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A bio-economic model for calculating economic values of traits for intensive and extensive beef cattle breeds

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ABSTRACT

A deterministic bio-economic model was developed to estimate marginal economic values for production and functional traits for intensive (Continental) and extensive (British) breed groups in their typical production systems, and to estimate the relative importance of these two groups of traits. The model simulates the economic result of one purebred beef suckler cow and her progeny of each breed group on the basis of their lifetime production. The level of performance of the cow and progeny was set to the population means of traits in the respective breed group. Relative economic values (REV, in percentage) were estimated for 14 traits, seven production and seven functional traits. The REV for the intensive and extensive breed groups, respectively, were: herd life of cow; 39 and 29%, age at first calving; 6 and 4%, calving interval; 4 and 3%, calving difficulty; 2 and 3%, carcass weight; 24 and 29%, carcass conformation; 5 and 5%, carcass fatness; 2 and 5%, growth rate from birth to 200 days; 4 and 6%, growth rate from 200 days to 365 days; 6 and 9% and growth rate from 365 days to slaughter; 7 and 7%. The value of stillbirth, twinning frequency, limb and claw disorders and birth weight were all close to zero in both breed groups. Functional traits were almost as important as the production traits for both breed groups; however, functional traits were even more important for the intensive breed group (51 vs. 39%). The results suggest that functional traits are important traits to include, regardless of breed, when developing breeding objectives for beef cattle, and should to a much larger extent than at present, be recorded in breeding schemes for beef cattle.

1. Introduction

When developing breeding objectives for beef cattle, several steps need to be considered as pointed out by Ponzoni (1986) (ref. by Ponzoni and Newman, 1989). Those steps are: "1) defining breeding, production and marketing system, 2) identifying different sources of income and costs, 3) determining which traits influence income and costs, and finally, 4) derivation of economic values for each of the economically important traits". Differences in production intensity and breeds will influence the profit and thus should be included when developing a model for the derivation of economic values for more than one breed.

As many factors influence the economy of beef cattle production, a model that handles this complexity needs to be developed for the estimation of economic values. Bio-economic models are well suited to describe the complex nature of beef suckler cow production, taking genetic, nutritional, management and economic factors into account (Jones et al., 2004).

A large number of beef cattle breeds are present in Europe, and these may be split into two main biological types: British and Continental breeds. British breed types (e.g. Hereford and A. Angus) are primarily known as extensive breeds, while Continental breeds (e.g. Charolais, Limousin and Simmental) are known as intensive breeds. British breeds are generally

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smaller in size, reach a mature size at an earlier age and have a lower growth potential than the Continental breeds.

The production system and choice of breed are often linked; intensive breeds are usually found in more intensive production systems compared to extensive breeds. Aass and Vangen (1999) found several differences in management between extensive and intensive production systems, and thus the costs associated with the two production systems are expected to differ. Based on data from 32 Norwegian beef suckler cow producers, farms with intensive breeds were having considerably higher production costs than extensive breeds (NILF, 2007). Additionally, the income will differ as a result of the differences in production level in different production systems.

Most of the published bio-economic models developed for deriving economic values in beef cattle consider only production traits (e.g. Amer et al., 1997; Hirooka et al., 1998; Wolfova et al., 1995), or have a limited inclusion of functional traits in the model (e.g. Albera et al., 2004; MacNeil et al., 1994; Ponzoni and Newman, 1989). Production and functional traits need to be included simultaneously in the model in order to obtain a thorough understanding of the relative importance of functional vs. production traits in beef cattle. The aim of this study was to develop a deterministic bio-economic model, including several production and functional traits, for the derivation of economic values for breeding goal traits for extensive and intensive breeds.

2. Materials and methods

2.1. Description of breeding, production and marketing systems

The beef suckler cow population size in Norway is approximately 60,000, and 56% of these cows are included in the Norwegian Beef Cattle Herd Recording System (NBS) (NBS, 2008). The majority of suckler cows are crossbreds (75%). The current breeding scheme for Norwegian beef cattle was implemented in 2001, and the 5 main beef cattle breeds are included: Hereford, Angus, Charolais, Simmental and Limousin. Both AI and NS (natural service) bulls are selected after a 150 day station performance test, including recordings of daily growth rate, feed efficiency and muscle and fat depth (ultrasound). Additionally, the bulls' temperament and conformation are assessed. After finishing the performance test, the best third are selected as AI bulls. The middle third are sold as NS bulls, while the rest are culled. The AI bulls are finally progeny tested based on crosses with the dairy cattle population (Norwegian Red) to get data on carcass quality and calving performance.

BLUP breeding values are calculated for 7 traits based on recordings in the NBS: birth weight, weaning weight, yearling weight, carcass weight, EUROP carcass conformation and fatness and maternal effect for weaning weight.

Production systems can be defined according to the intensity of production: 1) intensive concentrate-based systems, and 2) extensive pasture-based systems (Zjalic et al., 2006). In addition, there is a third production system in which some parts of the enterprise are intensive (e.g. the fattening of bulls), while other parts are more extensive (e.g. the suckler cow-calf enterprise). The latter production system is also found in many countries e.g. Norway, and will, in the following, be referred to as semi-intensive.

According to normal Norwegian practice, the suckler cows are kept inside during winter and out on pasture with their calves during summer (June 1. to September 15.). The diet during winter consists of a high amount of roughage and some concentrates. Calves are weaned at approximately six months of age, and thereafter enter one of the following categories: 1) replacement heifer, or 2) bulls and surplus heifers for fattening on farm. Bull calves are kept indoors and fed a high amount of concentrates in their diet (app. 50%), and therefore slaughtered within 16 months of age. Surplus heifers are slaughtered after two seasons on pasture (approx. 18 months of age). Replacement heifers usually calve for the first time in spring as two year olds. Heifers failing to become pregnant are usually kept in the herd one more year and calve as three year olds. Mating season is during the pasture period as described above, thus the calving season is from 1. March to 15. June. A large proportion of cows (approx. 38%) have a 12 month calving while a smaller proportion of cows has prolonged calving intervals (approx. 16% 13 months, approx. 6% 14 months, approx. 10% above 15 months). This range implies that the average calving interval in Norwegian beef herds exceeds 12 months. However, due to breeding management most cows will still be able to conceive within the main mating period as described above. Cows calving late may be given extra attention during the beginning of the mating season and will be able to conceive at the same time as the cows calving early in the calving season, resulting in shortened calving interval for these cows. Approximately 31% have calving interval below 12 months. Cows failing to conceive within the mating period are either kept barren and mated the subsequent mating season or culled (approximately 13% of the culled cows annually are culled due to infertility according to NBS).

2.2. Model description

The deterministic model describes a typical Norwegian semi-intensive production system and estimates the lifetime production and economic results of an average beef suckler cow and her progeny of one of two breed groups (one cow of an extensive breed and one of an intensive breed). The performance level of the suckler cow and progeny was set to the population means of the included traits. The model follows the cow from first calving until culling. From each cow, one heifer calf is kept as a replacement, and the replacement heifers are followed until (but not including) their first calving. Heifers failing to calve as 2 year olds are kept one more year and calve as three year olds (e.g. it is assumed that heifers will not fail to conceive two subsequent years). The average calving date is set to 1. April.

The production system and choice of breed is often linked; intensive breeds are usually found in more intensive production systems compared to extensive breeds. Several differences between the intensive and extensive herds are defined. Feed is one of the largest expenses in suckler cow production, indicating the importance of including differences in feed requirements and feed composition between the breed groups. The feed composition (Aass and Vangen, 1999) and feed requirements (Refsgaard Andersen, 1990) for intensive and extensive breeds in different categories and periods are shown in Table 1. The intensive breed group has a