EFFECTS OF GENOTYPE AND ENVIRONMENT ON MILK PRODUCTION AND REPRODUCTION OF IMPROVED GENOTYPES FROM THE TROPICAL HIGHLANDS OF CAMEROON

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SUMMARY
Records on 101 crossbred cows from the Dairy Research Unit of the Wakwa Animal and Veterinary Research Station were analysed to investigate fixed effects of genotype, parity, age of cow at calving, and season and year of birth of cows on lactation and reproductive performance. Traits analysed were: lactation milk yield (LMY), lactation length (LL), annualised milk production (AMP), calving interval (CI), dry period (DP) and age at first calving (AFC). Effects of genotype and year influenced ($P<0.01$) LMY and AMP. Lactation length was favourably associated with LMY, AMP, DP and CI. Effects of genotype and season affected AFC ($P<0.01$). Parity and age of cow at calving only significantly affected DP and CI. G1H1 tended to be consistently superior to G1M1 for most dairy and reproductive traits, suggesting that G1H1 may be better than G1M1 for milk production, while the latter may be better for dual-purpose (dairy-beef) production systems. G1M3 were not better than GMF2 in LMY and AMP, suggesting that *inter se* matings of F_1 crosses, coupled with selection, may be recommended for production of synthetic dairy breeds.
Keywords: *Bos indicus, Bos taurus*, crossbreeding, dairy, tropical highlands

INTRODUCTION
Lactation and reproduction contribute greatly to gross margins in the dairy industry. Both hereditary and environmental factors are known to influence these traits. Factors like length of lactation, number of milkings per day and age at first calving are well documented mostly in temperate environments (Lasley, 1978). Reducing the environmental variation is expected to leave a larger proportion of the residual variance to inheritance, thereby increasing the accuracy of predicting the superiority of the individual.

Dairy research in Cameroon began in the '70s with imported Brown Swiss cattle (Tchoumboue and Jousset, 1982) and indigenous breeds (Lhoste and Pierson, 1974). However, the former became inadapted and the latter turned out to be poor milkers (Mbah *et al.*, 1987). The need to combat protein malnutrition in Cameroon (Kelso and Gagne-Gervais, 1983) prompted government to import dairy products and to set up a local dairy industry. Importations became too expensive. As a result, efforts were intensified to search for alternative solutions. Crossbreeding was, thus, initiated at Bambui and Wakwa Research Stations to identify productive and adapted genotypes for enhanced dairy production in

Cameroon (Lhoste and Pierson, 1976). Mbah *et al.* (1987) published mainly descriptive statistics of part of these data. The primary objective of this study was to investigate effects of genotype and environment on milk production and reproduction of improved genotypes on the Adamawa highlands of Cameroon.

MATERIALS AND METHODS

Holstein Friesian (H), F_1 Ngaundere Gudali (G) x H (G1H1) and G x Montbeliard (G1M1), backcross HxGH (G1H3) and MxG1M1 (G1M3) and *inter se* cross G1M1xG1M1 (GMF2) cows born in Wakwa from 1979 to 1991 generated the records for this study. The production environment and management of animals have been described by Mbah *et al.* (1987) and Tawah *et al.* (1997a). The natural vegetation is woody savannah (Piot and Rippstein, 1975). *Brachiaria* and *Stylosanthes* spp are major improved pastures fed to dairy animals. Mbah (1982a, 1982b; 1984) has reported major pathological problems at the station and susceptibility of crossbred genotypes to disease and heat stresses.

A number of independent data sets was created and several edits resulted in reductions in total number of records per trait (Tawah *et al.*, 1997a). Cases of abortions and mastitis were deleted. Two calving/birth seasons were defined: summer from April to October and winter from November to March. Traits analysed were: lactation milk yield (LMY), lactation length (LL), calving interval (CI), annualised milk production (AMP) calculated as (LMY/CI) X 365, length of dry period (DP) and age at first calving (AFC). Effects of genotype, year, season/month of calving, parity and age of cow at calving were investigated using GLM (SAS, 1991). Only specific contrasts were investigated given the nature of the mating design.

RESULTS AND DISCUSSION

Results of least-squares analyses of variance (Table 1) indicate significant effects of genotype and year of birth on LMY and AMP. Year of birth also significantly affected LL and CI, while season of birth affected AFC ($P<0.01$). Effect of genotype also influenced LL ($P<0.05$) and AFC ($P<0.01$). Effects of parity and age of cow at calving affected ($P<0.05$) DP and CI. Lactation length had a favourable association ($P<0.01$) with LMY, AMP, DP and CI. Similar results have also been reported in other parts of the tropics (Mandakmale and Kale, 1990; Rege *et al.*, 1994; Thorpe *et al.*, 1994; Mackinnon *et al.*, 1996).

Least-squares means (Table 2) suggest that G1H1 tended to perform better than G1M1 for LMY, LL, AMP and CI. This trend was consistent with most studies involving the Holstein Friesian (Kiwuwa *et al.*, 1983; McDowell, 1985). This implies that G1H1 may be recommended for use in dairy production systems, while the latter may be suitable for dual-purpose (dairy-beef) production systems under similar tropical conditions; a conclusion which is compatible with the finding that both G1M1 and Gudali x Charolais F_1s have similar preweaning growth abilities (Tawah *et al.*, 1997b).

Table 1. Results of least-squares analyses of variance for cow traits by fixed effects[¶]

Trait	n[‡]	CG	Sbirth	Cyear	Parity	ACC	LL	CV	RSQ	RSD
Cow production traits:										
LMY (kg)	310	***		***			***	0..299	0.725	470.3
LL (days)	315	*		***				0.199	0.124	54.9
Cow reproductive traits:										
AMP (kg)	200	***		***			***	0.287	0.807	427.9
DP (days)	196	ns[†]			*	*	***	0.120	0.161	1.8
CI (days)	194	ns		*	**	*	**	0.171	0.318	70.5
AFC (mo.)	66	**	**					0.178	0.249	7.3

[¶]CG = cow genotype; Sbirth = season of birth of cow; Cyear = year of calving; Parity = lactation number; ACC = age of cow at calving; CV = Coefficient of variation; RSQ = R-square (coefficient of determination); RSD = Residual standard deviation (unitsin parentheses apply to this column only); [‡]Number of records; [†]Non-significant

Table 2. Least-squares means (se) of cow traits for Holstein and Montbeliard crosses[§]

Trait	Overall LSM[‡]	Holstein	G1H1	G1H3	G1M1	G1M3	GMF$_2$
Cow production traits:							
LMY (kg)	1655 (38.4)	3124 (101.2)	1551 (51.0)	1220 (140.2)	1490 65.4)	1234 (130.6)	1303 (48.4)
LL (days)	276 (4.5)	294 (11.7)	280 (5.8)	264 (16.3)	267 (7.6)	291 (15.2)	263 (5.5)
Cow reproductive traits:							
AMP (kg)	1611 (49.0)	2927 (147.1)	1561 (57.6)	1186 (160.5)	1450 (75.4)	1280 (155.0)	1194 (56.7)
CI (days)	383 (12.4)	431 (25.9)	364 (12.8)	366 (28.3)	390 (15.4)	356 (27.4)	387 (16.6)
DP (days)	150 (1.1)	147 (1.2)	157 (1.1)	152 (1.2)	145 (1.1)	117 (1.3)	192 (1.1)
AFC (mo.)	41.5 (1.01)		39.0 (1.43)		39.9 2.16)		45.5 1.42)

[§]LMY = Lactation milk yield; LL = Lactation length; AMP = Annualized milk production; CI = Calving interval; DP = Length of dry period; AFC = Age at first calving; [‡]Least-squares means

That F_1 crosses were better than other crosses was consistent with previous reports by Buvanendran *et al.* (1981), McDowell (1985), Syrstad (1990), Rege *et al.* (1994) and Mackinnon *et al.* (1996). The superiority of F_1 crosses may be associated with a greater degree of crossbred heterozygosity and a higher level of adaptation to unfavourable environments as reported by Barlow (1981), McDowell (1985) and Syrstad (1989, 1990). The substantive decline in performance of F_2 crosses relative to F_1 crosses may be partially attributed to a reduction in heterozygosity and a breakdown in epistatic gene effects as reported by Syrstad (1989)

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