ASSOCIATIONS OF FEED EFFICIENCY WITH FERTILITY AND SEXUAL MATURITY IN YOUNG BEEF BULLS

Ananda Fontoura, Yuri Montanholi, Mariana Amorim, Steve Miller
Outline

- Introduction
- Material and Methods
- Results and Discussion
- Conclusion
- Acknowledgements
Introduction
Assessing Feed Efficiency

Breeding Programs

Colateral response to selection

Molecular and Quantitative Genetics

Feed Efficiency
Residual Feed Intake (RFI)

RFI = DMI observed – DMI predicted

- Immunity
- Reproduction
- Organ Function
- Physiological Workload

- Growth and Production
- Maintenance Requirements

Intake

Efficient
Low-RFI

Inefficient
High-RFI
Production vs. Fertility

↑ Leanness  ↓ Sexual Maturity
↑ Body weight line  ↓ Semen quality
↑ Milk  ↓ Fertility

(Hutchens et al, 1981; Marini and Goodman, 1969; Butler, 2000)
Production vs. Fertility

Feed Efficient heifers $\uparrow$ Pregnancy rates $\downarrow$
Feed Efficient bulls $\uparrow$ Semen Morphology $\downarrow$
Feed Efficient bulls $\uparrow$ Semen Motility $\downarrow$

(Basarab et al, 2011; Hafla et al, 2012; Awda et al, 2013)
Hypothesis

Considering that cattle with divergent feed efficiency have metabolic differences and that sexual maturity influences energy partition, one can hypothesize that young bulls varying in feed efficiency may also differ in fertility and sexual development indirect measures.
Objective

To measure fertility and sexual maturity related phenotypes in the context of feed efficiency (RFI).
Material and Methods
Feed Efficiency Assessment

Breed Composition
60.5% Angus
24.4% Simmental
4.3% Limousin
11% Other *Bos taurus*

Corn Based Diet
53% high moisture corn
39.84% alfalfa silage
5.61% corn gluten meal
0.6% limestone
1.31% mineral premix

Performance Assessment
112 d Feeding test
28 d of US assessment and body weight (BW)
Feed Efficiency Assessment

\[ DMI_{predicted} = 1.05 + 1.74 \times \text{(daily gain; kg/d)} + 0.03 \times \text{(mid-body weight)} + \text{RFI (kg/d)} \]

\[ DMI_{predicted} = -7.60 + 1.58 \times \text{(daily gain; kg/d)} + 0.03 \times \text{(mid-body weight)} + 0.87 \times \text{(backfat thickness; mm)} + 0.03 \times \text{(rib eye area; cm²)} + 1.27 \times \text{(marbling score)} - 0.22 \times \text{(rump fat gain; mm/d)} + \text{RFI (kg/d)} \]

\[ R^2 = 0.84 \]

\[ R^2 = 0.88 \]
Feed Efficiency Assessment

HALVES
17 efficiency
17 inefficient

TAILS
7 efficient
7 inefficient

\( RFI_{koch} \) \( \rightarrow \) HALVES \( \rightarrow \) TAILS \( \rightarrow \) \( RFI_{us} \)
Fertility Related Measures

- Semen Quality
- Organ Biometry
- Thermography
- Testis Tubular Development
- Testicular Echogenicity
Results and Discussion
## Organ Biometry

<table>
<thead>
<tr>
<th>Measure (unit)</th>
<th>RFI&lt;sub&gt;koch&lt;/sub&gt;</th>
<th>RFI&lt;sub&gt;us&lt;/sub&gt;</th>
<th>RFI&lt;sub&gt;koch&lt;/sub&gt;</th>
<th>RFI&lt;sub&gt;us&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Scrotal Circumference (cm)</td>
<td>36.8</td>
<td>36.1</td>
<td>37.0</td>
<td>36.0</td>
</tr>
<tr>
<td>Testis Weight (g)</td>
<td>363</td>
<td>358</td>
<td>380</td>
<td>355</td>
</tr>
<tr>
<td>Testis Volume (mL)</td>
<td>331</td>
<td>322</td>
<td>348</td>
<td>321</td>
</tr>
</tbody>
</table>

Population Size | Low | High  
--- | --- | ---  
204 | 33.9 | 34.0  
328 | 38.3 | 35.3  

(Adapted from Hafla et al, 2012; Awda et al, 2013)
## Semen Quality

<table>
<thead>
<tr>
<th>Measure (unit)</th>
<th>RFI(_{\text{koch}})</th>
<th>RFI(_{\text{us}})</th>
<th>RFI(_{\text{koch}})</th>
<th>RFI(_{\text{us}})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Motility (%)</td>
<td>61.2</td>
<td>62.2</td>
<td>68.9</td>
<td>60.7</td>
</tr>
<tr>
<td>Progressive Motility (%)</td>
<td>53.9</td>
<td>53.7</td>
<td>61.7</td>
<td>51.8</td>
</tr>
<tr>
<td>Semen Concentration (sperm/mL)</td>
<td>314</td>
<td>298</td>
<td>347</td>
<td>252</td>
</tr>
</tbody>
</table>

Motility (%) | Low | High | P-value  
44.0 | 20.0 | 0.002

Progressive Motility (%) | 26.0 | 11.0 | 0.02

(Adapted from Awda et al, 2013)
### Semen Quality

#### HALVES

<table>
<thead>
<tr>
<th>Measure (unit)</th>
<th>$\text{RFI}_{koch}$</th>
<th>$\text{RFI}_{us}$</th>
<th>$\text{RFI}_{koch}$</th>
<th>$\text{RFI}_{us}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Normal Morphology (%)</td>
<td>70.8</td>
<td>68.5</td>
<td>73.1</td>
<td>66.2</td>
</tr>
<tr>
<td>Head Pathologies (%)</td>
<td>5.6</td>
<td>6.1</td>
<td>5.7</td>
<td>5.6</td>
</tr>
<tr>
<td>Tail Pathologies (%)</td>
<td>2.3</td>
<td>3.8</td>
<td>1.3</td>
<td>5.3</td>
</tr>
<tr>
<td>Midpiece Pathologies (%)</td>
<td>10.1</td>
<td>7.6</td>
<td>6.3</td>
<td>7.1</td>
</tr>
</tbody>
</table>

#### TAILS

- Normal Morphology (%)
  - Low: 77.2
  - High: 74.0
  - P-value: 0.09

(Adapted from Hafla et al, 2012)
Thermography

Base of the scrotum

Larger Temperature Variation

29.8 ± 1.16 °C

30.0 ± 0.62 °C

2X
### Ultrasound

#### Testicular echogenicity

<table>
<thead>
<tr>
<th>Measure (unit)</th>
<th>RFI\textsubscript{koch}</th>
<th>RFI\textsubscript{us}</th>
<th>RFI\textsubscript{koch}</th>
<th>RFI\textsubscript{us}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Pixel Intensity (pixels)</td>
<td>Low 90.0</td>
<td>High 79.7</td>
<td>Low 89.7</td>
<td>High 69.8</td>
</tr>
<tr>
<td>Maximum Pixel Intensity (pixels)</td>
<td>Low 198.1</td>
<td>High 184.3</td>
<td>Low 198.0</td>
<td>High 175.5</td>
</tr>
</tbody>
</table>

- 0.05 < P < 0.10
- P < 0.05

*Sexual maturity*

(Evans et al, 1996; Brito et al, 2012; Kastelic and Brito, 2012)
# Histology

## Percentage of Maturity Stages

<table>
<thead>
<tr>
<th>Measure (unit)</th>
<th>$RFI_{koch}$ Low</th>
<th>$RFI_{koch}$ High</th>
<th>$RFI_{us}$ Low</th>
<th>$RFI_{us}$ High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immature (%)</td>
<td>4.9</td>
<td>7.4</td>
<td>5.1</td>
<td>7.8</td>
</tr>
<tr>
<td>Reaching Maturity (%)</td>
<td>13.0</td>
<td>19.0</td>
<td>12.8</td>
<td>17.0</td>
</tr>
<tr>
<td>Mature (%)</td>
<td>34.1</td>
<td>27.5</td>
<td>34.8</td>
<td>29.5</td>
</tr>
</tbody>
</table>

- 0.05 < $P$ < 0.10
- $P$ < 0.05

![Histology Images](image1.png)
# Histology

<table>
<thead>
<tr>
<th>Measure (unit)</th>
<th>RFI&lt;sub&gt;koch&lt;/sub&gt;</th>
<th>RFI&lt;sub&gt;us&lt;/sub&gt;</th>
<th>RFI&lt;sub&gt;koch&lt;/sub&gt;</th>
<th>RFI&lt;sub&gt;us&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low High</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immature Size (mm²)</td>
<td>36.1 38.5</td>
<td>32.1 38.6</td>
<td>26.7 51.1</td>
<td>29.0 50.2</td>
</tr>
<tr>
<td>Reaching Maturity Size (mm²)</td>
<td>38.1 33.5</td>
<td>31.7 35.9</td>
<td>25.4 51.8</td>
<td>25.12 48.7</td>
</tr>
<tr>
<td>Mature Size (mm²)</td>
<td>48.7 46.7</td>
<td>38.5 53.9</td>
<td>31.6 67.2</td>
<td>32.63 62.1</td>
</tr>
</tbody>
</table>

- **0.05<P<0.10**
- **P<0.05**

- **Size of Tubules**
Conclusion

↓ Progressive motile
↓ Normal morphology

Poor Thermoregulation

Lower Echogenicity

↑ Tubule Diameter
Acknowledgments
Tak!
Thank You!
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