Effect of heat stress on methane emissions of Dutch Holstein population

Introduction
Objectives

Investigate the *potential impact of temperature and humidity on methane emissions* in the Dutch Holstein population.
Measuring CH$_4$

- Breath sample devices to measure enteric methane (CH$_4$) and carbon dioxide (CO$_2$)
- Unit is concentration in parts per million (ppm)
Databases

### CH₄ phenotypes
- 7,669 Holstein cows
- 130K weekly records
- 375 DIM
- 66 farms
- 2019-2023 recording
- Parities 1-4+

### Temperature-Humidity Indicator
- Formula from National Research Council
- Daily meteorological records from Netherlands Meteorological Institute
- 24 stations closest to the farms
- THI weekly average
First analysis (model) Population level

\[ y = \text{Fixed Effects} + a + pe + e \]

\[ HYS + Lact_{week} + \text{par. ACC} + \text{THI} \]
First results: Population level

"positive effect"
Descriptive Statistics

<table>
<thead>
<tr>
<th>Trait</th>
<th>Mean</th>
<th>SD</th>
<th>CV %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_4$ ppm</td>
<td>573.8</td>
<td>297.1</td>
<td>51</td>
</tr>
</tbody>
</table>
$y = \text{Fixed Effects} + a + a \cdot THI_{46} + pe + e$

$HYS + Lact_{week} + par.\ ACC + THI\_group$

- low
- medium
- high
Heritabilities and permanent enviromental ratio

<table>
<thead>
<tr>
<th>Trait</th>
<th>$h^2$</th>
<th>a.Thi ratio</th>
<th>pe$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_4$ ppm</td>
<td>0.27 (0.01)</td>
<td>0.003 (0.01)</td>
<td>0.28 (0.01)</td>
</tr>
</tbody>
</table>

$r_g$

| a - a.THI | -0.80 (0.02) |
Choosing top and bottom animals

[Diagram showing CH$_4$ levels with two circles at 50 on either side, an arrow pointing to 46 THI at 72]
Plotting EBV of 50 top and bottom animals
Conclusions

- There is a **strong negative correlation** between genetic effect and the interaction with THI.

- **High CH$_4$ emitting animals could reduce** their CH$_4$ emissions at higher THI.

- **Low CH$_4$ emitting animals** had a **slightly increase** on CH$_4$ emissions.
Implications

We should put attention to this genetic interaction with THI, given we want to select for low $CH_4$ emitting animals and with global warming THI levels can increase in the future.
Thank you for your attention