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Linking animal welfare to sustainability indicators of farms

Sylvia Warnecke^{1*}, Hans Marten Paulsen¹, Harald Schmid², Jan Brinkmann¹, Helmut Frank², Solveig March¹

¹ *Thünen Institute of Organic Farming, Westerau, Germany*

² *Technische Universität München, Chair of Organic Farming and Agronomy, Freising, Germany*

In a German network of so-called pilot farms we determined the animal health and welfare status of dairy cows with the Welfare Quality® Assessment protocol for cattle. Based on the results, we developed scenarios for the farm model REPRO to investigate interactions and potential environmental trade-offs in dairy production when dairy cow health and welfare are improved. This study was done in winter 2013/2014 as a preliminary study with four farms (two organic and conventional, each) and served as learning tool for an ongoing project with a total of 40 farms. Animal welfare status on the four farms was categorised as enhanced or acceptable, showing that all of the farms have a potential for improving animal welfare. The changes in management derived for the scenarios were: An increase in concentrate feeding in farm A, where only low amounts of concentrates are originally used. In farm B pasture access for dry cows was introduced and parts of maize silage in the diet of the cows were replaced by grass-clover silage. In farm C dry cows and youngstock were introduced to pasture. In farm D a hypothetically improved health management resulted in increasing the productive lifetime by one year. The calculated product related global warming potential (GWP) of milk did not change on farm A. On farms B and D, the GWP per kg of energy corrected milk decreased by 3.9 % and 5 %, while it increased by 2.6 % on farm C. The changes in GWP could be attributed e.g. to changes in land use and associated soil organic carbon contents on and off farm (B, C) or to a reduced number of replacement heifers (D). For the four farms and four scenarios that were analysed in this pilot study, the improvement of the animal health and welfare status by changing farm management only slightly influenced the product related GWP of milk. However, interactions of parameters of health and welfare and management in dairy farms are known to be strong. Hence, further analyses beyond this pilot study are ongoing for 40 farms in the network to assess effects of improving animal health and welfare on environmental burdens and resource efficiency of milk production.

Keywords: greenhouse gas emissions, animal health, animal welfare, resource efficiency, modelling

1 Introduction

On basis of farm level analyses, the product related global warming potential (GWP) of milk is farm individual (Warnecke et al., 2014) and highly impacted on by milk yield (Yan et al., 2013). E.g., milk yield is influenced by feeding, which again impacts on GWP by a response of soil organic carbon balances or by altered energy efficiency of feed production. Milk yield is also influenced by cow health and wellbeing, e.g. increases if lameness decreases because of pasture access (Olmos et al., 2009). On basis of optimization scenarios on the farm level we address the question of how a change of the health and welfare status of dairy cows by feeding and health management might impact on the GWP of milk.

2 Material and Methods

Two organic and two conventional farms were assessed for their animal health and welfare status in winter 2013/2014 by applying the Welfare Quality® (2009) Assessment protocol for cattle and by analysing the farm records on the use of veterinary drugs. Agronomic

* **Correspondence:** Sylvia Warnecke, Thünen Institute of Organic Farming, Trenthorst 32, 23847 Westerau, Germany. E-mail: sylvia.warnecke@ti.bund.de

monitoring data were used as model input for the farm model REPRO and its Excel extension (Frank et al., 2014; Schmid et al., 2013). One or more of the problems identified in the animal health and welfare assessment was tackled by one optimization scenario per farm. Results of the original situation and of the scenario were compared as GWP per kg energy corrected milk (ECM). Farm A (organic, 21 cows) represents a low input system based on grass-clover hay and without feed imports at a milk yield of 5,285 kg ECM year⁻¹. The other farms used external feeds and showed milk yields of 7,353 (B, 46 cows), 8,447 (C, 505 cows) and 8,598 (D, organic, 237 cows) kg ECM a⁻¹, respectively.

3 Results

According to the overall Welfare Quality® assessment, three farms were rated as enhanced, farm B was rated as acceptable (Tab. 1). On this basis, the optimization scenarios in Table 1 were defined and their effects on the GWP of milk were modelled.

Table 1 Welfare Quality® (WQ) principle scores and overall scores of the farms in winter 2013/2014, scenario assumptions for improved animal welfare and their calculated effects on GWP of milk

	Farm A	Farm B	Farm C	Farm D
WQ principle of:				
Good feeding	61	12	64	73
Good housing	68	59	60	59
Good health	58	31	34	42
Appropriate behaviour	68	31	42	65
Overall WQ Ass.	Enhanced	Acceptable	Enhanced	Enhanced
Scenario	Intensification: Increased milk production	Improving behavior: Introducing pasture to dry cows; Altering feed: less maize silage, more grass-clover silage	Improving behavior: Introducing pasture to dry cows and youngstock	Improving health: Reducing mastitis
Measure assessed	+1,1 kg concentrates per cow and day = +920 kg ECM per dairy cow and year	5% pasture per dairy cow/year; 4.5 ha maize to grass-clover	3 % pasture per dairy cow and year, 14 % pasture per youngstock and year	Longevity +1 year on herd average
GWP 'original' and GWP 'scenario' (g CO ₂ eq. kg ⁻¹ ECM)	1,030 1,031	1,248 1,199	913 937	840 798
Scenario effect on GWP (%)	±0	-3.9	+2.6	-5

Ranking of WQ principle scores: 0 = worst, 100 = best.

In the optimization scenario on farm A, the need for an increase of concentrate production led to a small carbon loss in the humus balance of farmland. This was counterbalanced in the GWP of milk by the growth in milk yield per cow and year. On farm B, the largest share of the reduction of the GWP (-30 g CO₂ eq. kg⁻¹ ECM) in the scenario resulted from decreasing effects of land use change with imported concentrates. The changes in roughage supply allowed for a substitution of imported soy bean with cereals from the farm itself. The substitution of maize silage with grass-clover improved the humus balance (-4 g CO₂ eq. kg⁻¹ ECM). Introducing pasture access on farm C e.g. decreased the overall demand for concentrates (-0.7 kg cow⁻¹ day⁻¹) for the same milk yield as well as the need for litter in the stable (-0.5 kg straw cow⁻¹ day⁻¹). However, due to correspondingly lower amounts of stable manure the humus balance was negatively affected (+39 g CO₂ eq. kg⁻¹ ECM). The GWP of milk in the scenario of farm D was primarily reduced because less heifers (-25 animals) had to be kept for replacement.

4 Conclusions

Animal health and welfare as principle scores and overall scores as well as the range of product related GWP were comparable to the range given by e.g. Kirchner et al. (2014) and Yan et al. (2013). For the four farms and the selected scenarios, improving animal health and welfare by changing management only slightly influenced the product related GWP of milk. Further analyses for 40 farms in the network are ongoing for winter 2014/2015 and summer 2015 to assess effects of improving animal health and welfare on environmental burdens and resource efficiency of milk production.

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