage of Calves Sired

Bull	Year 1	Year 2	Year 3	Year 4	Year 5
A Age	10	11	12	13	14
Percent	70	76	12	0	0
B Age	4	5	6	7	8
Percent	17	18	63	73	25
C Age	3	4	5	6	7
Percent	7	6	12	13	63
D Age	2	3	4	5	6
Percent	6	0	12	15	12

✓ What if the dominant bull is sterile?

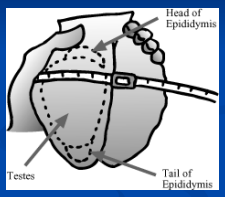
Bull Fertility Measures – Fort Keogh

- Annual breeding soundness exams (BSE) on all bulls.
- Puberty exams at 10.5 mo of age (n = 1,100).
  - Phenotypes for genomics
  - Sperm morphology traits
    - Heritability
    - Puberty



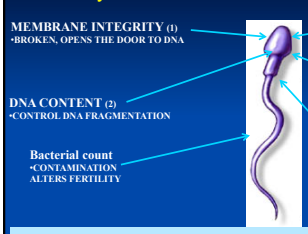
Heritability of Bull Fertility Traits

Trait	h^2
Scrotal circumference, cm	0.67 ± 0.09
% Normal	0.18 ± 0.07
% Knobbed acrosome	0.02 ± 0.04
% Head defects	0.00 ± 0.05
% Distal midpiece reflex	0.01 ± 0.04
% Dag defect	0.50 ± 0.10
% Bowed midpiece	0.19 ± 0.07
% Proximal droplets	0.37 ± 0.08
% Distal droplets	0.09 ± 0.06
% Coiled principle piece	0.07 ± 0.05
% Bent principle piece	0.18 ± 0.08
Gross motility score	0.20 ± 0.07
% Progressive motility	0.20 ± 0.08



Selection for improved sperm morphology should increase fertility!

Key Parameters of Sperm Fertility



Measuring these key physiological functions provides insight into the fertilization potential of sperm.

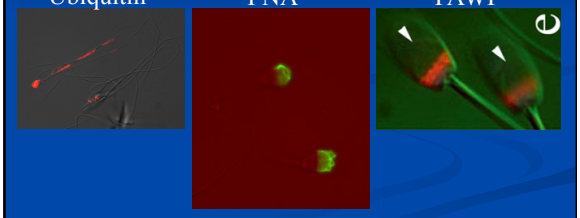
EasyCyte Flow Cytometer

Evaluates 5000 sperm/min

Currently: 2 studies on bull fertility with Guava EasyCyte.

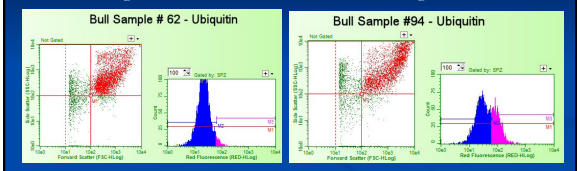
Biological Markers Associated with Fertility

Ubiquitin PNA PAWP



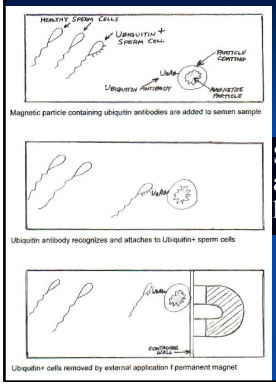
Bull Fertility Biomarker Trial - UBI

Normal Histogram Abnormal Histogram



Identify bulls of greater/lesser fertility???
Selection for improved fertility in bulls???

IVF Using Magnetic Sperm Depletion



Sperm sorted with Ubiquitin antibody resulted in 2 to 4x higher fertilization rate.

Future Research Bull Fertility Analysis

ASSAY	Microscope	CASA	Easy Cyte
Motility	++	+++	-
Concentration	-	+++	+++
Viability	+	+	+++
Acrosome	+	+	+++
Mitochondria	-	-	+++
Capacitation (Ca)	-	-	+++
DNA fragment	-	-	+++
Bacterial count	-	-	+++
Morphology/physiology	+/-	++/-	++/+++
Objectivity	+	++	+++

CASA = Computer Assisted Semen Analysis.
Easy Cyte = Flow cytometer with various assays built in.

Additional "Chute Side" measures within 5 years

"Grass always greener on the other side of the fence!" Cow Fertility?

Fertile Mating?

Heritability Rates

- Birth Weight 40%
- Weaning Weight 30%
- Yearling Weight 30%
- Fleshing Ability (BCS) 40%
- Frame Size 55%
- Pelvic Area 40%
- Fertility 10%
  - Source: "Scientific Farm Animal Production"

Requirements for Reproductive Success

1. Puberty / Resume cycling ✓ / ✓
2. Fertile ovulation ✓
3. Conception (Ovum and Sperm) ✓
4. Pregnancy establishment ✓d. 27
5. Pregnancy maintenance ✓

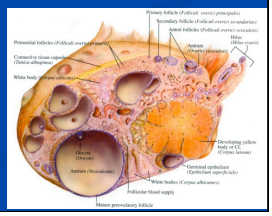
→ Successfully Reproduce

Fort Keogh Research:

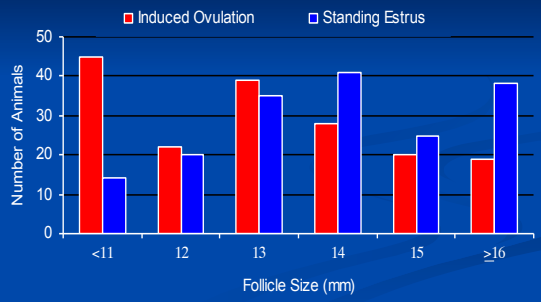
- Identify genes/DNA markers involved with **fertility** in beef cattle.

Identification of New Phenotypic Traits involved in Fertility

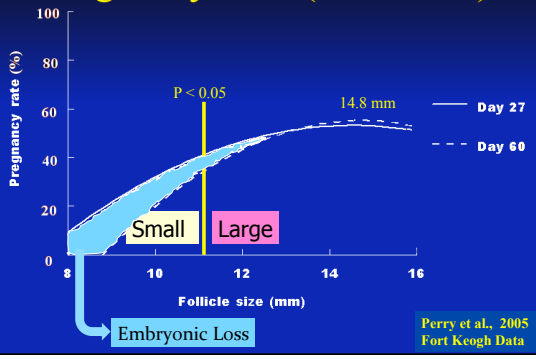
- Beef Cow / Heifer
  - Used AI to obtain numerous measures & keep bull fertility constant
    - Ovulatory follicle size



Distribution of Ovulatory Follicle Size



Effect of Follicle Size on Pregnancy Rate (Timed-AI)



Fort Keogh Reciprocal Embryo Transfer Study (2007-09)

Goal: Determine how size of the ovulatory follicle affects pregnancy establishment and maintenance.

Does it affect oocyte maturation and/or viability?

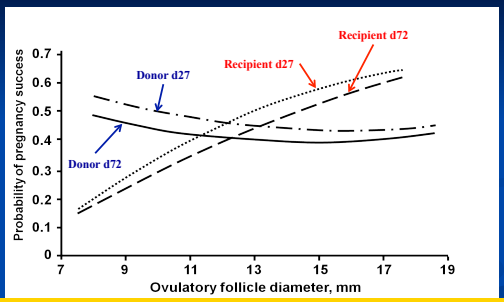
Does it affect the maternal reproductive tract in assisting pregnancy maintenance/establishment?

Treatment groups

No. of transfers	GnRH-induced follicle size: Donor	GnRH-induced follicle size: Recipient	Purpose
71	Small	Small	Negative control
111	Small	Large	Effects 1° of oocyte origin*
122	Large	Small	Effects 1° of maternal origin*
50	Large	Large	Positive control

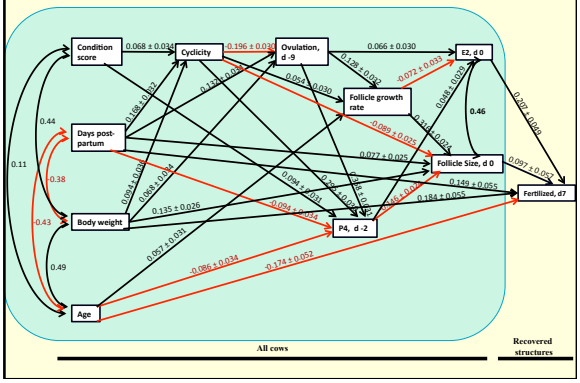
n = 1,164 suckled beef cows; 810 = donor and 354 = recipient

Results – Reciprocal Embryo Transfer Study

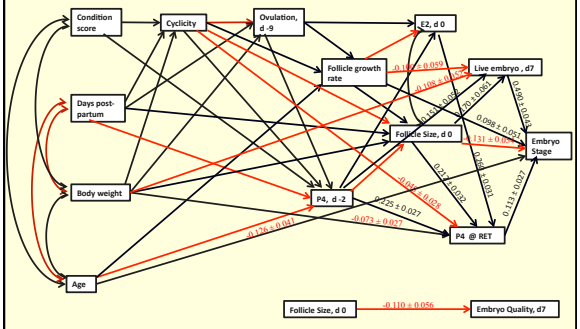


Suggests that ovulatory follicle size of the recipient is the only one that matters so effects of follicle size acting through maternal environment prepared for embryo.

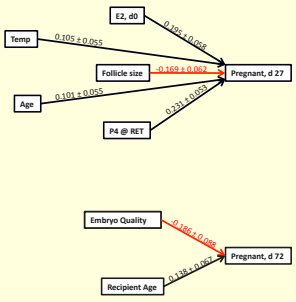
Path Diagram: Embryo Donor Cow



Path Diagram: Additional Fertility Measures



Path Diagram: Embryo Recipient Cow



All the preceding stuff back here

Reciprocal Embryo Transfer Study: Fertility

Fertility of individual breeding affected by:

1. Estradiol at time of breeding 18%
2. Progesterone on d 7 after breeding 15%
3. Progesterone before breeding 8%
4. Ovulatory follicle size 7%
5. Embryo quality 3%
6. Days postpartum at breeding 2%

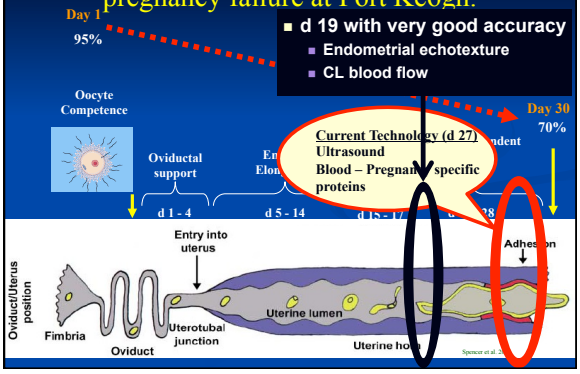
NOTE: Cows were not used if they exhibited estrus.

Take Home Message – RET Study

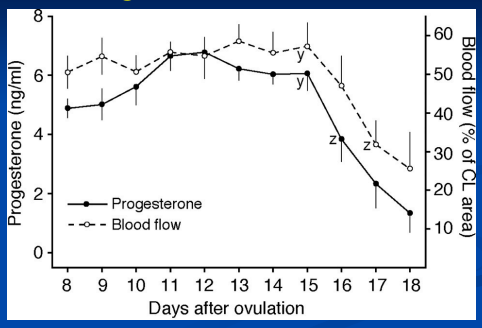
- Fertility is much more complicated than we hope.
- The most important variable related to pregnancy success was estradiol concentration at the time of breeding.

If using synchronization and timed AI, insemination must coincide with expression of estrus.

Early pregnancy diagnosis to identify causes of pregnancy failure at Fort Keogh.

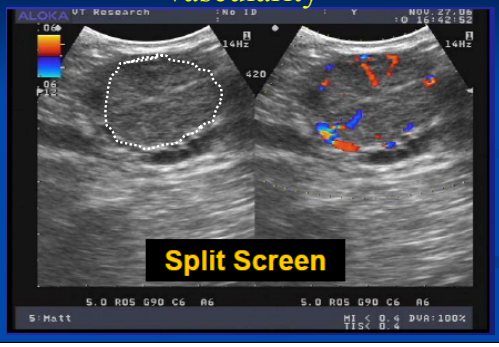


Serum Progesterone vs CL Blood Flow



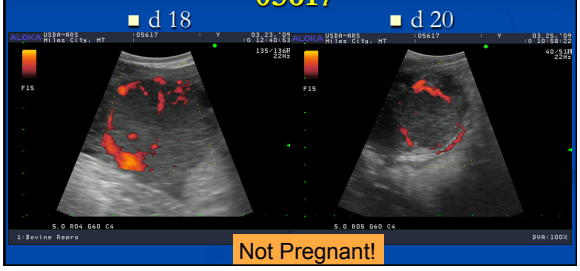
Ginther, O.J. et al. Biol Reprod 2007;76:506-513

Doppler Ultrasound Imaging of CL Vascularity



Sequential CL Vascularity for Pregnancy Diagnosis

05617



Sequential CL Vascularity for Pregnancy Diagnosis

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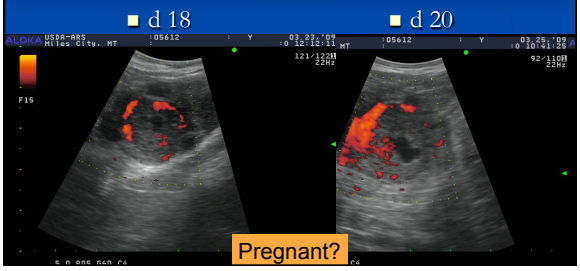
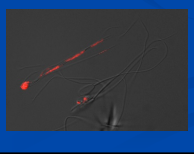


Thank You! Questions?

ROY WALLACE, SELECT SIRES

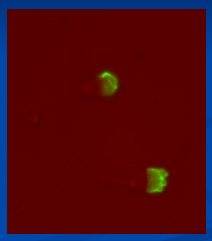
Ubiquitin (UBI)

- Proteolytic marker peptide that binds to the surface of defective sperm.
- Ubiquitination causes immobilization and/or resorption of these defective sperm during epididymal passage.
- increased binding of anti-ubiquitin antibodies to the sperm surface reflect the occurrence of abnormalities



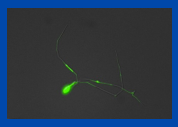
Peanut Agglutinin (PNA)

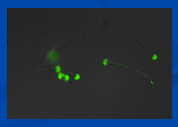
- High affinity/strong specificity for disaccharides with terminal galactose, especially the D Gal α (1,3) D GalNAc disaccharide
- Binds to the outer acrosomal membrane (OAM), exposed during the acrosome reaction



Lentil Lectin (LCA)

- Shows a strong specificity to d-glucosyl and d-manosyl residues
- Binds to the acrosome in normal sperm, whole surface in defective sperm





Postacrosomal Sheath WW-Domain-Binding Protein (PAWP)

- Resides exclusively in the post-acrosomal sheath (PAS) region of the sperm head perinuclear theca (PT) and is expressed and assembled in elongating spermatids
- Promotes meiotic resumption and pronuclear development during fertilization
- Abnormal sperm may have unusually high levels of this protein

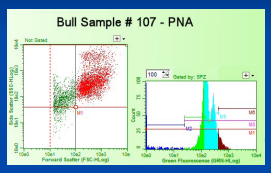
Bull Fertility Biomarker Trial

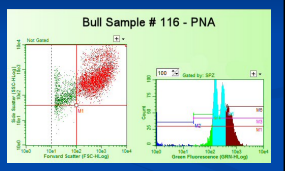
- n = 162 samples
- Samples analyzed via UBI, PNA, LCA, PAWP
- Flow cytometry via GUAVA
- Analysis performed via Excel and SAS

Bull Fertility Biomarker Trial - PNA

Normal Histogram

Abnormal Histogram

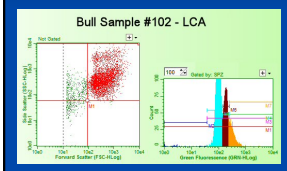


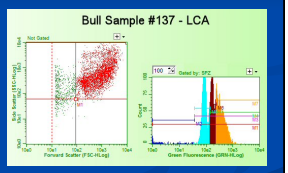


Bull Fertility Biomarker Trial - LCA

Normal Histogram

Abnormal Histogram





Bull Fertility Biomarker Trial - PAWP

Normal Histogram

Abnormal Histogram