Timed AI with Sex-Sorted Semen: Research and Application in Commercial Beef Herds

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Sex-Sorted Semen: Why Do We Care?

- For any one mating
  always more valuat
  - Terminal versus ma
    potential
- The questions:
  - What is the value c
  - What is the true cc
    semen?
  - Is the value differe
    heifer calf large en

In a Perfect World…

- Pregnancy rates with sex-sorted semen would be equal to (or better than) those with conventional semen

In the Real World…

- Lower pregnancy rates are often observed with sex-sorted semen

In a Perfect World…

- Sex-sorted semen would be available for any bull

In the Real World…

- Sex-sorted semen is only available for certain bulls
  - Not always clear whose fertility is acceptable

In a Perfect World…

- Sex-sorted semen could be used in fixed-time AI programs
  - Labor is a key limiter of adoption of AI in general

In the Real World…

- Sex-sorted semen is not very forgiving of less-than-ideal timing of AI

In a Perfect World…

- It would be free!

When they find out how to burn water
And the gasoline car is gone
When an airplane flies without any fuel
And the sunlight heats our home…

We'll all be drinking that free bubble-up
And eating that rainbow stew

- Merle Haggard, "Rainbow Stew"

In the Real World…

- Achieving sex-selected pregnancies has a cost
  - **Direct cost:** Higher cost per straw of semen
  - **Indirect costs:** Potentially lower pregnancy rates, reduced sire availability, and labor of estrus detection

The High Cost of Low Pregnancy Rates

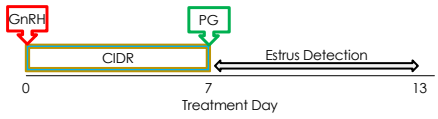
- Unlike conventional dairy, beef production systems are seasonal
  - Fixed-length breeding season
- Low first-service pregnancy rates are costly
  - Decreased lifetime productivity of replacement heifers
  - Younger age and lighter weight of calves at weaning
  - Reduced likelihood of cows becoming pregnant early in the breeding season next year

Overarching Research Question:

Can we optimize *male* fertility in timed AI programs by better managing the *female*?

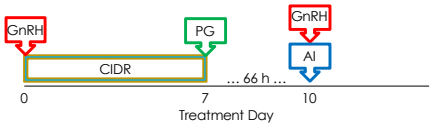
Background and Rationale

- **Estrus Detection**: AI over several days based on observed standing estrus



Background and Rationale

- **Fixed-Time AI (FTAI)**: AI and administration of GnRH at an appointed time



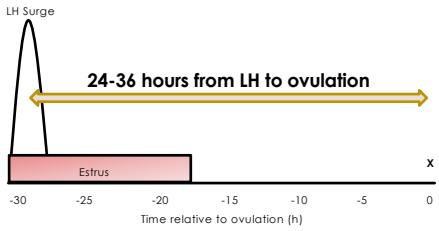
Background and Rationale

- **Advantages of Fixed-Time AI**
  - AI all cows at one time on one day
  - Eliminate estrus detection
  - It works

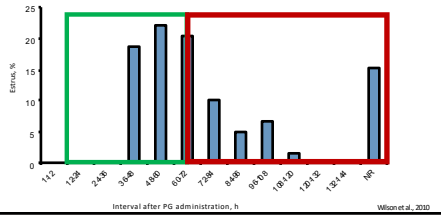
Background and Rationale

- **Disadvantages of Fixed-Time AI**
  - Lower fertility for cows that fail to express estrus
    - 27% lower pregnancy rate (Richardson et al., 2016)
  - AI is less precisely aligned with ovulation

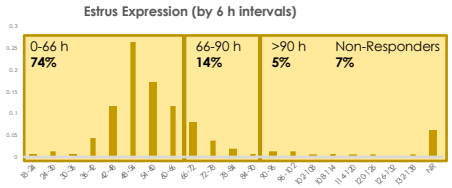
Background and Rationale



Estrus Response Following the 7-d CO-Synch + CIDR (Cows)



Estrus Response Following the 14-d CIDR-PG Protocol



Leitman et al. 2009a; Leitman et al. 2009b; Mallory et al., 2010

Estrus Detection Aids

Could we do anything differently?

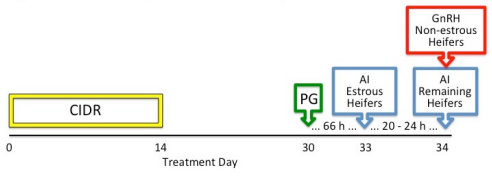
Split-Time AI

Mature Beef Cows

Pregnancy Rate to Timed AI			
	Fixed-Time AI Conventional	Fixed-Time AI Sex-sorted	Split-Time AI Sex-sorted
Estrous	77% [a] (81/105)	51% [b] (53/104)	42% [b] (47/111)
Non-estrous	37% [bc] (42/113)	2% [d] (3/113)	36% [bc] (40/110)
Total	56% [x] (123/218)	26% [z] (56/217)	39% [y] (87/221)

Thomas et al., 2014a

14-d CIDR-PG with Split-Time AI



Thomas et al., 2014; Bishop et al., 2014

Results in Beef Heifers with Conventional Semen

Pregnancy Rate to Timed AI		
	Fixed-Time AI Conventional	Split-Time AI Conventional
Estrous	52% [a] (161/311)	56% [a] (183/328)
Non-estrous	34% [b] (54/157)	49% [a] (66/135)
Total	46% [x] (215/468)	54% [y] (249/463)

Thomas et al., 2014

What happens when we use SexedULTRA™ 4M in split-time AI?

Trial Design

- 856 heifers in four locations
- Semen collected from two bulls
  - SexedULTRA 4M™ sex-sorted semen (4 x 10^6 cells per unit)
  - Conventional semen (25 x 10^6 cells per unit)
- Heifers pre-assigned to balanced treatments within location
  - Reproductive tract score
  - Weight

Summary Statistics

	Conventional	SexedULTRA 4M™
RTS	4.2 ± 0.1	4.3 ± 0.1
Weight (lbs)	858 ± 5	858 ± 5
Estrous Response	90% (384/429)	88% (373/422)

Thomas et al., 2017

Pregnancy Rates to Split-Time AI

Location	Conventional	SexedULTRA 4M™
Location 1	62% (37/60)	61% (37/61)
Location 2	60% (128/212)	52% (108/209)
Location 3	60% (36/60)	58% (33/57)
Location 4	58% (56/97)	42% (40/95)
Total	**60%^{x} (257/429)**	**52%^{y} (218/422)**

^{xy} $p = 0.09$

Thomas et al., 2017

Pregnancy Rates to STAI by Bull

	Conventional	SexedULTRA 4M™
Bull A	62% (151/245)	54% (131/242)
Bull B	58% (106/184)	48% (87/180)
Total	60%^{x} (257/429)	52%^{y} (218/422)

Thomas et al., 2017

Pregnancy Rates to STAI by Estrous Response

Estrous Status	Conventional	SexedULTRA 4M™
Before 66 h	62% (177/286)	53% (136/259)
From 66 to 90 h	68% (67/98)	60% (68/114)
Non-estrous	29% (13/45)	29% (14/49)
Total	60%^{x} (257/429)	52%^{y} (218/422)

Thomas et al., 2017

Final Pregnancy Rates

	Conventional	SexedULTRA 4M™
STAI Pregnancy Pate	60%^{x} (257/429)	52%^{y} (218/422)
Final Pregnancy Rate (60 day season)	89% (382/429)	89% (376/422)

Thomas et al., 2017

Effect on Calf Sex Ratio

	Conventional	SexedULTRA 4M™
AI-sired calves	49:51	96:4
Across all calves	49:51	77:23

Thomas et al., 2017

Mature Beef Cows

- Results with STAI are less consistent in mature cows
  - Likely most beneficial when estrous response is low prior to FTAI time
- More work needed (and underway) in mature beef cows

Split-Time AI: Using Estrus Detection Aids to Optimize Timed Artificial Insemination

https://extension2.missouri.edu/mp739

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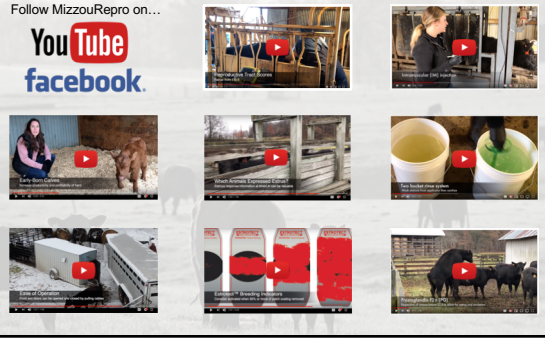

Final Thoughts - Looking Forward

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- Would the ability to use sex-sorted semen get more commercial producers using AI?
- Would sex-sorted semen lead to more crossbreeding in the commercial beef industry?
- What does heifer selection look like in the commercial industry with sex-sorted semen?
  - Heifer calves primarily retained out of replacement heifers?
  - Internal nucleus herd of elite cows that would receive sex-sorted semen?
  - More specialization? E.g. more commercial producers focused only on terminal progeny, sourcing replacement heifers from heifer-focused producers

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Questions?
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