An assessment of variable importance when predicting greenhouse gas emissions, beef output and land use of German dairy farms

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Conclusions

The dominance analysis approach enabled a ranking of a set of regressors with different units in terms of relative importance. The implementation of the indicator „beef output per kg FPCM” helped to identify those variables that have a high potential to reduce GHG emissions and land use per kg FPCM but could result in a shift of GHG emissions between production systems.

Objectives

This study investigates GHG emissions, beef output and land use per kg of FPCM of commercial dairy farms from two regions in Germany as affected by breed. Those variables will be identified that have a high potential to mitigate GHG emissions i.e. (a) are highly variable between farms, (b) have a high level of contribution on GHG emissions (c) do not show a trade off with beef output per kg FPCM and land use per kg FPCM.

Material and Methods

Dairy farms from Bavaria with dual purpose Fleckvieh cows (South-Dual purpose) and from Nordrhein-Westfalia with milk breed Holstein-Friesian dairy cows (West-Milk breed) were investigated. GHG emissions and land use were calculated using a LCA approach.

Table 1: Value of farm characteristics for the investigated dairy farms (2010) (FPCM=fat and protein corrected milk yield)

<table>
<thead>
<tr>
<th>Number of farms</th>
<th>South-Dual purpose</th>
<th>West-Milk breed</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>Mean (max-min)</td>
<td>Mean (max-min)</td>
</tr>
<tr>
<td>Dairy cows</td>
<td>86 (145-49)</td>
<td>149 (457-67)</td>
</tr>
<tr>
<td>Milk yield kg FPCM/cow/year</td>
<td>8559 (9840-7507)</td>
<td>9596 (10680-8186)</td>
</tr>
<tr>
<td>Adjusted replacement rate</td>
<td>29 (55-14)</td>
<td>27 (51-15)</td>
</tr>
<tr>
<td>Culling interval days</td>
<td>340 (416-359)</td>
<td>410 (461-380)</td>
</tr>
<tr>
<td>Fixed intake kg dairy cow DM%/cow/year</td>
<td>7081 (8816-6153)</td>
<td>7686 (8700-7033)</td>
</tr>
</tbody>
</table>

Results

- Lower GHG emissions (p<0.05) within West- Milk breed dairy farms but also considerable lower potential beef output
- No statistical significant difference between land use
- Wide range in GHG emissions and land use within the investigated regions and production systems

Controls to e.g. GHG emissions, beef output or land use and show a high degree of variability are defined as ‘important parameters/variables’.

Most important variables were identified using multiple linear regression and dominance analysis, “relaimpo” package in R (Azen and Budescu, 2003; Groemping, 2006).

\[ LMG(x_k) = \frac{1}{p} \sum_{i=1}^{p-1} \frac{\text{var}(x_k | x_1, \ldots, x_{i-1}, x_{i+1}, \ldots, x_p)}{\text{var}(x_k)} \]

where LMG (xk) equals the average over model sizes i of average improvements in R² when adding regressor xk to a model of size i without xk, \( \text{var}(x_k | x_1, \ldots, x_{i-1}, x_{i+1}, \ldots, x_p) \) equals additional R² when adding xk to a model with the regressors in set S (Groemping, 2006).

References & Contact

Variables that are high contributors to e.g. GHG emissions, beef output or land use and show a high degree of variability are defined as ‘important parameters/variables’.

Milk yield and replacement rate had the highest impact on variation of GHG emissions of both dairy farm groups.

A trade off between GHG emissions per kg of FPCM and potential beef output per kg of FPCM was shown in the case of milk yield and replacement rate.

An increase in milk yield per day of life (joint indicator of milk yield/cow, replacement rate and age of first calving) (Roemer, 2011) captures a high percentage of variance in GHG emission outcomes.

References:


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3 fat and protein corrected milk

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