

# Control of the Estrous Cycle

Division of  
Animal Sciences  
University of Missouri

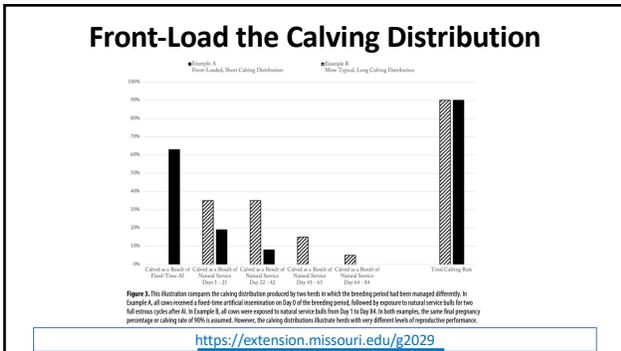
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## Synchronization is a Tool in Your Toolbox

- In the right reproductive management system...
  - Increase total value of calves weaned across the farm or ranch
  - Decrease costs associated with cow depreciation
  - Decrease costs associated with inefficient use of labor, feed, and other resources

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### Front-Load the Calving Distribution

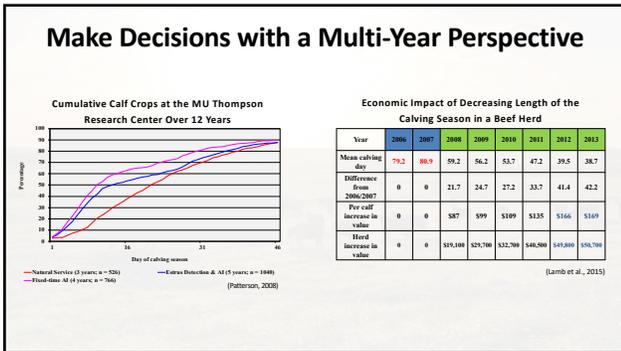
**Table 2. Illustration of the impact of calving distribution on age and weight of calves at weaning.**

Calving Period	Number of Calves	Age at Weaning	Weaning Weight	Pounds of Calf Weaned
<b>Example A</b>				
Front-loaded, Short Calving Distribution				
Calved as a result of fixed-time AI	43	220 days	570 lbs	24,330 lbs
Calved as a result of natural service, Day 1-21	19	199 days	460 lbs	8,892 lbs
Calved as a result of natural service, Day 22-42	8	178 days	420 lbs	3,408 lbs
<b>Overall</b>	<b>90</b>	<b>212 days</b>	<b>494 lbs</b>	<b>44,630 lbs</b>
<b>Example B</b>				
More Typical, Long Calving Distribution				
Calved as a result of natural service, Day 1-21	35	210 days	490 lbs	17,150 lbs
Calved as a result of natural service, Day 22-42	35	189 days	448 lbs	15,680 lbs
Calved as a result of natural service, Day 43-63	15	168 days	406 lbs	6,090 lbs
Calved as a result of natural service, Day 64-84	5	147 days	364 lbs	1,820 lbs
<b>Overall</b>	<b>90</b>	<b>191 days</b>	<b>453 lbs</b>	<b>40,740 lbs</b>

**Figure 3.** This illustration compares the age and weight at weaning for the calf crops produced by the two herds presented in Figure 3. Herd size is assumed to be 100 cows for each example. In Example A, cows conceiving to natural service are assumed to have conceived at the end of each 21-day period, as estrus was synchronized in this example to occur prior to fixed-time AI on Day 0. In Example B, cows conceiving to natural service are assumed to have conceived at the midpoint of each 21-day period on average, as no estrus synchronization was used. These calculations assume a 70 lb birth weight and an average daily gain of 2.5 lb from birth to weaning. Weaning was assumed to have occurred on Day 220 after the start of the calving season. Despite identical pregnancy percentages obtained overall, the front-loaded, shorter calving distribution from Example A produces nearly 10% more total pounds of calf weaned.

<https://extension.missouri.edu/g2029>

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#### BEEF COW PROTOCOLS 2024

For additional synchronization protocols visit [MizzouRepro.org](https://mizzourepro.com)

##### HEAT DETECTION & TAI

For best reproductive results, the synchronization protocol should be initiated at the beginning of the estrous cycle.

**Select Synchron-CDDP & TAI**

**PG 6-day CDDP & TAI**

**7-day CO-Synch-CDDP & Split-TAI**

**Fixed-Time AI**

Time for Fixed-time AI (TAI) should be considered at the appropriate average time of insemination based on the number of inseminations, when and how often.

**5-day CO-Synch-CDDP**

**7-day CO-Synch-CDDP**

**8-day Indefinite PG 5-day CDDP**

**T&T Synchron**

#### BEEF HEIFER PROTOCOLS 2024

For additional synchronization protocols visit [MizzouRepro.org](https://mizzourepro.com)

##### HEAT DETECTION & TAI

For best reproductive results, the synchronization protocol should be initiated at the beginning of the estrous cycle.

**Select Synchron-CDDP & TAI**

**7-day CO-Synch-CDDP & Split-TAI**

**14-day CDDP-PG & TAI**

**Fixed-Time AI**

Time for Fixed-time AI (TAI) should be considered at the appropriate average time of insemination based on the number of inseminations, when and how often.

**8-day CO-Synch-CDDP**

**MG+PG & TAI**

**14-day CDDP-PG & TAI**

**T&T Synchron**

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- Selection of Replacement Heifers for Commercial Beef Cattle Operations
- Calving Season Considerations for Commercial Beef Cattle Operations
- Determination of Pregnancy Status in Beef Cattle Herds
- Understanding and Minimizing Pregnancy Loss in Cattle
- Herd Health and Reproductive Efficiency of Beef Cattle
- Production Records for Commercial Cow-Calf Operations
- Reproductive Management of Bos Indicus-Influenced Beef Cattle
- Managing the Effects of Stress and Temperament on Beef Cattle Reproduction
- Cow-Calf Systems that Minimize Cow Depreciation Costs
- Determining Reproductive Fertility in Herd Bulls
- Nutritional Management of Developing Heifers: Intensive Versus Extensive Systems
- Beef Cow Nutrition Through the Year: Managing for Efficient Reproduction
- Body Condition Scoring of Beef Cattle
- Reproductive Anatomy and Physiology of the Cow
- Reproductive Anatomy and Physiology of the Bull
- Detection of Estrus in Beef Cattle
- Guide to Estrus Synchronization Products
- Estrus Synchronization Recommendations for Artificial Insemination of Beef Cows
- Estrus Synchronization Recommendations for Artificial Insemination of Beef Heifers
- Sperm Selection for Artificial Insemination: Recommendations and AI Approaches
- Estrus Synchronization Recommendations for Natural Service Bull Breeding
- Systems to Facilitate Multiple Services of Artificial Insemination in Beef Herds
- 7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows
- Split-Time AI
- Care and Maintenance of a Liquid Nitrogen Tank
- Preparation and Handling of Catheters for Artificial Insemination of Cattle
- Artificial Insemination of Cattle: Step by Step
- Facilities for Artificial Insemination of Beef Cattle
- The Random Shuffle of Genes: Putting the E in EPD
- Decreasing Generation Interval to Increase Genetic Progress
- Hair Shedding: A Tool to Select Heat Tolerant Cattle
- Crossbreeding Systems for Small Herds of Beef Cattle

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### 7 & 7 Synch

*(Bosacker et al., 2020a and 2020b; Andersen et al., 2020)*

	Estrus Expression Before Fixed-Time AI
7 & 7 Synch	82% <sup>a</sup> (631/773)
7 Day CO-Synch + CIDR	64% <sup>b</sup> (493/776)

	Conventional	Sexed Semen
7 & 7 Synch	72% <sup>a</sup> (280/389)	52% <sup>c</sup> (199/380)
7 Day CO-Synch + CIDR	61% <sup>b</sup> (233/383)	44% <sup>d</sup> (171/386)

<https://extension.missouri.edu/g2023>

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### Relationship between Follicular Waves and GnRH

YES

NO

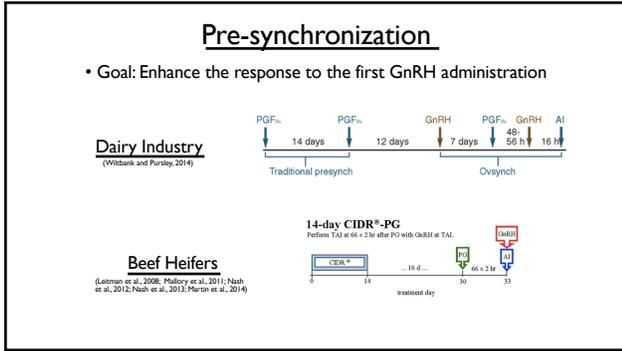
In cows, response rate to GnRH is only 65% at a random time point.

(Vasconcelos et al. 1999, Geary et al. 2000)

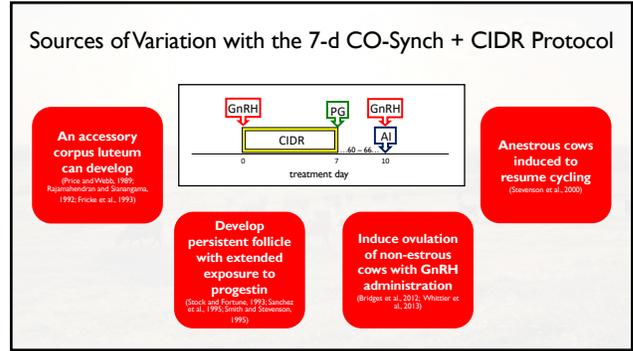
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follicles, less than 10 mm in diameter (premature) and regressing follicles (aged and not healthy)

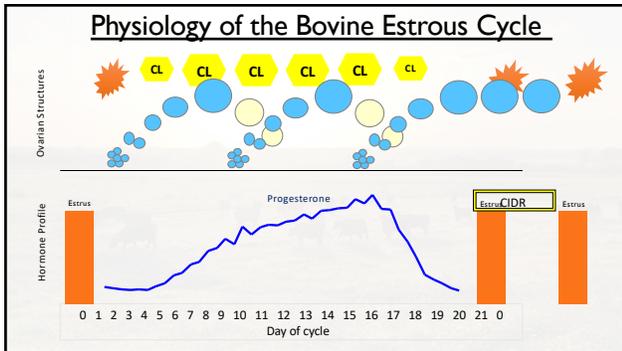
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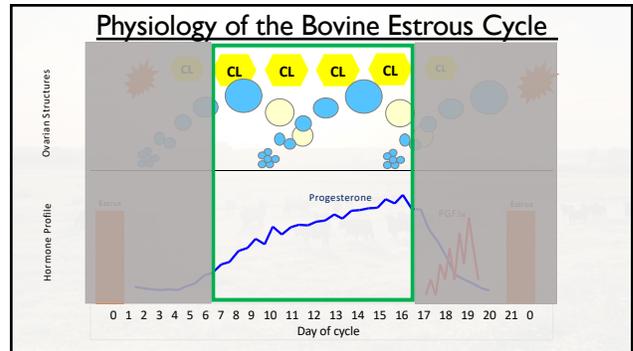
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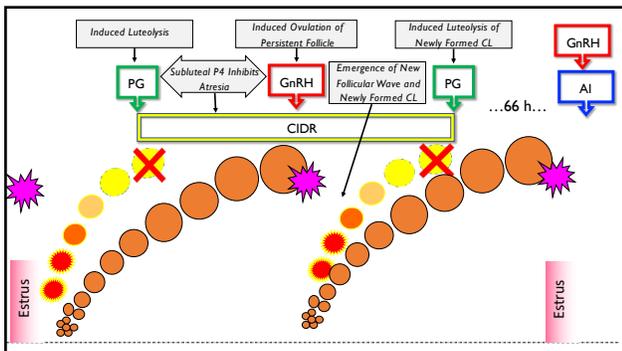
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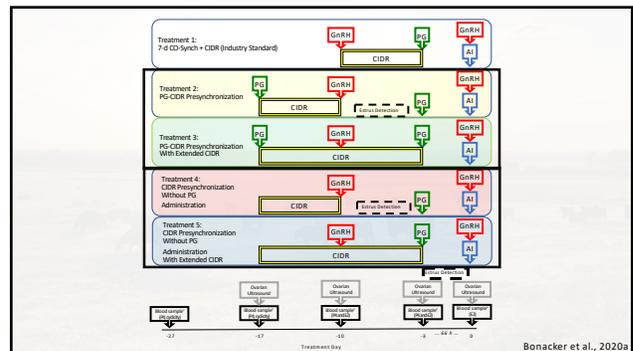
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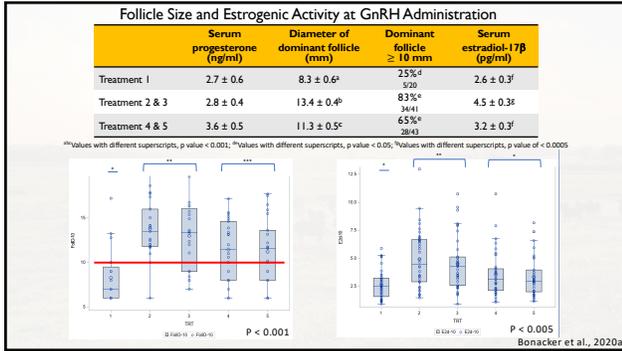
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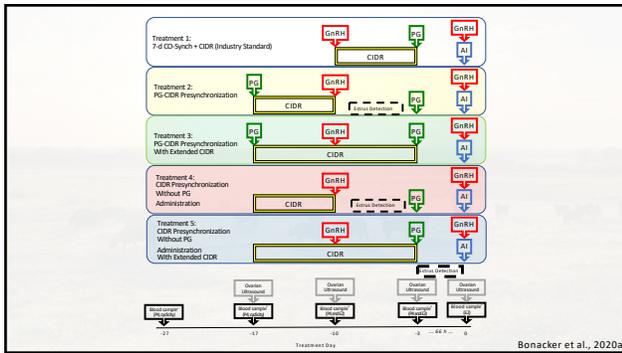
### CL Status and Progesterone Concentration on Day -3

Treatment	CL Status on Day -3			Serum progesterone (ng/ml) on Day -3
	Absence of CL	Single CL	CL and acc. CL	
7-Day CO-Synch + CIDR	35% 7/20	45% 9/20	20% 4/20	4.9 $\pm$ 0.7 <sup>a</sup>
PG-CIDR Presynchronization	14% 3/21	81% 17/21	5% 1/21	3.8 $\pm$ 0.5 <sup>ab</sup>
PG-CIDR Presynchronization with Extended CIDR	10% 2/20	75% 15/20	15% 3/20	3.3 $\pm$ 0.5 <sup>b</sup>
CIDR Presynchronization without PG Administration	5% 1/22	91% 20/22	5% 1/22	2.8 $\pm$ 0.5 <sup>b</sup>
CIDR Presynchronization Without PG Administration With Extended CIDR	24% 5/21	67% 14/21	10% 2/21	3.9 $\pm$ 0.7 <sup>ab</sup>

<sup>ab</sup>Values with different superscripts have a p value < 0.05

Bonacker et al., 2020a

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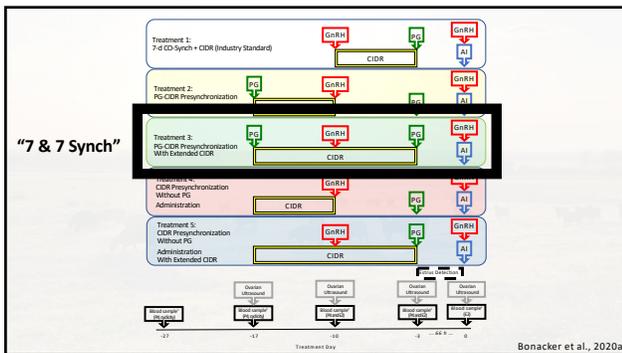
### Estrous Response Results

Treatment	Estrous Response between GnRH & PGF <sub>2a</sub>		Estrous Response by 66 hours
	%	p = 0.03	
7-Day CO-Synch + CIDR			68% 25/37
PG-CIDR Presynchronization	0% <sup>a</sup> 0/36		92% 33/36
PG-CIDR Presynchronization with Extended CIDR			82% 31/38
CIDR Presynchronization without PG Administration	13% <sup>b</sup> 5/39		69% 27/39
CIDR Presynchronization Without PG Administration With Extended CIDR			78% 29/37

<sup>ab</sup>Values with different superscripts have a p value < 0.05

Bonacker et al., 2020a

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# Multi-Location Field Trials with Embryo Transfer

Division of Animal Sciences  
 University of Missouri

Rachael Bonacker  
 Graduate Research Assistant

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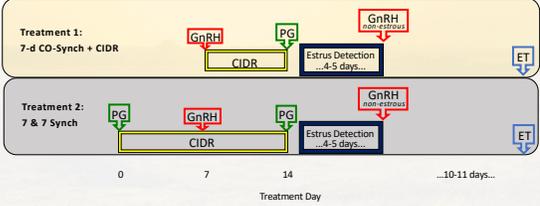
### Materials and Methods

- Cross Country Genetics, Westmoreland, Kansas
  - Kirk Gray, DVM, MS; Clay Breiner, DVM; Joel Anderson, DVM
- N = 1,358
  - Multiparous and primiparous beef cows
- 13 Locations
- Preassigned to treatments within location
  - Age
  - Days postpartum
  - BCS recorded at embryo transfer



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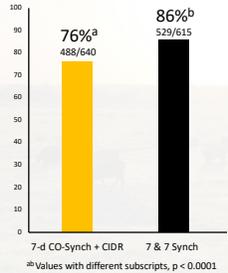
### Experimental Design – Embryo Transfer Field Trial



Bonacker et al., 2020b

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### Estrous Response



### Cumulative Estrous Response and Timing of Estrus Expression

Estrus expression (12 h intervals)	7-d CO-Synch + CIDR	7 & 7 Synch
24-36	62/640	92/615
36-48	145/640	199/615
48-60	324/640	367/615
60-72	400/640	454/615
72-84	444/640	492/615
84-96	468/640	510/615
96-108	477/640	521/615
108-120	484/640	529/615
120-132	488/640	529/615
<b>Total</b>	<b>488/640</b>	<b>529/615</b>

7-d CO-Synch + CIDR: 76%<sup>a</sup>  
 7 & 7 Synch: 86%<sup>b</sup>

<sup>a</sup> Values within row with different superscripts, p value < 0.0001  
<sup>b</sup> Values with different superscripts, p < 0.0001

Bonacker et al., 2020b

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### Utilization Rates

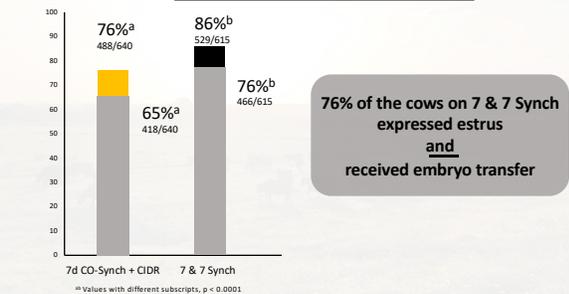
	Utilization Rate for Estrous Recipients	Utilization Rate for Non-Estrous Recipients Administered GnRH	Utilization Rate Overall
7-d CO Synch + CIDR	418/488	75/127	493/615
7 & 7 Synch	466/529	54/110	520/639



Bonacker et al., 2020b

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### Utilization Rate For Estrous Cows



7d CO-Synch + CIDR: 76%<sup>a</sup>  
 7 & 7 Synch: 86%<sup>b</sup>

76% of the cows on 7 & 7 Synch expressed estrus and received embryo transfer

<sup>a</sup> Values with different superscripts, p = 0.0001

Bonacker et al., 2020b

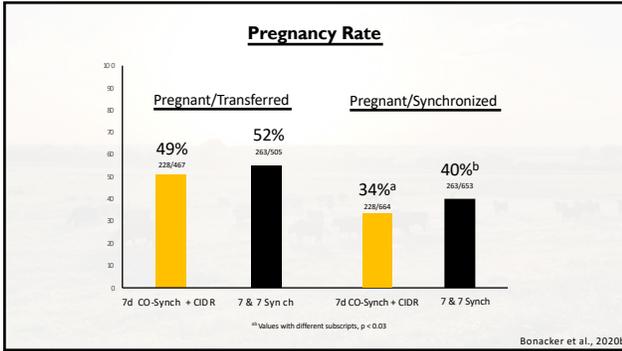
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### Pregnancy Rate

	7 & 7 Synch	7-d CO Synch + CIDR
Estrous Recipients	239/454	196/394
Non-Estrous Recipients Administered GnRH	24/51	32/73

Bonacker et al., 2020b

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## Multi-Location Field Trials with Fixed-Time AI

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Graduate Research Assistant  
Advised by Dr. Jordan Thomas

Division of Animal Sciences  
University of Missouri

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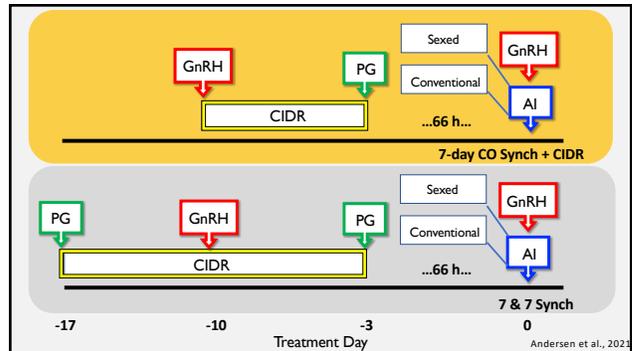
### Materials and Methods

**Location:**  
Langford, South Dakota  
Frankfort, South Dakota  
Milan, Missouri  
Lebanon, Missouri  
Mount Vernon, Missouri

**Numbers:**  
213 primiparous  
1336 multiparous beef cows

Cows in 11 locations were blocked based on DPP and age and randomly assigned to treatment within block.

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Location Averages				
Location	N	DPP	BCS	Age
		Mean ± SD	Mean ± SD	Mean ± SD
Location 1	89	97 ± 19	5.5 ± 0.5	3.7 ± 1.8
Location 2	143	74 ± 12	5.6 ± 0.4	4.1 ± 1.5
Location 3	169	96 ± 26	5.7 ± 0.4	4.7 ± 2.2
Location 4	117	64 ± 18	5.9 ± 0.6	4.7 ± 1.7
Location 5	160	77 ± 17	5.5 ± 0.4	3.0 ± 1.6
Location 6	190	73 ± 12	5.9 ± 0.5	5.3 ± 1.9
Location 7	156	67 ± 12	5.5 ± 0.5	4.3 ± 1.2
Location 8	122	87 ± 16	5.9 ± 0.7	5.1 ± 2.9
Location 9	154	81 ± 12	6.0 ± 0.6	5.0 ± 0
Location 10	128	88 ± 13	5.7 ± 0.4	6.0 ± 0
Location 11	121	80 ± 14	5.7 ± 0.5	-
<b>All Locations</b>	<b>1549</b>	<b>80 ± 22</b>	<b>5.7 ± 0.5</b>	<b>4.2 ± 2.0</b>

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### Results: Estrous Response

**Significant Effects**

- Protocol (P = 0.01)
- DPP (P = 0.04)
- DPP × Protocol (P = 0.0004)

**Tendencies**

- BCS (P = 0.07)
- Age × Protocol (P = 0.08)

Andersen et al., 2023

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Results: Estrous Response				
Location	7 & 7 Synch		7 Day CO-Synch + CIDR	
	Location 1	89%	(41/46)	70%
Location 2	79%	(56/71)	72%	(52/72)
Location 3	93%	(85/91)	75%	(59/78)
Location 4	84%	(49/58)	80%	(47/59)
Location 5	73%	(56/77)	67%	(56/83)
Location 6	88%	(84/96)	73%	(69/94)
Location 7	67%	(48/72)	42%	(35/84)
Location 8	90%	(55/61)	69%	(42/61)
Location 9	73%	(54/74)	51%	(41/80)
Location 10	82%	(53/65)	52%	(33/63)
Location 11	81%	(50/62)	53%	(31/59)
<b>All Locations</b>	<b>82%<sup>a</sup></b>	<b>(631/773)</b>	<b>64%<sup>b</sup></b>	<b>(495/776)</b>

Protocol (P = 0.01) Andersen et al., 2021

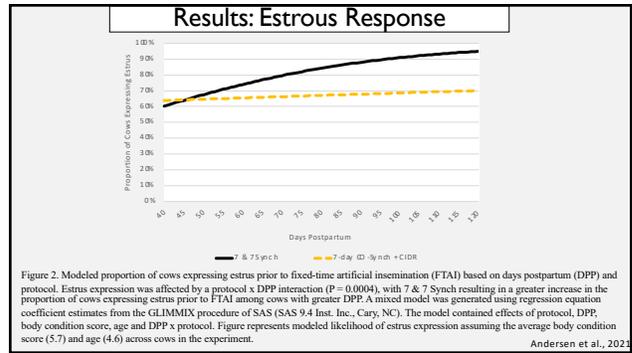
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Results: Pregnancy Rate				
Location	7 & 7 Synch		7 Day CO-Synch + CIDR	
	Conventional	SexedULTRA 4M	Conventional	SexedULTRA 4M
Location 1	76%	(19/25)	71%	(15/21)
Location 2	72%	(26/36)	65%	(24/37)
Location 3	84%	(38/45)	60%	(24/40)
Location 4	76%	(22/29)	60%	(18/30)
Location 5	69%	(27/39)	50%	(20/40)
Location 6	63%	(30/48)	62%	(29/47)
Location 7	61%	(22/36)	60%	(24/40)
Location 8	74%	(23/31)	63%	(19/30)
Location 9	70%	(26/37)	59%	(22/37)
Location 10	81%	(25/31)	61%	(19/31)
Location 11	69%	(22/32)	63%	(19/30)
<b>Total</b>	<b>72%</b>	<b>(280/389)</b>	<b>61%</b>	<b>(233/383)</b>

Protocol (P = 0.0001) Semen (P < 0.0001) Andersen et al., 2021

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### Conclusion

- 7 & 7 Synch significantly increased pregnancy rates to fixed-time AI whether using conventional or sex-sorted semen
  - Driven by significant increase in estrous response prior to timed AI
  - Additionally, greater pregnancy rates among estrous cows specifically
- 7 & 7 Synch particularly beneficial among animals that are likely to be cyclic at the start of synchronization
- Pregnancy rates are still reduced for sex-sorted semen in comparison to conventional semen

Andersen et al., 2021

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**7 & 7 Synch: An Estrus Synchronization Protocol for Postpartum Beef Cows**

Researchers at the University of Missouri recently evaluated a new protocol for synchronization of estrus among postpartum beef cows. This protocol was found to be highly effective both for cows receiving embryo transfer (ET) and cows receiving fixed-time artificial insemination (AI). Extensive field trials with the 7 & 7 Synch observed improvements in the proportion of cows expressing estrus and in the proportion of cows becoming pregnant to embryo transfer or to AI.

<https://extension2.missouri.edu/g2023>

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**Estrus response and pregnancy rates of beef replacement heifers enrolled in two fixed-time artificial insemination protocols, with or without pre-synchronization.**

Mercadante, V.R.G.<sup>1,2</sup>, N.W. Dias<sup>1</sup>, H. Haines<sup>1</sup>, S. Pancini<sup>1</sup>, J. Currin<sup>2</sup>, S. Clark<sup>2</sup>, J. Stewart<sup>2</sup>, G. Pent<sup>3</sup>, G.C. Lamb<sup>4</sup>, N. Oosthuizen<sup>5</sup>, P.L.P. Fontes<sup>6</sup>

<sup>1</sup>Animal and Poultry Sciences, Virginia Tech, Blacksburg, VA, USA  
<sup>2</sup>Large Animal Clinical Sciences, Virginia Tech, Blacksburg, VA, USA  
<sup>3</sup>Shenandoah Valley Agric. Res. Ext. Center, Virginia Tech, Raphine, VA, USA  
<sup>4</sup>Animal Science, Texas A&M, College Station, TX, USA  
<sup>5</sup>ABS Global, Sioux Falls, SD 57108  
<sup>6</sup>Animal and Dairy Science, Univ. of Georgia, Athens, GA, USA

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**Materials & Methods**

- **8 locations**
  - VA (4), MT (1), GA (3), SD (2)
- **Total of 1,552 beef heifers**
  - Age = 15 ± 2 months
  - BW = 381.6 ± 30.5 kg
  - BCS = 5.7 ± 0.5 (1 to 9 scale)
  - **Bos taurus**: Angus crossed

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**Materials & Methods**

**7 day CO-Synch** (n = 779): Estrus Patches, GnRH, CIDR, PGF, Estrus Patches, TAI at 54 h GnRH, Pregnancy Diagnosis.

**7&7 Synch** (n = 773): Estrus Patches, PGF, GnRH, CIDR, PGF, Estrus Patches, TAI at 54 h GnRH, Pregnancy Diagnosis.

Day -14 US, -7 US, 0 US, 2, 30 to 47 d post TAI.

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**Results**

**Heifer BW by Location and Treatment**

Location P = 0.047  
 Treatment P = 0.891

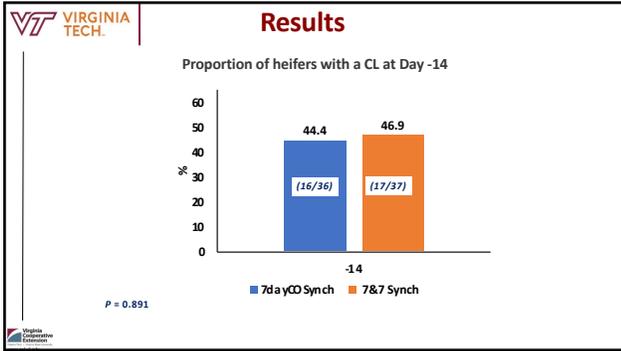
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**Results**

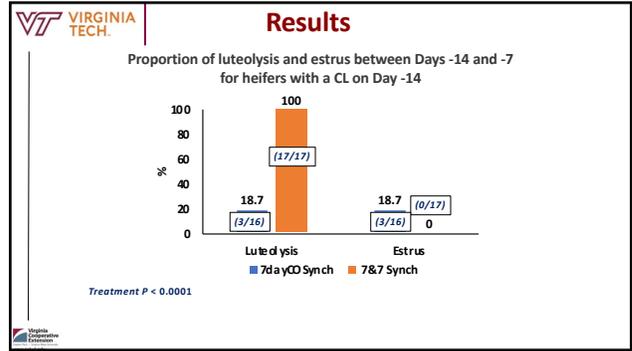
**Heifer Reproductive Tract Score by Location and Treatment**

Location P = 0.035  
 Treatment P = 0.879

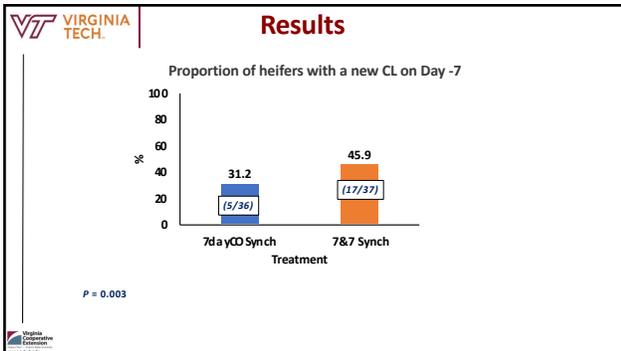
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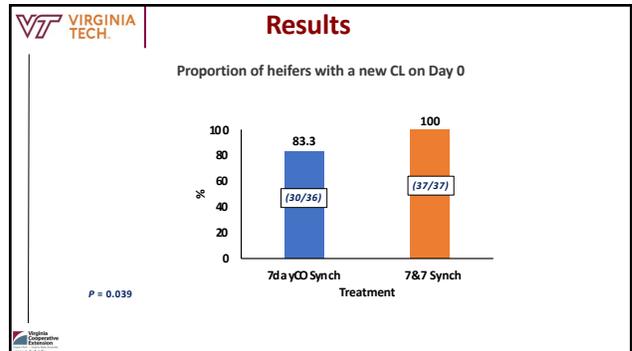
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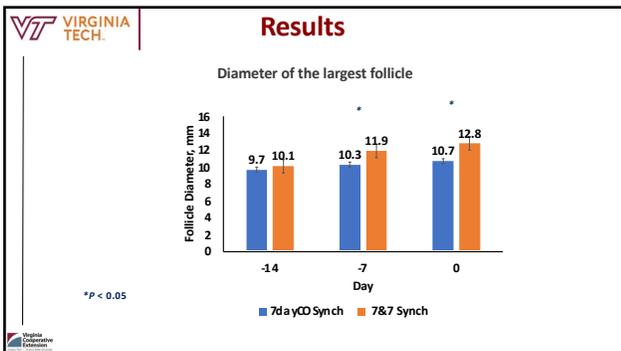
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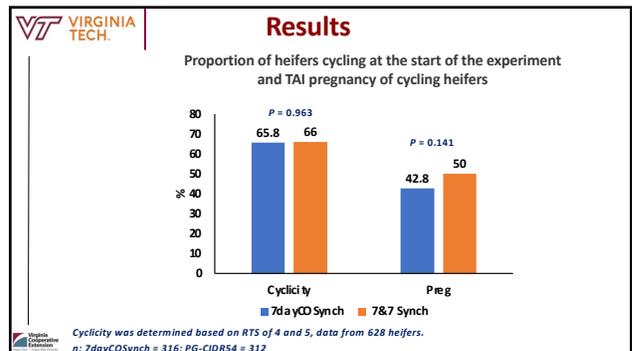
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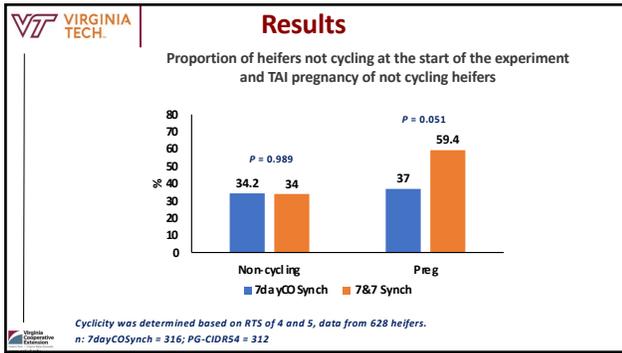
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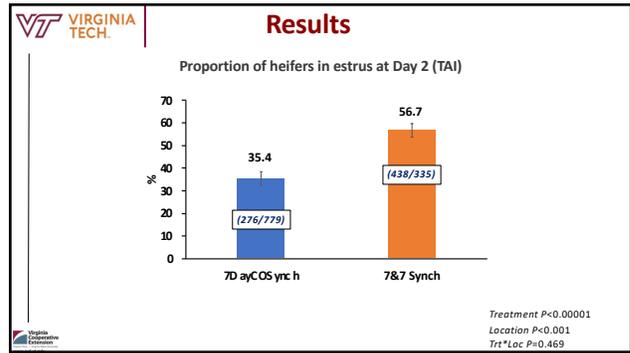
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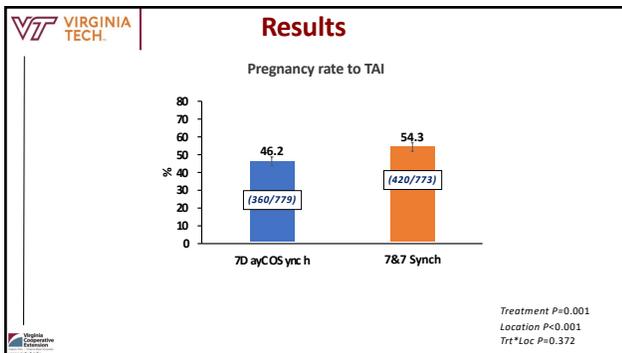
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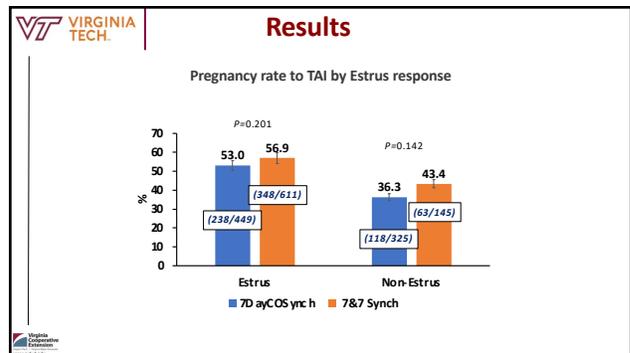
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**Summary Heifers**

- **In comparison to the 7-day CO-Synch+CIDR, the 7&7 Synch increased:**
  - Ovulation response to first GnRH (Day-7)
  - Diameter of the dominant follicle on days -7 and 0
  - Estrus expression at Day 2 (TAI)
  - Pregnancy rate to TAI

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