AN UPDATE ON TIMED-AI (TAI) PROGRAMS FOR DAIRY CATTLE

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Outline of Webinar

- Review the physiology and endocrinology of the estrous cycle
- How estrous cycle and ovarian follicular dynamic can be manipulated
- Discuss a few controlled timed-AI (TAI) programs for dairy cattle
- Show reproductive performance data from a commercial Dairy herd
Estrous cycle in cattle

- Average 21 days long (18 to 24)
- Two phases: luteal (14-18 days) and follicular (4-6 days)
- Four stages:
  - Proestrus (Day 18-20)
  - Estrus (Day 0)
  - Metestrus (Day 1 - 3)
  - Diestrus (Day 4 - 17)
Hormones of the Estrous Cycle

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Produced</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>GnRH</td>
<td>Hypothalamus</td>
<td>LH &amp; FSH release</td>
</tr>
<tr>
<td>FSH</td>
<td>Hypophysis</td>
<td>Follicle growth</td>
</tr>
<tr>
<td>LH</td>
<td>Hypophysis</td>
<td>Regulates ovulation and CL formation</td>
</tr>
<tr>
<td>Estrogen</td>
<td>Ovarian follicle</td>
<td>Estrus behavior &amp; GnRH surge</td>
</tr>
<tr>
<td>Progesterone</td>
<td>CL &amp; Placenta</td>
<td>Maintenance of pregnancy</td>
</tr>
<tr>
<td>Prostaglandin 2α</td>
<td>Uterus</td>
<td>CL regression</td>
</tr>
</tbody>
</table>
Estrous cycle cont’d

- **Follicular phase**
  - Low P4, high E2
  - GnRH surge → LH&FSH surge → Ovulation

- **Luteal phase**
  - CL development
  - High P4, low LH
  - Follicular waves
FOLLICULAR WAVES

2-wave cycle

3-wave cycle

Days of Estrous Cycle

Follicle Size (mm)
Controlling the estrous cycle

- By shortening the luteal phase (Prostaglandin 2α)
- By lengthening the luteal phase (Progestins)
Distribution of heat in Holstein heifers given PGF 14 d apart

Colazo, unpublished

N = 132
PERSISTENT FOLLICLE

Low progesterone in plasma

Oocyte of low fertility
Protocols that synchronize follicular dynamics, CL regression and ovulation, and allow for timed artificial insemination (TAI)
Estradiol and Progesterone

CIDR+ P4 and E2

4 days

New follicular wave

Follicle diameter (mm)

Days

FSH

LH

Bo et al., 1995
TAI protocol
(Progesterone & Estrogen)

DAY 0
Insert CIDR
Give
2 mg EB
or 5 mg E-17B

7
Remove CIDR
Give
PGF2α

8
1 mg EB

9
TAI

Bo et al., 1995; Martinez et al., 2005
TAI protocol
(Progesterone & Estrogen)

DAY 0
- Insert CIDR
- Give 5 mg E-17B

DAY 7
- Remove CIDR
- Give PGF 0.5 mg ECP

DAY 9
- TAI

Colazo et al., 2003
GnRH or pLH

GnRH (Ovulation?)

Wave emergence

~2.0 days

Martinez et al., 1999

Follicle Size

Days

Martinez et al., 1999
Effect of presynchronization and cyclicity status on ovulatory response to first GnRH in cattle subjected to a GnRH-based protocol.

<table>
<thead>
<tr>
<th>Animal category</th>
<th>Presynchronization</th>
<th>Cyclic</th>
<th>Acyclic</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactating dairy cows</td>
<td>--</td>
<td>--</td>
<td>56/146 (38%)</td>
<td>17/20 (85%)</td>
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<tr>
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<td>149/241 (62%)</td>
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<tr>
<td></td>
<td>99/217 (46%)</td>
<td>110/391 (28%)</td>
<td>150/501 (30%)</td>
<td>59/107 (55%)</td>
</tr>
<tr>
<td>Dairy heifers</td>
<td>--</td>
<td>27/91 (30%)</td>
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</tr>
<tr>
<td>Suckled beef cows</td>
<td>59/79 (75%)</td>
<td>39/80 (49%)</td>
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</tr>
<tr>
<td>Suckled beef cows</td>
<td>99/129 (77%)</td>
<td>72/131 (55%)</td>
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</tr>
<tr>
<td>Beef heifers</td>
<td>78/128 (61%)</td>
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</tr>
<tr>
<td>Beef heifers</td>
<td>29/49 (59%)</td>
<td>30/49 (61%)</td>
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</tr>
</tbody>
</table>
7-d OVSYNCH

GnRH
D 0

PGF
D 7

GnRH
D 9

AI
D 10

Pursley et al., 1995
7-d COSYNCH

D 0  7 d  D 7  2 d  D 9

GnRH  PGF  GnRH + AI

Geary et al., 1998
Conception rate between 28-35%

LACK OF SYNCHRONY!

N = 744

Colazo et al., 2009; 2013 and unpublished data
Improving the fertility of GnRH-based protocols

- Incorporate a progestin device
- Presynch
  - 2 doses of PGF
  - G6G or Double Ovsynch
  - Progestin presynchronization
7-d OVSYNCH + P4

GnRH

PGF

Progesterone

GnRH

AI

D 0

7 d

D 7

2 d

D 9

16 h

D 10

CIDR

PRID

CUE-MATE
7-d OVSYNCH + P4

- GnRH
- PGF
- GnRH
- AI

- Progesterone
- CIDR
- PRID
- CUE-MATE

D0  7d  D7  2d  D9  16h  D10
7-d OVSYNCH +/- P4

N = 608; Presynchronized N=217

Colazo et al., 2013
Pregnancy rate: PRID effect

N = 608; P < 0.05

Colazo et al., 2013
<table>
<thead>
<tr>
<th></th>
<th>Ovsynch</th>
<th>Ovsynch + PRID</th>
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</thead>
<tbody>
<tr>
<td>Ov. to 1st GnRH</td>
<td>35%</td>
<td>33%</td>
</tr>
<tr>
<td>Ov. to 2nd GnRH</td>
<td>83%</td>
<td>86%</td>
</tr>
<tr>
<td>Ov. before TAI</td>
<td>11%</td>
<td>* 6%</td>
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<tr>
<td>No resp. PGF</td>
<td>4%</td>
<td>3%</td>
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<tr>
<td>Double Ov.</td>
<td>11%</td>
<td>10%</td>
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</table>

N = 608  
Colazo et al., 2013
Pregnancy rate: PRID effect

Colazo et al., 2013

N = 608; P < 0.05
PRID treatment by TAI protocol

Interaction $P < 0.05$

Colazo et al., 2013
### PRESYNCH-OVSYNCH 14/11 d

<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
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<td>GnRH</td>
<td>TAI</td>
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<td>PGF</td>
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<tr>
<td></td>
<td>Ovsynch</td>
<td>Presynch + Ovsynch</td>
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<tr>
<td>Ov. to 1st GnRH</td>
<td>39%</td>
<td>* 61%</td>
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<tr>
<td>Ov. to 2nd GnRH</td>
<td>83%</td>
<td>87%</td>
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<tr>
<td>Ov. before TAI</td>
<td>12%</td>
<td>* 5%</td>
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<tr>
<td>No resp. PGF</td>
<td>8%</td>
<td>5%</td>
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<tr>
<td>Double Ov.</td>
<td>13%</td>
<td>15%</td>
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</tbody>
</table>

N = 744

Colazo et al., 2009; 2013 and unpublished data
Conception rate to first AI

- Estrus: 31% (n = 706)
- Presynch-11/Ovsynch: 45% (n = 651)

P < 0.0001

Strickland et al., 2010
<table>
<thead>
<tr>
<th>Sun</th>
<th>Mon</th>
<th>Tue</th>
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<th>Thu</th>
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<td>GnRH</td>
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<td>PGF</td>
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<td>GnRH</td>
<td>TAI</td>
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</tbody>
</table>
Double Ovsynch vs Presynch/Ovsynch

- Primiparous: 65% (DO) vs 45% (PRE/OVS)
- Multiparous: 38% (DO) vs 39% (PRE/OVS)

n = 337
Souza et al., 2008
Improving the fertility of GnRH-based protocols

-5-d Cosynch + CIDR-

Bridges et al., 2008
Experimental Design - 5- vs 7-d Cosynch/PRID

Colazo and Ambrose, 2011
TAI Pregnancy Rate 28 d

5-d Cosynch PRID

7-d Cosynch PRID

59
58

19/32
18/31

Trt, P >0.05

Colazo and Ambrose, 2011
<table>
<thead>
<tr>
<th>Event</th>
<th>Cosynch/PRID (5-d)</th>
<th>Cosynch/PRID (7-d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ov. to 1st GnRH</td>
<td>25%</td>
<td>* 39%</td>
</tr>
<tr>
<td>Ov. to 2nd GnRH</td>
<td>65%</td>
<td>84%</td>
</tr>
<tr>
<td>Ov. before TAI</td>
<td>22%</td>
<td>* 10%</td>
</tr>
<tr>
<td>No resp. PGF</td>
<td>6%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Colazo and Ambrose, 2011
Experimental Design - 5-d Modified Cosynch

- **d -5**
  - 5-d PRID
  - GnRH
  - PGF$_{2\alpha}$

- **d 0**
  - 5-d PRID
  - PGF$_{2\alpha}$

- 72 h
  - GnRH + AI

*Colazo and Ambrose, 2011*
TAI Pregnancy Rate 28 d

- 5-d Cosynch PRID: 68%
- 5-d Modified Cosynch PRID: 71%

N=28 for both treatments, Trt, P >0.05

Colazo and Ambrose, 2011
Resynch 7-d Ovsynch/PRID Protocol

- TAI
- 0d
- GnRH
- PRID
- 39d
- 32d
- Ultrasound Pregnancy Diagnosis
- Pregnant
- d60
- PGF$_{2\alpha}$
- GnRH
- Monday
- 60h
- 12h
- Wed
- Thurs
- TAI
- Monday
- 39d
Resynch 5-d Ovsynch/PRID Protocol

- GnRH on Monday & Tuesday
- PGF on Monday and Wednesday
- GnRH followed by PRID on Thursday
- Ultrasound Pregnancy Diagnosis on 39d
- Pregnant on d60
Resynch 5-d Modified Ovsynch/PRID Protocol

- Monday: PGF
- Wednesday: PRID
- 39d: PRID
- 60h: GnRH
- 12h: TAI
- TAI: 0d
- 32d: Ultrasound Pregnancy Diagnosis
- 34d: TAI
- d60: Pregnant

Ultrasound Pregnancy Diagnosis
Resynch Pregnancy Rate 32 d

Trt, P <0.05

Colazo unpublished
Pregnancy loss between 32 and 60 d

Colazo unpublished

Trt, P < 0.1
Conception rates (957 AI - 2012)

Wetaskiwin, AB
475 Lac cows
11460 kg

13%
SUMMARY

- Estrus synchronization is a management tool that can help to overcome problems associated with estrus detection.

- Treatments that synchronize estrus and ovulation improve the efficiency of timed-AI programs:
  - Eliminating the need for estrus detection
  - Improving overall pregnancy rates by increasing the number of animals inseminated

- Both estradiol and GnRH are efficacious in timed-AI protocols, specially if combined with a progestin device.
Presynchronization improves pregnancy rates to GnRH-based TAI protocols by increasing the number of animals ovulating to the first GnRH.

The 5-d protocol improves pregnancy rates in resynchronized cows and the initial GnRH is not essential to achieve acceptable pregnancy rates in heifers.
Thank you!

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