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Land Occupation Affects Nitrogen Load on Dairy Farms in Northern Italy

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Introduction

Land occupation is one of the most discussed aspects about livestock competition for agricultural land. The ReCiPe method, one of the most widely used environmental impact calculation methods, calculates a land occupation (LO) value as the impact on biodiversity and does not consider real land occupation of the crops (Huijbregts et al., 2017). The computation of LO to grow purchased feed out of the farm with different levels of self-sufficiency is needed to evaluate meat and milk contribution to food supply and their impacts on environment on global scale (Gerssen-Gondelach et al., 2017). The aims of the study were to evaluate different methods of calculating LO of milk production and to evaluate implications on nitrogen load on farm surfaces of dairy farms.

Materials and Methods

Two years (2019 – 2020) of data collection were used to assess LO in fourteen dairy farms in Northern Italy. Five criteria to calculate LO were evaluated considering the farm utilized agricultural area (UAA) plus the surface used to produce the purchased feeds and bedding materials. The surface occupied by the purchased products was attributed following five criteria. LO1 considered the surface needed to produce soybean and corn obtained converting the animal requirements for purchased feeds (for energy and protein) into corn and soybean grain equivalents. LO2 was calculated as LO1 for purchased concentrates and converting purchased straws and forages into hay equivalent [10.4% Crude protein (CP) and 7.35 MJ kg^{-1} Dry matter (DM)]. LO3 considered all off-farm products actually purchased including by-products (considering the actual surface needed to be produced). LO4 was calculated as for LO3 except for by-products that were considered as zero land occupation. LO5 was calculated as for LO3 except for by-products that were considered as a fraction determined as a mass allocation of the whole original crop. LO6 was the value obtained from ReCiPe methodology (SimaPro V 9.0 software tool). Agronomic and farm management data were collected from on-farm detailed questionnaires and all data were cross-checked through farm records and other documentary evidences. Nitrogen balance at the farm gate was used to calculate N surplus per hectare.

Results

The farms were characterised by different stocking rates from, 1.6 livestock unit (LU) ha^{-1} to 8.6 LU ha^{-1} (Table 1), and different milk production per cow. In addition, a wide range of cropping systems and farm management determined a wide range of self-sufficiency in terms of Metabolizable energy, CP and DM. The milk production intensity expressed as tonne of fat-protein corrected milk (FPCM) ha^{-1} was calculated with reference to both the UAA and the actual LO (Figure 1a). The milk intensity calculated on the UAA (minimum of 3.7 t FPCM ha^{-1}, maximum of 60.9 t FPCM ha^{-1} and mean of 25.9 t FPCM ha^{-1}) increases in the highly intensive farms that produce a lot of milk often on few land, with a high animal load. Milk intensity on the actual LO is lower than the one with UUA, ranges from a minimum of 2.8 t FPCM ha^{-1} to a maximum of 10 t FPCM ha^{-1} with an average of 7.8 t FPCM ha^{-1}. Farms that are very market-oriented import a large amount of nutrients from outside into their farm area, causing environmental problems (excessive nutrient load). There is high correlation between milk intensity calculated in UAA and N input and N surplus per hectare (Figure 1b); farms with high milk production per hectare of farm UAA are those with high N input and consequently high N surplus per hectare of UAA.

Table 2. Farm characteristics, self-production of ME, CP and DM, and Land Occupation criteria in the studied dairy farms.

	Farms													
Farm characteristics	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Stocking rate (LU ha^{-1})	1.6	1.4	2.1	1.9	3.0	3.0	4.3	3.3	3.7	3.7	5.6	8.6	6.1	8.4
Milk FPCM per cow (kg d^{-1})	17.5	26.0	30.7	19.2	29.3	37.8	35.1	35.7	33.3	34.9	37.9	30.8	37.4	38.0
Self-sufficiency ME (%)	0.61	0.57	0.64	0.64	0.61	0.68	0.53	0.57	0.57	0.48	0.28	0.43	0.41	0.41
Self-sufficiency CP (%)	0.77	0.46	0.61	0.75	0.44	0.56	0.40	0.51	0.56	0.48	0.16	0.23	0.26	0.36
Self-sufficiency DM (%)	0.80	0.73	0.62	0.76	0.69	0.71	0.58	0.65	0.59	0.59	0.47	0.51	0.43	0.41
Farm UUA (ha)	38	83	54	180	85	64	121	109	94	177	44	37	37	55
LO1 (ha)	49	125	90	256	182	145	385	280	243	496	220	206	190	325
LO2 (ha)	67	125	127	284	189	166	434	298	261	516	264	209	204	380
LO3 (ha)	96	461	216	319	207	208	502	499	335	1170	508	786	286	530
LO4 (ha)	45	107	74	265	185	125	416	250	252	369	198	136	125	307
LO5 (ha)	54	124	99	271	163	133	383	259	238	432	203	199	178	334
LO6 (ha)	23	93	113	179	155	132	457	283	268	593	243	255	310	425

*LU: Livestock unit; FPCM: Fat Protein Corrected Milk; ME: Metabolizable Energy; CP: Crude Protein; DM: Dry Matter; UAA: Utilized Agricultural Area; LO: Land Occupation.

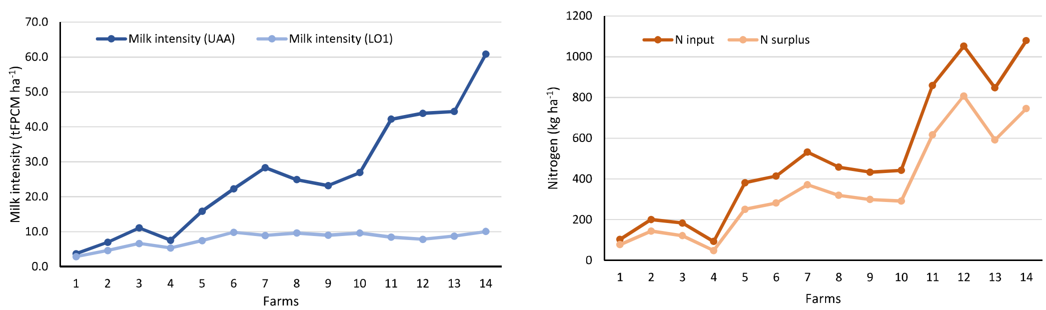

Figure 8 – Milk intensity reported on UUA and on actual land occupation calculated with LO1 criteria (a); Nitrogen input and nitrogen surplus per hectare of UUA (b).

Conclusion

Reducing dependency on the market by increasing the efficiency of self-production on the farm area represent a strategy for farms to reduce land occupation and nitrogen surplus and ensure sustainable development of milk production by reducing environmental pressure and improving nitrogen efficiency.

Literature

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