Economic Relevance of Selection for Live Weight and Feed Intake Capacity in Dairy Cattle

Erwin Koenen[1]*, Paul Berentsen[2] and Ab Groen[1]

[1]Animal Breeding and Genetics Group, Wageningen University, P.O. Box 338, 6700 AH Wageningen The Netherlands

[2]Farm Management Group, Wageningen University, Hollandseweg 1, 6707 KN Wageningen, The Netherlands

** Present address: NRS, P.O. Box 454, 6800 AL Arnhem, The Netherlands*

Introduction

Live weight (LW) and dry-matter intake capacity (DMIC) can be changed by genetic selection. The effect of selection on the economic efficiency of dairy production is expressed by its economic value (EV). Most estimates for the EV of LW are negative: increased maintenance requirements exceed increased beef revenues (Dempfle, 1986; VanRaden, 1988). The DMIC has a positive EV when DMIC limits roughage intake and when roughages are cheaper than concentrates (Groen and Korver, 1989). It is not clear how the EVs will change under future production circumstances. Therefore, the aim of this study was to estimate the EVs of LW and DMIC for different Dutch production circumstances that varied in market and price situations, production intensities and environmental legislation.

Material and Methods

Production circumstances

Four sets of production circumstances (scenarios) were considered. Production circumstances in 1998 (1998-Actual) are based on actual data. Three future (2008) scenarios include technological and institutional changes (Berentsen et al., 1996; European Commission, 1998). The first scenario (2008-Trend) includes a moderate market liberalisation within the European Union ("Agenda 2000"). The second scenario (2008-Liberal) includes a total market liberalisation (no price interventions or restrictions on milk output). The third scenario (2008-Environmental) is in line with the 2008-Trend scenario but also includes two additional environmental restrictions (strong restrictions on stocking density and no exchange of roughages between farms).

Farm model

Within each scenario, yearly inputs and outputs of a dairy farm are described by a deterministic model (Berentsen and Giessen, 1995). Within this model, labour income is maximised using linear programming. Main activities are milk- and beef production, raising young stock and feed production (grass, grass silage, maize silage). Main restrictions are maximum milk output, land size, feeding requirements and environmental legislation. Maximum yearly milk output is 390,000 kg in the 1998-Actual scenario, 480,000 kg in the 2008-Trend and 2008-Environmental scenarios and unrestricted in the 2008-Liberal scenario. Farm size is 33 ha in 1998-Actual scenario and increases to 40 ha in all scenarios in 2008. Environmental legislation includes maximum levels of acceptable surplus for nitrogen and phosphate and maximum stocking densities. Maximum stocking density (grazing units per ha) is unrestricted in the 1998-Actual scenario, 2.5 in the 2008-Trend and 2008-Liberal scenarios and decreases to 2.0 in the 2008-Environmental scenario.

Phenotypic levels for LW, DMIC, and milk production were simulated by deterministic models (Groen, 1988). These simulations assume for 1998 a mean mature LW of 625 kg, a DMI of 18.5 kg/DM/day in the second month of third lactation, and a mean 305-days lactation milk yield of 7,950 kg milk. For 2008, these figures are 650 kg, 19.8 kg/DM/day and 9,000 kg. Beef production originates from newborn male calves, surplus female calves and culled cows. Feeding strategy is based on energy and protein requirements, DMIC, feeding restrictions and availability of feeds.

Product prices for milk, beef and feeds in 1998 are based on actual market prices whereas prices in 2008-Trend and 2008-Environmental scenario are based on EU-plans which include a moderate reduction of intervention prices. Product prices in the 2008-Liberal scenario are expected to be at world market prices, representing a reduction of 40% and 50% for milk and beef prices, respectively.

Derivation of economic values

The EVs for LW and DMIC are estimated by comparing maximum labour income before and after changing LW and DMIC by 1%. Furthermore, the sensitivity of some model assumptions on the estimates of the EVs is tested in two additional analyses for the 2008-Trend scenario. In the first analysis, production intensity is varied by changing land size by 10 ha at a constant total milk production. In the second analysis, DMIC and milk production levels are independently varied by 10 and 20%.

Results

Farm characteristics

The optimal dairy farm includes 49, 53, 72 and 53 cows in the 1998-Actual, 2008-Trend, 2008-Liberal and 2008-Environmental scenario. Land use for grazing, production of grass and maize silages varied among scenarios, depending on the optimal feeding strategy. In summer, rations mainly include grass and are supplemented by concentrates or dried beet pulp. In winter, the rations include grass and maize silage supplemented by concentrates or ground ear silage. In the 1998-Actual and 2008-Trend scenarios, a surplus of maize silage exists, which is sold.

The number of cows increases to 53 in the 2008-Trend and 2008-Environmental scenarios and to 72 in the 2008-Liberal scenario.

Economic values

Estimated EVs of LW and DMIC are in Table 1. When LW increases in the 1998-Actual scenario, more concentrates are included in the diet to replace grass (summer) or maize silage (winter). The increase in concentrates input is about 31 kg/cow/year. A higher LW also results in higher returns from sold beef and maize silage. Total costs increase by 224 €, whereas total revenues increase by 173 €. The resulting EV for LW is -0.17 €/kg/cow.

When DMIC increases in the 1998 scenario, concentrates input decreases (- 97 kg/cow/year), while more homegrown grass and maize silage is used. A higher DMIC reduces costs for concentrates and returns from sold maize. The EV for DMIC in the 1998 scenario is 33 €/kg/cow/year.

In the 2008-Trend scenario, the lower EV for LW is caused by lower beef prices and higher marginal feed costs (inclusion of dried beet pulp in the diet). When LW is increased, produced maize is partly harvested as ground ear silage. The higher productivity of grass and maize production decreased the costs of roughage, which resulted in a higher EV for DMIC, compared to the 1998 scenario.

In the 2008-Liberal scenario, higher levels for LW and DMIC change the number of cows and consequently affect many returns and costs. A higher LW increases total returns from milk and beef production. Total costs increase by higher costs for concentrates and higher variable costs due to the higher number of cows. The EV of LW (-0.29 €/kg/cow/year) was lower than in other scenarios, mainly because of much lower beef prices. The EV of DMIC (18 €/kg/cow/year) is much lower than in other scenarios as DMIC was only limiting in summer period.

In the 2008-Environmental scenario, a higher LW results in higher beef returns and in higher costs for concentrates. The EV for LW of -0.19 €/kg/cow/year is less negative than in the 2008-Trend scenario as the value of saved roughage is lower. With a higher DMIC, the area of grassland increases and all 40 ha are now used. The EV of DMIC is € 40 /kg/cow/year.

Table 1. Economic values (€/kg/cow/year) of live weight and dry-matter intake capacity in the 4 scenarios

		2008		
	1998-Actual	Trend	Liberal	Environmental
Live weight	-0.17	-0.22	-0.29	-0.19
Dry-matter intake capacity	33	37	18	40

Sensitivity analysis

At a high production intensity (land area was decreased by 10 ha), farms in the 1998-Actual, 2008-Trend and 2008-Liberal scenarios have to purchase maize silage. In the 2008-Environmental scenario, the number of cows has to decrease to comply with the relatively low maximum stocking density. In situations with purchased maize silage, marginal costs of roughage increase. Also in the 2008-Environmental scenario, marginal costs of roughage increase as relatively more land has to be used for (more intensive) crop production. When LW then increases, the value of the reduced amount of roughage is lower which results in fewer negatives EVs of LW compared to the basic situations. The higher marginal costs for roughage also reduces the price difference between concentrates and roughage, which consequently reduces the EVs of DMIC.

Table 2. Economic values (€/kg/cow/year) of live weight and dry-matter intake capacity for farms with an increased quotum/ha in the 4 scenarios

		2008		
	1998-Actual	Trend	Liberal	Environmental
Live weight	-0.10	-0.22	-0.14	-0.22
Dry matter intake capacity	16	29	13	35

Table 3. Economic values (€/kg/cow/year) of live weight and dry-matter intake capacity (DMIC) in the 2008-Trend scenario at different levels of DMIC and 305-day milk yield

Trait	Level	LW	DMIC
DMIC (kg DM/day)	15.81	n.a.[a]	n.a.[a]
	17.78	-0.28	37
	21.74	-0.01	6
	23.71	0.06	0
Milk yield (kg/year)	7,200	0.00	2
	8,100	-0.16	25
	9,900	-0.21	36
	10,800	-0.28	46

[a] not available.

Estimated EVs at various levels of DMIC and milk yield in the 2008-Trend scenario are in Table 3. For DMIC, estimated EVs tend to increase with higher LW as increased maintenance requirements at constant DMIC result in rations with higher energy densities. These higher energy rations increase marginal feed costs. Assumed DMIC levels largely affect the EVs for LW and DMIC. When DMIC is 10% lower, ground ear silage is included in the diet, which increases marginal feed costs. The EV for LW decreases to –0.28 €/kg/cow/year, whereas the EV for DMIC increases to 37 €/kg/cow/year.

At DMIC levels of 23.71 kg DM/day or higher the EV of DMIC is zero as DMIC no longer restricts the ration.

Milk production level affects the EVs of LW and DMIC largely. At a milk production level of 7,200 kg, only small amounts of concentrates are used. The EV for LW is zero, whereas the EV for DMIC is only slightly positive. Generally, at higher milk production levels, marginal feed costs increase which result in more negative EVs for LW and more positive EVs for DMIC.

Conclusion

Economic values for LW range from -0.29 to –0.17 €/kg/cow/year and depend on beef prices and marginal feed costs. Economic values for DMIC range from 18 to 40 €/kg/cow/year and depend on the difference between marginal costs of roughage and concentrates. Estimated EVs are highly sensitive to levels of dry-matter intake and milk production. At higher DMIC levels, the EV for LW becomes less negative, whereas the EV for DMIC becomes more positive. At higher milk production levels, the EV for LW become more negative, whereas the EV for DMIC becomes more positive. At higher production intensities (more quota/ha) the EV for DMIC decreases.

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