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Environmental Impacts and Economic Differences in grassland based Organic Dairy Farms in Germany – Modelling the Extremes

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Abstract

Differences in environmental impact and economic returns between intensive and low-input organic dairy production are investigated using two simplified model farms with different amounts of concentrates being fed. In four scenarios, ecological and economic effects of restricting the more intensive farm management practice beyond the existing regulations of organic farming are analysed. In the initial situation, the intensive farm has a financial advantage of about 600.00 € per ha compared with the low-input farm, while the environmental risks caused by its production system are higher in several Life Cycle Assessment (LCA) categories. We showed for the model case that limiting livestock density and using regional grown concentrates bring about considerable improvements in LCA results, while restricting the amount of concentrates used does not. These three scenarios result in economic deterioration for the intensive farm. A fourth scenario increasing the share of pasture in daily dry matter intake (DMI) to a minimum of 50% during the grazing season has positive effects environmentally as well as economically.

Introduction

The spectrum of production systems in organic dairy farming in Germany ranges from traditional grass-based feeding systems with milk yields of about 6000 kg or less to herds fed with large amounts of concentrates yielding up to 9000 kg milk per cow and year. More intensive strategies are often justified economically, while the price paid in view of a possible aggravation of ecological impact is not accounted for. Then again, economic implications need to be considered when discussing more severe restrictions to farming practice meant for improving environmental performance. We investigated the interrelation between economic and ecological returns using two model farm types. These model farms are assumed to be perfect twins in every aspect but dairy management practice. In the initial situation, the feeding strategy was modelled extremely low-input (0.2 t DM of concentrates per cow and year, 6000 l milk yield) for one farm and extremely intensive (2 t DM of concentrates, 9000 l milk yield) for the other. The more intensive farm is adapted to four different scenarios describing restrictions that may be imposed in order to decrease environmental burdens and that are already fulfilled by the low-input farm in the present situation. We calculated the ecological changes obtained through these impositions and the resulting economic effects for the intensive farm.

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Materials and methods

The model assumptions were derived from analyses of 36 German organic dairy farms carried out between 1999 und 2007 (Deittert et al. 2008). Both farms are supposed to be grassland farms situated in one of the hilly regions in Mid-Western Germany. Both have a farmed area of 100 ha, on which 100 (intensive) or 80 (low-input) cows plus young cattle are kept respectively. Both farms have simplified farm geometry with the farm buildings being situated in the middle of a square farm area. Thus, the total of the farm area could theoretically be used for pasture. The low-input farmer practices a pasture based regime in summer and relies primarily on grass silage in winter, while in intensive system only 1 kg dry matter (DM) per day are taken in as pasture in the initial situation. The concentrates available in the scenarios are wheat and rapeseed oil cake assumed to be produced within an average distance of 100 km. In addition, imported soybean residues are used as cake and pulp. Milk yield and feeding intensity are assumed to be directly related through the energy and protein contents of the rations (GfE 2001), daily dry matter intake (DMI) is estimated according to Schwarz et al. (1996). One quarter of the herd is replaced per year in the low-input farm, while the intensive farm has a replacement rate of 40%. The cost of a heifer is the same in both models.
As the model farms are equal in every respect but number of cows, feeding system, replacement rate and milk yield, the difference in economic outcome per cow and per kg milk is calculated as the balance of the returns from milk and replaced cows on the one hand and the costs for replacement, fodder and concentrates on the other hand. To study the environmental impacts, we did a LCA of both farms based on the methodology developed by Haas et al. (2000). The calculation of energy use comprises fodder production, provision of fuel and machinery, and production, processing and transportation of concentrates. The calculation of the climate impact - measured in CO_2 equivalents emitted per milk unit – comprises the CO_2 emissions caused by energy consumption, the CH_4 - emissions from ruminants and excrements and the N_2O emissions from excrements and fields. Results are related to one milk unit. In the evaluation of animal welfare the positive effect of pasturing and a ruminant adapted ration is taken into account. The N supply, calculated per hectares, is an indirect indicator for the potential biodiversity of the grasslands. For details of the methods applied see Müller-Lindenlauf (2008).

Besides the initial situation we considered the following scenarios:

1) Limitation of livestock density to 1.4 LU per ha of farm area
2) Restriction of the amount of concentrates used to a minimum of 20% of daily DMI
3) Increase of the share of pasture to a minimum of 50% of daily DMI during the grazing season
4) Replacement of imported feedstuff by regional wheat and rapeseed cake.

The requirements of these scenarios are already fulfilled by the low-input farm in the initial situation.

Results and Discussion

In the initial situation, the low-input farmer has a financial disadvantage of 600.00 € per ha based on actual prices for milk and feedstuff. Rising prices for concentrates diminish this disadvantage, but doubling the concentrate price would be necessary to equalize economic return of the model farms. As for the environmental effects, the low-input farm resulted in higher positive environmental impacts compared with the intensive farm in all categories except for emissions of CO_2 equivalents per kg milk (Fig 1 (a)). Since a reduction of greenhouse gas emissions is considered to be obtainable mainly by reducing the fibre content of the ration - i.e. intensification – we did not focus on this category further.

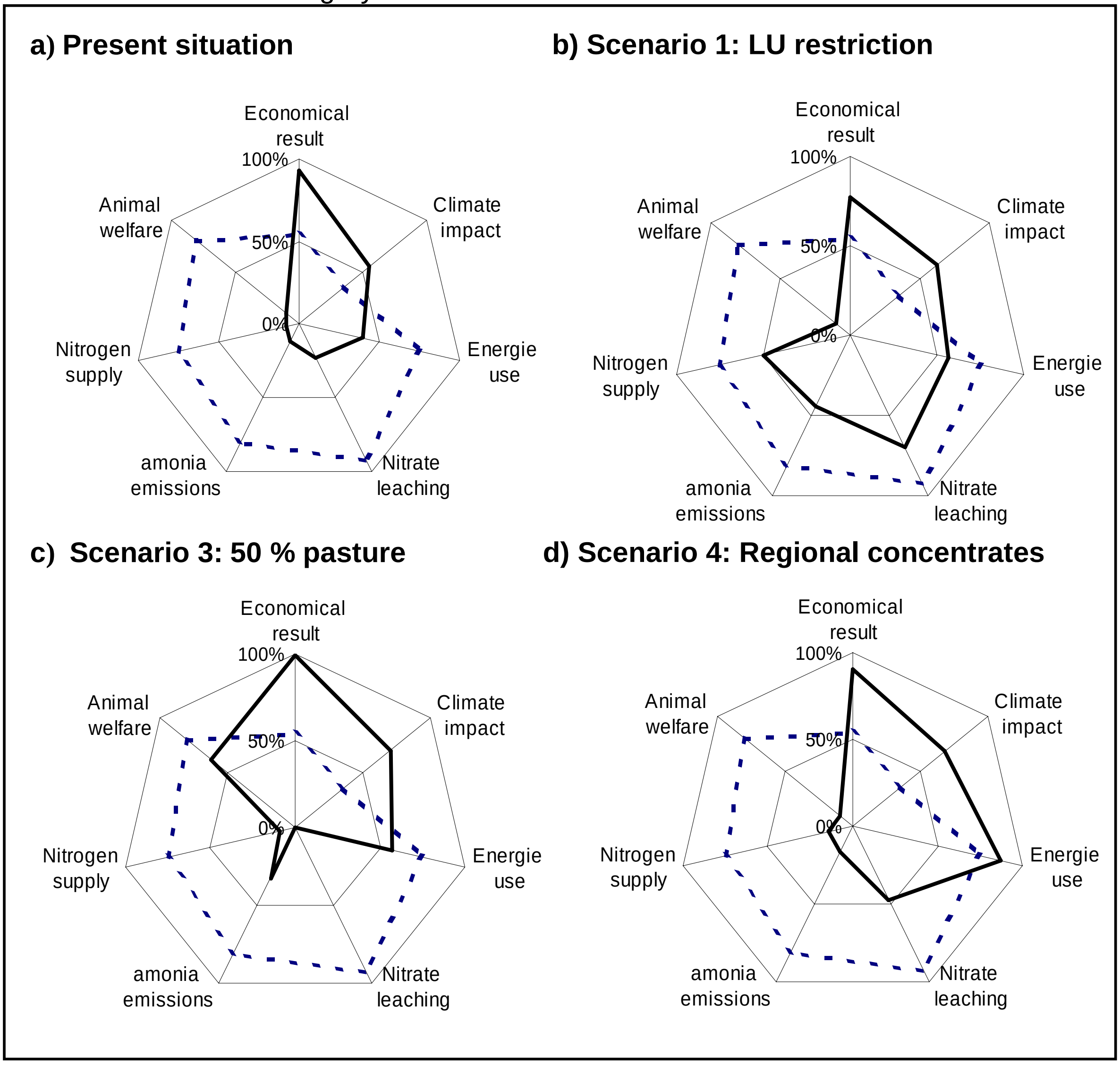

Figure 1: Economic return and environmental impacts of the intensive farming model in the present situation and under three scenarios in comparison with the extensive model farm. – – Extensive Farm, —— Intensive farm; Best results are displayed on the boundary, worst in the center. (Scenario 2 not shown because it did not lead to environmental enhancement). Climate impact, energy use and economic result: calculated per kg milk. Nitrate leaching, ammonia emissions and nitrogen supply: calculated per hectare. Animal welfare: rating value.

Energy use efficiency is considerably lower for the intensive farm and nitrate leaching potential and emission of ammonia are higher. The restricted pasturing is assumed to have a negative effect on animal welfare and the high N supply might cause negative effects on the biodiversity of the grasslands. The imposition of a livestock density of 1.4 LU per ha reduces the risk of nitrate leaching by 50% and also diminishes ammonia emissions (Fig 1 (b)). At the same time, the financial advantage of the intensive farm is reduced to 350.00 € per ha. If the concentrate is calculated to be

20% of DMI, this advantage would decrease further to 150.00 € per ha, while the environmental effects remain essentially unchanged. Imposing a minimum of 50% of pasture in daily summer DMI (scenario 3) does not only lead to improved energy efficiency, but also slightly enlarges the intensive farmer's financial benefit compared with the initial scenario. In addition, animal welfare would be enhanced. However, a prolonged grazing time for the intensively fed cows may lead to a higher risk of nitrate leaching through excrements.

A confinement to regional feedstuff would primarily improve the energy efficiency, while the financial effect observed would be small (scenario 4).

It has to be pointed out, however, that the described results do not apply to farms situated on arable land. In contrast to grassland, negative environmental effects of intensified feeding strategies are less distinct in these cases, because the import of nutrients into the farm either does not occur or can be compensated by an export of other farm products.

Conclusions

Our results show that restriction of livestock density, confinement to regional feedstuff and the use of pasture based feeding strategies are measures for reducing environmental risks caused by milk production on grassland farms. At the same time restriction of livestock density implies severe economic deterioration for the farmer of about 250.00 € per ha in the model case while for regionalization of feedstuff purchased and enhanced use of pasture the economic effects were comparatively small.

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References

Deittert, C., Müller-Lindenlauf, M. und Köpke, U. (2008): „Ökobilanz und Wirtschaftlichkeit ökologisch wirtschaftender Milchviehbetriebe mit unterschiedlicher Fütterungsintensität und Produktionsstruktur“. Final Report of the Research Project O3 OE 414 der Bundesanstalt für Landwirtschaft und Ernährung (BLE). Available under *www.orgprints.org*.

GfE (2001): Empfehlungen zur Energie- und Nährstoffversorgung der Milchkühe und Aufzuchtrinder. DLG-Verlag, Frankfurt, 136 p.

Haas, G.; Wetterich, F.; Geier, U. (2000): Framework in Agriculture on the Farm Level. International Journal of LCA 5: 1-4.

Müller-Lindenlauf, M. (2008): Umweltwirkungen ökologisch wirtschaftender Milchviehbetriebe unterschiedlicher Fütterungsintensität und Produktionsstruktur. Dissertation Universität Bonn. In prep..

Schwarz, F.J., Heindl, U., Kirchgessner, M. (1996): Zur Schätzung der Grundfutteraufnahme von Milchkühen. Züchtungskunde 68:65-76