Nitrogen use efficiency ($\text{NUE}_N$) of dairy cows under intensive grazing

20 June, Cindy Klootwijk

Components of Amazing Grazing

- Feed supplementation
- Grass intake
- Grass supply
- Grass growth
- Soil
- Cow behaviour
Challenges intensive grazing vs $\text{NUE}_N$

- Dutch dairy sector
  - $> x$ cows per grazing area
  - High demand for grazing
  - Focus on improving $\text{NUE}_N$

- Limited knowledge on grass (N) intake
- High level of feed supplementation
Grazing systems for intensive grazing

- Higher grassland utilization
- More equal distribution of manure

Stripgrazing (SG)  
Compartmented continuous grazing (CCG)
Objective:
To test the effects of intensive grazing systems and dietary protein level on $\text{NUE}_N$ at cow level
2 x 2 factorial design

<table>
<thead>
<tr>
<th>Grazing system</th>
<th>Protein level</th>
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<tbody>
<tr>
<td></td>
<td>SG</td>
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<tr>
<td></td>
<td>Low RDP</td>
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<td></td>
<td>CCG</td>
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<td>Low RDP</td>
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<td>CCG</td>
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<td></td>
<td>High RDP</td>
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- RDP = rumen degradable protein
  - Contrast of 500 g RDP cow\(^{-1}\) day\(^{-1}\)

5 kg concentrates with sugar beet pulp (-50) or rapeseed meal (+50)
2 x 2 factorial design

- April – October 2016 + 2017
- 8 ha: 7.5 cow per ha
- Daytime grazing

- 4 groups of 15 dairy cows (HF)
  - Before start: 38.8 kg FPCM cow\(^{-1}\) day\(^{-1}\)
  - At start: 175 (115-247) days in lactation
  - 2.6 (1-7) lactations
Quantifying inputs and outputs

- Fresh grass
- Maize
- Concentrates

- Milk
- Faeces
- Urine

\[ \text{NUE}_N = \frac{N \text{ milk}}{N \text{ feed}} \]

\[ \text{N digestibility} = \frac{(N \text{ feed} - N \text{ faeces})}{N \text{ feed}} \]

- 60 individual dairy cows
- Subset: July + September 2016
Quantifying inputs and outputs

Marker technique: n-alkane
(Mayes et al., 1986)

Automated registration

Fresh grass  Faeces
Maize  Milk
Concentrates
Quantifying inputs and outputs

- Grass samples: daily at 09:00
- Manure samples: twice a day after milking
- Milk samples: 4 consecutive milkings
Results $NUE_N$: SG vs CCG

- **July:** SG < CCG (37% vs 39%; $P=0.003$)
  - due to higher grass (N) intake

- **Sept.:** No difference SG and CCG ($P=0.723$)
  - due to lower grass RDP content

SG: 4.2 kg DM cow$^{-1}$ day$^{-1}$
CCG: 3.6 kg DM cow$^{-1}$ day$^{-1}$
Results $\text{NUE}_N$: high vs low RDP

- High RDP < low RDP (35% vs 41%; $P<0.001$)
  - due to higher concentrate N intake
  - despite higher milk output: 30 vs 26 kg cow$^{-1}$ day$^{-1}$
Results N digestibility

Increase in dietary N

Fresh grass
Concentrates

Milk
Faeces
Urine
Low N digestibility

- **Absolute RDP levels**
  - Low RDP was very low (-300)
  - High RDP was ‘normal’ (+200)

- **Shortage N on rumen level**
  - Low NH$_3$ in rumen: <3 mmol/L
  - Low milk urea: 10 mg/dl

→ N digestibility grass?
Conclusions

- SG slightly higher grass intake compared to CCG
  - Grass N digestibility?

- Increase in feed N
  - Increase in urine N
  - Increase in N digestibility
  - Decrease in NUE$_N$

- High faeces N; low urine N → environmental impact
Further analyses

- Tested with higher N level in 2017
- $\text{NUE}_N$ at farm level
Amazing Grazing!!!

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- Provincie Fryslân
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- Op naar Precisielandbouw 2.0
- Ruwvoer & Bodem
<table>
<thead>
<tr>
<th></th>
<th>Treatment groups</th>
<th>GS</th>
<th>RDP</th>
<th>GS*RDP</th>
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</thead>
<tbody>
<tr>
<td><strong>Total feed in kg DM cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>19.3</td>
<td>18.3</td>
<td>18.8</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>18.9</td>
<td>18.0</td>
<td>18.9</td>
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<tr>
<td><strong>Total feed N in g cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>472</td>
<td>354</td>
<td>480</td>
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<td></td>
<td>S</td>
<td>447</td>
<td>360</td>
<td>454</td>
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<td><strong>Grass in kg DM cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>4.1</td>
<td>4.2</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>2.8</td>
<td>3.4</td>
<td>3.6</td>
</tr>
<tr>
<td><strong>Grass N in g cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>140</td>
<td>132</td>
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<td></td>
<td>S</td>
<td>113</td>
<td>139</td>
<td>128</td>
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<tr>
<td><strong>Milk in kg cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>30.8</td>
<td>25.8</td>
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<tr>
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<td>S</td>
<td>28.9</td>
<td>25.2</td>
<td>29.4</td>
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<tr>
<td><strong>Milk N in g cow⁻¹ day⁻¹</strong></td>
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<td>170</td>
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<td></td>
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<tr>
<td><strong>Faecal N in g cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>162</td>
<td>152</td>
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<td></td>
<td>S</td>
<td>136</td>
<td>148</td>
<td>146</td>
</tr>
<tr>
<td><strong>Urine N in g cow⁻¹ day⁻¹</strong></td>
<td>J</td>
<td>140</td>
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<td>S</td>
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<td>155</td>
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<tr>
<td><strong>NUE₅ in %</strong></td>
<td>J</td>
<td>36</td>
<td>42</td>
<td>34</td>
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<tr>
<td></td>
<td>S</td>
<td>34</td>
<td>40</td>
<td>34</td>
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<tr>
<td><strong>N digestibility₆ in %</strong></td>
<td>J</td>
<td>66</td>
<td>57</td>
<td>70</td>
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<tr>
<td></td>
<td>S</td>
<td>69</td>
<td>58</td>
<td>68</td>
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</table>
Compared to an efficient Dutch cow

Jan Dijkstra, 2013

<table>
<thead>
<tr>
<th></th>
<th>Efficient cow</th>
<th>Low RDP</th>
<th>High RDP</th>
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<tbody>
<tr>
<td><strong>N feed</strong></td>
<td>461</td>
<td>360</td>
<td>463</td>
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<tr>
<td><strong>N faeces</strong></td>
<td>89</td>
<td>143</td>
<td>148</td>
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<tr>
<td><strong>N urine</strong></td>
<td>174</td>
<td>73</td>
<td>156</td>
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<tr>
<td><strong>N milk</strong></td>
<td>198</td>
<td>144</td>
<td>159</td>
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<tr>
<td><strong>$NUE_N$ %</strong></td>
<td>43</td>
<td>40</td>
<td>34</td>
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<tr>
<td><strong>N digestibility %</strong></td>
<td>81</td>
<td>61</td>
<td>68</td>
</tr>
</tbody>
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- High average $NUE_N$: 37%
  - Low N feed input
- Low average digestibility: 64%
  - High N faeces
  - Low N urine