Climate change (greenhouse gas emissions) and other environmental impacts of dairy systems based either on maize silage or on grass only

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Introduction There is a large variability in dairy systems in temperate countries, depending on animal management strategies and farmer goals. This results in differences in environmental impacts, for which greenhouse gas (GHG) emissions are a major issue. Feeding strategies, especially the nature of forages, may influence impacts. We compared systems based either on maize silage and grass (MS) or on grass alone (G). Life cycle assessments (LCAs) were performed to evaluate the environmental impacts climate change (due to GHG emissions), eutrophication and land occupation.

Material and methods Two dairy systems, composed of a dairy sub-system plus a cash-crop sub-system, with the same on-farm area (55 ha) and milk quota were compared. The MS dairy sub-system had 33% of silage maize in the forage area with highly productive cows (8.7 t fat and protein-corrected milk (FPCM)/cow/yr), whereas the G dairy sub-system was based on grassland only (i.e. no silage maize in the forage area) with cows producing 6.7 t FPCM/yr. More details about system description are given in Nguyen *et al.* (2013). The LCAs of these dairy-production systems were conducted from cradle-to-farm gate for a one-year period, i.e. including the production and delivery of inputs used for grassland and cereals produced on-farm and for feed produced off-farm, herd management and associated upstream processes, emissions from the animals and manure storage. Environmental burdens from the application of manure to cereal crops and pasture were included, as were those from buildings. Veterinary medicines were excluded due to lack of data. Allocation based on the protein contents of commercialised milk and beef was used to attribute the impacts to milk and meat co-products of dairy sub-systems. The impacts, i.e. climate change (GHG emissions with the effects of land use and land-use change (LULUC)), eutrophication and land occupation, were expressed per 1 kg FPCM.

Results GHG emissions per kg FPCM of G was higher than that of the MS dairy farm by 12% (Table 1). The highest contribution to GHG emissions per kg of FPCM was enteric fermentation (43 and 50% for MS and G, respectively), followed by feed production (40 and 48% for MS and G, respectively, including grassland, maize silage and concentrate feed) (Figure 1). N_2O emission from feed production per kg FPCM of G was higher than that of MS by 56% (Table 1). CO_2 emission due to LULUC per kg FPCM of G was lower than that of MS by 18% because C sequestration was higher and CO_2 emissions related to deforestation due to soybean meal were lower in G than in MS. There was no significant difference per kg FPCM of G and MS for eutrophication, but land occupation of G was higher than that of MS by 36%. Differences in impacts of milk of MS and G can be explained by (1) G having a lower milk yield/cow (more cows were needed to produce the same milk quota, even though it produced more meat), (2) cows in G having first calving at age 3 whereas MS cows calved at age 2, and (3) grass requiring more N fertiliser, but producing lower yields than silage maize, even though grassland sequestered C in the soil.

Table 1 Environmental impacts per kg FPCM of dairy systems based on maize silage and grass (MS) or on grassland only (G)

Emissions/impacts	MS	G
GHG emissions (kg CO_2 eq.)	1.28	1.44
CH_4 (kg CO_2 eq.)	0.69	0.72
N_2O (kg CO_2 eq.)	0.37	0.58
CO_2 (kg CO_2 eq.)	0.17	0.20
CO_2 LULUC (kg CO_2 eq.)	0.05	-0.06
Eutrophication (g PO_4^{3-} eq.)	4.98	4.92
Land occupation (m^2*yr)	1.17	1.59

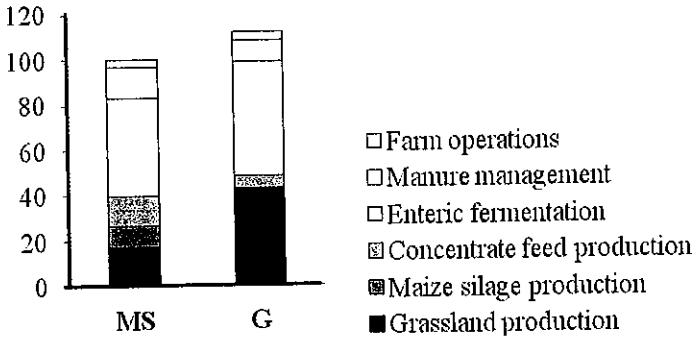

Figure 1 Contribution (in %) of main processes to GHG emissions per kg FPCM of dairy systems based on maize silage and grass (MS) or on grassland only (G) (MS represents 100%, G is relative to MS)

Conclusions Differences in impacts of milk of MS and G dairy systems were due not only to ration (maize silage and grass vs. grass only) but also to whole-system management (animal, feed and cash-crop production). The large differences in land occupation of systems producing MS and G milk could influence land-use change and GHG emissions if demand for grass-based milk increased.

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Reference

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