Biological Implications of Rumination and Its Use On-Farm

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Rumination...

- One-third of cow’s day spent ruminating.
- Innate behavioral need.
- Influenced by diet, health, and environment.
- Using rumination data on-farm to enhance management is increasingly common.

What Controls Rumination?

- Internal environment
  - Within the reticulorumen
  - Receptors in reticulum reactive to dietary “scratch”
- External environment
  - Management environment
- Cows voluntarily control rumination and stop when disturbed; depressed activity under acute and chronic stress (Gordon, 1968).
- Rumination is highly sensitive to cow well-being.

Rumination and Management Environment

- Physically effective NDF + Fragility
- Heat Stress: -10 to 22%
- Overcrowding: -10 to 20%
- Excessive Headlock Time: -14%
- Mixed Parity Pens: -15%
- 8 to 9 h/d
Rumination and Resting

• Cows prefer to ruminate while lying down (Cooper et al., 2007).
  – >90% of rumination occurs in stalls (Krawczel et al., 2012)
  – 2% increase in resting associated with 7% increase in rumination (Honig et al., 2012)
  – Management that impairs lying time also reduces rumination

• Favored resting posture is sternal recumbency (Albright, 1987).

Rumination: More than Salivation

• Sleep time in cattle is short.
  – 3 h NREM
  – 45 min REM

• Rumination provides physiological benefits provided by deep sleep (Ewbank, 1978).

• EEG patterns during rumination similar to sleep or somnolence.

• Rumination closely associated with drowsiness and can even occur when cow progresses into NREM sleep (Arnold, 1978).

Real-World Rumination Paradigm

• More than amount and quality of fiber influence rumination time.

• Cow and nutritional factors set “normal” maximum on rumination.
  – DMI (Metz, 1975).
  – Fiber content, particle size, digestibility (Mertens, 1997; Cotanch et al., 2005).

• We can reduce that amount with non-ideal management.

Use of Rumination On-Farm as a Management Tool

• Rumination responds to stressor 12 to 48 hours sooner than traditional measurements such as elevated temperature, depressed feed intake, and milk yield.

• Deviation from baseline rumination is sign that rumen function is negatively affected.

• On-farm systems are becoming available to monitor rumination and other activities.
Rumination Index and Rumination Time (Campbell, 2015, unpublished)

\[ y = 583.8x + 221.9 \]

\[ R^2 = 0.54 \]

- Is there any role for simple index?
- Direct observation is labor intensive; only few cows monitored at once.
- “Snapshot”

Challenges Faced by Producers that Benefit from Rumination Monitoring

- Identifying nutritional problems.
- Improving reproductive performance.
- Detecting health problems earlier such as metabolic disorders, mastitis, and lameness.
- Gauging management effectiveness: grouping and stocking density.
- Modifying traditional fresh-cow checks with less disturbance of cows and time in headlocks, less labor, more focus on high-risk cows.
- Changing treatment and culling decisions: cow can be monitored after treatment to decide whether it is working or not.

Changes in Rumination Time

<table>
<thead>
<tr>
<th>Measure</th>
<th>Calving</th>
<th>Estrus</th>
<th>Hoof</th>
<th>Heat</th>
<th>Mastitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in ruminaton, min/d</td>
<td>-170 to 255</td>
<td>-75</td>
<td>0 to -45</td>
<td>-20 to -70</td>
<td>-40 to -120</td>
</tr>
</tbody>
</table>

- Average ruminaton: 450-550 min/d.
- Goal: <30-50 min/d variation on pen basis.
- Look for deviations from consistent, baseline ruminaton.
- Look for patterns in variation.
- Variation in pen mean across days or variation within a pen across days?

Examples of Ruminaton Monitoring On-Farm

- Identifying transition cow health issues sooner
- Identifying hoof health/lameness sooner
- Gauging effectiveness of management
  - Grouping strategy
  - Heat stress abatement
Rumination During Transition Period
(Daniels et al., 2003; Soriani et al., 2012)

- Primi- and multiparous cows with greater lying and ruminating times for days -2 and -6 prepartum have greater DMI and milk yield days 1 to 14 postpartum.
- Cows with less rumination pre-partum tend to have less rumination time postpartum.
- Shorter rumination time associated with increased risk of metabolic disorders.

Heathy Fresh Cows Have Higher Rumination Before and Immediately After Calving

- Begin to diverge at -6 d
- Decrease 50 min more for ill cows
- For first 7 d, ill cows increase 50 min/d
- For first 7 d, healthy cows increase 70 min/d

Miner Institute, 2013 to 2015

Rumination Decreases Several Days Before a DA is Diagnosed

- day -6 to 0 slope = -20 min/d
- day 0 to 4 slope = +57 min/d

Miner Institute, 2013 to 2015

Rumination and Activity Monitoring System IDs Health Problems Before Clinical Signs

<table>
<thead>
<tr>
<th>Health Problem</th>
<th>Day of Alert Relative to Clinical Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>-3</td>
</tr>
<tr>
<td>Ketosis</td>
<td>-1.6</td>
</tr>
<tr>
<td>Indigestion</td>
<td>-0.5</td>
</tr>
<tr>
<td>Metritis</td>
<td>-0.8</td>
</tr>
<tr>
<td>Mastitis</td>
<td>-0.8</td>
</tr>
</tbody>
</table>

Stangaferro et al. (2015)
Cows Ruminated Less at Night (8 pm to 4 am) Before Being Diagnosed as Lame

(Van Hertem et al., 2013; J. Dairy Sci. 96:4286)

Hoof Health and Rumination

Dominance and Rumination

(Ungerfeld et al., 2014)

- Compared rumination activity of high and low ranked dairy cows.
- Lower ranked cows ruminated 35% less than higher ranked cows.
  - Shorter rumination bouts
  - Reflected lower feed intake by low ranking cows
  - Compromised well-being

Using Rumination to Assess Grouping Strategies

1st lactation cows moved to separate pen

Data courtesy of St. Cyr (2014)
Rumination by Primiparous Cows inPreferred/ Less Preferred Stalls (Krawczel, 2007)

<table>
<thead>
<tr>
<th></th>
<th>Preferred</th>
<th>Less preferred</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>Rumination time, min/d</td>
<td>81.4</td>
<td>147.8</td>
<td>0.09</td>
</tr>
<tr>
<td>% resting time spent ruminating</td>
<td>35.2</td>
<td>58.4</td>
<td>0.05</td>
</tr>
</tbody>
</table>

➢ Long-term implications?

Heat Stress and Behavioral Responses (Tapki and Sahin, 2006)

- As air temp increases from 25 to 40°C
  - Eating: decreases 46%
  - Ruminating: decreases 22%
  - Standing: increases 34%
- Higher producing cows (>32 kg/d) more sensitive than low producing cows
  - Especially for lying and ruminating activity
- 2.2 min reduction in rumination time for each maximum THI unit over 76 (Soriani et al., 2013).

Heat Stress and Rumination

Miner Institute, 2013

Heat Abatement Effectiveness Indicated by Rumination

Miner Institute, 2013
Summary

• Rumination is highly sensitive to changes in cow health and comfort.
• Monitoring allows
  — earlier identification of problems and intervention
  — earlier gauging of effectiveness of management
  — earlier assessment of treatment effectiveness

Final Perspectives

• Not all studies find useful relationships.
• Should not focus on only one measure to diagnose cows that will develop disease.
• Focus needs to be on change from day-to-day versus baseline.
• Expect routine use of rumination monitoring to grow because it flags problems sooner.