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Milk production, feeding systems and environmental impact of dairy cattle farming in Alpine areas: results of a field study

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ABSTRACT - Intensification of milk production occurs even in areas traditionally characterized by low-intensive farming systems like mountain areas, leading to environmental concern. The aim of this study was to analyze management and feeding systems in a sample of 31 dairy farms in a mountain area of Lombardy (Valtellina) and their effects on milk production and environmental sustainability. In 2006 daily milk sold was 17.5±5.6 kg/cow on average and daily DMI was 19.4±1.3 kg/cow, with a high forages content (65.8±9.2% DM). Rations were quite energetically balanced (+0.09±17.6 MJ/d of ME). Rations higher in starch and lower in NDF resulted in higher milk yields but significantly compromised farm self-sufficiency (which was 62.9±16.8% DM on average). Average Metabolizable Protein balance was negative (-280±203 g/d of MP), mainly due to the low CP content of diets (13.5±1.5% DM). When CP content increased, N manure and N excreted in urine increased ($P<0.05$ and $P<0.01$ respectively), probably due to insufficient energy intake which is partly caused by the scarce quality of forages. An improvement in forages quality could increase ME and MP contents of diets without compromising farm self-sufficiency.

Key words: Dairy cow, Environment, Ration, Alpine region.

Introduction – In developed countries, intensive animal production has caused serious environmental problems through nutrient losses from the farms to the environment. Nitrogen contributes to soil and water pollution as nitrate (NO_3^-) and to air pollution as ammonia (NH_3) and nitrogen oxides (NO_x) (Tamminga, 1992). Intensification of milk production occurs even in areas traditionally characterized by extensive systems like mountain areas. Trying to maintain their profitability, many dairy farms in the mountains switch from local to specialized dairy breeds (particularly Holstein Friesian) and increase feed purchase (especially concentrates) to sustain higher milk production. Dairy cow rations shift towards an increase in the use of concentrates and maize silage. In Alpine mountain areas, dairy production is still an important economic activity and it is strictly connected to the production of traditional cheese varieties. The average number of dairy cows per farm in the mountain areas of Lombardy increased from 6 to 9 between 1990 and 2000 (ISTAT, 2002) and annual milk production per cow increased from 5871 kg in 2000 to 6798 kg in 2007 (AIA, 2008). The aim of this study was to analyze management and feeding systems in a sample of dairy farms in a mountain area of Lombardy (Valtellina) and their effects on milk production, milk quality and environmental sustainability.

Material and methods – A sample of 31 Holstein and Brown Swiss dairy cattle farms in Valtellina and Valchiavenna was taken among farms selling their milk to a local cheese factory (Latteria

Table 1. Descriptive parameters of the farms in the sample (n=31, except for arable land n=23).

	Cows	Low-land	Grass-land	Arable land	Animal density	Milk production	Self-sufficiency
	(n)	(ha)	(ha)	(ha)	(LU/ha lowland)	(kg/cow)	(%DM)
Mean	51.9	22.5	16.9	6.7	2.9	5732	62.9
SD	54.9	24.0	18.0	7.5	1.4	1448	16.8

Sociale Valtellina) in Delebio (SO). Data on milk yield and composition were obtained from the cheese factory database. The number of concentrates and forages analysed were 39 and 83, respectively. Additional data required, such as rations, feed purchase and self-production, were collected through farm interviews. All data were referred to 2006. Rations were checked by CPM Dairy software (version 3.0.6), and evaluated for ME, MP and bacterial protein production. General Linear Model was performed for farms and diets variables with LU number, milk yield per year, forages, CP and maize silage (% of DM) in diets as fixed effects (SAS, 2000).

Results and conclusions – Characteristics of the farms in the sample are in Table 1. In 2006 milk sold was 17.5±5.6 kg per day on average, with 656±150 g/d of fat (4.06% on average) and 578±132 g/d of protein (3.58% on average). The protein fraction of milk included 450±103 g/d of casein (2.80% on average) and milk urea content was 25.9±3.4 mg/dL.

The average daily DMI was 19.4±1.3 kg/cow; all the farms in the sample used self-produced grass hay in their rations (from 1 to 14 kg/d as fed) whereas only 24 farms used self-produced maize silage (from 5 to 28 kg/d as fed). Rations were quite energetically balanced (+0.09±17.6 MJ/d of ME) but the average Metabolizable Protein balance was negative (-280±203 g/d of MP), mainly due to the low CP content of dairy cow diets (13.5±1.5% DM). Forage content was quite high (65.8±9.2% DM) and NDF content in diets was high (43.7±6.1% DM). Diets with lower NDF content, higher NFC and starch contents allowed higher milk productions (Table 2). In mountain areas, where energetic feeds production is very difficult, high energy rations are achievable only by increasing the amount of purchased feeds, leading to environmental concerns and higher production costs.

Milk quality and N efficiency were not significantly affected by production levels.

Table 2. Least square means of farm and diet parameters on the basis of milk production.

		<4650 kg/cow	4650-6350 kg/cow	>6350 kg/cow	SEM	P value
Farms	n	8	12	11		
Cows	n	54.8	52.2	51.7	16.0	ns
Self-suff	% DM	58.1 ^{a}	68.7 ^{a}	51.3 ^{b}	5.56	0.08
Feed cost	€/cow/year	582 ^{B}	603 ^{B}	1007 ^{A}	84.3	0.00
Milk yield	kg/cow/d	13.2 ^{B}	14.6 ^{B}	19.8 ^{A}	1.03	0.00
DMI	kg/d	18.9	19.5	19.7	0.47	ns
ME balance	MJ	-8.2	-3.5	6.5	6.45	ns
MP balance	g	-334	-346	-186	79.2	ns
CP	% DM	13.7	13.1	13.9	0.43	ns
NDF	% DM	45.7 ^{a}	45.6 ^{a}	40.4 ^{b}	1.40	0.01
NFC	% DM	32.3 ^{b}	33.1 ^{b}	38.1 ^{a}	1.49	0.02
Starch	% DM	20.1 ^{B}	19.4 ^{B}	25.9 ^{A}	1.55	0.01
Forage	% DM	70.1 ^{B}	67.0 ^{B}	60.4 ^{A}	2.14	0.01

a, b, c=P<0.05; A, B, C=P<0.01.

Table 3. Least square means of farm and diet parameters on the basis of CP content of the cow rations.

		CP<12.5%	CP 12.5-14.5%	CP>14.5%	SEM	P value
Farms	n	9	13	9		
Cows	n	45.1	38.3	69.4	18.3	ns
Milk yield	kg/d	15.7	15.8	15.8	1.23	ns
Milk protein	%	3.57	3.64	3.58	0.07	ns
Milk urea	mg/dL	24.9	27.0	27.4	1.56	ns
DMI	kg/d	19.4	19.6	19.3	0.56	ns
ME balance	MJ	-3.99	1.46	-3.92	7.86	ns
MP balance	g	-351	-267	-203	96.8	ns
Bacterial MP	% MP	67.5 ^{a}	64.3 ^{b}	61.6 ^{b}	1.35	0.02
NDF	% DM	44.2	45.4	41.7	1.62	ns
Forage	% DM	68.0	65.6	62.0	2.43	ns
NFC	% DM	36.3	33.3	34.7	1.69	ns
N manure	% N intake	60.5 ^{c}	65.3 ^{b}	69.1 ^{a}	1.59	0.00
N urine	% N intake	-1.7 ^{C}	12.2 ^{B}	21.1 ^{A}	2.94	0.00
N faeces	% N intake	62.2 ^{A}	53.0 ^{B}	48.0 ^{C}	2.01	0.00

a, b, c=P<0.05; A, B, C=P<0.01.

Farms with higher CP content in their rations did not succeed in increasing nor milk production neither milk protein content (Table 3). On the contrary they had lower bacterial MP percentages (P<0.05), an important increase in N excreted with manure (P<0.05) and a slight but not significant increase in milk urea content. Furthermore N manure composition shifted towards a significant increase in N urine (P<0.01). A high proportion of the urinary N is in the form of urea, which can be degraded to ammonia by the urease enzyme in the faeces on the barn floor, being the primary source of N emissions from a dairy barn (Chase, 2004). The incapability in converting dietary CP to milk protein is probably caused by a not proportional increase in energy content of diets. It is not advisable to offset energy requirements by importing more concentrates into the farm; a solution could rather be an improvement of forages quality. In this study, self-produced maize silage was found to be very low in NFC (34.9±8.8%) and high in NDF (49.1±6.6%) if compared with the results of a research conducted in Lombardy where NFC and NDF contents of maize silage were respectively 47.0% and 39.5% (Amodeo, 2007). Also self-produced hay showed low quality parameters with 62.3% of NDF and 10.6% of CP on DM.

In conclusion low energetic balance and high forage content of rations negatively affected milk yield and N efficiency. Considering concentrates production not feasible in mountain areas, the only possibility for farmers to increase energy and protein balances of dairy cows seems to be forage quality improvement.

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