Differences in feeding practices on organic and conventional dairy farms – data from a farm network

SYLVIA WARNECKE[1], FRANZISKA SCHULZ[2], HANS MARTEN PAULSEN[1], GEROLD RAHMANN[1]

Key words: methane, feeding, dairy farming, dairy cattle, on-farm, greenhouse gas

Abstract

More than half of the methane (CH_4) emissions in Germany can be attributed to enteric fermentation of dairy cattle. Enteric CH_4 production is influenced by feedstuff quality. In a network of 44 dairy farms the mean diets of the dairy cows differed considerably between organic and conventional farms and between regions. Feeding also proved to be very farm specific. On average, organic dairy cows received significantly less concentrates (13.9 % of the total diet on a dry matter basis) and maize silage (7.2 %) and more pasture (29.5 %) and hay (11.8 %) than conventional dairy cows (24.1, 30.9, 5.5, and 3.1 %). No difference was found between organic and conventional feedstuff quality. Since hay produces relatively more and concentrates produce relatively less CH_4, organic dairy cows are, on average, expected to release slightly more enteric CH_4 per kg fermentable organic matter than conventional ones.

Introduction

Feeding influences CH_4 production in the rumen. Organic and conventional feeding practices of dairy cattle are expected to differ due to specific regulations that are in place for organic farming. E.g., dairy cows must have access to pasture, and soybean extract, a very common concentrate in conventional dairy feeding, may not be fed. It is unknown how the actual feeding practices and their potential effects on CH_4 emissions from enteric fermentation are in organic farming in comparison to conventional farming. The joint project "Climate Effects and Sustainability of Agricultural Systems – Analyses in a Network of Pilot Farms" determined feeding practices and feed qualities on a total of 44 dairy farms in four German regions in the course of three years.

Material and methods

All feedstuffs were sampled and analyzed for the years 2008-2010 on the pilot farms of the network (22 organic and conventional, each). Feedstuffs were characterized for their crude contents by Weende analysis. Energy and protein contents were calculated according to GfE (2001). The average diets fed to the lactating and dry cows were collected via interviews with the farmers. The diets were then calculated from the animals' energy demands while considering the average winter and summer diets, feed qualities from the laboratory analysis, average milk yields from milk recordings and cow weights. Access to pasture was also recorded from the interviews with the farmers. Energy corrected milk (ECM) yield per cow and year was calculated according to DLG (2001) as [kg ECM cow^{-1} a^{-1}].

Results and discussion

As expected, the average diets of the dairy cows differed between organic and conventional dairy farms (Table 1). On average, organic farms used less ($p \leq 0.001$; Table 1) concentrates (13.9 % of the total diet on a dry matter (DM) basis) than conventional farms (24.1 %). Nevertheless, individual organic farms fed as much as 31.5 % concentrates (data not shown). Organic dairy cows were fed significantly less maize silage (7.2 %) than conventional cows (30.9 %), while organic cows received far more ($p \leq 0,001$) pasture (29.5 %) than conventional ones (5.5 %). On a total of 13 conventional farms, dairy cows had no access to pasture at all (data not shown). No difference was found between organic and conventional use of grass silage (28.9 % and 28.4 %). Also, the other roughages and feedstuffs used were not fed significantly different on organic (20.4 %) and conventional farms (11.7 %).

[1] Thünen Institute of Organic Farming, Germany, www.ti.bund.de, eMail: sylvia.warnecke@ti.bund.de, hans.paulsen@ti.bund.de, gerold.rahmann@ti.bund.de

[2] Institute of Animal Nutrition and Physiology, Kiel University, Germany, www.aninut.uni-kiel.de, eMail: fschulz@aninut.uni-kiel.de

Table 1. Average diets of the dairy cows (including both lactation and dry period) on the organic (o; n=22) and conventional (c; n=22) pilot farms (means of the years 2008-2010). The sum of the columns 3, 4, 5, 8, 9 is 100 % per row.

	1	2	3	4	5	6	7	8	9
	Milk yield (ECM)	No. of years analyzed	Concentrates	Maize silage	Other roughage + feedstuffs [1]	Hay [2]	Straw [2]	Grass silage	Pasture
	[kg cow^{-1} a^{-1}]	[n]	Share in diet [% of DM]						
Mean organic	6,382[a]	1.9	13.9[a]	7.2[a]	20.4	11.8[a]	0.8[a]	28.9	29.5[a]
Mean conventional	8,660[b]	1.9	24.1[b]	30.9[b]	11.7	3.1[b]	3.2[b]	28.4	5.0[b]

[1] Category "Other roughage and feedstuffs" consists of spent grains, maize cobs, chicoree roots, freshly cut feedstuffs such as rape or grass, whole plant silage, hay, haylage, potatoes, carrots, wet pulp, soybean pulp und straw.
[2] Also included in column 5.
[a, b] Means that are significantly different (t-test; p ≤ 0,05) have different letters.

Figure 1 shows the regional comparison of the feeding regime between organic and conventional farms. Organic farms with low milk yields and a high percentage of hay in the diet were found in East and South Germany. Those were largely farms that did not use advisory services for dairy feeding (data not shown). The low percentage of concentrates in dairy rations is typical for the organic farms in the alpine region. The conventional farms in that region feed more hay than conventional farms in the other regions, and the use of maize silage is of lower importance than in other regions.

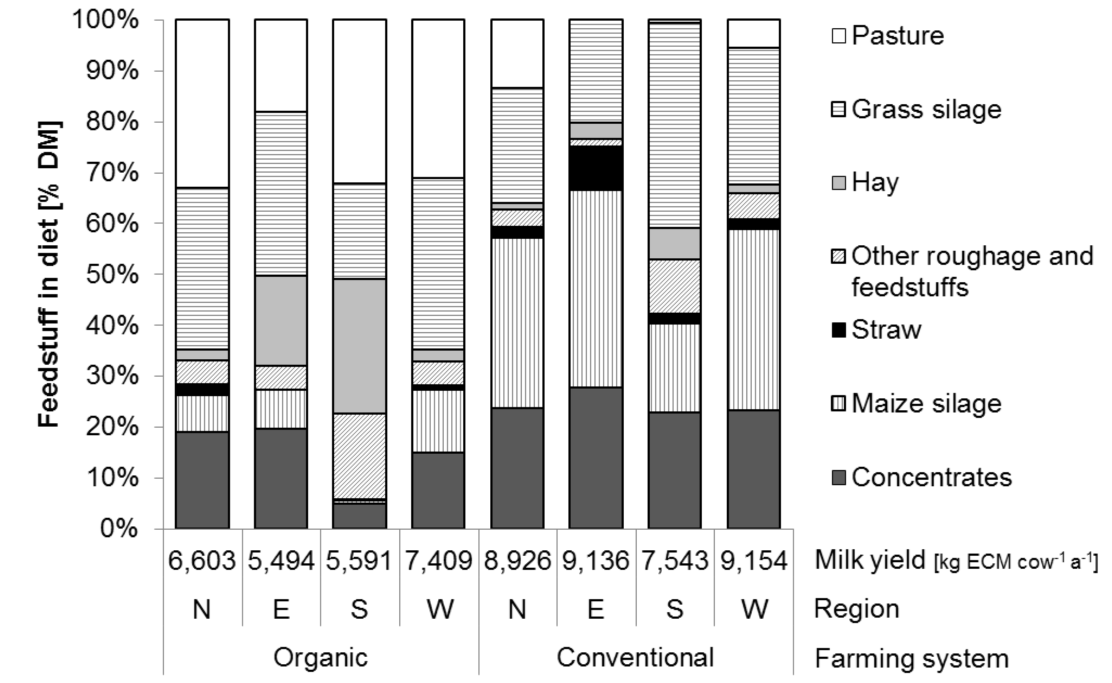

Figure 1. Means (2008-2010) of the average annual diets of the dairy cows (including both lactation and dry period) and milk yields on the organic (n=22) and conventional (n=22) pilot farms by region (North, East, South, West). Table 1 details the feedstuffs summarized in category "Other roughage + feedstuffs".

In all regions feed intake during grazing was significantly higher on the organic compared to the conventional farms. In the coastal region of North Germany grazing was of higher importance in conventional farming than in conventional farming in the other regions. Due to the small number of analyzed farm pairs (5-6 pairs per region) these means are highly influenced by the individual farm management. However, a more variable diet composition in organic farms is obvious in all regions (Table 1). The diets and feed qualities must be considered when calculating enteric CH_4 production. When comparing farming systems, feeds should also be assessed for the primary energy use for their production. The feedstuff qualities varied more or less, but no statistically significant difference was found between organic and conventional feedstuffs nor of feedstuffs between regions (data not shown). For this reason, Table 2 summarizes feedstuff qualities for all farms. Hay and straw had the lowest energy (NEL) contents (5.55 and 4.01 MJ NEL kg^{-1} DM) and the highest crude fiber (XF) contents (307.59 and 476.49 g kg^{-1} DM). In comparison to grass silage, maize silage displayed lower XF contents and only half the crude protein (XP) contents at slightly higher NEL contents. Pasture and maize silage had comparable XF contents (216.49 and 213.58 g kg^{-1} DM), but XP contents were far higher in pasture samples than in maize silage (185.01 vs. 77.57 g kg^{-1} DM).

Readily degradable feed components reduce CH_4 production per kg fermentable organic matter, while feedstuffs high in crude fibre increase it. Kirchgeßner et al. (1994) take crude nutrients into account when calculating CH_4 emissions from enteric fermentation (CH_4 [g] = (63 + 79 XF + 10 NfE + 26 XP – 212 XL) [kg], see Table 2 for abbreviations). Using this formula for the feedstuffs in Table 2 yields the following results: Hay 91.6, straw 103.5, pasture 82.6, grass silage 86.9, maize silage 82.2, concentrates 73.1 g CH_4 kg^{-1} DM. Although the diets were quite different with respect to the share of pasture and maize silage, respectively, no overall difference between organic and conventional CH_4 output from enteric fermentation can be anticipated from these feeds, since CH_4 emission per kg feedstuff is very similar. Organic dairy cows received more fiber rich hay that produces relatively more CH_4 and conventional dairy cows were fed more readily degradable concentrates that produce relatively less CH_4. Hence, it can be expected from the combination of diet and feed quality that organic dairy cows produce slightly more CH_4 from enteric fermentation per kg feed consumed (DM) than conventional dairy cows.

Table 2. Feed qualities (XF=crude fibre, NfE=nitrogen-free extracts, XP=crude protein, XL=crude fat, NEL=net energy lactation) of feedstuffs (means of all farms; 2008-2010).

		XF	NfE	XP	XL	NEL
Feedstuff	[n]	[g kg^{-1} DM]				[MJ kg^{-1} DM]
Hay	119	307.59	486.21	112.12	16.37	5.55
Straw	60	476.49	434.88	29.63	10.71	4.01
Pasture	19	216.49	478.16	185.01	33.35	6.90
Grass silage	237	268.16	444.80	153.63	26.92	6.21
Maize silage	100	213.58	641.21	77.57	28.59	6.45
Concentrates	252	97.83	588.27	219.63	43.49	7.90

Conclusions

Since organic and conventional dairy farms differed in feeding concentrate, maize silage and pasture and since feedstuff qualities were farm specific, both the diet and the feed quality should be considered for calculating enteric CH_4 emissions.

When assessing farms or systems with respect to their global warming potential, primary energy use for feed production, milk yield per year and per cow life and all emissions over the animal's total life should be analyzed to conclude over greenhouse gas emissions from milk production.

References

DLG (Deutsche Landwirtschafts-Gesellschaft e.V.) (1997): Futterwerttabellen Wiederkäuer: 7. erweiterte und überarbeitete Auflage. Frankfurt am Main: DLG-Verlag, 212p

Ellis JL, Kebreab E, Odongo NE, McBride BW, Okine EK, France J (2007): Prediction of methane production from dairy and beef cattle. J Dairy Sci 90(7):3456-3466

GfE (Ausschuss für Bedarfsnormen der Gesellschaft für Ernährungsphysiologie) (2001): Empfehlungen zur Energie- und Nährstoffversorgung der Milchkühe und Aufzuchtrinder 2001. Frankfurt am Main: DLG-Verlag, 136p

Kirchgeßner M, Windisch W, Müller HL (1994): Methane release from dairy cows and pigs. In: Aguilera JF (ed): Proc. 13th Symposium on Energy Metabolism of Farm Animal; EAAP Publ. 76, 399-402.