ZOOTECHNIE, GENETIQUE ET REPRODUCTION

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Crossbreeding of Holstein Friesian, Brown Swiss and Sanga breeds in Zaire. II. Growth rate, calving interval and body size

WANG (N.), VANDEPITTE (W.), NOUWEN (J.), CARBONEZ (R.). Croisement de bovins de races Holstein Frisonne, Brown Swiss et Sanga au Zaïre. II. Vitesse de croissance, intervalle de vêlage et taille corporelle. *Revue Élev. Méd. vét. Pays trop.*, 1992, 45 (3-4) : 353-356

La présente analyse a été réalisée à partir de 332 enregistrements de mesures corporelles (poids vif ; profondeur de la poitrine ; largeur de la croupe ; hauteur au garrot) et intervalles de vêlage, et de 147 mesures de vitesses de croissance, effectués lors d'une expérience de croisement entre des bovins de races Holstein Frisonne, Brown Swiss et Ankole dans l'élevage de Lushebere, dans la région de Masisi, Kivu-Nord, Zaïre. Un effet addditif positif significatif de la Holstein Frisonne a été trouvé en ce qui concerne le poids vif. Pour ce paramètre, d'importants effets positifs d'hétérosis individuels ont été trouvés avec les croisements Holstein Frisonne x Ankole et Brown Swiss x Ankole. En ce qui concerne les intervalles de vêlage, les effets additifs des races Holstein Frisonne et Brown Swiss se sont révélés intéressants de façon significative ; en outre, il existait des effets significatifs d'hétérosis individuels des croisements Holstein Frisonne x Ankole et Brown Swiss x Ankole, diminuant les intervalles de vêlage. De faibles héritabilités ont été trouvées en ce qui concerne la vitesse de croissance (0,07). Le coefficient estimé pour l'intervalle de vêlage était de 0,26 alors que les estimations d'héritabilité étaient plus fortes en ce qui concerne la profondeur de la poitrine (0,31) et le poids vif (0,36). Des chiffres intermédiaires ont été obtenus pour la hauteur au garrot (0,19), et la largeur de la croupe (0,29). Les corrélations génétiques entre le rendement laitier et les mesures corporelles étaient les suivantes : 0,63 pour la hauteur au garrot ; 0,57 pour la profondeur de la poitrine ; 0,61 pour la largeur de la croupe ; 0,76 pour le poids vif. Les corrélations génétiques pour les mesures corporelles étaient les suivantes : 0,83 pour la hauteur au garrot et la largeur de la croupe ; 0,41 pour la hauteur au garrot et le poids vif ; 0,81 pour la profondeur de la poitrine et la largeur de la croupe ; 0,79 pour la profondeur de la poitrine et le poids le vif ; 0,80 pour la largeur de la croupe et le poids vif. *Mots clés* : Bovin - Croisement - Croissance - Intervalle entre vêlages - Taille - Hétérosis - Zaïre.

INTRODUCTION

A crossbreeding experiment between Holstein Friesian, Brown Swiss and Ankole cattle was conducted during the years 1978-1988 on the Lushebere farm in the Masisi zone, North-Kivu in the Republic of Zaire. It was found that the crossbreds were better adapted to specific environmental conditions than the purebred Holstein Friesian and Brown Swiss breeds (4). Comparing with local breeds, crossbreds gave higher milk yields. However, the

beef traits are also of economic importance. Growth rate and body size measurements are indicators of beef production in the crossbreds and may also be related to the milk producing potential as indicated by LEGATES and WARWICK (2). The analysis confirmed the data summarised by LONG (3) that average heterosis is important for body size and growth measures.

In this report, more precise information about crossbreeding effects was given and genetic parameters were estimated for growth rate, calving interval and body size measurements. The relationship between milk production and body size measurements was also investigated.

MATERIALS AND METHODS

Data

The body measurements included wither height, depth of chest, width of rump and body weight. To estimate the genetic correlations between body measurements and milk yield, first lactation records were used. The calving interval used was the average calving interval per cow. Growth rate was calculated from birth to 12 months of age. In total, 332 observations concerning average calving intervals and body measurements were available and 147 observations on growth rates. The coefficients of the crossbreeding effects were derived from the additive proportion of the three breeds in daughters, dams and sires.

Crossbreeding effects

The model was defined as :

$$[1] \; y = Qf + X\beta + e$$

where y = a vector of observations ; f = a vector of fixed environmental effects ; Q = a matrix relating fixed environmental effects to observations ; β = a vector of crossbreeding parameters ; X = a matrix relating crossbreeding parameters to observations ; e = a random error vector (NID, 0, σ_e^2).

Growth rate, sex and month of birth effects were defined as fixed effects. Only body measurements of females were available. The effect of birth season was not included in the model.

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Genetic parameters

The results of the body measurements and milk yields were statistically analysed by the least squares of HARVEY's mixed model and maximum likelihood computer program (1). The year effects were fixed and the sire effects were random.

For the traits, calving interval and growth rate, heritabilities were estimated by the general least square procedure with the sire effects as random effects.

RESULTS AND DISCUSSION

Crossbreeding parameter estimates of wither height, depth of chest, width of rump, live weight, average calving interval and growth rate are given in table I. The relative importance of crossbreeding parameter estimates for these six traits is shown in figures 1, 2 and 3. A significant
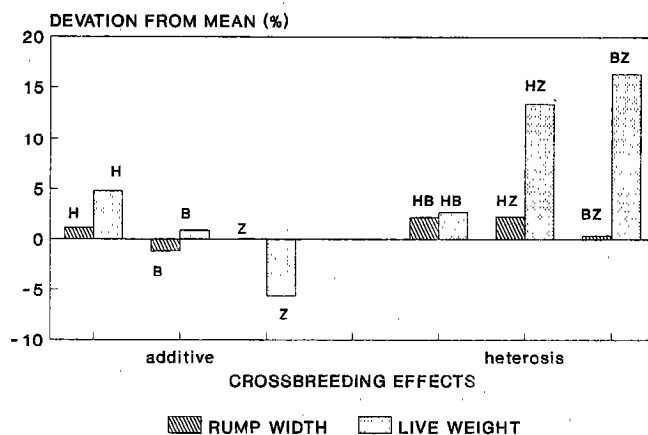
Fig. 2 : Crossbreeding parameters for rump width and live weight (H : Holstein Friesian ; B : Brown Swiss ; Z : Ankole).
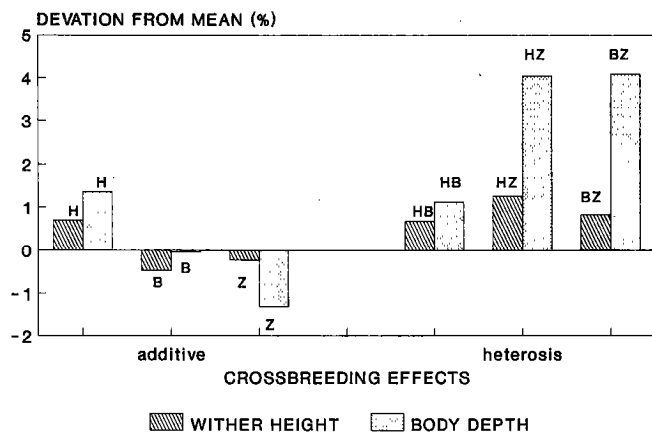
Fig. 1 : Crossbreeding parameters for wither height and body depth (H : Holstein Friesian ; B : Brown Swiss ; Z : Ankole).
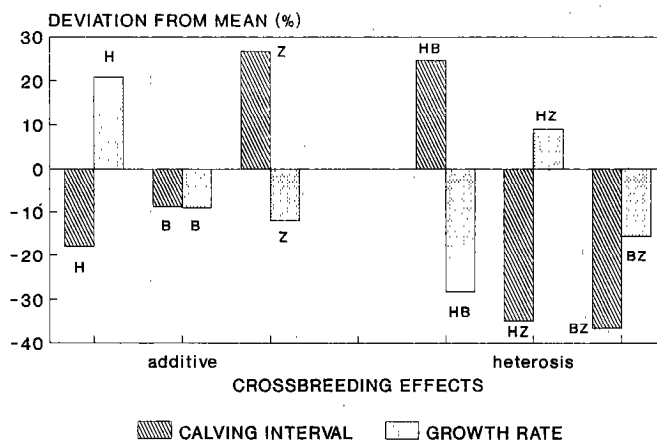
Fig. 3 : Crossbreeding parameters for calving interval and growth rate (H : Holstein Friesian ; B : Brown Swiss ; Z : Ankole).

TABLE I   *Least square estimates of crossbreeding effects for body measurements (at first lactation).*

	WH		HG		HR		LW		CI		GR	
	constants	%	constants	%	constants	%	constants	%	constants	%	constants	%
Mean	128.1		73.9		51.3		478.1		526		1.5	
H	0.9	0.7	1.0	1.4	0.6	1.1	22.9	4.8*	− 94	− 17.9*	0.3	21
B	− 0.6	− 0.5	0.0	0.0	− 0.6	− 1.2	4.1	0.9	− 46	− 8.7*	− 0.1	− 9
Z	− 0.3	− 0.2	− 1.0	− 1.3	0.0	0.0	− 27.0	− 5.7	140	26.6*	− 0.2	− 12
HB	0.9	0.7	0.8	1.1	1.1	2.2	12.6	2.6	130	24.7	− 0.4	− 28
HZ	1.6	1.3	3.0	4.0	1.1	2.2	64.0	13.4*	− 183	− 34.8*	0.1	9
BZ	1.1	0.8	3.0	4.1	0.2	0.4	77.9	16.3*	− 193	− 36.6*	− 0.2	− 16

*: p < 0.05.
WH : wither height (cm) ; HG : depth of chest (cm) ; HR : width of rump (cm) ; LW : live weight (kg) ; CI : calving interval (days) ; GR : growth rate in kg/day from birth to 12 months.
H : Holstein Friesian additive effect ; B : Brown Swiss additive effect ; Z : Ankole breeds additive effect ; HB : Holstein Friesian × Brown Swiss heterosis effect, etc.

additive effect was found for live weight for the Holstein Friesian breed, which showed to be superior to the local breed. Holstein Friesian x Ankole and Brown Swiss x Ankole crosses expressed significant positive individual heterosis effects for live weight. As regards calving interval, Holstein Friesian and Brown Swiss additive effects were significantly different from the Ankole additive effect. A shorter calving interval was found in the two European breeds. The individual heterosis for calving interval of Holstein Friesian x Ankole and Brown Swiss x Ankole was significant and reduced the calving interval. However, for Ankole, a significant additive effect was found, which extended the calving interval. Concerning wither height, depth of chest, width of rump and growth rate, there were no significant effects. The Brown Swiss additive effects, the Holstein Friesian x Brown Swiss individual heterosis for live weight and the Holstein Friesian x Brown Swiss individual heterosis for calving interval were not significant either.

The heritability and phenotypic correlations between wither height, depth of chest, width of rump and live weight were estimated from the growth rate data (147 observations). The heritability estimate of growth rate was very low (0.07). Because of a small number of observations per sire, the within-sire variance was large. The rather low heritabilities of growth rate (0.07) and milk yield (0.14) might be caused by a long-term phenotypic selection, particularly in the Ankole breed and the limited possibilities for expressing the genetic potential of the European breeds, due for example to the lack of concentrate feeding.

Table II gives the heritabilities and the genetic and phenotypic correlation estimates of milk yield, wither height, depth of chest, width of rump and live weight. The large standard errors of the genetic parameter estimates might be caused by the small sample. The heritability estimate of milk yield (0.35) was rather high as compared with estimates obtained previously (0.14). The main reason might be that a part of the non-additive genetic variance was

included in the daughter group variance. Also, rather high heritability estimates for depth of chest (0.31) and live weight (0.36) were observed. Medium estimates were found for wither height (0.19) and width of rump (0.29). High genetic correlations were found between milk yield and body measurement traits (0.63 for milk yield and wither height, 0.57 for milk yield and depth of chest, 0.61 for milk yield and width of rump and 0.76 for milk yield and live weight). In conditions where milk is produced exclusively on roughages, milk production is strongly linked to feed intake and body capacity. The genetic correlations between body measurement were large and positive (0.83 for wither height and depth of chest, 0.41 for wither height and live weight, 0.81 for depth of chest and width of rump, 0.79 for depth of chest and live weight and 0.80 width of rump and live weight). These high correlations were all related to the high correlations between body measurements and milk yield. The heritability estimate of calving interval was 0.26.

CONCLUSION

A significant positive Holstein Friesian additive effect was found on live weight. The Holstein Friesian x Ankole and Brown Swiss x Ankole crosses showed rather large heterosis effects for live weight.

Crossing Ankole with Holstein Friesian and Brown Swiss led to a significant reduction of the calving interval of 183 and 193 days, respectively. This was due to breed differences, but also to important heterosis effects.

Crossbreeding had no significant effects on growth rate.

The genetic correlations between wither height, depth of chest, width of rump and milk yield were relatively high. In particular the level of milk production obtained with roughages was strongly linked to the level of feed intake and body capacity.

TABLE II Genetic parameters and phenotypic correlations for milk yield and body measurements.

Traits	MY	WH	HG	HR	LW
MY	0.35 ± 0.22	0.10	0.35	0.31	0.20
WH	0.63 ± 0.43	0.19 ± 0.18	0.34	0.42	0.36
HG	0.57 ± 0.27	0.83 ± 0.43	0.31 ± 0.19	0.59	0.59
HR	0.61 ± 0.29	(^)	0.81 ± 0.24	0.29 ± 0.19	0.48
LW	0.76 ± 0.28	0.41 ± 0.45	0.79 ± 0.23	0.80 ± 0.27	0.36 ± 0.19

^ value is larger than 1.
Heritabilities : diagonal elements ; phenotypic correlations : above diagonal elements ; genetic correlations : under diagonal elements.
MY : milk yield ; WH : wither height ; HG : depth of chest ; HR : width of rump ; LW : live weight.

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The analysis involved 332 records of body measurements (live weight : LW, depth of chest : HG, width of rump : HR and wither height : WH) and calving intervals and 147 records of growth data from a crossbreeding experiment between Holstein Friesian, Brown Swiss and Ankole cattle at the Lushebere farm in the Masisi zone, North-Kivu in the Republic of Zaire. A significant positive Holstein Friesian additive effect was found for LW. For LW, large positive individual heterosis effects were found for Holstein Friesian x Ankole and Brown Swiss x Ankole crosses. For calving interval, the Holstein Friesian and Brown Swiss additive effects were significantly favourable. Individual heterosis for calving interval of Holstein Friesian x Ankole and Brown Swiss x Ankole was significant and reduces the calving interval. Low heritabilities were found for growth rate (0.07). The heritability estimate for calving interval was 0.26. Higher heritability estimates for depth of chest (0.31) and live weight (0.36) were observed. Medium estimates were found for wither height (0.19) and width of rump (0.29). The genetic correlations between milk yield and body measurements were : 0.63 for wither height, 0.57 for depth of chest, 0.61 for width of rump and 0.76 for live weight. The genetic correlations between body measurements were : 0.83 for WH and HR, 0.41 for WH and LW, 0.81 for HG and HR, 0.79 for HG and LW and 0.80 for HR and LW. *Key words* : Cattle - Crossbreeding - Growth rate - Calving interval - Body size - Heterosis - Zaire.

WANG (N.), VANDEPITTE (W.), NOUWEN (J.), CARBONEZ (R.). Cruzamiento de las razas Holstein Frisia, Pardo Suizo y Sanga en Zaire. II. Tasa de crecimiento, intervalo entre partos y talla corporal. *Revue Élev. Méd. vét. Pays trop.*, 1992, **45** (3-4) : 353-356

El análisis incluyó 332 registos de medidas corporales (peso vivo : LW, profundidad del pecho : HG, amplitud de la grupa : HR, altura observada : WH) e intervalos entre partos y 147 registros de datos de crecimiento, provenientes de un experimento de cruces de Holstein Frisia, Pardo Suizo y Ankole, en el rancho Lushebere en la zona Masisi de Kivu del Norte de la República de Zaire. Se encontró un efecto aditivo positivo de la raza Holstein Frisia para el LW. Un efecto positivo de heterosis individual se encontró para el LW para los cruzamientos Holstein Frisia x Ankole y Pardo Suizo x Ankole. En cuanto al período entre partos, los efectos de las razas Holstein Frisia y Pardo Suizo fueron altamente favorables. La heterosis individual para el intervalo entre parto del cruce Holstein Frisia x Ankole y Pardo Suizo x Ankole fue significativa, reduciendo dicho intervalo. Se encontró una baja tasa de heredabilidad (0,07) para la tasa de crecimiento. La heredabilidad estimada para el intervalo entre partos fue de 0,26. Una heredabilidad más elevada se observó para la profundidad del pecho (0,31) y el peso vivo (0,36). La altura observada (0,19) y la amplitud de la grupa (0,29) obtuvieron estimaciones promedio. Las correlaciones genéticas entre la producción lactea y las medidas corporales fueron : 0,63 para WH, 0,57 para HG, 0,61 para HR y 0,76 para el peso vivo. Las correlaciones genéticas entre las medidas corporales fueron : 0,83 para WH y HR, 0,41 para WH y LW, 0,81 para HG y HR, 0,79 para HG y LW y 0,80 para HR y LW. *Palabras claves :* Bovino - Cruzamiento - Crecimineto - Intervalo entre partos - Talla corporal - Heterosis - Zaire.

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