Evaluation of the Cornell Net Carbohydrate and Protein System version 7.0 for pasture-based systems

Dineen, M., Higgs, R., McCarthy, B. and Van Amburgh, M.E.
What is the CNCPS?

- Nutritional model designed to evaluate diets and animal performance
- Uses science-based principals:
  - Physiological state
  - Rumen function
  - Feed digestion and passage kinetics
  - Microbial growth
- Helps to balance/complement the available resources
- Increase efficiency of milk production systems
Nutrient requirements

<table>
<thead>
<tr>
<th></th>
<th>ME</th>
<th>MP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>50.5</td>
<td>1962</td>
</tr>
<tr>
<td>Maintenance</td>
<td>19.6</td>
<td>487</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Lactation</td>
<td>31.7</td>
<td>1282.1</td>
</tr>
<tr>
<td>Growth</td>
<td>0.5</td>
<td>23.7</td>
</tr>
<tr>
<td>Reserves</td>
<td>1.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Balance</td>
<td>-1.3</td>
<td>169.2</td>
</tr>
<tr>
<td>% Required</td>
<td>97</td>
<td>109</td>
</tr>
</tbody>
</table>
Cornell University

Heart of the model

- Feed library
- Over 800 feeds
- Stable ingredients
- Forages – biweekly/monthly
- Continuous refinement and further development
- Incorporation of NIR technology

Feed chemistry analysis

Raffrenato et al., 2011
CNCPS v7.0 in development

- New dynamic structure for the entire GIT
- Can model meal patterns
- Mechanistic large intestine
- Inclusion of protozoa in the microbial sub model
- Inclusion of endogenous N transactions along the GIT
- Revised efficiencies of AA use (g AA/Mcal ME)
- New passage rates implemented (NorFor, 2011)
<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet composition, % of DM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crude Protein</td>
<td>18.9</td>
<td>2.5</td>
<td>13.8</td>
<td>25.4</td>
</tr>
<tr>
<td>Neutral detergent fibre (aNDFom)</td>
<td>34.7</td>
<td>6.0</td>
<td>25.5</td>
<td>51.6</td>
</tr>
<tr>
<td>Sugar</td>
<td>9.9</td>
<td>2.0</td>
<td>6.5</td>
<td>13.6</td>
</tr>
<tr>
<td>Starch</td>
<td>3.8</td>
<td>4.1</td>
<td>0.1</td>
<td>18.0</td>
</tr>
<tr>
<td>Forage inclusion</td>
<td>87.7</td>
<td>14.3</td>
<td>52.2</td>
<td>100</td>
</tr>
<tr>
<td>Animal inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Body weight, kg</td>
<td>511</td>
<td>23</td>
<td>434</td>
<td>576</td>
</tr>
<tr>
<td>Body Condition Score, 1-5 scale</td>
<td>2.8</td>
<td>0.2</td>
<td>2.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Dry Matter Intake, kg day⁻¹</td>
<td>17.4</td>
<td>2.1</td>
<td>13.6</td>
<td>21.2</td>
</tr>
<tr>
<td>Production inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk yield, kg day⁻¹</td>
<td>23.5</td>
<td>5.1</td>
<td>12.8</td>
<td>31.9</td>
</tr>
<tr>
<td>Milk true protein, %</td>
<td>3.3</td>
<td>0.2</td>
<td>3.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Milk fat, %</td>
<td>4.2</td>
<td>0.8</td>
<td>3.4</td>
<td>7.7</td>
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<tr>
<td>Model outputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metabolisable protein (MP) supply, gram day⁻¹</td>
<td>2,045</td>
<td>322</td>
<td>1,470</td>
<td>2,804</td>
</tr>
<tr>
<td>Microbial protein, % of MP</td>
<td>68</td>
<td>6</td>
<td>43</td>
<td>77</td>
</tr>
<tr>
<td>Metabolisable energy supply, Mcals day⁻¹</td>
<td>44.9</td>
<td>5.5</td>
<td>34.0</td>
<td>56.2</td>
</tr>
<tr>
<td>aNDFom intake, grams day⁻¹</td>
<td>6,000</td>
<td>1,115</td>
<td>4,300</td>
<td>8,900</td>
</tr>
<tr>
<td>Rumen degraded, % aNDFom</td>
<td>73</td>
<td>6</td>
<td>56</td>
<td>82</td>
</tr>
<tr>
<td>Total tract degraded, % aNDFom</td>
<td>78</td>
<td>6</td>
<td>62</td>
<td>85</td>
</tr>
</tbody>
</table>
y = 0.84x + 3.57
$R^2 = 0.67$
How to increase accuracy and precision?
- More in-depth feed chemistry analysis

- Mechanistic understanding of intake

**aNDFom vs. uNDFom240**

- Spring $kd = 9.5 \% / h$
- Autumn $kd = 7.8 \% / h$

<table>
<thead>
<tr>
<th>Intake (kg DM)</th>
<th>CNCPS v7.0</th>
<th>Observed MD17</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>17.615</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rumen uNDFom pool size (kg)</th>
<th>1.473</th>
<th>1.6475</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rumen uNDFom pool size (% BW)</td>
<td>0.29%</td>
<td>0.32%</td>
</tr>
</tbody>
</table>

Dineen et al., unpublished
Potential application in pasture based systems?

- Quantify what is first limiting milk solid production
- Grass breeding – new traits (uNDF), cultivar evaluation
- Mechanistic understanding of the biology of the cow
  - Substitution effect
  - Response to supplement
- Link to PastureBase
- Education and extension
- Environmental – methane production, nitrogen efficiency
- Sensor technology
- How to influence milk composition
Thank you!

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