

Supplementary Materials:

The following tables are available online at <https://www.mdpi.com/2077-0472/11/1/41/s1>

Supplementary Table S1: Proportion of young DSN bulls assigned to carcass conformation classes and to carcass fat classes (EUROP system). Prices per kg for the respective carcass and fat classes stem from records of 711 young bulls. These prices are taken as the marginal revenue per kg of carcass in this study. Sub-groups (“+”, “0”, “-”) were not considered in this table. Young bulls of this study were not assigned to carcass class E and fat class 5.

Carcass conformation	E	U	R	O	P
Proportion of animals (%)	0.0	9.4	75.1	14.6	0.8
Price per kg (EUR)	3.87	3.82	3.73	3.48	2.23
Carcass fat class	1	2	3	4	5
Proportion of animals (%)	0.3	20.1	77.8	1.8	0.0
Price per kg (EUR)	0.00	-0.10	-0.20	-0.30	-0.40

Example: marginal revenue for “R3” = 3.73 EUR – 0.20 EUR = 3.53 EUR

Supplementary Table S2: Biological and economical parameters included in the calculation of DSN Net Merit.

	Trait/Service	DSN value
Biological	Functional herd life (fHL)	1,100 days
	Calving interval (CI)	387 days
	Days in milk (DIM)	330 days
	Number of calves during fHL (CA)	3
	Proportion of cows inseminated in their last lactation	75%
	Still birth rate heifers/cows for both male and female calves (SBr)	6.2 %
	Still birth rate heifers/cows for male calves (SBrm)	8.8%
Economical	Marginal revenue per kg fat from milk	3.73 EUR ¹
	Marginal costs per kg fat from milk	1.19 EUR ²
	Marginal revenue per kg protein from milk	5.60 EUR ¹
	Marginal costs per kg protein from milk	1.53 EUR ²
	Marginal costs per kg lactose from milk	0.52 EUR ²
	Replacement costs per culled cow	698.23 EUR
	Price per calf (average of male and female)	130.00 EUR
	Price per calf of loss until day 458 (Supplementary Table S5)	592.10 EUR
	Price per semen dose + service insemination	10.00 EUR + 14.41 EUR
	Marginal revenue young bull's carcass per kg "R3"	3.53 EUR
	Marginal costs per day of fattening young bulls	2.15 EUR ³

¹ Average milk price Friesland Campina, DMK, MUH-Arla for 1 kg milk (4.0% fat, 3.4% protein)
 $\sim 3.73 \text{ EUR} * 0.04 + 5.60 \text{ EUR} * 0.034 = 0.34 \text{ EUR/kg milk}$

² Feeding costs result from 66% roughage and 34% concentrate intake and a surplus of 3.5% maintenance energy required per additional kg compared to Holstein cows.

³ Feeding costs for fattening are calculated from the largest DSN farm and aligned to an experimental design from Dummerstorf, 2018 [20]

Supplementary Table S3: Equations for calculating marginal profit in Euro per SD (mp_{σ}) corrected for lactation length (LE) and average number of lactations (LA) for absolute EBVs included in DSN Net Milk and DSN Net Beef.

Description	Equation
Factor for lactation length (LE)	330 d (DIM) / 305 d (standard lactation) = 1.08
Average number of lactations (LA)	1,100 d (fHL) / 387 d (CI) = 2.84
Number of male calves (mCA)	3 (CA) * (1 - 0.088) (SBrm) * 0.5 = 1.37
Milk fat kg	25.1 kg/SD _{Fat} * 2.54 EUR/kg (mp_{σ}) * 1.08 (LE) * 2.84 (LA) = 195.55 EUR/SD
Milk protein kg	19.8 kg/SD _{Protein} * 4.07 EUR/kg (mp_{σ}) * 1.08 (LE) * 2.84 (LA) = 247.17 EUR/SD
Milk lactose kg	33.1 kg/SD _{Lact} * -0.52 EUR/kg (mp_{σ}) * 1.08 (LE) * 2.84 (LA) = -52.79 EUR/SD
Carcass conformation, class "R3"	15 kg/SD _{eCW} * 1.38 EUR/kg (mp_{σ}) * 1.37 (mCA) = 28.32 EUR/SD
Carcass fat class	0.4 fat/SD _{carc_fat} * 15 kg/SD _{eCW} * -0.10 EUR/kg (mp_{σ}) * 1.37 (mCA) = -0.82 EUR/SD

Supplementary Table S4: Equations for calculating marginal profit in Euro per SD (mp_{σ}) corrected for average number of calves (CA) for relative EBVs included in DSN Net Fitness.

Description	Equation
Costs per additional day of calving interval (AdCI)	130.00 EUR (Price per calf) / 387 d (CI) = 0.34 EUR/d
Calving-to-first-Insemination (CFc)	9.01 d/SD _{CFc} * 0.34 EUR/d (AdCI) * (CA - 1) = 6.13 EUR/SD
First-to-last heifers (FLh)	6.21 d/SD _{FLh} * (10 EUR + 14.41 EUR)/21 d * 1 = 7.20 EUR/SD
First-to-last cows (FLc)	10.1 d/SD _{FLc} * ((10 EUR + 14.41 EUR)/21 d + 0.34 EUR/d AdCI) * (CA - 1) = 30.30 EUR/SD 10.1 d/SD _{FLc} * (10 EUR + 14.41 EUR)/21 d * 0.75 = 8.79 EUR/SD FLc = 30.30 + 8.79 = 39.09 EUR/SD
Calf survival (RZcalfhealth) see Supplementary Table S5	0.044 %/SD _{calf_survival} * 592.10 EUR/calf * 3 (CA) * (1 - 0.062 SBr) = 73.33 EUR/SD
Still birth rate direct (SBd)	0.024 %/SD _{SBd} * 130.00 EUR (price per calf) * 3 (CA) = 9.36 EUR/SD
Still birth rate maternal (SBm)	0.031 %/SD _{SBm} * 130.00 EUR (price per calf) * 3 (CA) = 12.09 EUR/SD
Calving ease direct (CEd)	1.676 EUR/SD _{CEd} * 3 (CA) = 5.03 EUR/SD
Calving ease maternal (CEm)	1.343 EUR/SD _{CEm} * 3 (CA) = 4.03 EUR/SD
Functional herd life (RZN)	698.23 EUR (replacement costs) / 1,100 d (fHL) = 0.63 EUR/d 258.7 d/SD _{RZN} * 0.63 EUR/d = 164.21 EUR/SD

Supplementary Table S5: Marginal costs for premature loss of female calves in the respective time interval to survive (days of age) (n = 2,578).

Interval [d]	Mean age [d]	Proportion of premature loss [%]	Marginal costs per calf [EUR]	Marginal costs per interval [EUR]
3-14	9.9	11	179	19.69
15-60	31.1	27	367	99.09
61-120	89.3	14	485	67.90
121-200	157.1	18	604	108.72
201-458	328.2	30	989	296.70
3-458	144.2	100		592.10