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Conference paper

DETERMINATION OF AN APPROPRIATE SELECTION CRITERIA FOR GROWTH COMPOSITION IN CHAROLAIS

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Summary

A total of 3994 carcass records representing 170 sires were used to determine an appropriate lean-related trait to be used in a genetic improvement program. Learn yield (LY) was predicted using carcass weight (CW), ribeye area (REA) and fat thickness (FAT) and used to calculate other composite traits: lean carcass weight (LW) and 3 variants of lean growth rate (LGR1, LGR2 and LGR3). Variance components were estimated using MTDFREML under a sire model with a sire-MGS relationship matrix. Heritabilities of composite traits were moderate and ranged from .24 for LGR3 to .40 for LY. The composite trait being the least associated to composition of gain (REA and FAT) was LGR3. LY will be more suitable to be incorporated in an economic index while LGR2 might be considered as a biological index.

Key words: Beef cattle, genetic parameters, lean, carcass, selection criteria.

Introduction

In North America, most of the selection pressure has been applied on growth traits in beef cattle. In the early 1960's, research was initiated and continues today to characterize carcass traits associations with other traits (Marshall, 1994). However, the difficulty and cost of measurement of such traits has hindered their utilization in industry programs. In the last 5 years, interest has been renewed with the development of indirect carcass measurement technology (ultrasound) and the implementation of a value-based payment pricing system. Thus the Canadian Charolais Association initiated a research study using data recorded as part of their Conception to Consumer (CtoC) progeny test program. Since its initiation in 1967, the CtoC program

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has collected calving, growth and carcass information on more than 10000 calves. The objective of this study was to develop an appropriate lean-related trait that could be used as part of the genetic improvement programs offered by the Association.

Materials and methods

Records of 3994 calves from the CtoC program were used. All calves were progeny of 170 Charolais sires randomly mated to cows of various breed composition types. These calves were born and raised to weaning ($\bar{x}$ =216d) in several commercial herds in Western Canada from 1975 to 1996. At weaning, all calves were placed in one commercial feedlot until reaching the desired slaughter endpoint (fat thickness). Carcass weight (CW), ribeye area (REA) and fat thickness (FAT) were recorded and used to estimate lean yield (LY), a composite trait, using the following equation (S. D. M. Jones, pers. comm.):

$$LY (\%) = 57.96 - .027\ CW\ (kg) + .202\ REA\ (cm^2) - .703\ FAT\ (mm)$$

Lean yield (LY) was used to derive 4 other composite traits as follows:

Lean carcass weight (kg)	LW = CW x LY
Lean growth rate 1 (g/d)	LGR1 = [(CW x LY) - (BW x DP x LY)] / AGE
Lean growth rate 2 (g/d)	LGR2 = (CW x LY) / AGE
Lean growth rate 3 (g/d)	LGR3 = ADG x DP x LY

where BW, DP, AGE and ADG are birth weight, dressing percentage (constant at 60%), age at slaughter and post-weaning average daily gain, respectively. Each of the trait on the right-hand side of the above equations will be identified as a component trait.

Variance components were estimated using MTDFREML procedures under a sire model with a sire-MGS relationship matrix (n=657 sires). For all traits, the evaluation model included contemporary group (herd x sex x date on-test) and dam breed type as fixed effects while sire was a random effect. Each multiple-trait (MT) evaluation included the composite trait with all the component traits used in its derivation. For LY and LW, component traits were pre-adjusted for age at slaughter within year. For LGR1 and LGR2, no adjustment was necessary as age at slaughter was a component while for LGR3 only LY was pre-adjusted. More details on the data and the methodology are given in Caron and Kemp (1997).

For the composite traits, rank correlation among solutions of sires with progeny (n=170) were calculated. Direct and correlated response to selection were predicted using standard formulas. A selection differential of 1 genetic standard deviation was assumed. Selection on ADG was added to represent current selection practices.

Results

Genetic parameters. The estimates of heritabilities in Table 1 are similar to those reported by Koots et al., (1994) with the exception of FAT. In this study, the h^2 of FAT varied from .30 to .32 compared to .44 in Koots et al., (1994) due to its use as the slaughter endpoint. Heritability estimates of .42 and .30 were obtained for LGR2 by Mrode et al., (1990a) and Woodward et al., (1992), respectively. On the other hand, Mrode et al., (1990b) gave a h^2 of .52 for LY in contrast to a h^2 of .18 for cutability (CU), a trait similar to LY, by Woodward et al., (1992). In general, the average h^2 for CU from previous studies was .47 while one of .40 was found for LW. However, most studies from which these averages were calculated used small data sets of British type cattle (Woodward et al., 1992). Mrode et al., (1990b) estimated genetic correlations of -.04 and -.67 for BW with LGR2 and LY, respectively, and of .90 and .12 average daily gain (birth to 400 days of age) with LGR2 and LY, respectively.

Sire rankings. In table 2, three groups of traits can be distinguished: LY, LGR3 and a group made of LW, LGR1 and LGR2. In fact, LGR1 and LGR2 are essentially the same trait and LGR2 is preferred due to its ease of computation. The relatedness among LGR1, LGR2 and LW was expected given the similarity of their formulas. On the other hand, LY and LGR3 showed the largest difference between composite traits according to their rank correlation.

Response to selection. Selection on LY had the least effects on other composite traits with an efficiency lower than .75 relative to their possible direct responses (table 3). In all cases, selection on LGR2 yields a larger correlated response than LGR1. Of all composite traits considered, LGR3 is the one with the smallest impact on composition of gain (REA and FAT). In decreasing order of their relative impact on composition of gain (REA and FAT), the remaining composite traits are LY, LW and LGR2. Most component traits (ADG, BW, AGE and CW but not MARB) show small correlated responses when direct selection was on LY.

Table 1. - ESTIMATES OF HERITABILITY AND GENETIC CORRELATIONS[a]

Trait	Set of traits				
	LY	LW	LGR1	LGR2	LGR3
Heritabilities					
COMP[b]	.40	.25	.27	.28	.24
CW	.20	.20	.17	.17	.20
REA	.36	.36	.36	.36	.36
FAT	.30	.30	.32	.32	.31
AGE			.26	.26	
BW			.34		
ADG					.25
Genetic correlations					
COMP-CW	.01	.76	.78	.75	.83
COMP-REA	.82	.76	.68	.69	.50
COMP-FAT	-.83	-.51	-.34	-.36	-.12
COMP-AGE	**.15**	**-.20**	-.48	-.51	**-.50**
COMP-BW	**.15**	**.34**	.34	**.45**	**.30**
COMP-ADG	**-.20**	**.52**	**.68**	**.66**	.91
COMP-MARB[c]	**.46**	**.22**	**.19**	**.22**	**.22**

[a] - Underscored values were estimated in separate bivariate analyses.

[b] - COMP = composite trait as determined by the set of traits under consideration.

[c] - Marbling scores range from 1 (more marbling) to 10 (less marbling).

Table 2. - RANK CORRELATIONS BETWEEN SIRE EPD OF COMPOSITE TRAITS FROM MT EVALUATIONS

Composite	Correlations				
	LY	LW	LGR1	LGR2	LGR3
LY	-	.71	.57	.59	.26
LW		-	.90	.89	.70
LGR1			-	.99	.78
LGR2				-	.77

Table 3. - EXPECTED DIRECT AND CORRELATED RESPONSES TO SELECTION ON COMPOSITE TRAITS

Correlated response	Unit	Composite selected					
		LY	LW	LGR1	LGR2	LGR3	ADG
LY	%	1.13	.57	.41	.43	.19	-.18
LW	kg	3.29	4.13	3.90	3.95	3.14	2.16
LGR1	g/d	5.69	9.43	10.52	10.65	8.69	7.01
LGR2	g/d	6.50	10.19	11.37	11.75	9.38	7.43
LGR3	g/d	5.04	14.15	16.19	16.38	17.67	16.60
ADG	g/d	-12.93	26.63	35.73	35.48	45.34	51.49
BW	kg	.27	.49	.51	.68	.42	.35
AGE	d	.88	-.93	-2.27	-2.51	-2.26	-2.66
CW	kg	.04	4.05	4.01	3.97	4.34	4.53
REA	cm^2	2.65	1.94	1.79	1.84	1.24	.46
FAT	mm	-.81	-.39	-.28	-.30	-.09	.19
MARB	score	1.10	.42	.37	.44	.41	.08

Discussion

The use of a biological index (Fowler et al., 1976) will avoid the uncertainty associated to the economic values and the need to estimate parameters among traits (genetic and phenotypic). In this study, LW, LGR1, LGR2 and LGR3 might be called biological indices or product traits. However, the components of a product trait are still weighted according to their heritabilities coefficients of variation and correlations between traits (Smith, 1967). The best choice as biological index would be LGR2 as it constitutes an acceptable compromise between composition of gain and growth rate. In an economic index, the lean-related EPD would be weighted by its economic value and combined with EPD's of other traits (e.g. growth) currently evaluated. In this situation, a trait like LY would be desirable as it was relatively uncorrelated to most secondary traits although possible correlated changes in both marbling and birth weight need to be monitored. Future studies will be necessary in order to identify the best genetic strategy for the efficient production of high quality of lean meat.

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ODREĐIVANJE ODGOVARAJUĆIH KRITERIJA SELEKCIJE ZA SASTAV RASTA U CHAROLAISA

Sažetak

Da bi se odredile odgovarajuće osobine u vezi s mršavosti za primjenu u programu genetskog poboljšanja upotrijebljeni su zapisi od ukupno 3994 trupova, što je predstavljalo 170 rasplodnjaka. Prinos mršavog mesa (LY) predviđen je upotrebom težine trupova (CW), površina presjeka MLD (REA) i debljine slanine (FAT) te upotrijebljen za izračunavanje drugih kombiniranih osobina: težine mršavih trupova (LW) i 3 varijante stope mršavog rasta (LGR1, LGR2, LGR3). Procijenjene su komponente varijance primjenom MTDFREML po modelu rasplodnjaka s matricom odnosa rasplodnjak – MGS. Heritabilitet kombiniranih osobina bile su umjerene i kretale se od .24 za LGR3 do .40 za LY. Kombinirana osobina najmanje povezana sa sastavom prirasta (REA i FAT) bila je LGR3. LY će biti prikladniji za unošenje u ekonomski indeks, dok se LGR2 može smatrati biološkim indeksom.

Ključne riječi: govedo, genetski parametri, mršav, trup, selekcijski kriteriji

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