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EBV RESTRICTION FOR OPTIMAL BEEF PRODUCTION

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INTRODUCTION

In the 1930's, J.L. Lush (Lush 1945) introduced methods of estimating breeding values of animal. He also designed the construction of a selection index.

In 1963, C.R. Henderson (Henderson 1973) gave simple proof that economic weights could be applied to the mean computed for simple traits, by using correlated records coming from measurements on other traits either on the individual or it's relatives. This led to the development of BLUP (Best Linear Unbiased Prediction) mixed models and our first powerful computing tool for animal breeding.

It has worked well for the dairy industry where selection for the single trait of milk volume has resulted in big increases in financial returns. However, in the poultry industry it has been noted that selection for increased egg weight has led to bigger birds. Bigger birds eat more and lay less eggs due to a positive genetic correlation between egg size and bird size and a negative genetic correlation between egg size and egg number.

BREEDPLAN has embraced BLUP technology and has an increasing number of beef cattle herds recorded through the national beef recording scheme. These are receiving estimated breeding values (EBV's) for an increasing number of traits. The primary EBV's used to date have been for 200 day growth and milk and 400 day growth. Most breeders using these objectively measured breeding values have selected single trait leaders.

Growth is vital for beef production but so is fertility; and survival. Selection for growth has led to an increase in birth weight and a subsequent increase in birthing difficulties (Koch et al. 1982). It has also led to an increase in mature cow size. This does not necessarily achieve optimum production in terms of kilograms beef produced per hectare per year. Some researchers realising this have attempted to determine optimum sizes for specific environments (Johnson et al. 1991).

Bigger cows eat more, are later maturing and their progeny may be difficult to finish to market specifications within a given time frame. Recent work in the U.S. on the efficiency of beef production has determined that bigger cows with higher milk production and rearing heavier weaners are less efficient than the more traditional beef type cattle (Lusby and Marston 1994).

Consumers, producers and veterinarians are becoming increasingly concerned for the welfare of production animals. Many seedstock breeders embarking on selection for growth have needed veterinarian assistance to deliver oversize calves by caesarean section. The cost of this operation to the seedstock breeder is insignificant compared to dystocia losses in many commercial herds. These are commonly in the range of 10 to 30% for first calf heifers. Producers presently combat dystocia by selective mating, they mate low birth weight bulls to heifers. Mate selection is another field (Allaire 1980), outside the scope of this paper.

A method of selecting for growth while restricting birth weight has been considered by the authors. It was discovered that the use of a negative quadratic economic weight for birth weight has the potential to prevent birth weight from increasing or decreasing while selection pressure is applied to the correlated trait of growth. In layman's terms, a mechanism to bend the growth curve. Whether the negative quadratic is the most appropriate function to restrict an index is open to debate. The main concern of the authors is that a restriction is required because the problem of dystocia exists. Several authors have compared the efficiency of restricted selection indices and concluded that non-linear indices are less efficient than linear indices (Goddard 1983; Famula 1992; and Groen et al. 1994). Goddard (1983) comments that epistatic effects on fitness traits could warrant the use of a non-linear selection index, while accepting that, with traits presently not optimal, a linear selection index will result in superior genetic gains. The authors would like to propose that birth weight is a trait of fitness that requires use of a non-linear selection index to restrict changes and prevent losses due to dystocia. The result of these discussions was the development of a simple selection index described below.

THE SIMPLE RESTRICTIVE SELECTION INDEX

Calves with small birth weight have reduced viability, a greater incidence of postnatal deaths, while calves with high birth weight are prone to dystocia. Thus an optimum birth weight is desirable for maximum calf survival. This concept is also supported by human data despite the availability of excellent medical care (Ulizzi et al. 1981 in Falconer 1989) and by sheep data (Allexander 1974). The discussion of this optimum is beyond this paper.

Animals that deviate from their 'optimum' can be penalised by subtracting the 'optimal' EBV from their EBV, squaring the difference and multiplying it by an economic weight which would be negative.

$$-a(\text{EBV} - \text{“OptimumEBV”})^2$$

This concept can be simply incorporated into a selection index. The genetic and phenotypic variances and covariances, plus the breeders' estimates of economic importance of the trait and the optimum EBV will be used to correctly estimate economic weights for each trait included in the selection index.

The index developed to restrict birth weight while selecting for increased growth to 200 and 400 days of age took the following form;

$$EBV_{SI} = \alpha(EBV\text{-}EBV_{optBW})^2 + \beta EBV_{BW} + \delta EBV_{WW} + \mu EBV_{YW} + \text{other traits}$$

where: EBV_{SI} = Estimated breeding value for multi trait selection index
EBV_{BW} = Estimated breeding value for birth weight
EBV_{optBW} = Estimated breeding value for optimum birth weight
EBV_{WW} = Estimated breeding value for weaning (200) day weight
EBV_{YW} = Estimated breeding value for yearling (400) day weight

α, β, δ and μ are economic weights for their respective traits. α will be a negative weight penalising deviations from the desired optimum EBV for birth weight.

DISCUSSION

This concept is designed to be used with BREEDPLAN EBV's. Once the terms and economic weights have been estimated, index values for the selection of animals can be simply calculated with the aid of a spread sheet. Ideally these weights need to be individually estimated according to each breeder's current genetic values, attitude to risk, production resources, aims and objectives. This will allow each breeder to achieve their desired economic gains and favour retention of genetic variability.

Simple linear regression is normally used to calculate economic weights for selection indices. The authors believe that a method capable of dealing with curvilinear relationships, such as polynomial regression, should be used to estimate economic weights. Linear regression assumes that over a small range of breeding values linearity exists. This is true over a small range but we believe that selection is not operating over a 'small' range. We believe that the validity of this assumption should be questioned.

Additional traits may be included in such an index provided the correct economic weights and index terms are estimated to be used with that trait's EBV. For example, the intercalving interval can be easily measured. For breeders desiring one calf per year it can be optimised by the above method to 365 days. Current selection for scrotal circumference has tended to favour the bigger the better approach. This has been shown to be a threshold trait for male fertility and optimum testicular sizes no doubt exist for a given breed and environment. Breeders will need to continue independent culling for qualitative traits to remove problems such as conformation faults, cancer eye and bottle teats.

Selection for calving ease has been clouded by apparent antagonism between direct and maternal effects on calving. The American Simmental Association (1987 in Notter 1988) reported a genetic correlation of -0.27 between direct and maternal calving ease. This supports the hypothesis that smaller calves grow into smaller heifers and are thus more prone to calving difficulties. However Meijering and Postma (1985 in Notter 1988) have formally tested and disproved this hypothesis, finding that smaller birth weight heifers with shorter gestation periods, joined to bulls selected for calving ease had 7.8% fewer difficult calvings.

CONCLUSION

With the advent of personal computers and user friendly spread sheets customised selection indices may now be a reality. Breeders will need:

- Reliable estimates of breeding values for traits to be used in the index;
- Estimates of the genetic and phenotypic correlations, variances and covariances for the traits;
- Predictions of the production economics for future selection gains and a perception of the optimum beast for their production system.

Group BREEDPLAN EBV's can provide the first. Continuing research will be needed to provide the second. The last should be left up to individual breeders, along with the choice of traits to include in the index and the desired amount and direction of change from breed average EBV's.

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