Estimation Of Economic Values For Milk Production, SCS and Milk Coagulation Properties In Italian Holstein Friesian Dairy Cattle

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Introduction

To ensure maximal benefit from genetic improvement, selection index should be for an appropriate breeding goal (Wolfová *et al*. (2007)). Definition of breeding goal, not only genetic parameters, but also economic values (EV) for traits are required. Hazel (1943) defined the EV of a trait as the improvement in profitability resulting from one unit of genetic improvement in that trait, keeping all other traits in the aggregate genotype constant. The EV of cattle production traits are sensitive to circumstances that change over the time like presence of quota system limitations and milk pricing systems (PS) (Pieters *et al*. (1997); Wolfová *et al*. (2007)). The PS in Italy is usually function of carrier, fat, protein content and somatic cell count (SCC) and weight of each trait could be different for fluid milk or cheese industry market. In the last years is growing interest for improvement milk coagulation properties (MCP) due to the their important role on cheese yield (Aleandri *et al*., 1989). Moreover MCP have a exploitable additive genetic variation, and a heritability estimates range from 15 to 40% (Ikonen *et al*. (1999); Ikonen *et al*. (2004); Cassandro *et al*. (2008)). Recently has been proposed the use of the mid-infrared spectroscopy to routinely record MCP on individual milk samples, and the application of this technique on a large-scale for the genetic improvement of MCP is so feasible (De Marchi *et al*. (2009); Cecchinato *et al*. (2009)). In Italy since an high percentage of milk is processed into cheese (about 75 %) there are more interests to include the MCP in milk PS and in breeding selection index. Aims of this work were to estimate of EV for milk production, SCS and MCP traits in Italian Holstein Friesian (HF) dairy cattle in order to proposed a selection subindex for milk-cheese chain.

Material and methods

The equation model used in this study to estimate the EV of milk trait is based on the work of Pieters *et al*. (1997):

$$T = N(R-C)-c_f$$

Where T= total annual profit of a dairy herd, N= number of lactating cows, R= average revenues during a lactation per cow, C= average costs during a lactation per cow and c_f= fixed costs of total enterprise. In this study were considered variable only the costs (C_{milk})

and revenues (R_{milk}) related to the milk production level and milk quality estimate using the following equations:

$$R_{milk}=(p_m+p_{scs}+p_{RCT}RCT+p_{a30}a_{30})M+(p_f+p_{scs}+p_{RCT}RCT+p_{a30}a_{30})F+(p_p+p_{scs}+p_{RCT}RCT+ +p_{a30}a_{30})P$$

$$C_{milk}= c_mM + c_fF + c_pP$$

Where:

M, F, P: annual yield level of milk carrier, fat and protein (kg); RCT= rennet coagulation time (min); a_{30}= curd firmness (mm); p_m, p_f, p_p: price of milk carrier, fat and protein (€ kg^{-1}); p_{scs}= price for SCS (€ kg^{-1}), p_{RCT}= price for RCT (€/min); p_{a30}=price for a_{30} (€/mm); c_m, c_f, c_p: feed costs of milk carrier, fat and protein (€ kg^{-1}).

Two Italian milk PS were investigated, first with emphasis to milk production (PS_{Milk}) and the second one usually applied when milk is sold at cheese industry (PS_{Cheese}). The two PS have the same base price (0.355 €/kg) and differ for p_m, p_f, p_p and for the bonus or penalty for class of SCC. Since discontinuous price of milk for SCC level a method illustrated by Weller *et al*. (1996) was applied to express p_{scs} as non-linear function with respect to Somatic Cell Score (SCS). Using a regression procedure of SAS®, the following expressions were obtained:

$$PS_{milk}: \quad p_{scs}= 0.00383+0.00352(SCS)^{0.5}-0.00125SCS-0.000254(SCS)^2$$

$$PS_{cheese}: p_{scs}= 0.01326-0.04539(SCS)^{0.5}+0.04112SCS-0.00555(SCS)^2$$

Estimation for p_{RCT}, p_{a30} was derived simulating a PS where the bonus or penalty for MCP was a linear function of cheese yield value. Lacking scientific studies on the MCP effects on cheese yield, in this work it was assumed a difference in cheese yield of 1% ($PS_{MCP1\%}$), 2.5% ($PS_{MCP2.5\%}$) and 5% ($PS_{MCP5\%}$) from the worse to the best MCP in HF population, assuming that the effect was due to 50% both for RCT and a_{30} traits. Cheese yield and cheese value was estimated for average of Italian HF population using equation of Van Slyke and Price (Emmons *et al*. (1990)), and considering the cheese moisture, price and cost of production for the Asiago cheese in 2009 (39.5%, 4.15 € kg^{-1} and 0.78 € kg^{-1}, respectively). For $PS_{MCP1\%}$, $PS_{MCP2.5\%}$ and $PS_{MCP5\%}$ the p_m, p_f, p_p, p_{scs} were set to PS_{cheese}; c_m, c_f, c_p were estimated using requirements suggested from AFCR (1993) adopting a ration of 50 % of roughages and 50 % of concentrates for milking cow, while no costs were assumed for variation of MCP traits and SCS. The EV of trait *x* was obtained as the first partial derivative of the profit equation at the current population mean for all traits. All EV were expressed per animal and calculated at year 2009, in situation without quota restriction as the future market liberalization is expected in the UE. For a better comparison of the relative importance of different traits in the PS considered, the EV were standardized by multiplying them by the genetic standard deviation of each respective trait and expressed as percentage of the total.

Results and discussion

In table 1 is reported the parameters and price used in the model while table 2 showed the prices of milk components in the 5 PS investigated. PS_{cheese} have almost the same price for

Table 1: Production parameters, price and energy requirements in the basic situation

Production factors		Feed costs	
Carrier yield, kg $cow^{-1} year^{-1}$	8449[a]	Concentrate, MJ NE kg^{-1} dm	9.02
Fat yield, kg $cow^{-1} year^{-1}$	330[a]	Roughage, MJ NE kg^{-1} dm	5.07
Protein yield, kg $cow^{-1} year^{-1}$	300[a]	Concentrate, € MJ NE kg^{-1} dm	0.028
SCS, point	3.08[b]	Roughage, € MJ NE kg^{-1} dm	0.027
RCT, min	16.9[b]	Milk carrier, MJ NE kg^{-1}	0.95[c]
a_{30}, mm	32[b]	Milk fat, MJ NE kg^{-1}	37.60[c]
		Milk protein, MJ NE kg^{-1}	20.90[c]
[a] A.I.A. (2008) [b] Cassandro *et al*. (2008)		[c] AFCR (1993)	

Table 2: Price per unit of milk production traits in different PS

Traits	PS_{milk}	PS_{cheese}	$PS_{MCP1\%}$	$PS_{MCP2.5\%}$	$PS_{MCP5\%}$
Carrier, € kg^{-1}	0.14	0.08	0.08	0.08	0.08
Fat, € kg^{-1}	2.07	2.00	2.00	2.00	2.00
Protein, € kg^{-1}	4.65	6.20	6.20	6.20	6.20
SCS, € kg^{-1} $point^{-1}$	-0.002	-0.006	-0.006	-0.006	-0.006
RCT, € $kg^{-1} min^{-1}$			-0.00008	-0.00020	-0.00040
a_{30}, € kg^{-1} mm^{-1}			0.00003	0.00008	0.00016

Table 3: EV for milk production, SCS and MCP traits

	Economic Value, €/unit				
Traits	PS_{milk}	PS_{cheese}	$PS_{MCP1\%}$	$PS_{MCP2.5\%}$	$PS_{MCP5\%}$
Carrier, € kg^{-1} $year^{-1}$	0.11	0.06	0.06	0.06	0.06
Fat, € kg^{-1} $year^{-1}$	1.03	0.97	0.97	0.97	0.97
Protein, € kg^{-1} $year^{-1}$	4.07	5.63	5.63	5.63	5.63
SCS, € kg^{-1} $point^{-1}$ $year^{-1}$	-16.47	-54.47	-54.47	-54.47	-54.47
RCT, € $kg^{-1} min^{-1}$ $year^{-1}$			-0.73	-1.82	-3.63
a_{30}, € kg^{-1} mm^{-1} $year^{-1}$			0.29	0.72	1.44

Table 4: Relative EV emphasis for milk production, SCS and MCP traits

		Relative EV, %				
Traits	σ_a[a]	PS_{milk}	PS_{cheese}	$PS_{MCP1\%}$	$PS_{MCP2.5\%}$	$PS_{MCP5\%}$
Carrier, € kg^{-1} $year^{-1}$	579.3[b]	40.8	21.3	21.0	20.5	19.8
Fat, € kg^{-1} $year^{-1}$	20.7[b]	13.3	11.6	11.4	11.1	10.7
Protein, € kg^{-1} $year^{-1}$	16.2[b]	41.1	52.4	51.6	50.4	48.5
SCS, € kg^{-1} $point^{-1}$ $year^{-1}$	0.47[c]	-4.8	-14.7	-14.5	-14.2	-13.6
RCT, € $kg^{-1} min^{-1}$ $year^{-1}$	2.22[c]			-0.9	-2.2	-4.3
a_{30}, € kg^{-1} mm^{-1} $year^{-1}$	4.06[c]			0.7	1.6	3.1

[a]genetic standard deviation [b] Pieters *et al*. (1997) [c] Cassandro *et al*. (2008)

fat, but pay about half the milk carrier and give a premium about one third more for protein and a penalty three time more for SCS point, compare to PS_{milk}. $PS_{MCP1\%,}$ $PS_{MCP2.5\%,}$ $PS_{MCP5\%}$ have a progressive weight for RCT and a_{30}, with opposite sing because for cheese production is preferred lower RCT and higher $a_{30.}$ Table 3 showed the absolute EV estimate for each unit of change in milk production, SCS and MCP in the different PS. In according with the literature the EV are more affect by the PS. Table 4 reported the relative EV expressed as percentage. In the PS_{milk} 40 % is the emphasis for milk carrier, while in the PS_{cheese} the weight is almost the half. Protein showed the highest relative EV respect to all other traits. Relative EV for protein trait ranged from 41.1 % to 52.4%. Fat showed a quite stable relative EV around 10.7 % to 13.3 %. SCS have a negative weight ranging from -4.8 % to -14.7 %, for PS_{milk} and PS_{cheese}., respectively. The weight for MCP ranged from 1.6 to 7.4 % (sum of absolute weight for RCT and $_{a30}$), when the effect on the Asiago cheese yield ranged from 1 to 5 % from the worst and the best MCP.

Conclusion

The relative EV weights estimated in this study might be used for a selection subindex on milk-cheese chain. Further research is need to estimate effect of MCP in cheese yield for different types of cheese considering additional costs for breeders related to produce milk with favorable aptitude for cheese making.

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