INTERBULL-meeting
Aarhus, Denmark, Aug. 19-20, 1993

Use of Total Merit Index in bull selection

Jan Philipsson, Georgios Banos and Thorvaldur Arnason
Department of Animal Breeding and Genetics
Swedish University of Agricultural Sciences
S-750 07 Uppsala, Sweden

Application of Total Merit Index (TMI) has been noted in an increasing number of countries. However, still less than half the number of countries being surveyed by INTERBULL in 1992 apply such selection index. All of these countries include production and some conformation traits. A few countries also include milking ability, while only the Scandinavian countries consider fertility, calving performance or stillbirth, and health traits into their TMI.

Lifetime profitability of dairy cows certainly involves a number of traits, the importance of which might vary by breed and environmental and economic conditions of production. Reviews by Burnside et al. (1984) and Wynn-Jones (1987) clearly pointed out first-lactation yield or product value as a good indicator of lifetime yield and longevity, but also that considerable room was left for other traits contributing to lifetime productivity and profitability. Culling statistics of many dairy populations generally indicate fertility problems and mastitis as the two most common single causes of culling dairy cows besides low production. Furthermore, stillbirths occur in a number of breeds at the rate of 4-10% as average at first calving.

Thus, it is surprising that still so few countries have included into a TMI such functionally important traits as female fertility, stillbirth or dystocia as a maternal trait, and resistance to mastitis otherwise than indirectly by udder and teat conformation. In some cases sires are evaluated for these traits but selection indexes have not been worked out. However, in the majority of the cases no evaluations at all are available. This may result from lack of records or disintegrated recording and evaluation schemes. It may also be the result of neglecting traits of low heritability without estimating the real amount of additive genetic variation. Mass selection will be inefficient for such traits but modern AI-programs based on integrated data bases of AI-services, milk-recording and health-recording schemes offer other opportunities.

The purpose of this study was to investigate the principal importance of including reproduction and udder health traits into a TMI in combination with production.

PARAMETERS CHOSEN

Several alternatives for selection index construction were examined. A simplified breeding objective consisting of protein yield, female fertility and clinical mastitis was defined, thereby including three quite important components contributing to lifetime productivity of dairy cows. It was assumed that these three traits were recorded routinely in an integrated milk, AI, and health recording scheme. Information on SCC and udder conformation were used in addition to the breeding goal traits. Genetic and phenotypic parameters were chosen from the literature and are given in Table 1. The economic weights were chosen in close agreement with those of Christensen (1990) for Danish conditions and of Rogers (1993) for North-American conditions. Two alternative sets of weights were chosen and are expressed in relative units per genetic standard deviation in Table 2. Alternative selection schemes considered are shown in Table 3. Effects of progeny testing based on 50, 100 and 150 daughters were analyzed. One alternative assumed recording of only production, although the breeding objective still included fertility and mastitis resistance.

RESULTS

It is obvious from the results presented in Table 4 that realistic weighting of production, mastitis and fertility imply that a considerable loss in total economic gain, 15-25%, from dairy production will follow single trait selection for yield versus consideration of all three trait categories into an index. The advantage of increased daughter group size is clearly demonstrated when traits with low heritability are included. Similarly, increased accuracy in evaluation of production only has limited value for total economic gain compared to recording and inclusion of fertility and mastitis into a TMI. The restricted index showed that the unfavourable correlated responses in fertility and mastitis from selection for production could be offset at the expense of 12-15% lowered gain in production.

CONCLUDING REMARKS

The surveys presented and the examples of alternative recording schemes and selection index construction given would imply that larger research efforts should in the future be placed on methods for recording and evaluating, economically and genetically, traits other than production. It is quite obvious that more economic gain could be obtained by controlling the unfavourable correlated responses in reproduction and udder health, thereby keeping costs low for culling due to mastitis and fertility problems. This would imply more integrated recording schemes in many countries.

Accurate selection for a TMI, as has been described, would require more research to find reliable estimates of genetic and phenotypic parameters applicable to the trait recording schemes and data obtained for each population or country. The same applies to estimation of economic weights.

In the international context the most important development to be seen would be the availability of breeding values for bulls for all the economically most important traits. The weighting of traits, and thus the construction of TMI would then be a matter of consideration for each country depending on the variable economic market conditions. Certainly globalized cattle breeding programs would largely benefit from a better acceptance of TMI in each country; additionally, international publication of proofs will enable somewhat different weighting of traits when the bulls are selected for use in different countries. Furthermore, the present potential of heavy international use of individual bulls definitely requires accurate proofs for a range of economically or functionally important traits, in order to prevent spreading of defects or other undesirable genes.

REFERENCES

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Table 1. Assumed heritabilities (diagonal), genetic correlations (above) and phenotypic correlations (below diagonal)

Trait	Protein	Mastitis	Fertility	SCC	Udder conf.
Protein	**.25**	.30	-.30	.30	-.20
Mastitis	-.10	**.03**	0	.70	-.30
Fertility	-.20	0	**.04**	0	0
SCC	-.10	.10	0	**.10**	-.30
Udder conf.	-.10	-.10	0	-.10	**.20**

Table 2. Means, genetic standard deviations and economic weights of traits included in the breeding objective under two alternatives

Trait	Mean	Gen.S.D.	Economic weight per genetic S.D. alt.A	alt.B
Protein, kg	230	16	2.5	3.5
Mastitis, %	30	10	-1	-1
Fertility, % NR	67	9	1.5	1.5

Table 3. Alternative selection index construction

Breeding objective[1)]	Alternative	Recorded traits on daughters for progeny testing of bulls
A	1 a, b, c	Protein (50, 100 and 150 daughters)
	2 a, b, c	Protein, mastitis, fertility, SCC, udder[2)] (50, 100 and 150 daughters)
	3 a, b, c	Protein, udder[2)] (50, 100 and 150 daughters)
	4 a, b, c	As alt. 2 but restriction on unchanged mastitis and fertility
B	1-4	As above

[1)] A:economic weight protein, mastitis, fertility: 2.5, -1, 1.5
B: " " " " " 3.5, -1, 1.5

[2)] 50 daughters in all alternatives

Table 4. Accuracy (R_{TI}) of total merit index (TMI) and response in breeding objective traits of alternative index constructions

Alternative[1)]			R_{TI}	Response[2)]			
				Protein	Mastitis	Fertility	Total (Relative value)
A 1	a	(Protein)	.640	14.0	2.6	-2.4	100
	b		.681	14.9	2.8	-2.5	106
	c		.696	15.3	2.9	-2.6	109
2	a	(All traits)	.737	12.1	1.4	.1	115
	b		.819	12.3	.9	.8	128
	c		.859	12.3	.6	1.2	134
3	a	(Protein and	.641	14.0	2.5	-2.4	100
	b	udder)	.683	14.9	2.6	-2.5	107
	c		.699	15.2	2.7	-2.6	109
4	a	(Restricted)	.693	11.1	0	0	113
	b		.816	12.4	0	0	126
	c		.870	13.0	0	0	132
B 1	a	(Protein)	.753	14.0	2.6	-2.4	100
	c		.819	15.3	2.9	-2.6	109
2	a	(All traits)	.801	13.2	2.1	-.7	106
	c		.901	13.8	1.5	.0	120

1) A:economic weight protein, mastitis, fertility: 2.5, -1, 1.5
B: " " " " " 3.5, -1, 1.5
a, b and c: 50, 100 and 150 daughters resp.
2)per generation with standardized selection differential = 1.