Greenhouse gas emissions of organic and conventional dairy farms — results from a pilot farm network in Germany

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Key challenges

Dairy farming heavily contributes to greenhouse gas (GHG) emissions of agriculture. A complete assessment of all GHG sources is necessary to identify weak areas of systems (i.e., organic vs. conventional farming) and farms, thus helping to detect mitigation potential of GHG emissions. Additionally, parameters of dairy cow welfare and health might also affect environmental performance of dairy farms.

Material and Methods

The farm model REPRO and its Excel extension (Schmid et al., 2013; Frank et al., 2014) were used to calculate complete GHG balances for 34 dairy farms of our network.

To study the effects of using different estimation equations on the level of enteric methane (CH_4) emissions in dairy cows, the equations by Ellis et al. (2007) and Kirchgeßner et al. (1995) were applied, which are based on daily dry matter intake alone and considering also nutrient composition of diets, respectively.

Status quo of dairy cow welfare was assessed by applying the Welfare Quality® assessment protocol for cattle (2009). Measures with the aim of improving the farm's sustainability and/or dairy cow welfare were put into scenarios (all at once as a bundle) for REPRO to yield an estimate on how the improvements affect sustainability indicators (e.g., GHG emissions).

Results

Product related GHG emissions did not differ between organic and conventional farms and were rather farm individual (**TAB 1**). Product related GHG emissions declined with increasing milk yields, but from a certain milk yield onwards no further decrease in GHG emissions was observed (**FIG 1**).

On average, values for enteric CH_4 emissions in dairy cows were 112 g CO_{2eq} kg^{-1} energy corrected milk (ECM) higher when using the estimation equation by Kirchgeßner et al. (1995) vs. Ellis et al. (2007; data not shown).

TAB 1: Product related GHG emissions (g CO_{2eq} kg^{-1} ECM) at the farm gate of organic (n = 16) and conventional farms (n = 18).

Source of GHG emissions	Organic farms		Conventional farms		
	Mean ± SD	MIN-MAX	Mean ± SD	MIN-MAX	
Fodder production	114 ± 58	4 - 237	301 ± 57	197 - 393	*
On-farm	92 ± 59	2 - 183	187 ± 52	109 - 284	*
Purchase of fodder	22 ± 24	1 - 79	114 ± 60	7 - 224	*
Storage of fodder	12 ± 6	3 - 22	12 ± 3	6 - 18	ns
Enteric fermentation	405 ± 45	349 - 492	320 ± 19	294 - 355	*
Housing	20 ± 12	8 - 51	10 ± 5	5 - 27	*
Manure management	128 ± 36	77 - 221	117 ± 33	47 - 151	ns
Breeding of heifers	258 ± 75	132 - 423	242 ± 71	164 - 437	ns
Milking process	46 ± 4	43 - 60	45 ± 4	42 - 62	ns
Total	**983 ± 149**	**835 - 1397**	**1047 ± 88**	**911 - 1248**	**ns**

* = p ≤ 0.05, ns = not significant.

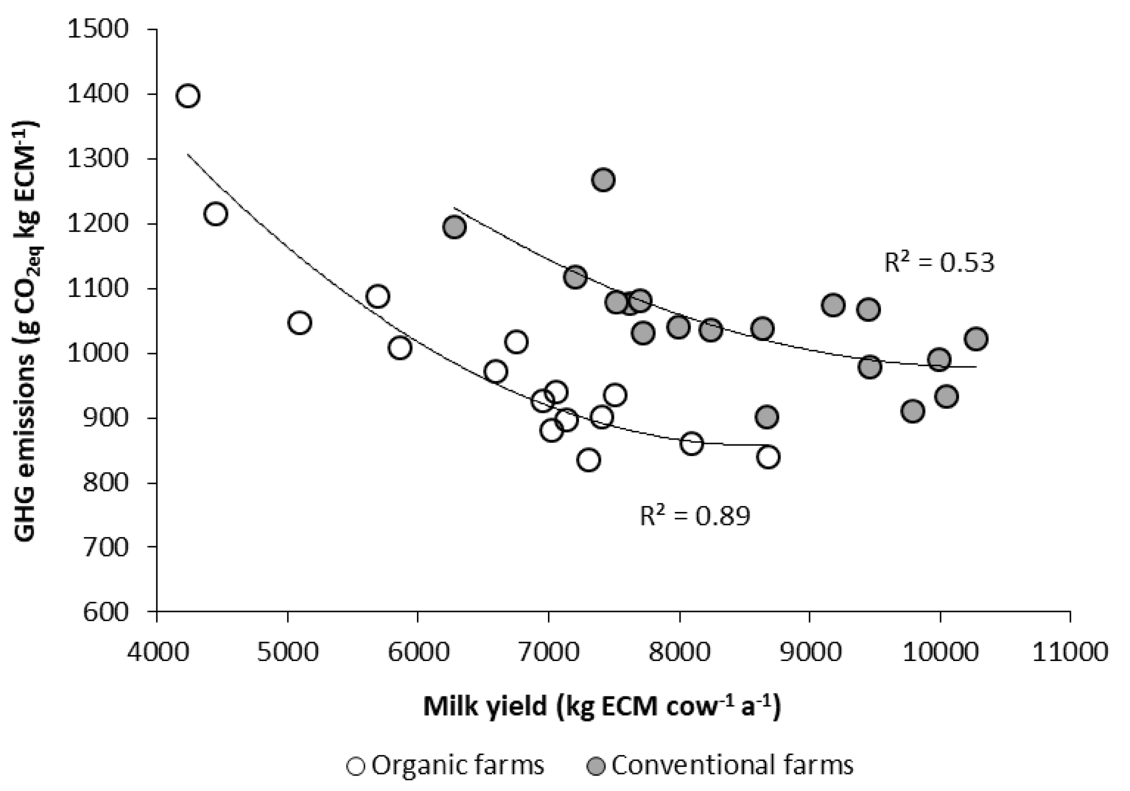


FIG 1: Relation of milk yield and product related GHG emissions of organic (n = 16) and conventional farms (n = 18).

Scenario modelling for the pilot farm used here as an example resulted in a reduction of 3.9 % in GHG emissions (**FIG 2**).

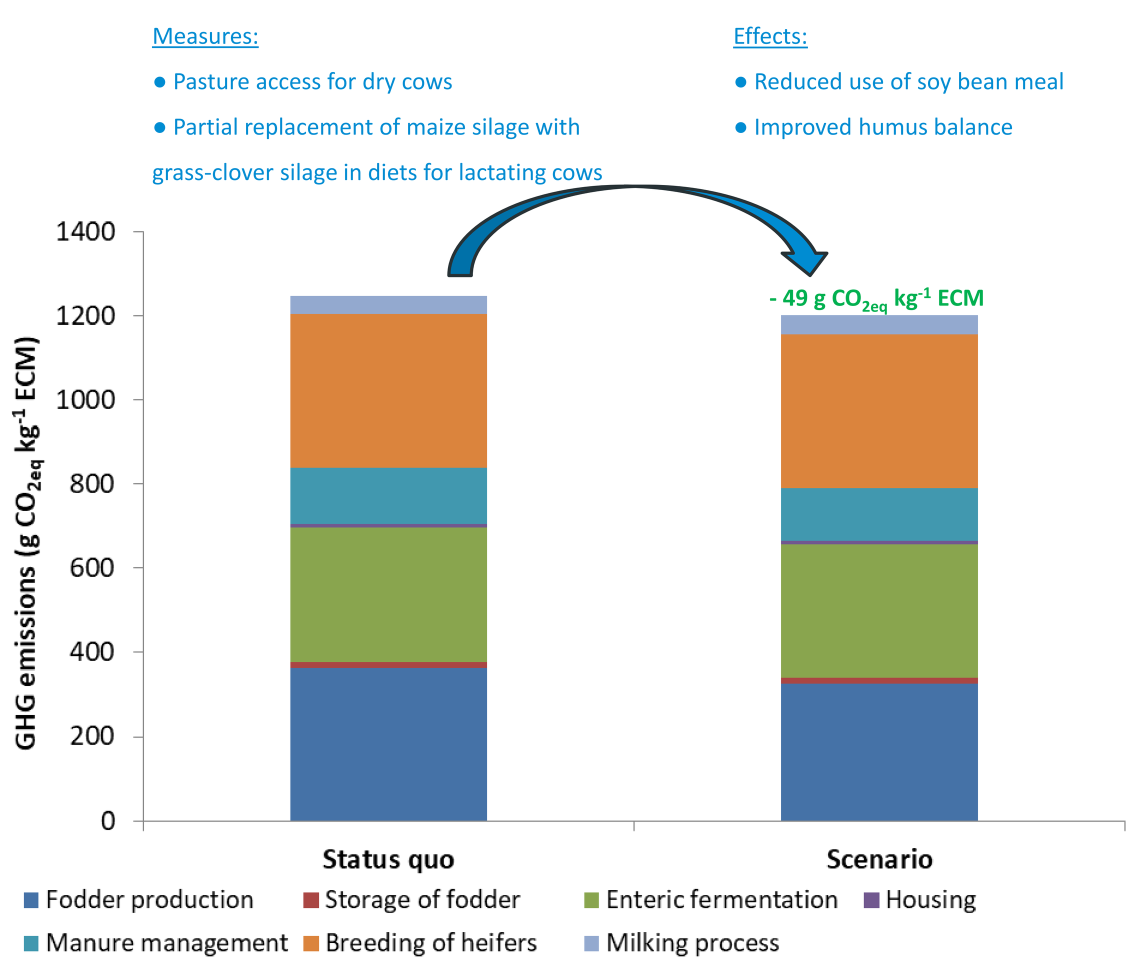


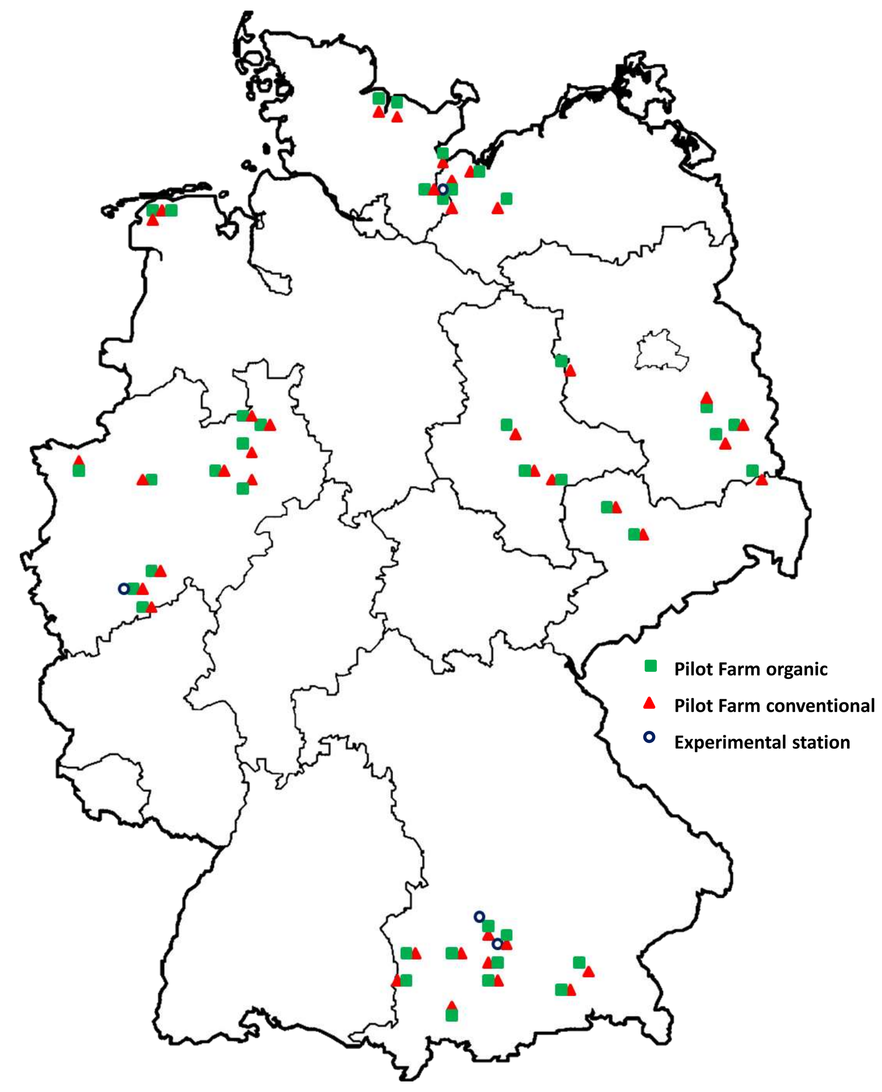
FIG 2: Scenario assumptions for improved dairy cow welfare and environmental performance of production and their calculated effects on product related GHG emissions for a conventional dairy farm of our pilot farm network.

Pilot farm network

In the network of pilot farms we analyse material flows in arable and livestock production to study resource efficiency in organic and conventional farms in Germany.

For this we determine climate effects of production, energy-, nutrient- and soil carbon-balances and evaluate livestock health and welfare.

Together with the farmers we develop suitable scenarios for farm specific optimisation towards both, sustainability and livestock welfare.



Conclusions

The example of different approaches to calculate enteric CH_4 emissions highlighted the influence of research methodology on the results.

Simultaneously considering animal related parameters, management procedures and their effects on environmental performance of production provides an innovative possibility to address different sustainability goals on whole farm level and to approach win-win solutions.

Project Partners

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