Economic Weights for Longevity in the Italian Holstein Breed

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Introduction

Total lifetime profitability of dairy cattle is influenced by more than milk production alone. From different studies it is known that longevity is related to total profitability; measurements of longevity are about one third as important as yield in total profitability (Van Raden and Wiggans, 1995).

Most studies use involuntary culling and length of productive life to express longevity (Rogers et al., 1988; Van Arendonk, 1991). Were the economic value for involuntary culling expresses a performance in total profitability in addition to production, while length of productive life (herd life) expresses both, as it is determined by voluntary and involuntary culling.

Selection for longevity will result in reduction of involuntary culling rates rather than an increase of average age of the herd. This because with a decrease of involuntary culling rates farmers will raise the level of voluntary culling (Rogers et al., 1988). The improvement in total profitability from selection on herd life, in addition to production, will be determined by the revenues from reducing annual replacement costs per cow, more cows in the herd producing at mature level, more production factors available for milking cows, and an increase of culling of low producing cows (Groen, 1996).

The objective of this study is to derive the economic value for longevity traits, involuntary culling and herd life for the Italian situation.

Material and Methods

The dynamic programming model of Van Arendonk and Dijkhuizen (1985) was used. The program was developed for defining optimum insemination and replacement decisions on herd level. With making these decisions the model considers all economic aspects involving selection for longevity. Following decisions results in an average herd life and an annual profit per cow. Next to this the model offers the possibility to evaluate the effect of involuntary culling on herd life and profit per cow.

The objective function of the model is: maximize profit per cow following optimum insemination and replacement policies. This is done with respect to the biological production status of lactating cows. For describing the biological production status of cows the model uses status variables, each consisting of a number of distinct values. Status variables are: 12 lactation numbers, 16 months for stage in lactation, 7 states for time of conception (3 to 8 months after calving and one class for open cows), 15 levels for milk production during previous and present lactation. Level of milk production is based on a within herd variation coefficient of 12% (<74%, 74 to 78%,...122 to 126%, and >126%). Repeatability of lactation production was assumed to be .55 for successive records, and .50 for records two parities away. During time steps of one month cows can move from one state to another. The next state of a cow depends on the current state, the probability of conception, the probability of survival to the next state, and the probability of reaching an other production level in the next lactation (Van Arendonk and Dijkhuizen, 1985). Net revenues considering milk, fat, and protein yields, calf values, carcass values, feed costs, health costs, housing costs, heifer replacement costs, and interest, were used to make optimum insemination and replacement policies (Van Arendonk, 1985*a*). For a more detailed description reference is made to Van

Arendonk and Dijkhuizen (1985), and Van Arendonk (1985*a*).

Involuntary culling was defined as culling because the cow was not able to produce in a biological sense. Voluntary culling occurred when the future revenues of the cow were lower than revenues expected from a replacement heifer (opportunity costs) (Van Arendonk and Dijkhuizen, 1985). This makes the value of herd life equal to the net revenues during the additional day of herd life corrected for the average net revenue of a replacement heifer (Van Arendonk, 1991).

Prices and base parameters used in the model were adapted, as much as possible, to the Italian situation and are shown in Table 1.

Economic values were estimated from the change in annual profit per cow due to a change in the trait from its base level. For involuntary culling the base level was lowered with 1%, which also resulted in a change for herd life from its base level. With this the economic value for involuntary culling represents the extra net revenues per cow affected by reducing the involuntary culling probability with 1%. Economic values were calculated for three different Italian payment systems for milk (see also Table 1). The first one is based on an 'average' payment system employed by Unalat (PS1), the second one based on a payment system that mainly counts for protein to process Parmesan cheese (PS2), and the third one based on a payment system derived by Badino for an optimal cheese production (PS3). The latter one is the payment system on which the currently used ILQ (milk quality index) is based (Pieters et al., 1995). Next to this the effect of different levels for involuntary culling and conception rate on the economic values were examined. Base levels of involuntary culling over parities were taken from Van Arendonk (1985). The base level was set to higher values by (1) adding 6% in absolute value to the base level to get values better fitting to the Italian situation (personal communication, ANAFI), and (2) an steeper slope of probability of involuntary culling over parities. Base levels for conception rates over parities were taken from Bagnato and Oltenacu (1994), reflecting an average conception rate of 62%, and increased with 3% to express a conception rate of 65% for an alternative value, see Table 2.

Results and Discussion

Economic values

Table 3 shows the effect of reducing probabilities of involuntary by 1% on culling rates, profit, and herd life, and from this the resulting economic values under the three payment systems. Annual culling rates and herd life are more or less of an equal level for all payment systems. Annual profit per cow is under PS2 higher due to a higher milk price per kg of milk compared to PS1 and PS2. However, a lower milk price for PS2, with respect to component price ratio, did not influence the economic values.

A relative decrease of involuntary culling probability of 1% resulted in an increase of profit per cow of 4644, 4692, and 4644 L.lt. under PS1, PS2, and PS3 respectively, which was defined as the economic value for involuntary culling. This correspond to 31,000 to 33,000 L.lt. per absolute percent decrease in the annual involuntary culling rate. With somewhat higher annual involuntary culling rates, Dekkers (1991), and Rogers et al. (1988) found much lower values of 14,000 L.lt. (Can $ 12.11) and 11,000 L.lt. (US $ 7.33). This might have been affected by use of other basic parameters. The level of involuntary culling rates is probably not the cause of the different results, with higher involuntary culling rates (see Table 4) even a small increase of the economic value (34,000) per absolute percent of involuntary culling is obtained.

Economic value of herd life was calculated as the extra profit per cow divided by the difference in herd life in days (1 month equals 30.5 days). The resulting economic values of 1088, 1099, and 952 L.lt. for PS1, PS2, and PS3 respectively, fit close with other studies. Van Arendonk (1991) and Harris and Freeman (1993) calculated values of 1300 L.lt. (DfL 1.08) and 900 L.lt. (US $ 5916) respectively.

Probabilities and conception rate

The results of a higher level of involuntary culling probabilities, a steeper slope of involuntary culling probabilities over parities, and a higher conception rate are given in Table 4 for PS3. Results from PS1 and PS2 were consistent with those of PS3 and therefore not further discussed.

Increased involuntary culling probabilities, either by level or slope, resulted in other culling decisions that resulted in lower values for herd life and profit per cow, and all economic values, especially in case of a higher level of involuntary culling probabilities, were increased. This is confirmed by figures from Van Arendonk (1985*b*), increasing base level of involuntary culling probabilities with 20%, resulted in a higher economic value per percentage point involuntary culling than a decreasing of 20% from the base level. The opposite was found using figures from Rogers et al. (1988), while Dekkers (1991) found for different (lower) levels of involuntary culling probabilities no big difference in economic value for involuntary culling.

Higher conception rate had much less emphasis; it somewhat increased involuntary culling rate and lowered voluntary culling rate. With a lower total culling, higher herd life and higher profit per cow, higher conception rate resulted in lower economic values.

From other studies it is known that optimum culling decisions are highly dependent on basic parameters like cost for replacement heifers and prices for culled animals. Economic values for involuntary culling and herd life, which are influenced by culling decisions, depend on these parameters (Dekkers, 1991; Rogers et al., 1988; Van Arendonk, 1985*b*). In this study level of involuntary culling probabilities had a great impact on the estimated economic values especially for involuntary culling.

Conclusion

The economic value for involuntary culling and herd life for the Italian situation is highly determined by level of involuntary culling probabilities and was found to be approximately 7000 L.It. and 1150 L.It. for one percent of involuntary culling and one day of herd life respectively.

Literature

Bagnato, A. and Oltenacu, P.A. 1994. Phenotypic evaluation of fertility traits and their association with milk production of Italian Friesian Cattle. J. Dairy Sci. 77, 874-882.

Dekkers, J.C.M. 1991. Estimation of economic values for dairy cattle breeding goals: bias due to sub-optimal management policies. Livest . Prod. Sci. 29, 1916-1925.

Pieters, T., Canavesi, F., Cassandro, M., Dadati, E. and Van Arendonk, J.A.M. 1995. Economic values and their effect on cattle breeding programs considering different payment systems, with and without product limitations. Unpublished.

Rogers, G.W., Van Arendonk, J.A.M. and McDaniel, B.T. 1988. Influence of involuntary culling on optimum culling rates and annualised net revenue. J. Dairy Sci. 71, 3463-3469.

Van Arendonk, J.A.M. 1985*a*. A model to estimate the performance, revenues and costs of dairy cows under different production and price situations. Agr. Systems 16, 157-189.

Van Arendonk, J.A.M. and Dijkhuizen, A.A. 1985. Studies on the replacement policies in dairy cattle. III. Influence of variation in reproduction and production. Livest. Prod. Sci. 13, 333-349.

Van Arendonk, J.A.M. 1985*b*. Studies on the replacement policies in dairy cattle. II. Optimum policy and influence of change in production and prices. Livest. Prod. Sci. 13, 101-121.

Van Raden, P.M. and Wiggans, G.R. 1995. Productive life evaluations: calculation, accuracy, and economic value. J. Dairy Sci. 76, 2758-2764.

Table 1. Production factors and prices

Production factors			
Mature equivalent herd level			
Milk production (kg cow year)		8500	
Fat %		3,53	
Protein %		3,20	
Prices in L.lt.			
Payment system	PS1	PS	PS3
Milk fat (kg)	3000	1634	5286
Milk protein (kg)	6800	21970	25425
Milk volume (kg)	430	4	-252
Calves (kg)		8125	
Carcass price disposed cows		1550.000	
Roughage (Lit MJ NE kg DM)		569	
Concentrate (Lit MJ NE kg DM)		735	
Housing and equipment		1440.000	
Veterinary costs (cow year)		175.000	
Interest per month corrected for inflation of agricultural products (5% interest year)		0,407%	
Replacement heifer		3200.000	

Table 2. Over parities, levels of involuntary culling probabilities: 1 base level (Van Arendonk, 1985*a*), 2 added 6% to the base level, and conception rates: 1 base level representing an average of 62% Bagnato and Oltenacu, 1994), 2 added 3%, representing an average of 65%

	% involuntary culling probabilities, failure to conceive excluded			Conception rate	
Parity	1	2	3	1	2
1	12	18	12	64	67
2	13	19	13.5	63	66
3	14	20	15	61	64
4	15	21	16.5	59	62
5	17	23	18	58	61
6	17	23	19.5	57	60
7	18	24	21	56	59
8	19	25	22.5	56	59
9	21	27	25.5	54	57
10	23	29	28.5	52	55
11	25	31	31.5	50	53
12	28	34	36.5	50	53

Table 3. The effect of different levels of involuntary culling probabilities on culling rates, herd life, profit, and estimates of economic values for involuntary culling (invol. culling) and herd life for the three payment systems (PS1, PS2, PS3)

Involuntary culling probabilities (% of base level)		Annual culling rates (%)			Herd life months	Profit x 1000 (L.lt./cow per year)	Econ. value (L.lt.)[3]	
		Involuntary[1]	Voluntary[2]	Total			Invol. culling (1%)	Herd life (day)
PS1	100	14.34 (56.02)	11.26 (43.98)	25.60	44.53	2011.608	4644	1088
	99	14.20 (55.61)	11.33 (44.39)	25.53	44.67	2016.252		
PS2	100	14.40 (55.46)	11.57 (44.54)	25.97	44.25	2130.540	4692	1099
	99	14.26 (55.07)	11.64 (44.93)	25.90	44.39	2135.232		
PS3	100	14.51 (55.54)	11.61 (44.46)	26.12	44.45	2009.196	4644	952
	99	14.36 (55.16)	11.67 (44.84)	26.04	44.61	2013.84		

[1]Between brackets the percentage of all culling which is involuntary.
[2]Between brackets the percentage of all culling which is voluntary.
[3]Economic values derived from difference in profit at base level.

Table 4. The effect of 6% higher involuntary culling probabilities, a steeper slope for involuntary culling probabilities over parities, and a higher level for conception rate on culling rates, herd life, profit, and estimates of economic values for involuntary culling (invol. culling) and herd life specified for PS3

Involuntary culling probabilities (% of base level)	Annual culling rates (%)			Herd life months	Profit x 1000 (L.lt./cow per year)	Econ. value (L.lt.)[3]	
	Involuntary[1]	Voluntary[2]	Total			Invol. culling (1%)	Herd life (day)
Increased involuntary culling rate							
100	20.72 (70.81)	8.53 (29.14)	29.26	38.68	1796.616	7140	1170
99	20.51 (70.41)	8.61 (29.55)	29.13	38.88	1803.756		
Steeper slope of involuntary culling							
100	15.28 (56.94)	11.56 (43.06)	26.84	43.15	1985.940	4880	991
99	15.13 (56.56)	11.62 43.44)	26.75	43.31	1990.776		
Conception rate of 65%							
100	14.53 (56.35)	11.26 (43.65)	25.79	45.03	2017.080	4656	848
99	14.39 (55.98)	11.32 (44.02)	25.71	45.21	2021.736		

[1]Between brackets the percentage of all culling which is involuntary.
[2]Between brackets the percentage of all culling which is voluntary.
[3]Economic values derived from difference in profit at base level.