LCA study on sheep milk production in Sardinian farms at different input levels

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Introduction

This paper illustrates a Life Cycle Assessment (LCA) study carried out with the purposes of comparing the environmental impacts of sheep milk production from three different dairy farms in Sardinia, Italy, characterized by different production systems.

Material and methods

Data were collected in 2011 from three different dairy farms located in Provence of Sassari (40°43′36″N, 8°33′33″E), Sardinia, Italy. These farms were chosen since they are representative of the sheep milk production systems in the region and were characterized by different levels of intensification, as summarized in Table 1.

The methodology used to carry out the LCA study is consistent with the international standards ISO 14040-14044. The analysis was conducted using two different functional units (FU): 1 kg of Fat and Protein Corrected Milk (FPCM) and 1 ha of Utilized Agricultural Area (UAA). Three different evaluation methods were used: (1) IPCC (2007), which provides estimates on greenhouse gases emitted in the life cycle of products, expressed in kg CO_2-equivalents; (2) Blue Virtual Water, that estimates the virtual water content incorporated into a product, expressed in litre equivalents; and (3) Recipe, expressed in eco-points, which includes 17 impact categories and provides a more comprehensive assessment of life cycle environmental performances. The higher the eco-point score, the greater the impact.

LCA calculation was made using LCA software Sima Pro 7.3.3 (PRé Consultants, 2011), which contains various LCA databases including Ecoinvent (Ecoinvent Centre, 2010).

Results and discussion

The LCA analysis based on the three methods indicated an overall environmental impact lower in the extensive farm compared to the semi-intensive and intensive ones (Table 2). These differences were more evident using the Blue virtual water method, which highlighted that the litre equivalents consumed by F1 per kg of FPCM were 5 times lower than F2 and F3. In fact, F1 showed a very low direct water consumption, mainly due to the absence of mechanical milking and irrigation. The analysis conducted using 1 ha of UAA as functional unit showed that the extensive dairy farm, with a high surface area for natural pasture, has much lower environmental impacts than the semi-intensive and intensive farms, regardless of the method used. Figure 1 shows the results of the

Table 1: Main production system characteristics of dairy farms F1 (extensive), F2 (semi-intensive), and F3 (intensive). Data are referred to 2011.

	F 1 - extensive	F 2 – semi-intensive	F 3 - intensive
Utilized Agricultural Area (ha)	125	70	67
Heads (number)	120	320	370
Stocking rate (ewes/ha)	1.0	4.6	5.5
Milk production (kg/year)	25000	79655	110000
Milk pro-capita annual production (kg/ewe/year)	208	249	297
Natural pasture area (ha)	95	52	12
Arable land – cereals and annual forage crops (ha)	30*	18	55
Concentrate feed annual consumption (t) **	1	121	204

*10% of the arable land production is used for sheep feeding, the remaining part is sold as hay and grain; ** F1 produces all concentrates on farm, F2 imports them all and F3 imports the 86%.

Table 2: Main LCA results for three farm management systems (F1, extensive; F2, semi-intensive; F3, extensive) using IPCC, Blue Virtual Water and Recipe methods and two different functional units (1 kg of FPCM and 1 ha of UAA).

	F1-extensive	F2-semi-intensive	F3-intensive
IPCC method (kg			
FU: 1 kg FPCM	1.85	2.20	2.01
FU: 1 ha UAA	432	2430	3680
Blue Virtual Water (l			
FU: 1 kg FPCM	7.1	37.8	33.7
FU: 1 ha UAA	1660	41700	61600
Recipe method (eco-pt)			
FU: 1 kg FPCM	0.29	0.47	0.41
FU: 1 ha UAA	67	520	745

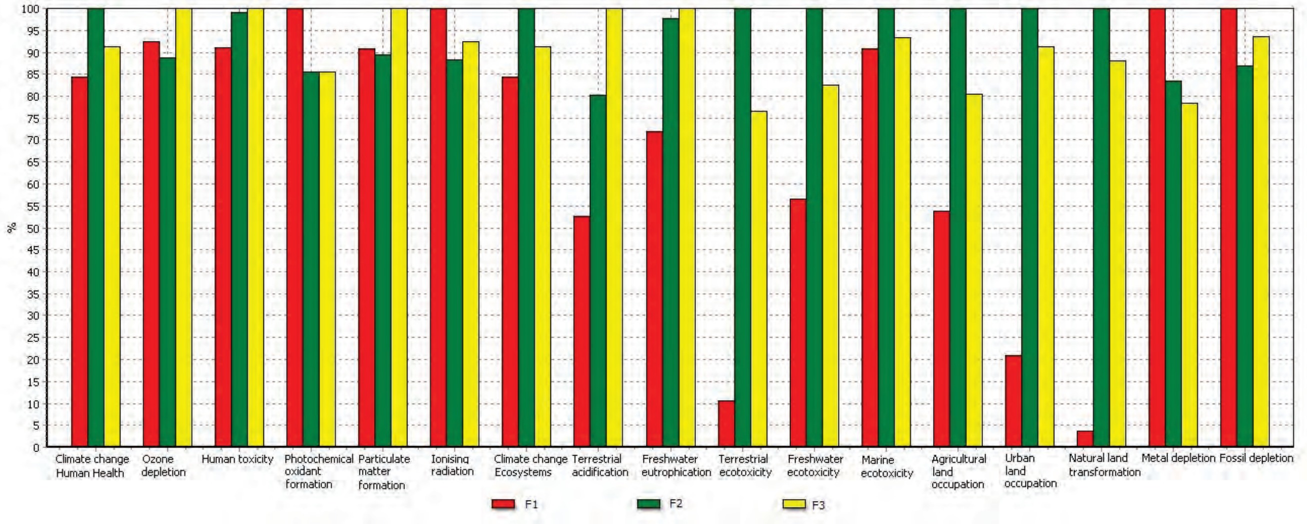

Figure 1. LCA results per kg of FPCM (Recipe method). Note red = F1 extensive; green = F2 semi-intensive; yellow F3 intensive.

characterization of the impact categories regarding the life cycle of the FPCM for the three farms. Impacts of F2 were more relevant for most of the categories, except for those relatives to photochemical smog, particulate formation, ionising radiation and ozone and fossil depletion, where it showed the smaller value, for those F1 showed a higher environmental impacts.

Conclusion

The results highlight the link between farming system and environmental performances. It is very important to note that the parallel use of two functional units and the adoption of the three different evaluation methods, offer a multiple analysis perspective, allowed to a more comprehensive assessment. The assessment carried out with the first functional unit, 1 kg of FPCM, allows to evaluate better the global impact of the life cycle analysed, focusing on the total amount of milk farm's production. The second functional unit allows a better assessment of local effects by analysing the environmental impacts of the life cycle of sheep's milk production depending on one hectare of UAA. In this case, it appears more evident that there is a link between intensive farming, with a consequent greater consumption of inputs, and a greater environmental impact.

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