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

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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 implimentation of the indicator „beef output per kg FPCM[3]" 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 emssions 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)

		South – Dual purpose		West – Milk breed	
Number of farms	#	27		26	
Farm characteristics and production traits					
Item	Unit	Mean	(max-min)	Mean	(max-min)
Dairy cows	#	86	(145-49)	149	(457-67)
Milk yield	kg FPCM/cow per year	8559	(9840-7507)	9596	(10680-8186)
Adjusted replacement rate	%	29	(55-14)	27	(51-15)
Calving interval	days	380	(416-359)	410	(461-380)
Feed intake dairy cow	kg DM*/cow/year	7081	(8816-6153)	7686	(8700-7033)

*Dorfner et al. (2010), *DM=dry matter*

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'.

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

$$LMG(x_k) = \frac{1}{p} * \sum_{i=0}^{p-1} \left(\sum_{\substack{S \subseteq \{x_1,\ldots,x_p\} \setminus \{x_k\} \\ n(S)=i}} \frac{seqR^2(\{x_k\} \mid S)}{\binom{p-1}{i}} \right)$$

where LMG (xk) equals the average over model sizes i of average improvements in R^2 when adding regressor xk to a model of size i without xk, seqR^2 ({xk}|S) equals = additional R^2 when adding xk to a model with the regressors in set S (Groemping, 2006).

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

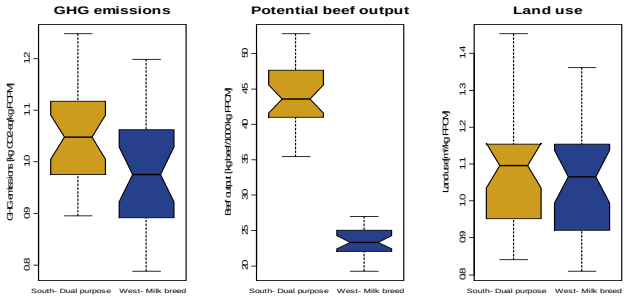

Fig 1: GHG emissions, potential beef output and land use per kg of FPCM of investigated dairy farms

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.

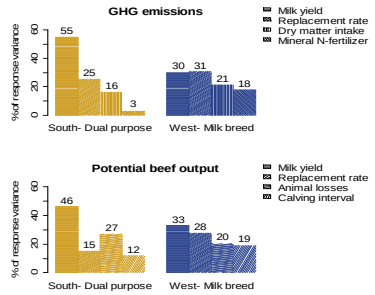

Fig 2: Linear regression with variance decomposition indicating the percent of variance in GHG emissions and potential beef output per kg of FPCM accounted for by predictor variables

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.

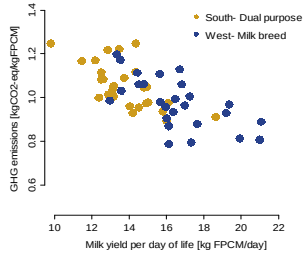

Fig 3: GHG emissions per FPCM as a function of milk yield per day of life (milk yield per cow per life divided by days of life from birth to culled)

References & Contact

References:

Azen, R., Budescu, D.V., 2003; Dorfner, G. und Hofmann, G., 2012; Groemping, U., 2006; Roemer, A., 2011.

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