Reducing the economic burden of the replacement heifer enterprise through reproductive management

Julio Giordano, DVM, MS, PhD
Dairy Cattle Biology and Management Laboratory
Department of Animal Science

Vermont Veterinary Medical Association, Vermont
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Several motivations to reduce days to pregnancy and thus AFC

Reducing days to pregnancy…

- …has substantial positive effects on heifer enterprise profitability
- …does not compromise productivity and reproductive performance during lactation provided heifers are well fed and managed
- …is possible for most herds – usually a management decision not limited by heifer biology

Goal is to get pregnant as soon as possible after heifer is eligible for pregnancy!!!
Does reducing AFC due to a reduction in time to pregnancy affect the heifer enterprise economics?
Average rearing cost until calving = $2,505
26 dairies in NY in 2019

Karzsez and Hill, 2020 Pro-Dairy
Does time to pregnancy affect the heifer enterprise economics?

Hypothesis:
Reduced AFC due to improved reproductive performance would improve the economics of Holstein replacements

- Nulliparous Holstein heifers from 3 commercial farms in NY (n = 1,144)
- Eligible for AI at 368 ± 10 days (12 mo) of age
- After calving, heifers were retrospectively assigned to 1 of 3 groups based on AFC tertiles within farm:
  - Low (20.2 to 21.8 mo; n = 391)
  - Medium (21.4 to 22.8 mo; n = 376)
  - High (22.1 to 28.7 mo; n = 377)
Cash flow estimations conducted per 15 mo per slot

AIP = artificial insemination period

Cash flow rearing period = Repro cost + Feed cost + Replacement Cost + Other operating expenses

Cash flow lactating period = IOFC + Calf value + Replacement Cost + Other operating expenses

Cash flow ($/slot/15 mo)

AIP to PG: 3.25 mo
Gestation: 9 mo
Months in lactation: 2.75

0 to 15 months from beginning of AIP

1st Calving

1st Lactation

Nonlactating
Differences in AFC among groups were explained by differences in age and P/AI at first service

<table>
<thead>
<tr>
<th></th>
<th>AFC group</th>
<th></th>
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<th>P-value</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Low (n = 391)</td>
<td>Med (n = 376)</td>
<td>High (n = 377)</td>
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<tr>
<td>Age 1st AI (d)</td>
<td>371 ± 0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>376 ± 0.5&lt;sup&gt;a&lt;/sup&gt;</td>
<td>378 ± 0.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.01</td>
<td></td>
</tr>
<tr>
<td>P/AI 1st AI</td>
<td>95.9%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>33.2%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.3%&lt;sup&gt;c&lt;/sup&gt;</td>
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Reduced AFC led to lower reproductive cost

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<td>TOTAL RP cost, $</td>
<td>807 ± 22&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>TOTAL FLP profit, $</td>
<td>454 ± 45&lt;sup&gt;a&lt;/sup&gt;</td>
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Reduced AFC reduced rearing cost after end of the VWP

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Reduced AFC increased first lactation profit per slot per unit of time

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Cornell CALS College of Agriculture and Life Sciences
Does time to pregnancy affect the heifer enterprise economics?

• Differences in time to pregnancy driven by differences in reproductive performance (not on growth) led to substantial benefits:
  • Reduced reproductive cost
  • Reduced rearing cost after the beginning of the insemination period
  • Earlier first lactation revenue ---- more profits per unit of time

• A major driver of the reduction in time to pregnancy is days to and fertility after first service
Does earlier AFC negatively impact reproductive performance during first lactation?
Evaluated effect of AFC on first lactation reproductive outcomes

Retrospective Cohort Study
- Primiparous Holstein lactating dairy cows from 5 farms in NY (n = 2,235)
- Cows grouped by AFC tertiles within farm (n; mean; range):
  - **Low 21.5 (18.5-22.4)**
  - **Medium 22.1 (21.3-23.3)**
  - **High 23.5 (21.8-29.7)**
- Cows managed with program designed to either inseminate as many cows after detection of estrus or synchronization of ovulation as possible
Summary

We did not observe significant negative consequences for heifers in the Low and Medium AFC categories for:
- AI at detected estrus
- Pregnancy per AI to first service for AI at detected estrus or TAI services
- Percent pregnant by 200 DIM
- Percent sold and died by 200 DIM

In fact, we observed some positive effects for Low and Medium AFC for:
- AI at detected estrus
- Pregnant by 200 DIM
**Most common issue with heifer repro is poor service rate**

<table>
<thead>
<tr>
<th>Farm</th>
<th>VWP (d)</th>
<th>21 d-SR (%)</th>
<th>CR (%)</th>
<th>21 d-PR (%)</th>
<th>21 d-SR (%)</th>
<th>CR (%)</th>
<th>21 d-PR (%)</th>
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<tr>
<td>A</td>
<td>395</td>
<td>57</td>
<td>53</td>
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<td>68</td>
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<td>B</td>
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<td>64</td>
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<td>390</td>
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<td>325</td>
<td>36</td>
<td>45</td>
<td>18</td>
<td>68</td>
<td>33</td>
<td>23</td>
</tr>
<tr>
<td>Avg.</td>
<td>368</td>
<td>44</td>
<td>50</td>
<td>23</td>
<td>62</td>
<td>34</td>
<td>21</td>
</tr>
</tbody>
</table>

18 percentage points
Heifers DO NOT present same limitations to estrus expression as cows
- No milk production
- Less metabolically challenged
- Fewer health issues

Key factors for success
- Good nutrition
- Good health
- Reasonable environmental conditions
Efficient estrous detection possible without hormonal intervention

Promotion of estrus with PGF or P4-based protocols is effective for heifers

PGF = e.g., Lutalyse, Estrumate, Synchsure, EstroPlan

PGF = e.g., Lutalyse, Estrumate, Synchsure, EstroPlan
Example (proven) program: predominant AIE with up to 3 PGF treatments and synch protocol for TAI as safety net

Recent work (Masello et al., 2019 JDS 102(2):1671-1681) showed program can be effective and lead to reasonable preg. rate – good estrus detection is key!!!

May not maximize profitability as compared to more aggressive use of TAI

VWP = voluntary waiting period, PGF = e.g., Lutalyse, Estrumate, Synchsure, EstroPlan, 5dCP = 5 day Cosynch
Traditional methods or automated technologies for detection of estrus work well for heifers

Traditional methods

Automated detection of estrus

- Heifers DO NOT present same limitations to estrus expression as cows
  - No milk production
  - Less metabolically challenged
  - Fewer health issues
- Key factors for success
  - Good nutrition
  - Good health
  - Reasonable environmental conditions
- Unlikely to present biological limitations to express estrus!!!
Automated estrus detection (AED) systems are effective for heifers

There were no significant differences for detection of estrus and P/AI for an AED system versus tail-head mount detectors.

<table>
<thead>
<tr>
<th>Group</th>
<th>AED (n = 260)</th>
<th>Mount detector (n = 236)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>First service rate</td>
<td>No difference</td>
<td>No difference</td>
<td>0.11</td>
</tr>
<tr>
<td>P/AI for AI services</td>
<td>50.6%</td>
<td>50.6%</td>
<td>0.30</td>
</tr>
<tr>
<td>Pregnancy rate ET</td>
<td>26.7%</td>
<td>31.1%</td>
<td>0.14</td>
</tr>
</tbody>
</table>

No difference for 2+ IA P/AI. Tendency (P = 0.06) to reduce days to second AI for AED system.
Automated estrus detection systems are effective for heifers

- AED system (eSense, Allflex) detected the vast majority (>90%) of estrus events and generated a reasonable number of false positives (<10%) when using mount detectors as control

<table>
<thead>
<tr>
<th>Reference method</th>
<th>Sensitivity</th>
<th>False positives</th>
<th>PPV¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mount patches (Estrotec) (n = 468)</td>
<td>91.0%</td>
<td>8.0%</td>
<td>83.5%</td>
</tr>
</tbody>
</table>

¹PPV = positive predictive value

Reference

Mcmillan et al., 2020 Theriogenology 155:197-204
AED systems are a tool available for dairies that struggle with traditional methods for detection of estrus or benefit by use of this technology

- AED systems **effective but not superior to** traditional methods of detection of estrus (at least under research conditions)

- **Useful tool** for implementation of reproductive management programs that depends primarily on AI at detected estrus
Effective TAI programs are available for heifers

To synch or not to synch (?)

- Entail complex treatment schemes of difficult implementation for some farms

- May be more expensive to implement than predominant AIE programs

- May be more profitable through a reduction of time to pregnancy
5 d-Cosynch + Progesterone optimal for TAI in Heifers

Expected
P/Al* = ~60-65%

Rabaglino et al., 2010, Lima et al., 2013; Santos et al., 2011

*with conventional semen
5 d-Cosynch + Progesterone optimal for TAI in Heifers

Expected
P/AI* = ~50-55%

*with conventional semen

Rabaglino et al., 2010, Lima et al., 2013; Santos et al., 2011
ALL-TAI or TAI after 2 PGF treatments works well and more profitable than predominant estrus AI breeding

Example (proven) program: Predominant AIE with up to 2 PGF (Presynch) and synch protocol for TAI as safety net

Example (proven) program: ALL-TAI for first service

Recent work (Masello et al., 2019 JDS 102(2):1671-1681) showed programs can be more effective for improving preg. rate compared with almost ALL-estrus AI

Expected to maximize profitability as compared to ALL-AIE
• Holstein heifers 3 commercial farms in NY
  • Farms A & B → relatively equal repro management (MORE effort on estrus detection)
  • Farm C → different approach to repro management (LESS effort on estrus detection)

• Enrolled at 368 ± 10 days (12 mo) of age

• Semen use
  • 1st service - 100% sexed semen
  • 2+ AI service – 100% conventional semen
Compared predominant AIE, TAI, or combined programs

1st AI Service – Sexed sorted semen

TAI use

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PGF+AIE (n = 400)

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PGF+TAI (n = 428)

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ALL-TAI (n = 421)

---

PGF

14 d

PGF

14 d

PGF

9 d

PGF

8 d

5d-Cosynch

TAI

---

Masello et al., 2018 JDS 102:1671-1681
**Time to Pregnancy for up to 100 d affected by Treatment and Farm**

**FARMS A & B**

Mean days to Pregnancy
- PGF+AIE = 36
- PGF+TAI = 32
- All TAI = 28

**FARM C**

Median days to Pregnancy
- PGF + EDAI = 45
- 100% TAI = 24
- Presynch+ TAI = 23

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**Hazard Ratios (95% CI)**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>PGF + EDAI</th>
<th>100% TAI</th>
<th>Presynch + TAI</th>
</tr>
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<tbody>
<tr>
<td>REF</td>
<td>1.20 (1.02 - 1.42)</td>
<td>1.13 (0.96 - 1.32)</td>
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Masello et al., 2018 JDS 102:1671-1681
## FARMS A & B

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment Groups</th>
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<tbody>
<tr>
<td></td>
<td>PGF+AIE (n = 313)</td>
<td>PGF + TAI (n = 330)</td>
</tr>
<tr>
<td>Repro cost ($/heifer slot)</td>
<td>69.9 ± 2.0a</td>
<td>72.3 ± 2.0a</td>
</tr>
<tr>
<td>Rearing cost ($/heifer slot)</td>
<td>931 ± 9</td>
<td>911 ± 10</td>
</tr>
<tr>
<td>First lact profit ($/heifer slot)</td>
<td>393 ± 20</td>
<td>424 ± 18</td>
</tr>
<tr>
<td>Total cash flow ($/heifer slot)</td>
<td>(-538) ± 24</td>
<td>(-486) ± 21</td>
</tr>
</tbody>
</table>

+ $52 X Presynch+TAI

+ $43 X 100%TAI

Presynch + TAI strategy most (numerically) profitable when accounting for rearing cost and opportunity cost of lactation in herds with GOOD detection of estrus!!!
### FARM C

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<td>Repro cost ($/heifer slot)</td>
<td>PGF+AIE (n = 83)</td>
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<td>PGF + TAI (n = 94)</td>
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<td></td>
<td>100% TAI (n = 106)</td>
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<tr>
<td>P-value</td>
<td></td>
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<tr>
<td>Repro cost ($/heifer slot)</td>
<td>87.8 ± 5.1</td>
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<tr>
<td></td>
<td>100 ± 5.7</td>
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<td></td>
<td>89.7 ± 4.4</td>
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<td>0.19</td>
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<td>Rearing cost ($/heifer slot)</td>
<td>1046 ± 33 a</td>
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<td></td>
<td>968 ± 26 a</td>
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<td>+$132 100% TAI vs. Presynch+TAI</td>
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<td>0.01</td>
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<td>First lact profit ($/heifer slot)</td>
<td>291 ± 29</td>
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<td>199 ± 4</td>
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<td>+$118 100% TAI</td>
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<td>Total cash flow ($/heifer slot)</td>
<td>(-755) ± 48 ab</td>
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<td></td>
<td>(-769) ± 50 a</td>
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<td></td>
<td>(-637) ± 33 b</td>
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<td>0.05</td>
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+$14 X Presynch+TAI

+$118 100% TAI

### Economics – “Up to 15 mo of VWP”

100% TAI strategy most profitable when accounting for rearing cost and opportunity cost of lactation in herd with LOW detection of estrus!!!
Implement re-breeding program that takes advantage of good estrous expression by heifers.

92% re-bred before 45 d after previous AI

8% re-bred after 45 d after previous AI

High frequency of pregnancy testing (e.g., once per week)
TAI may help with re-breeding if detection of estrus is not optimal

- 71% re-bred **before** 45 d after previous AI
- 29% re-bred **after** 45 d after previous AI

Low frequency of pregnancy testing (e.g., once per month)
Combine estrous detection + TAI for re-breeding heifers

Previous AI

AI at detected estrus

Days to preg. check

Preg check as soon as practically possible - synch if open
Combine estrous detection + TAI for re-breeding heifers

Use any synchronization protocol that allows TAI and leads to good fertility
- Will help reduce days to pregnancy by earlier re-breeding
- The worse the estrous detection the greater the benefit of this type of strategy
Use any PGF to re-breed more heifers at detected estrus after pregnancy testing. Will need TAI in very few heifers.

Use synchronization protocol that allows TAI and leads to good fertility

Will help reduce days to pregnancy by earlier re-breeding
Combine estrous detection + TAI for re-breeding heifers

Previous AI at detected estrus → PGF → AI at detected estrus

Days to preg. check → 7 or 14 d

Preg check as soon as practically possible - synch if open

- Use any PGF to re-breed more heifers at detected estrus after pregnancy testing. Will need TAI in very few heifers.
- Use synchronization protocol that allows TAI and leads to good fertility
- Will help reduce days to pregnancy by earlier re-breeding
Use any PGF to re-breed more heifers at detected estrus after pregnancy testing. Will need TAI in very few heifers.

Use synchronization protocol that allows TAI and leads to good fertility

Will help reduce days to pregnancy by earlier re-breeding
Example proven first breeding reproductive programs for heifers

Predominant AIE with PGF

Combined AIE + TAI (e.g., Presynch + TAI)

ALL-TAI

Masello et al., 2018 JDS 102:1671-1681
Example proven **second+ breeding programs for heifers**

Promote AIE with PGF after Pregnancy testing

Combined AIE with TAI after pregnancy diagnosis

Cornell CALS College of Agriculture and Life Sciences
Summary

- Simple programs for promoting AI in estrus or more complex TAI programs available and effective

- Optimal reproductive program for heifers highly influenced by estrous detection efficiency

- Combined (AIE + TAI) or all TAI for 1st AI may be more profitable than predominant estrus detection programs even for farms with reasonable estrous detection efficiency

- Consider an aggressive re-breeding program including pregnancy testing and TAI
Acknowledgement

Commercial dairy farms

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Thank You! Questions?