A Bio-economical Model Including Many Functional Traits for Derivation of Economic Values in Beef Cattle

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Introduction

Two main production systems according to intensity of production may be defined for European conditions in beef cattle: 1) intensive concentrate based systems and 2) extensive pasture based systems (Zjalic, Dimitriadou & Rosati 2006). It can be difficult to categorize farms into one or the other production system, as one part of the enterprice may be intensive (e.g. fattening of bulls) while other parts may be more extensive (e.g. the suckler cow-calf enterprice). Such production systems will here be refered to as semi-intensive.
In the same way as production systems, breeds are classified according to their main production traits as intensive (e.g. Charolais, Simmental and Limousin), or extensive breeds (e.g. Hereford & Angus). Usually breed and production systems are linked, intensive breeds being more commonly found in intensive production systems. These production systems differ in level of production and management as well as income and cost of production. These factors will obviously influence the estimation of economic values.
Several bio-economical models for beef cattle are published over the last two decades. However, several disadvantages are associated with most of these models; they are often situation specific and not developed for broad breeding goals, thus not comparing the relative importance of production versus functional traits. The aim of this study was therefore to develop a deterministic bio-economic model including many functional traits for the estimation of economic values for intensive and extensive beef breeds kept in semi-intensive production systems.

Material and methods

Model description. A computer program was written specifically for this study, as most packages already developed and available for this purpose do not deal with the factors of main interest for the present study. The model describes a semi-intensive production system and calculates the life-time production and economic result of purebred beef suckler cows of two breeds, one of an extensive breed and one of an intensive breed. The model follows the cows from their first calving until they are culled due to age. From each cow, one heifer calf is kept as replacement. These replacement heifers are followed until their first calving. The suckler cows are kept in two different purebreeding herds with no sale or purchase of animals. Several management differences between these herds are defined. The intensive

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breed is kept in a more intensive production system, resulting in higher fixed costs and higher feed expenses due to higher feed requirement and larger amount of expensive high energy feedstuffs in diet (Aass & Vangen 1999; NILF 2007).
According to normal practice the suckler cows are assumed to be kept inside during winter and out on pasture during summer (June 1.-Septemer 15.). The diet during winter consists of roughage and concentrates. The heifers calve for the first time in spring, however a shift in calving date each year occour because the average calving interval exceeds 12 months. Most heifers calve as two year olds. Calves are weaned at approximately 6 months of age, and thereafter enter one of the following categories: 1) replacement heifer, 2) fattening of bulls and surplus heifers.

Input data. Average production data (2008) was obtained from the Norwegian Beef Cattle Recording Scheme and used as the base situation. Production data for a defined intensive breed was based on data from Charolais, Simmental and Limousin, while data for a defined extensive breed was based on production data from Hereford and Angus. Mean performance for the most important traits are given in table 1. The two groups of breeds obviously differ in production, the defined intensive breed having higher production results, but poorer reproductive performance.

Table 1: Mean performance of a defined extensive and intensive breed in base situation

Traits	HL	AFC	CI	S	T	CD	BW	GR1	GR2	GR3	CC	CF	CW	LC
Intensive	85.20	28.92	12.94	4.50	2.80	1.11	44.00	1.36	1.32	0.91	7.15	5.14	340.00	29.60
Extensive	87.00	26.52	12.52	3.80	2.20	1.08	40.00	1.18	1.08	0.84	6.10	6.70	274.00	29.60

HL=herd life cow (months), AFC=age at first calving (months), CI=calving interval (months), S=stillbirth (%), T= twinning frequency (%), CD=calving difficulty, BW=birth weight of bulls (kg) GR=growth rate bulls (kg/day), 1: age 0-200 days, 2=age 200-365 days, 3=age 365-slaughter, CC=carcass conformation score bulls (EUROP), CF=carcass fatness score bulls (EUROP),CW=carcass weight (kg), LC=limb and claw disorders (%)

Farm revenues come from slaughtering of fattened bulls, heifers, culled cows due to age and from subsidies. The included costs were fixed costs (machinery, tractor, car, buildings, diesel and oil, hired help, hired machinery, hired farmland, insurance, irrigation, electricity, social taxes, administration, plant seed, fertilizer, calcium carbonate, pesticides, perservatives, medicine, dairy product, breeding and miscellaneous), feed, labour, veterinary costs and claw trimming. The fixed costs were based on data from 33 Norwegian beef cattle producers, whereof 15 farms were classified, based on the carcass weight of bulls, as keeping an intensive breed (NILF 2007).
The economic values were estimated as the increase in profit as a result of 0.1 % increase in the mean of the trait of interest while keeping all other traits constant. The economic values were standardized by multiplying the economic value by the additive genetic standard deviation for each trait. The genetic standard deviations for the different traits were obtained from litterature. Relative economic values were expressed as a % of the total sum of absolute economic values.
Economic values for the categorical traits calving difficulty, calving interval, EUROP carcass conformation and fatness were calculated using the approach described by Meijering (1986).

Results and discussion

Simulated profit for the two breed groups were negative (-12190 vs. -7591 EUR) for the intensive and extensive breed group, respectively. In general, the total income was considerable higher for intensive breed group (21599 vs. 17492 EUR); however the costs were also considerably higher (33789 vs. 25170 EUR). Income from slaughter was higher for intensive breed group (7380 vs. 5928 EUR) even though they produced fewer offspring (4.27 vs. 4.69). This was due to prolonged calving interval, shorter herd life, and higher incidence of stillbirths. On the contrary, the settling prices were higher (5.60 vs. 5.19 EUR/kg for bulls) and a higher amount of beef produced per suckler cow due to heavier carcasses (1369 vs. 1204 kg).
The high fixed costs were the main reason why profit was negative, accounting for 72 and 65 % of the total costs for the intensive and extensive breed group. Labour costs accounted for 23 and 16 % of total costs for extensive and intensive breed, while feed costs accounted for approximately 11 % of the total costs for the farmer in both breed groups. Feed cost for the intensive breed was 48 % higher than for extensive breed due to higher feed requirement and larger amount of expensive, energy rich feedstuffs in diet. Of the total feed cost for suckler cows, maintenance costs accounted for approximately 50 % in both breed groups.

Relative economic values for the 14 traits in the base situation in the two breed groups are given in table 2.

Table 2: Relative economic values for the traits considered in the two breed groups

Traits	Intensive	Extensive
Functional traits:		
Stillbirth	42.69	27.90
Age at first calving	10.23	8.90
Calving interval	6.98	6.15
Calving difficulty	3.66	6.20
Twinning frequency	3.18	2.10
Herd life of cow	1.14	1.44
Limb and claw disoders	0.52	0.92
Birth weight	0.01	0.07
Production traits:		
Carcass weight	13.02	22.72
Carcass conformation (EUROP)	4.80	6.51
Carcass fatness (EUROP)	1.24	3.44
Growth rate:		
Periode 1	2.83	5.79
Periode 2	5.50	2.24
Periode 3	4.19	5.64

Stillbirth was the most important trait in both breed groups, followed by carcass weight and age at first calving. Birth weight, limb and claw disorders and herd life of cow was of little economic importance. In total, functional traits accounted for approximately 54.0 and 68.5 %, while the production traits accounted for 46.0 and 31.5 %, in the extensive and intensive

breed group respectively. The large economic importance of stillbirth is logical, as the calf normally represent the only possible source of income in beef suckler cow production. There are only a few examples of studies on bio-economical models in beef cattle including many functional and production traits. These studies all emphasised the economic importance of functional traits, however; Wolfova, Wolf, Pribyl *et al*. (2005) and Amer, Simm, Keane *et al*. (2001) did not present relative economic values, making it difficult to directly compare the relative importance of the two groups of traits. Phocas, Bloch, Chapelle *et al*. (1998) did present relative values, but lower figures for functional traits than this study.
The present study showed that production traits were more important for the extensive breed group. This is due to the non-linearity of the profit function for carcass quality, and different settling prices. If the economic values presented in table 2 were implemented in the breeding objectives, the two breed groups probably would approach each other in mean performance in the long run. It might be difficult to generalize the results obtained in this study due to differences in mean performance, production systems, models and considered traits. However, if the proportions between the different costs are almost equal, the results obtained in this study probably will be relevant to other populations as well. Regardless of the above mentioned conditions functional traits are important traits to be included in a breeding program in beef cattle.

Conclusion

The result of this present study indicates that the most important costs in suckler cow production are fixed cost followed by labour and feed costs.
Functional traits are the most important group of traits, accounting for approximately 54.0 and 68.5 % of the relative economic value for extensive and intensive breeds. These results clearly show that functional traits are of decisive economic importance and must be included in breeding goals for beef cattle. The value of functional traits seems to be neglected or underestimated in several studies.

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