VARIABILITY OF DIRECT GENETIC EFFECTS ON GROWTH AND SLAUGHTER PERFORMANCE IN THE CHAROLAIS BREED FOR PRODUCTION OF YOUNG BEEF BULLS.

VARIABILIDAD DE LOS EFECTOS GENETICOS DIRECTOS DE LOS CARACTERES DE CRECIMIENTO Y DE CANAL DE LA RAZA "CHAROLAIS" PARA LA PRODUCION DE TORITOS

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The economic advantage of terminal beef crossing in dual purpose or dairy breeds depends on the rate of AI beef crossing, but also on the extra beef value of crossbred over purebred calves (CUNNINGHAM, 1974). In France, AI units have set up integrated selection schemes for terminal crossing within the following three beef breeds : Charolais, Limousin and Blonde d'Aquitaine. Those schemes involve 3 stages : planned matings, performance and progeny testing. Since 1973 AI units set up in station progeny testing providing information on carcass traits. The bulls were tested on intensively reared veals or on young bulls.

The genetic parameters of growth and carcass traits have to be estimated accurately in these new conditions for choosing adequate selection criteria and for determining the possible correlated responses.

MATERIAL AND METHODS.

We analysed performance data of crossbred progenies of 39 Charolais bulls tested in 3 successive years (1974-75-76) by an AI unit in Western France Progenies of 3 references sires were controlled each year. About 100 AI were carried out by bull and randomly allocated to dairy herds all along the year. Two cow breeds (French Friesian and Normande) were inseminated the first year and only Normande cows the following years. Because of the economic consequences of birth difficulties in dairy herds, birth weight and condition score were recorded by most of the farmers.

Owing to the 3 reference sires used in each trial, we analysed data with the following crossclassified mixed model :

$$Y_{ijklm} = \ + S_i + b_j + p_k + g_e + sc_m + E_{ijklm}$$

where S_i was sire random effect (i = 1 ...... 42).
b_j was breed of dam fixed effect (j = 1-2).
p_k was calving parity fixed effect (k = 1 .... 6).
g_e was year-group fixed effect (e = 1 ....21).
sc_m was sanitary condition score fixed effect (m = 1-2-3).

To obtain connections between fattening group we had to make each year-group cell correspond to 2 or more successive fattening groups in each trial. Ranks of calving ranged from first alving of heifers to rank 6, the last classcorresponded to unknown calving parity. Sanitary condition scores in the nursery were taken into account because of their significant effects on nursery characters although they were not significant on subsequent fattening characters.

Because of a very unbalanced scheme a HENDERSON's linear model 3 was adequate for estimating variance components and HARVEY's computational program was used for that purpose. All heritability, genetic and phenotypic values and their standard errors are HARVEY's estimations and because of

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the unequal number of data per variable we had to perform 3 analysis separately : a) the first one was done on 647 birth performance recorded calves and the sanitary condition score was not included ; b) the second one was performed on the 699 calves which reached the desired final weight and supplied complete information on fattening performance and other carcass traits than length and thickness measures ; c) the third one was performed on the 608 animals whose carcasses had been measured.

RESULTS AND DISCUSSION.

a. - Heritability coefficients estimates and variance components are presented in table 1.

Estimate of birth weight heritability : 0.32 was some what higher than those estimated by POUJARDIEU & VISSAC (1968) : 0.24 or FOULLEY & al. (1978) : 0.17 when Charolais bulls were on the farm progeny-tested with veal calves. Our estimate was however similar to that calculated by GAILLARD & al.(1982) : 0.33. We have to investigate if these higher values were not due to difference in the type of bulls used in relation to modification of the production type. We have also to point out that all the French estimates from Charolais bulls were lower than the average value calculated from results of the litterature by BUCHANAN (1979) : 0.40.

The nonsignificant heritability estimate of frequency of birth difficulties : 0.05 was very close to that estimated by BELIC & MENISSIER (1968) : 0.05, FOULLEY & al. (1978) : 0.06 and GAILLARD & al. (1982) : 0.10 in Charolais bulls of terminal crossing and confirms that the accuracy of birth condition score is very poor to select against birth difficulties.

The growth performance heritabilities ranging between 0.32 and 0.40 were lower than the average value presented by BUCHANAN (1979) for post weaning daily gain : 0.46 or final fattening weight : 0.56. Our lower values were certainly a consequence of selection performed at the end of the performance testing, where 60 % of the bulls were eliminated on their growth performance and muscle conformation. Heritability estimates of muscle conformation and skeleton development were rather low : 0.20 and lower than estimate of veal muscle conformation score : 0.29 (POUJARDIEU & VISSAC, 1968 ; FOULLEY & al., 1978). BUCHANAN reported mean value of 0.34 for final fattening period conformation score. But we have to point out that there was a lack of variability between sires in the first trial while heritability estimates of muscle conformation score were 0.32 and 0.34 in the two following years.

b. - Genetic and phenotypic correlation coefficients are presented in table 2.

As pointed out by FOULLEY & al. (1978) the phenotypic correlation between birth condition score and birth weight was much lower than genetic

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TABLE 1

Analysis of variance and estimation of heritability coefficients (in 42 Charolais bulls crossbred progenies)

Traits	Number	Sire effect "F" test (a)	Variance components		Heritability coefficients	
			Sire	Residual	Estimates	Standard errors
Birth traits.						
. Birth weight (kg)	647	2.21**	3.84	44.10	0.32	0.12
. Frequency of birth difficulties (%) (b)		1.16NS	47.97	408.72	0.05	0.07
Fattening Performance.						
. Post weaning daily gain (g/day)	699	2.70**	2 431.8	21 628.3	0.40	0.13
. 365-day weight (kg)		2.33**	139.63	1 583.91	0.32	0.12
. Age at slaughter (days)		2.34**	117.43	1 319.43	0.33	0.12
. Muscle conformation score (/60)		1.78**	2.063	39.775	0.20	0.10
. Selection development score (/60)		1.79**	0.896	17.127	0.20	0.10
Carcass traits.						
. Carcass weight (kg)	699	1.81**	10.92	203.66	0.20	0.10
. Dressing percentage (%)		4.09**	0.591	2.883	0.68	0.17
. Conformation score (/16)		2.14**	0.281	3.727	0.28	0.11
. External fat score (/16)		2.08**	0.182	2.552	0.27	0.11
. Internal fat score (/16)		2.44**	0.411	4.305	0.35	0.12
. Carcass length (cm)	608	2.62**	0.818	6.638	0.44	0.14
. Limb thickness (cm)		2.57**	0.144	1.204	0.43	0.14
. Compactness (kg/cm)		2.70**	5.577	42.941	0.46	0.14

(a) NS : P ≥ 0.05 **: P < 0.01
(b) frequency of condition score ≥ 3 in a 4 point scale
(c) compactness : carcass weight/(carcass + kg length)

TABLE 2 - Estimates of genetic and phenotypic correlation coefficients. (a)

Traits	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
<u>Birth Traits</u>.															
(1) . Birth weight		+0.66	+0.18	+0.27	-0.29	+0.37	+0.10	+0.28	+0.31	+0.31	-0.13	-0.29	-0.39	+0.71	+0.57
(2) . Frequency of birth difficulies	+0.27		+0.12	+0.33	-0.39	-0.09	-0.29	-0.30	+0.00	+0.04	-0.10	-0.18	-0.19	-0.23	-0.30
<u>Fattening Performances</u>.															
(3) . Post weaning daily gain	+0.19	+0.07		+0.92	-0.93	-0.05	+0.46	-0.31	-0.62	-0.29	+0.49	+0.45	+0.30	-0.19	-0.16
(4) . 365 days weight	+0.18	+0.05	+0.81		-0.99	+0.08	+0.63	-0.12	-0.46	-0.13	+0.33	+0.41	+0.40	+0.00	-0.06
(5) . Age at slaughter	-0.20	-0.07	-0.81	-0.89		+0.01	-0.61	+0.17	+0.49	+0.25	-0.45	-0.47	-0.61	+0.10	+0.22
(6) . Muscle conformation score	+0.09	+0.06	+0.32	+0.27	-0.26		-0.24	+0.61	+0.53	+0.91	-0.06	+0.08	-0.90	+0.45	+0.73
(7) . Skeleton development score	+0.15	-0.02	+0.27	+0.28	-0.25	+0.16		-0.28	-0.51	-0.48	-0.30	-0.26	+0.64	-0.05	-0.32
<u>Carcass Traits</u>.															
(8) . Carcass weight	+0.06	-0.02	+0.31	+0.26	-0.04	+0.36	+0.15		+0.92	+1.00	-0.39	-0.31	-0.78	+0.68	+0.96
(9) . Dressing percentage	+0.06	+0.00	-0.15	-0.11	+0.12	+0.31	-0.01	+0.60		+0.90	-0.48	-0.33	-0.60	+0.65	+0.83
(10) . Conformation score	+0.05	+0.02	+0.20	+0.16	-0.12	+0.57	-0.00	+0.54	+0.51		-0.37	-0.05	-0.84	+0.76	+1.02
(11) . External fat score	-0.16	-0.10	+0.10	+0.11	-0.11	-0.02	-0.05	-0.12	-0.30	-0.06		+0.97	-0.11	-0.17	-0.18
(12) . Internal fat score	-0.06	-0.04	+0.07	+0.05	-0.03	+0.01	-0.12	-0.02	-0.14	+0.01	+0.62		+0.00	-0.09	-0.04
(13) . Carcass length	+0.03	-0.02	+0.17	+0.21	-0.11	-0.37	+0.24	+0.09	-0.21	-0.40	-0.04	-0.06		-0.55	-0.92
(14) . Limb thickness	+0.16	+0.03	+0.22	+0.18	-0.14	+0.52	+0.06	+0.66	+0.57	+0.69	-0.17	-0.10	-0.23		+0.63
(15) . Compacity	+0.05	-0.08	+0.25	+0.18	-0.05	+0.55	+0.05	+0.91	+0.66	+0.71	-0.08	-0.02	-0.29	+0.72	

(a) genetic correlation coefficients above the diagonal.

correlation. It would therefore be more efficient to use birth weight than only birth condition score to select against birth difficulties. Our genetic correlation estimate : + 0.66 was lower than that of FOULLEY & al. (1978) : + 0,91 or GAILLARD & al. (1982) : + 1.00.

Any one of the three following traits : fattening daily gain, 365 day weight and age at slaughter can be used as a growth potential criterion because they showed high genetic correlation (0.92). These values are higher than the average one reported by BUCHANAN (1979) : 0.75 between post weaning daily gain and yearling weight. Genetic correlation of these criteria with birth weight ranged between 0.20 and 0.30 and were lower than the average values reported by BUCHANAN for genetic correlation between birth weight and post weaning daily gain : + 0.48 or yearling weight : + 0.63. Accordingly, if AI units do not want to increase birth difficulties, it would be rather efficient to use a restricted index for selecting on high post-natal growth without increasing the birth weight (FOULLEY, 1976).

Muscle conformation score showed high positive genetic correlations with dressing percentage : + 0.53, carcass conformation : + 0.91 and compactness + 0.73 and a high genetic opposition with carcass length : -0.90. It is of interest to point out that this criterion of muscle assessment is independent of genetic effects on growth and carcass fatness, while growth potential showed a slight genetic opposition with carcass conformation : -0.15 to -0.30 and a higher one with dressing percentage : -0.45 to -0.60. Skeleton development score was highly correlated with growth potential : + 0.45 to + 0.65 and opposite to the beef traits.

CONCLUSION

Estimates of heritability coefficients of growth potential led us to conclude that progeny-testing the bulls on 15-20 offspring following a selection on performance test is the most efficient way to improve this caracter. But there is a positive genetic correlation between fattness and growth potential and genetic opposition between the latter and beef carcass traits. Therefore progeny testing on slaughtered offspring appears to be necessary and selection may be efficient owing the rather high heritability estimates of carcass traits.

However some AI units do not perform any progeny testing on slaughtered offspring arguing economical costs. In these conditions live muscle conformation score appears to be a necessary caracter for improving beef production owing its high genetic correlation with beef carcass traits. But its heritability estimates being rather moderate this visual scoring has to be done by a well trained expert on bulls in performance testing station but also on progenies.

S U M M A R Y

Growth and slaughter performance of about 700 young crossbred bulls from 42 A.I Charolais sires were evaluated in the same progeny station and over 3 successive years. These bulls were intensively fattened from 2 weeks of age to a final weight of about 530 kg at a mean age of 14 months. Because of 3 common reference sires in each year, data were analysed using a crossclassified model. HENDERSON's method 3 was applied to estimate variance components with HARVEY's computational programme.

Heritability estimates for growth traits ranged between 0.32 and 0.40. Those of carcass traits were : dressing percentage (0.68), conformation score (0.28), external and internal fat scores (0.27 and 0.35), carcass length, limb thickness and carcass compactness (about 0.44). There was a genetic antagonism between growth potential and dressing percentage (-0.46 to -0.62); this antagonism was lower with beef carcass traits (-0.13 to -0.29) and positive genetic correlations between growth traits and carcass fat scores (+ 0.33 to + 0.50) were found. Live muscle conformation score was highly correlated genetically with beef carcass traits (+ 0.53 to + 0.91), but it was independent of genetic effects on growth and fatness.

R E S U M E N

Durante 3 anos consecutivos fueron testados en unA estacion 700 toritos cruzados, hijos de 42 sementales "Charolais" por I.A. Llegaron a la estacion a la edad de 2 semanas, y fueron engordados intensivamente hasta obtener un peso final de aproximadamente 530 kg con una edad promedio de 14 meses. Se han analizados los resultados con un modelo factorial, gracias a la utilizacion de 3 sementales testigos durante los 3 años. Se ha aplicado el metodo III de HENDERSON para estimar los componentes de la varianza usando el programa de ordenador "HARVEY".

La heredabilidad estimada de los caracteres de crecimiento se situa entre 0,32 y 0,40 y la de los caracteres de canal : rendimiento al sacrificio (0.68); conformacion (0,28); nota de apreciacion de la grasa externa y interna (0,27 y 0,35); grosor de la pierna, longitud y compacidad de la canal alrededor de 0,44. Se ha encontrado una oposicion entre los caracteres de crecimiento y el rendimiento (-0,46 a -0,62), siendo esta oposicion mas discreta con los caracteres de conformacion de canal (-0,13 a -0,29); existiendo una correlacion genetica positiva entre los caracteres de crecimiento y los notas de apreciacion de la grasa (+ 0,33 a + 0,50). La nota de conformacion "in vivo" esta por una parte altamente correlacionada con el rendimiento y la conformacion de la canal (+ 0,53 a + 0,91), siendo por otra parte independiente del potencial de crecimiento y de la deposicion de grasa.

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