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Nitrogen farm balance and efficiency in mountain dairy farms

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Introduction: In the recent decades the evolution of dairy farming in the mountain areas led to the progressive abandonment of livestock activities, or, conversely, to an increase in animal density, in the attempt to maintain profitability. Intensification implied an increase of purchased feed (fodder and concentrates), not always from neighbouring mountain areas (Penati et al., 2011). The purchase of feed for livestock can be considered economically advantageous, compared to the cost of production in the mountain and the management of summer pastures (Sturaro et al., 2013), but certainly involves an increase in the surplus of nutrients (N and P) at the farm level (Gamborg and Sandøe, 2005). The aim of the study was to investigate the Nitrogen Balance (NB) at dairy farm level, in 2 Lombardy mountain areas, in relation to feed self-sufficiency and Dairy Efficiency (DE).

Materials and methods: The survey was carried out in 2 groups of dairy cattle farms for a total of 82 farms from the province of Sondrio (Italy), 38 from Valcamonica and 44 from Valtellina-Valchiavenna. Data were collected through questionnaires, provided with direct interviews to farmers. Data on the average milk production and quality were acquired from the dairies, or directly from the farm data. Composition of animal rations were collected as well as purchased (feed, animal, fertilisers), crop productions and pasture characteristics. Farm feed self-sufficiency was calculated as difference between the feed dry matter required by all animals and the purchased feed dry matter. Milk production was standardized (Fat and Protein Corrected Milk, FPCM). DE was calculated as FPCM/dry matter intake ratio, on individual dairy cow basis. Nitrogen Balance (NB kg/ha) at farm level was estimated as difference between N inputs (feed, fertilisers, bedding, animals purchased, deposition and fixation on the fields) and N outputs (delivered milk, feed/crops, slurry/manure, delivered or dead animals).

Results: The farms studied were representative of the mountain dairy farming in Lombardy, as small cultivated land area (18.2 ± 11.6 ha, of which 81.9% as permanent grass), small size in terms of livestock units (53.6 ± 39.9 LU) and lactating dairy cows (35.8 ± 26.0). The animal density per ha of cultivated area was high (3.07 ± 1.69 LU/ha) and only 48.8% of farms used high altitude pastures during the summer, both for dairy cows and heifers, while 12.2% of farms did not use summer pastures at all. Total farm feed self-sufficiency was low (49.7 ± 19.6% of the total DM intake for all farmed animals. Individual milk yield was low (17.9 ± 5.58 kg FPCM/d) and DE was very low (0.92 ± 0.22 kg FPCM/kg DM intake). Nitrogen Balance was unsatisfactory (206 ± 138 kg N/ha per year) and showed a high variability, with 117 kg N/ha for Q1 (25% of farms) and 263 kg N/ha for Q3 (75% of farms). From purchased feed, 82.3% of total N inputs was derived, while 89.0% of total N output was due to delivered milk. From a Factor Analysis, 3 significant (eigenvalues >1) factors emerged. The first one (39.4% of the total variance) including stocking rate (LU/ha), farm size (No. LU), N in purchased feed, N in delivered sand N balance as positive effect, and feed self-sufficiency % on total DM intake as negative effect was labelled "stocking rate and N balance". The second factor (24.6% of the total variance) was labelled "Dairy Efficiency and crop land size" and included DE, individual milk production and crop land size in ha, as positive effect). The third factor (13.6% of the total variance) was labelled "Forage % and farm N efficiency" (involving forage % of total DM intake of lactating cows and farm N efficiency, determined as N output/N input, as positive effects). The consequent Principal Component Analysis showed a high positive correlation for DE, N efficiency and farm size (total crop land area and total LU), and a negative correlation for N balance, N from purchased feed, stocking density and forage % of lactating cows DM intake. Feed self-sufficiency showed a negative correlation with other parameters, particularly with DE and stocking density.

Conclusion: The study showed some problems for the dairy farming systems in the considered Lombardy mountain area, in terms of low feed self-sufficiency, high stocking density and high farm N balance. The increase of DE and N efficiency can lead to the decrease of self-sufficiency and use of forage in the diets for cows. Therefore, a lot of effort must be made to improve forage quality in the mountain areas (production of haylage instead of hay, more attention to the stage of maturity of forage crops and permanent grasses at harvest). Summer pasture can be a solution to improve the total forage availability in farms, but it seems to be inefficient in terms of economic efficiency and DE. Low stocking density allows low farm N balance, but it seems to be achieved easier with a high total LU in a large crop land area than with a low LU in smaller farms, on basis of the low profitability.