Transforming the feeding regime towards low-input increases the carbon footprint of organic milk production

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Abstract

Feed production and management significantly contribute to greenhouse gas (GHG) emissions in dairy farming. This study conducted at Gladbacherhof, an organic research farm in Germany, aimed to compare the global warming potential (GWP) of a high-input feeding regime and a grassland-based low-input feeding scenario within an organic milk production system. Results revealed that the high-input system emitted 1.18 ± 0.24 kg CO2-eq/kg fat-protein-corrected-milk (FPCM), while the low-input scenario emitted 1.78 ± 0.41 kg CO2-eq/kg FPCM. The grassland-based low-input scenario exhibited a higher product-related environmental impact compared to the high-input system. The choice of feeding regime plays a crucial role in the environmental sustainability of milk production systems.

Introduction

Methane emissions through enteric fermentation is the most widely discussed source of GHG emission in dairy farming. However, feed production is a further source of GHG emissions, (mainly carbon dioxide and nitrous oxide) resulting from soil microbial processes but also field management like machinery use. Manure management and field application also produces GHG emissions, particularly that of nitrous oxide. The choice of feeding regime significantly influences the environmental impact of milk production systems. Given the interest in mitigation strategies and the potential of grassland-based feeding regimes to reduce environmental impacts, this study aims to compare the GWP of high-input feeding regime and a grassland-based low-input scenario within an organic milk production system.

Methods

The study was conducted at Gladbacherhof, an organic research farm in Central Germany. Gladbacherhof cultivates 180 hectares of land, including 100 hectares of arable land and 80 hectares of grassland, focusing on cereal seeds, potatoes, and dairy farming. Data was collected from on-farm sources and the Ecoinvent database. The high-input milk production system at Gladbacherhof has an average concentrate input of 1,600 kg/cow/year. The diet offered to the cows includes grass silage, alfalfa silage, maize silage, hay, and concentrate feed. The average milk yield for this high-input

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system was 8,000 kg/cow/year. A low-input feeding scenario was defined, aiming to reduce competition for human food by decreasing maize silage and concentrate use, favoring grass-based feed. The daily milk yield for this scenario was modeled at 17.5 kg fat-protein-corrected-milk (FPCM), resulting in an annual milk yield of 6,400 kg FPCM/cow. The system boundaries were cradle-to-farm gate, excluding activities like transportation, dairy processing, and veterinary treatments. The functional unit was 1 kg of FPCM. For the life cycle assessments (LCA) calculation, the OpenLCA tool was used. The impact category assessed was the GWP.

Results and Discussion

In terms of GWP, we observed that the high-input milk production system emits 1.18 ± 0.24 kg CO2-eq/kg FPCM, while the low-input scenario emits 1.78 ± 0.41 kg CO2-eq/kg FPCM. The primary reason for the observed GWP differences between the organic high- and low-input feeding regimes is the higher share of emissions from enteric fermentation, manure management, and feed production in the low-input scenario. This shift in the feed ration toward a grassland-based low-input scenario with reduced concentrate results in a feed mixture with lower digestibility, energy, and protein contents. On the other hand, through reducing maize silage and concentrates the low-input feed mixture was less competitive for human food, event though this is not captured with the current LCA analysis. Feed production remains a significant contributor to GWP in both production systems. At Gladbacherhof, grazing is limited for half of the year due to climatic conditions, impacting the quantity and nutritional quality of grassland (lower total dry matter and nutrient content). The quality of all forages becomes crucial when reducing concentrates in the diet, as higher-quality forage can increase milk yield and reduce the environmental impact per FPCM.

Conclusion

In terms of GWP, the study highlights that feeding intensity significantly affects the environmental impact of milk production systems. Contrary to expectations, the grassland-based low-input scenario present a higher product-related environmental impact compared to the high-input system.

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