Comparing the use of dry matter intake and residual feed intake to improve feed efficiency in Holstein cattle

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• Feed accounts for over **50%** of on-farm costs

• Animals with high genetic potential for production eat more

• More efficient cows have potential to decrease feed costs while maintaining production

• Selection on feed efficiency has been successful in other species:
  – Poultry
  – Swine
  – Aquaculture

*Beever et al., 2007; Hemme et al., 2014; Connor, 2016.*
Objective

Compare the use of DMI and RFI to improve feed efficiency in Holstein cattle through deterministic modeling
Scenarios

Base Index:

\[ BASE = b_1(FY) + b_2(PY) + b_3(BCS) + b_4(STAT) + b_5(AFS) + b_6(FSTC) + b_7(CK) + b_8(DA) \]

DMI Index:

\[ DMI = BASE + b_9(DMI) \]

RFI Index:

\[ RFI = BASE + b_9(RFI) \]

FY = fat yield, PY = protein yield, BCS = body condition score, STAT = stature, AFS = age at first service, FSTC = first service to conception, CK = clinical ketosis, DA = displaced abomasum, DMI = dry matter intake, RFI = residual feed intake
### Parameters

<table>
<thead>
<tr>
<th>Trait</th>
<th>Number of Records</th>
<th>$\sigma_p$</th>
<th>$h^2$</th>
<th>Genomic Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat yield (kg)</td>
<td>456,939</td>
<td>61.91</td>
<td>0.32$^b$</td>
<td>0.80</td>
</tr>
<tr>
<td>Protein yield (kg)</td>
<td>456,939</td>
<td>47.03</td>
<td>0.27$^a$</td>
<td>0.79</td>
</tr>
<tr>
<td>Body condition score (score)</td>
<td>391,319</td>
<td>0.36</td>
<td>0.24$^b$</td>
<td>0.77</td>
</tr>
<tr>
<td>Stature (cm)</td>
<td>391,319</td>
<td>3.48</td>
<td>0.46$^a$</td>
<td>0.77</td>
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<tr>
<td>Age at first service (days)</td>
<td>495,022</td>
<td>54.22</td>
<td>0.05$^a$</td>
<td>0.69</td>
</tr>
<tr>
<td>First service to conception (days)</td>
<td>399,339</td>
<td>46.34</td>
<td>0.03$^a$</td>
<td>0.74</td>
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<tr>
<td>Clinical ketosis (case)</td>
<td>101,374</td>
<td>0.21</td>
<td>0.04$^a$</td>
<td>0.61</td>
</tr>
<tr>
<td>Displaced abomasum (case)</td>
<td>239,257</td>
<td>0.15</td>
<td>0.02$^a$</td>
<td>0.59</td>
</tr>
<tr>
<td>Dry matter intake (kg/day)</td>
<td>1,909</td>
<td>2.45</td>
<td>0.49$^a$</td>
<td>0.59$^1$</td>
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<tr>
<td>Residual feed intake (kg/day)</td>
<td>1,595</td>
<td>2.25</td>
<td>0.28$^b$</td>
<td>0.40$^2$</td>
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</tbody>
</table>

$^a$Standard deviation < 0.10  $^b$Standard deviation < 0.10  $^1$Miglior et al., 2018, $^2$Pryce et al., 2014
<table>
<thead>
<tr>
<th></th>
<th>FY</th>
<th>PY</th>
<th>BCS</th>
<th>STAT</th>
<th>AFS</th>
<th>FSTC</th>
<th>CK</th>
<th>DA</th>
<th>DMI</th>
<th>RFI</th>
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<td>Fat yield</td>
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<td>Protein yield</td>
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<td>First service to conception</td>
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<td>Clinical ketosis</td>
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<td>Displaced abomasum</td>
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Genetic correlations (above diagonal) and phenotypic correlations (below diagonal)

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Breeding Structure

Genotyped Bull Calves
7% selected

Genomic Bulls
5% selected

Proven Bulls

Genomic Bulls
100% of matings

Elite Dams
70% of matings

Dams of Cows
30% of matings

Heifer Calves
10% selected

Elite Dams
85% selected

Dams of Cows

Interbull Annual Meeting - June 23 2019 - Cincinnati Ohio, USA - Houlahan et al.
## Trait Response to Selection

<table>
<thead>
<tr>
<th>FY (kg)</th>
<th>PY (kg)</th>
<th>BCS score</th>
<th>STAT cm</th>
<th>AFS days</th>
<th>FSTC days</th>
<th>CK case</th>
<th>DA case</th>
<th>DMI kg/day</th>
<th>RFI kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASE</td>
<td>14.68</td>
<td>9.44</td>
<td>0.00</td>
<td>0.05</td>
<td>-2.49</td>
<td>1.23</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
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<tr>
<td>DMI</td>
<td>14.63</td>
<td>9.59</td>
<td>-0.01</td>
<td>0.05</td>
<td>-1.80</td>
<td>1.76</td>
<td>0.00</td>
<td>0.00</td>
<td>0.03</td>
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<tr>
<td>RFI</td>
<td>14.85</td>
<td>9.60</td>
<td>-0.01</td>
<td>0.05</td>
<td>-2.39</td>
<td>1.31</td>
<td>0.00</td>
<td>0.00</td>
<td>-</td>
</tr>
</tbody>
</table>

FY = fat yield, PY = protein yield, BCS = body condition score, STAT = stature, AFS = age at first service, FSTC = first service to conception, CK = clinical ketosis, DA = displaced abomasum, DMI = dry matter intake, RFI = residual feed intake
Projecting Response to Selection

Cumulative Response per Cow for Feed Efficiency using DMI

Amount of Dry Matter Saved (kg) vs. Amount of Money Saved ($CAD)

- Amount of Dry Matter Saved
- Amount of Money Saved

Year

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Projected Response to Selection

Cumulative Response per Cow for Feed Efficiency using RFI

Amount of Dry Matter Saved (kg)

Amount of Money Saved ($CAD)

Year

1  2  3  4  5  6  7  8  9  10

0  5  10  15  20  25  30  35

$0  $5  $10  $15  $20  $25  $30  $35

Amount of Dry Matter Saved
Amount of Money Saved

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Conclusions

• Selecting on DMI or RFI will improve feed efficiency

• Improving feed efficiency does not show detrimental effects on other traits

• Increasing the weight on RFI could result in a similar response to selection as DMI
Acknowledgements