UDK 636.03

Izlaganje sa znanstvenog skupa

Conference paper

EXPECTED CORRELATED RESPONSES IN HEALTH AND FERTILITY TRAITS TO SELECTION ON PRODUCTION IN DAIRY CATTLE

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Summary

Parameter estimates from two UK recording schemes were used to predict correlated selection responses for two indices. The goal of both indices was to optimise responses to selection for production, using economic values of -0.03 £/kg, 0.60 £/kg and 4.04 £/kg for milk, butterfat and protein yields respectively. One index was used to maximise response in production (PIN) and the other was restricted to zero genetic change in several health and fertility traits (RIN). Selection on PIN was expected to increase calving intervals by 2.78 days per unit selection differential. Mastitis and lameness were expected to increase by 0.018 and 0.007 cows with one or more cases of mastitis and lameness respectively. Selection using RIN was expected to result in 11% less overall economic response in production than PIN.

Keywords: Selection index, mastitis, lameness, fertility,

Introduction

There is evidence to suggest that selection for production alone in dairy cattle leads to a deterioration in fertility (e.g. Jansen 1985; Hoekstra et al. 1994), and an increase in the incidence of mastitis and lameness (e.g. Emanuelson 1988; Lyons et al. 1991). Although heritability estimates for health and fertility, traits are low, it has been argued (Jansen 1985; Emanuelson 1988) that there is sufficient genetic variation to make genetic progress. Female fertility can be measured in several ways (Jansen 1985), but there is no universally accepted definition. In the UK, maintaining calving intervals of high producing cows is an important management objective in

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Rad je priopćen na "6[th] World Congress Genetics Applied to Livestock production", Armidale, 1998.

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many herds (Esslemont 1995). Therefore, in this study, calving interval was chosen as the measure of fertility. Mastitis and lameness were considered as they are economically important diseases (Kossaibati and Esslemont 1997). The objectives of this study were (i) to predict correlated responses in calving interval, mastitis and lameness when selection was for production only, and (ii) to predict responses in production traits when calving interval, mastitis and lameness were restricted to zero genetic change.

Methods

Genetic parameter estimates for milk, butterfat and protein yields, calving interval, mastitis and lameness (Table 1) were obtained from analysis of data from two UK recording schemes: Scottish Livestock Services, SLS (Pryce et al. 1997a) and the Dairy Information System, DAISY (Pryce er al. 1997b). Heritabilities, genetic correlations and phenotypic correlations used here were the means of estimates from the two studies. Correlations between butterfat and protein yields and health and fertility traits were from DAISY only (Pryce et al. 1997b). In both studies mastitis and lameness were considered to be all-or-none traits and analysed using a linear rather than a threshold model.

Table 1. - PHENOTYPIC STANDARD DEVIATIONS (σ_p), HERITABILITIES (ALONG THE DIAGONAL), GENETIC CORRELATIONS (BELOW THE DIAGONAL) AND PHENOTYPIC CORRELATIONS (ABOVE THE DIAGONAL)

Trait	σ_p	1	2	3	4	5	6
1. Milk yield	1075	0.33	0.69	0.71	0.20	-0.01	0.04
2. Butterfat yield	45	0.92	0.27	0.73	0.16	-0.02	0.01
3. Protein yield	36	0.99	0.96	0.27	0.16	0.02	-0.01
4. Calving interval	45	0.39	0.53	0.36	0.025	0.04	0.04
5. Mastitis	0.28	0.26	0.27	0.29	0.11	0.057	0.05
6. Lameness	0.28	0.17	0.12	0.13	0.20	0.33	0.036

It was assumed that all index traits were predicted transmitting abilities (PTAs) from a complete multivariate best linear unbiased prediction. Partial regressions were calculated from estimated genetic variances and covariances:

$$R = G^{-1}G_{ig}$$

where R is a matrix of partial genetic regression coefficients of m goal traits and n index traits and the matrix G_{ig} (n x m) contains the genetic covariances between the index and goal traits. The G matrix is symmetric (n x n) and is the genetic (co)variance matrix between index traits. Prior values of the (co)variance matrices were checked to ensure that these matrices were positive definite. Negative eigen values were set to 10-7. The optimal index weights (b) were the sum of the partial genetic regression coefficients of goal traits on index traits (Veerkamp et al. 1995): b = Rv where v is the vector of economic weights. Matrices for the restricted index, NG_{ig} and NG, were constructed from the G_{ig} and G matrices, modified from Cameron (1997):

$$NG=\begin{bmatrix} G & G_{ig1} \\ G'_{ig1} & M0 \end{bmatrix} \qquad NG_{ig}=\begin{bmatrix} G_{ig} \\ M0 \end{bmatrix}$$

NG included the G matrix and extra columns and rows from G_{ig} that corresponded to k restricted traits, G_{ig1} (n x k), and a k x k matrix consisting of zeros (M0). NG_{ig} was constructed using G_{ig} and an m x k matrix of zeros (M0). Economic weights from Veerkamp et al. (1995) were used. These estimates were based on assumptions for the future UK milk price and were £-0.03, £0.60 and £4.04 per kg of milk, butterfat and protein respectively. Selection index equations were used to evaluate the consequences of selection using two different indices (i) selection for yield only (PIN) (ii) restricted selection index where selection was for yield with no change in the health and fertility traits considered (RIN).

Results

Weights for the production index (PIN) were equal to the economic values of each of the yield traits, as expected, when multivariate BLUP PTAs are used. The index weight restricted index (RIN) were the same for the production traits as weights in PIN.

When selection was for yield only (PIN), calving intervals were expected to increase by 2.78 days per unit selection differential (Table 2). Mastitis and lameness were also expected to increase by 0.018 and 0.007 cows with one or more cases of mastitis and lameness respectively. When the index was restricted to no change in calving interval, mastitis and lameness, then a lower rate of genetic gain would be expected in milk yield, butterfat and protein yields compared to selection on PIN.

Table 2. - CONSEQUENCES OF ONE STANDARD DEVIATION OF SELECTION ON PIN AND RIN IN GENETIC STANDARD DEVIATIONS (σ_g) AND UNITS OF MEASUREMENT FOR (a) PRODUCTION TRAITS AND (b) HEALTH AND FERTILITY TRAITS

	Units of response:	σ_g		Unit of measurement	
	Selection on:	PIN	RIN	PIN	RIN
a	H	-	-	£71.3	£63.5
	Milk yield	0.97	0.87	600 kg	538 kg
	Butterfat yield	0.98	0.81	22.9 kg	19.0 kg
	Protein yield	1.0	0.90	18.7 kg	16.9 kg
b	Calving interval	0.39	0	2.78 days	0 days
	Mastitis	0.27	0	0.018	0
	Lameness	0.13	0	0.007	0

Discussion

Assuming that a change of 0.22 standard deviations in the index approximates the annual selection response in a four way pathway breeding scheme, annual economic responses for selection on PIN and RIN are £15.6 and £13.9 respectively. Selection for production traits alone was expected to result in longer calving intervals and more cases of mastitis and lameness. Restricting the index to no genetic change in calving interval, mastitis and lameness caused a reduction in overall economic response in milk production equivalent to 11% of the response in PIN. However, this ignores the economic benefit of preventing a decline in genetic merit for health and fertility. Derivation of economic values for health and fertility traits is necessary to optimise economic response of the aggregate genotype, as an economic index will always at least equal, but usually out-perform a constrained index (Gibson and Kennedy 1990). Assuming the economic values of these traits would be small (compared to the value of production traits), it is likely that health and fertility would still deteriorate. However, there may be justification in increasing the weighting given to health and fertility traits further, to account for animal welfare implications and associated opinion.

For mastitis and lameness in particular, it may be advantageous to use predictor traits as selection criteria rather than recording clinical cases in a progeny testing scheme, as they are generally easier to measure and record and have higher heritabilities. Feet and leg traits (e.g. linear type scores) and locomotion measurements may be suitable characteristics for incorporating into a breeding programme to reduce the incidence of lameness (Boelling and

Pollott 1997). A suitable candidate trait for predicting mastitis is somatic cell count (SCC) as it is recorded in many countries and has a reasonably high correlation with clinical mastitis and a higher heritability (Philipsson et al. 1995).

The results here demonstrate the importance of health and fertility traits in dairy cattle breeding programmes. Using a breeding goal constrained to no genetic change in health and fertility traits would have a substantial economic impact on returns from milk production. Using indicator traits for health and fertility may result in less loss of production. There is a strong case to expand breeding goals to include health and fertility traits. Achieving optimal economic progress would necessitate deriving appropriate economic weights, although consideration should be given to social and animal welfare aspects.

Acknowledgements

We are grateful to: Prof W. G. Hill and Prof R. Thompson for helpful comments; to Scottish Livestock Services and Dr R. J. Esslemont and Dr M. A. Kossaibati from the University of Reading for providing data for the original studies; and to the Ministry of Agriculture, Fisheries and Food and the Scottish Office Agriculture, Environment and Fisheries Department for financial support.

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OČEKIVANI UZAJAMNO POVEZANI ODGOVORI U ZNAČAJKAMA ZDRAVLJA I PLODNOSTI NA SELEKCIJU NA PROIZVODNJU KOD MLIJEČNOG GOVEDA

Sažetak

Procjene parametara iz dvaju programa bilježenja u UK upotrijebljene su za predviđanje uzajamno povezanih selekcijskih odgovora za dva pokazatelja. Cilj oba pokazatelja bio je optimizirati odgovore na selekciju za proizvodnju primjenom ekonomskih vrijednosti od –0-03 £/kg, 0.60 £/kg i 0-04 £/kg za proizvodnju mlijeka, maslačne masnoće i bjelančevina. Jedan je pokazatelj upotrijebljen za maksimalno povećanje odgovora u proizvodnji (PIN) a drugi je bio ograničen na ništicu genetske primjene u nekoliko značajki zdravlja i plodnosti (RIN). Očekivalo se da će selekcija na PIN povećati razmak telenja za 2.78 dana po jedinici selekcijskog diferencijala. Očekivalo se da će se mastitis i sakatost povećati za 0.018 i 0.007 krava s jednim ili više slučajeva mastitisa odnosno sakatosti. Očekivalo se da će selekcija primjenom RIN-a rezultirati s 11% manjim sveukupnim ekonomskim odgovorom u proizvodnji nego PIN.

Ključne riječi: Pokazatelj selekcije, mastitis, sakatost, plodnost.

Primljeno: 10. 1. 1999.