Eco-efficiency of grass-based dairy systems in Switzerland

Alig M.[1,2], Sutter M.[1,2] and Nemecek T.[1,2]
[1]*Institute for Sustainability Sciences ISS, Agroscope, Reckenholzstrasse 191, 8046 Zurich, Switzerland;*
[2]*School of Agricultural, Forest and Food Sciences HAFL, Bern University of Applied Sciences, Länggasse 85, 3052 Zollikofen, Switzerland*

Abstract

Grassland covers 70% of the Swiss agricultural area, resulting in a large proportion of grass in the diet of Swiss dairy cows. In recent years, an increase in milk yield has been achieved, which has led to an increasing use of concentrates. The Federal Office for Agriculture has started to subsidize the inclusion of a large proportion of grass in the ration of ruminants. In two studies we assessed the environmental performance of dairy systems with different proportions of grass in the ration, by life cycle analysis according to SALCA. The comparison of the Swiss dairy system, with low use of concentrates, with systems in France, Germany and Italy showed that despite the lower milk yield and concentrate input, the Swiss system performed equally or better in all environmental impacts analysed, with the exception of land use. In the comparison of an intensive and a pasture-based dairy system within Switzerland the pasture herd performed equally or better for most environmental impacts with the exception of global warming, ozone formation and land occupation. This shows that despite the lower milk yield, grass-based systems can be eco-efficient.

Keywords: LCA, environmental performance, pasture-based milk production, Switzerland

Introduction

Grass is an important resource for Swiss agriculture. Over 70% of Swiss agricultural area are covered by grassland (BFS, 2014) and grass still constitutes the main ingredient in the diet of Swiss dairy cows. Depending on the type of farm, grass accounts for 62 to 85% of their total dry matter intake (Schmid and Lanz, 2013). In recent years, an acceleration in the trend towards higher milk yield and a higher proportion of concentrates in the ration of dairy cows was observed (Erdin and Giuliani, 2011). To alter this trend, the Swiss Federal Office for Agriculture (FOAG) started to promote grass based ruminant systems for a variety of reasons (preservation of landscape, efficient use of domestic resources, presumed advantages for the environment) and subsidizes a high proportion of grass in the diet of ruminants. Therefore, analyses of the eco-efficiency of grass based dairy systems are of high relevance.

Materials and methods

In two studies (Sutter *et al.*, 2013; Bystricky *et al.*, 2014) we assessed the environmental performance of dairy systems with different proportions of grass in the ration by life cycle assessment (LCA) according to SALCA (Nemecek *et al.*, 2010), developed by Agroscope for agricultural systems. The following environmental impacts were examined: non-renewable energy demand, global warming potential, ozone formation potential, demand for phosphorus and potassium resources, land competition, deforestation, eutrophication potential, acidification potential, terrestrial ecotoxicity potential, aquatic ecotoxicity potential and human toxicity potential, as well as water use (water stress index, taking account of water scarcity in the different countries) for the international comparison. System boundaries were set at the farm gate, and all results were expressed per kg milk produced. A rating system was used to assess the differences in individual results.

In the first study (Bystricky *et al.*, 2014), dairy systems in four countries with different proportions of grass in the ration were compared: a Swiss system with relatively low use of concentrates (877 kg cow^{-1} a^{-1})

and a moderate milk yield of 6,800 kg cow^{-1} a^{-1} and systems with higher use of concentrates (2,000-2,500 kg cow^{-1} a^{-1}) and higher milk yields (8,000-9,450 kg cow^{-1} a^{-1}) in Germany, France and Italy. For each country, a typical system was modelled based on literature data and expert opinion.

In the second study (Sutter *et al.*, 2013) two different milk production systems on an experimental farm were assessed: a pasture-based system with synchronized calving and barn feeding based on maize and grass silage and relatively high use of concentrates. Data were assessed directly on farm over three years.

Results and discussion

In the international comparison, Swiss milk production generally scored more favourably or was within the same range as milk production abroad (Figure 1). The energy required to produce 1 kg of milk increased with the milk yield per cow due to the purchase of extra feed and the use of energy carriers on the farm, both of which were higher in the foreign systems than in Switzerland. Similarly, the use of arable land was higher in the foreign systems. Deforestation for soybean cultivation was higher abroad, due to higher soybean meal consumption, as was water requirement and aquatic eutrophication by phosphorus.

Though the methane emissions from enteric fermentation per kg milk produced were higher for the Swiss system as a result of the lower milk yield per cow, there was no difference in total global warming potential. The higher CO_2 emissions through the higher energy demand and from land transformation from the use of soybeans outweighed the lower methane emissions of the foreign systems. In the comparison of the two Swiss systems, the pasture-based system showed lower impacts than the barn-feeding system for most categories analysed (Figure 2). A weakness of the pasture-based system was the higher methane emissions (+41%) and the higher land use (+50%) per kg milk produced. The most important disadvantages of the barn-feeding system were the higher deforestation, higher use of phosphorus and potassium resources and the higher ecotoxicity, mostly due to more maize and soybean meal in the ration.

An important reason for the good performance of the Swiss and Swiss pasture based systems could be the grassland in Switzerland producing high-quality fodder. Its utilisation for livestock production and the resultant reduced need for fodder concentrate in milk production bring benefits which may be emphasised. Also, other LCA-studies in regions with abundant precipitation and good grass growth, e.g. Arsenault *et al.* (2009) and O'Brien *et al.* (2012), indicate possible positive effects of grass-based dairy production on the environment.

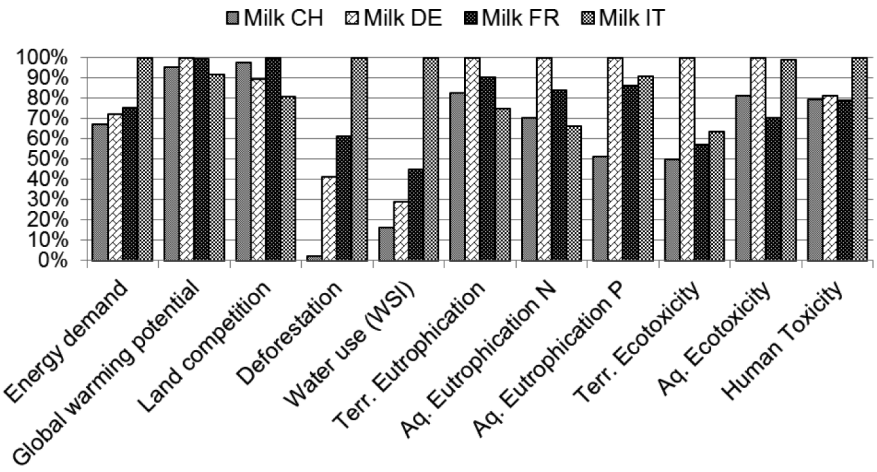

Figure 1. Relative environmental impacts per kg milk of the four systems analysed for selected impact categories. 100% = system with the highest impact.

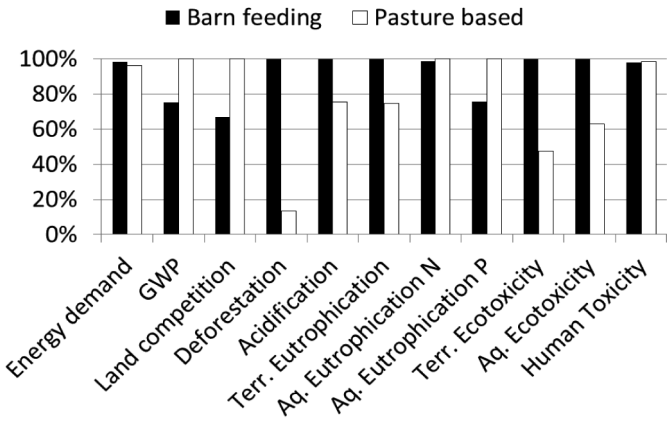

Figure 2. Relative environmental impacts of pasture-based milk compared to barn feeding for selected impact categories. 100% = system with the highest impact.

Conclusions

Despite the lower milk yield, the higher grass-based Swiss system performed equally or better for all environmental impacts analysed, compared to milk production systems in the neighbouring countries. Also within Switzerland, the environmental impacts of the pasture-based system were mostly lower than the impacts of the concentrate-based system. Grass-based milk production could make an important contribution to a more sustainable food production. To confirm these results, further studies with real farm data on a greater number of farms are needed.

References

Arsenault N., Tyedmers, P. and Fredeen, A. (2009) Comparing the environmental impacts of pasture-based and confinement-based dairy systems in Nova Scotia (Canada) using life cycle assessment. *International Journal of Agricultural Sustainability* 7(1), 19-41.

Bundesamt für Statistik BFS (2014) *Landwirtschaftliche Betriebsstrukturerhebung*. BFS, Neuchâtel, Switzerland.

Bystricky M., Alig M., Nemecek T. and Gaillard G. (2014). Ökobilanz ausgewählter Schweizer Landwirtschaftsprodukte im Vergleich zum Import. *Agroscope Science* 2, April 2014.

Erding D. and Giuliani S. (2011) Kraftfutterverbrauch der gemolkenen Kühe. *LMZ Aktuell* 5/2011: 4-6.

Nemecek T., Freiermuth Knuchel R., Alig M. and Gaillard G. (2010) The advantages of generic LCA tools for agriculture: examples SALCAcrop and SALCAfarm. In: Notarnicola B., Settanni E., Tassielli G. and Giungato P. (eds.) *Proceedings of the 7th int. conference on life cycle assessment in the agri-food sector*, Università degli studi di Bari Aldo Moro, Bari, Italy, pp. 433-438

O'Brien D., Shalloo L., Patton J., Buckley F., Grainger Ch. and Wallace M. (2012) A life cycle assessment of seasonal grass-based and confinement dairy farms. *Agricultural Systems* 107: 33-46

Schmid D. and Lanz S. (2013) Die Zusammensetzung der Futterration in der Milchviehhaltung der Schweiz. *Agrarforschung Schweiz* 4(4): 184-191.

Sutter M., Nemecek T. and Thomet P. (2013) Vergleich der Ökobilanzen von stall- und weidebasierter Milchproduktion. *Agrarforschung Schweiz* 4, 230-237.