Mortalities amongst different genotypes of crossbred dairy calves in a tropical environment

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ABSTRACT

Data on mortality of calves obtained from crossbreeding *Bos taurus* (Holstein and Montbeliard) with *Bos indicus* (Gudali) for milk production were extracted for 1985 to 1992, from records kept at the Ngaoundere Centre for Agricultural Research for Development. Data analyzed using the contingency Chi Square Method, were used to isolate and quantify some of the constraints of upgrading and factors affecting mortalities of crossbred dairy calves of ages between zero (birth) and 12 months. The results indicated that the genetic group of sire and dam and level of *Bos taurus* blood significantly ($P<0.001$) affected mortality in the crossbred calves. Also, the effect of month and year of calving and age group of the calf significantly ($P<0.001$) affected mortality rates in the crossbred calves. However, Holstein-sired crosses with mortality rates ranging from 12.5 % (H7G1) to 50.0 % (H1G1), showed trends of better adaptability and less susceptibility than were Montbeliard-sired crosses, with mortality rates ranging from 40.0 % (M7G1) to 75.0 % (M1G1).

Key words: Dairy - Crossbred calves – Holstein – Montbeliard – Gudali - Mortality.

RESUME

Les données (1985-1992) sur la mortalité des veaux laitiers, obtenus à partir des croisements *Bos taurus* (Holstein et Montbéliard) x *Bos indicus* (Goudali) pour la production de lait, ont été extraites des archives du Centre Régional de Recherche Agricole pour le Développement de Ngaoundéré. Les données analysées par la méthode de khi deux ont été utilisées pour l'isolement et la quantification des contraintes d'amélioration et les facteurs d'influence du taux de mortalité des veaux métis de la naissance à l'âge de 12 mois. Les résultats ont montré que le groupe génétique du taureau et de la vache et le niveau sanguin de *Bos taurus* affectent significativement ($P<0,001$) le taux de mortalité des veaux métis. Aussi, les effets de mois et de l'année de vêlage et l'âge du veau (($P<0,001$) ont été significatifs sur le taux de mortalité. Les métis du sang Holstein dont les taux de mortalité variaent de 12,5 % (H7G1) à 50,0 % (H1G1) étaient mieux adaptés et moins susceptibles à l'environnement que l'étaient les métis du sang Montbéliard avec des taux de mortalité allant de 40,0 % (M7G1) à 75,0 % (M1G1).

Mots clés: Laitière – Veaux métis – Holstein – Montbéliard – Goudali - Mortalité

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INTRODUCTION

The need to fight against malnutrition (Kelso and Gagne, 1983) and to meet-up with dairy demands, especially in the rising urban and high income populations, prompted the government of Cameroon to import huge amounts of dairy products. This strategy, however, turned out to be rather too expensive. The search for alternative sources led to the establishment of dairy research at the Wakwa and Bambui Research Centres of the Institute of Agricultural Research for Development in the 1970s, with the objective of identifying productive and adaptable genotypes for milk production. As a result, a number of approaches were tested under various experimental conditions.

The first attempt in this direction was to substitute the local populations with the importation of the Brown Swiss cattle (Tchoumboue and Jousset, 1982). It failed because of the breed's inability to adapt to the prevailing environmental conditions and still produce optimally. This led to the abandonment of this approach in favour of selection within the indigenous Gudali and White Fulani populations (Lhoste and Pierson, 1974). Both populations are the predominant *Bos indicus* breeds within smallholder farms in the Adamawa and North West Provinces of Cameroon. Still, for reasons of poor genetic potential for milk production (500 kg of milk yield per lactation on average), this approach was replaced by crossbreeding of the indigenous breeds with the American Holstein and French Montbeliard (Mbah *et al.*, 1987), with the objective of improving the milk production potential of the indigenous breeds while maintaining their adaptability in the crossbreeds.

Despite these attempts, not much exist in the literature on the dairy *Bos taurus* breeds introduced into Cameroon and the offspring resulting from crossbreeding them with the local *Bos indicus*. Tawah *et al.* (1999) quantified the major genetic and environmental factors that affected milk production from crossbred dairy genotypes at Wakwa Centre. Mbah (1982) quantified pathological causes of mortality amongst six crossbred genotypes and concluded that 50 %, 34.3 %, 12.7 % and 2.9 % of the mortalities were caused by rickettsia, trypanosomiasis, piroplasmosis and streptothricosis, respectively, with no reference to levels of exotic blood. Mbah *et al.* (1987) assessed milk production, reproduction and mortality in the Holstein, Jersey and their crosses without reference to levels of exotic blood as well. Mbah *et al.* (1988) reported that scours, bronchopneumonia and debility, amongst others, as accounting for 40.3 and 24.1 %, 17.7 and 37.9%, and 17.7 and 10.3%, morbidity and mortality respectively in crossbreeds (Table 1).

Table 1: Diseases Causing Morbidity and Mortality in Crossbred Calves

Causes	Morbidity (%)	Mortality (%)
Scours	40.3	24.1
Bronchopneumonia	17.7	37.9
General debility	17.7	10.3
Keratoconjunctivis	4.8	0.0
Bloat	4.8	6.9
Pasteurellosis	3.2	6.9
Anthritis	3.2	0.0
Heart water	1.6	3.4
Anaplasmosis	1.6	3.4
Mange infection	1.6	3.4
Abcesses	1.6	0.0
Unknown etiology	1.6	3.4
TOTAL	99.7	99.7

Source: Mbah *et al.* (1988)

It would, however, be useful determining the percentage of exotic blood adaptable to Cameroonian conditions. A crossbreeding system based on full knowledge can be more progressive and economically more profitable. The question on the optimum level of *Bos taurus* genes in the crossbreeds, therefore, remains a point of concern. The choice of the most profitable dairy crossbred genotypes depends not only on the genetic make-up of the animal but also on the environment in which the genotype is allowed to express itself. Hence, there is need to identify the various factors affecting the adaptability of crossbreds genotypes generated by such a system.

The present study was therefore aimed at isolating and quantifying some of the constraints of upgrading and factors affecting mortalities amongst crossbred dairy calves between the ages zero (birth) and 12 months. This will be useful in the identification of appropriate genotypes and design of improvement strategies to raise viable calves from birth to yearling.

MATERIALS AND METHODS

Experimental environment

The Dairy Herd Unit (DHU) of the Wakwa Centre of the Institute of the Agricultural Research for Development is located on the Adamawa plateau of Cameroon. Details on location, climate, seasons, vegetation and pastures have been documented (Piot and

Rippstein, 1975; Pamo and Yonkeu, 1996; Mbah *et al.*, 1987; Tawah et *al.*, 1999; Ebangi *et al.*, 2001).

Herd description and animal management
The Dairy Herd Unit (DHU), described by Tawah *et al.* (1999), was established with germplasm imports of Holstein (live and semen) and Montbeliard (semen) from United States of America and France, respectively. Gudali cows obtained locally were artificially inseminated with Holstein and Montbeliard semen as presented in the design in Table 2.

Three sire genotypes (H, M, H1G1) and five dam genotypes (G, H1G1, H3G1, M1G1, M3G1) were mated to produce seven calf genotypes (H1G1, M1G1, H3G1, M3G1, HGF2, H7G1, M7G1) composed of 50 % or more of the sire blood.

A total of 233 crossbred calves were produced from the crossbreeding design between 1985 and 1992 (Table 3). At calving, birth dates were recorded and the calves identified and pedigreed with sire and dam. The calves were allowed to suckle colostrum from their dams and taken away 24 to 72 h post partum. Thereafter, they were separated and raised in individual calf pens, bedded with either hay or sawdust. They were trained for artificial feeding teat and bucket-fed warmed whole milk twice a day. They were fed concentrate formulated essentially of cotton-seed-cake, brewer's dried grain, corn or millet, rice bran, rice polishing, bone meal and trace minerals (Mbah *et al.*,1987) until they attained the weaning age of three months. Water was available *ad libitum.* The weaners were allowed to graze *Brachiaria* and *Panicum* pastures in the rainy season and also fed 2.5kg/head of concentrate. In the dry season, while they fed on *Brachiaria* and *Stylosanthes* hay *ad libitum*, they also received 2.5 kg of the concentrate feed. Prophylactic and curative measures were taken against tick-borne diseases such as trypanosomiasis and streptothricosis. They were also treated against ecto and endoparasites once in the dry season, and twice in the rainy season.

Productivity trait studied
The trait of interest mortality (M), was defined as M/I * 100. Where M = number of recorded dead calves for specific sire, dam and calf genetic groups, season, sex, calving month and year and age category effects (Table 3), I = total number of calves born alive between 1985 to 1992. Four age categories were defined for dead calves: (1) calves that died between birth and three months of age; (2) calves that died at ages above three months to six months; (3) calves that died at ages above six months to nine months and (4) calves that died at ages above nine months to yearling age. The impact of these effects on mortality rates were analyzed using the Chi Square Method associated with the SAS (1991) in an R x C contingency table. A total of 108 dead calves were distributed within the factors as presented in Tables 3 and 4.

RESULTS AND DISCUSSION
The main factors affecting mortality rates in crossbred calves (from birth to 12 months of age) are presented in Table 3.

Table 2: Mating Design for Study of Crossbred Dairy Calves

SIRE GENOTYPE	DAM GENOTYPE				
	Gudali (G)	H1G1	H3G1	M1G1	M3G1
Holstein (H)	H1G1	H3G1	H7G1		
Holstein x Gudali (H1G1)		HGF2			
Montbeliard (M)	M1G1			M3G1	M7G1

G = Gudali; H = Holstein; M = Montbeliard; H1G1 = Holstein x Gudali (F1);H3G1 = Holstein backcross; H7G1 = H x H3G1; HGF2 = Holstein x Gudali (F2); M1G1 = Montbeliard x Gudali (F1); M3G1 = Montbeliard backcross; M7G1 = Montbeliard x Montbeliard backcross

Table 3: Main Factors Affecting Mortality in Crossbred Dairy Calves

EFFECT	Number of calves produced	Number of dead calves	Mortality rate
OVERALL	233	108	46.35
CALF GENOTYPE ***			
H1G1	16	8	50.0
H3G1	62	25	40.3
H7G1	8	1	12.5
HGF2	8	3	37.5
M1G1	16	12	75.0
M3G1	113	54	47.8
M7G1	10	4	40.0
SIRE BREED ***			
H	86	41	47.7
H1G1	8	1	12.5
M	139	66	47.5
DAM BREED ***			
G	32	21	65.6
H1GI	70	26	37.1
H3G1	8	3	37.5
M1G1	114	57	50.0
M3G1	9	1	11.1
CALF SEX (ns)			
Male	116	53	45.7
Female	117	55	47.0
CALVING SEASON (ns)			
Dry	130	55	42.3
Rainy	103	53	51.4
CALVING MONTH***			
January	27	4	14.8
February	24	6	25.0
March	18	4	22.2
April	13	11	84.6
May	16	10	65.2
June	16	13	81.3
July	21	11	52.4
August	16	10	62.5
September	21	11	52.4
October	15	8	53.3
November	20	11	55.0
December	14	9	64.3
CALVING YEAR***			
1985	53	17	32.1
1986	32	16	50.0
1987	35	16	45.7
1988	30	16	53.3
1989	33	23	69.7
1990	16	9	56.3
1991	22	11	50.0
1992	12		
Age group***			
0-3 mo	233	59	25.3
>3-6 mo	174	34	19.5
>6-9 mo	140	8	5.7
>9-12 mo	132	7	5.3

G = Gudali; H = Holstein; M = Montbeliard; H1G1 = Holstein x Gudali (F1); H3G1 = Holstein backcross; H7G1 = Holstein x Holstein backcross; HGF2 = Holstein x Gudali (F2); M1G1 = Montbeliard x Gudali (F1); M3G1 = Montbeliard backcross; M7G1 = Montbeliard x Montbeliard backcross; ns = P>0.05; *** = P<0.001.

The results show a highly significant ($p<0.001$) effect of calf genotype on mortality rate. Mortality rates in 50 % Holstein blood estimated at 50 % for H1G1 and 37.5 % for HGF2 were lower than estimated 75 % for 50 % Montbeliard (M1G1). Mortality rate in 75 % Holstein blood (H3G1) estimated at 40.3 % was also lower compared the estimated 47.8 % observed in 75 % Montbeliard blood (M3G1). Also, 87.5 % Holstein blood (H7G1) with the lowest mortality rate of 12.5 % tended to be more adapted than 87.5 % Montbeliard blood (M7G1) with mortality rate of 40 %. In spite of the small sample sizes at the various levels of exotic blood for any valid conclusion to be arrived at, these trends may, however, be indicative of better adaptability and lesser susceptibility, respectively, of the Holstein crosses to the prevailing environmental conditions than could be the case with Montbeliard crosses. The trends are also indicative that higher degrees of crossbred heterozygosity may be indicative of higher level of adaptability and lower level of susceptibility, respectively. However, this may not be the case with 87.5 % Holstein and Montbeliard crosses that appear to express the highest potential for adaptability and lowest potential for susceptibility to the prevailing environmental conditions than is the case with other levels of Holstein and Montbeliard blood, respectively. Tawah *et al.* (1999), studying milk production in some of these crossbred genotypes concluded that F1 crosses were superior to their back crosses in milk production and reported a significant difference between the Holstein x Gudali F1 and Montbeliard x Gudali F1 crosses in milk production. The relatively high mortality rate of 50 % reported for Holstein x Gudali (H1G1) and 37.5 % for HGF2 in this study may not be very supportive of the idea that 50 % Holstein blood crosses could be economically sustainable and adaptable to the prevailing environmental conditions (moderately intensive management) in Cameroon. However, Ola (1988) reported improvement in traits performance with increasing proportions of *Bos taurus* inheritance in the crosses up to 50 % level.

Pingpoh *et al.* (1997), in an economic assessment of the Holstein x Gudali against purebred Gudali, concluded that the practice of raising H1G1 for milk production was economically profitable. However, the trend shown by 87.5 % Holstein x 12.5 % Gudali provokes further investigation. The lower mortality rates observed for Holstein-sired crosses in this study support the adoption of Holstein crosses for milk production in various countries as they produce more milk per lactation than other breeds, independent of the prevailing environmental conditions, local feeding, husbandry management and socio-economic situations (Ola, 1985; Charan, 1998).

The effect of the sire genotype was also highly significant ($P<0.001$) on crossbred mortality. Holstein x Gudali (H1G1) sired crosses died less (12.5 %) compared to the 47.7 % and 47.5 % mortalities registered for crosses sired by Holstein (H) and Montbeliard, respectively. This corroborate the trends observed for 50 %, 75 % and 87.5 % Holstein and Montbeliard blood, respectively. Holstein-sired daughters have also been reported to be superior to the Montbeliard-sired daughters in milk production (Tawah *et al.*, 1999). These lower mortality rates registered by Holstein-sired crosses may therefore be indicative of the superiority of the Holstein breed to the Montbeliard breed in additive genetic merit for adaptation under prevailing environmental conditions.

The effect of the dam group was highly significant ($P<0.001$) on the mortality rates of the crossbred calves. Crossbred dams from Montbeliard backcross (M3G1) produced calves that tended to be more adapted and less susceptible as they died less (11.1 %) than calves from H3G1 that died more (37.5 %) (Table 3). Calves obtained from H1G1 dams tended to die less (37.1 %) than those obtained from G (65.6 %) and M1G1 (50 %), respectively. However, because of the dual-purpose background of the Montbeliard breed, it may be necessary to use dam genotypes of M3G1 for Montbeliard-sired calves as to reduce mortality and, consequently, improve on the beef-dairy production for more economic benefits.

The sex of the calf and the season of calving were of no consequence ($P>0.05$) on mortality rate. The non significant season effect could be explained by the fact that the management practices as described above were consistent the year round. All the calves from weanling to yearling, while grazing on *Brachiaria* and *Panicum* pastures in the rainy season, were supplemented as described above. In the dry season, while they fed on *Brachiaria* and *Panicum* hay *ad libitum*, they were equally supplemented as described. However, the month and year of calving highly significantly ($P<0.001$) affected mortality rates in crosses. This may be due to variations in the quality and quantity of milk produced by the dams as a result of fluctuation in the quality and quantity of pastures from month to month and year to year.

Table 4: Mortality (%) of Crossbred Dairy Calves by Age Group

Age/Genotype***	Number of calves produced	Mortality rate				Overall
		0 – 3 mo	> 3 – 6 mo	> 6 – 9 mo	> 9 – 12 mo	
H1G1	16	31.3 (5)	18.8 (3)	0.0 (0)	0.0 (0)	16.7
H3G1	62	24.2 (15)	11.3 (7)	1.6 (1)	3.2 (2)	13.4
H7G1	8	12.5 (1)	0.0 (0)	0.0 (0)	0.0 (0)	4.2
HGF2	8	12.5 (1)	12.5 (1)	12.5 (1)	0.0 (0)	12.5
M1G1	16	43.8 (7)	25.0 (4)	6.3 (1)	0.0 (0)	25.0
M3G1	113	21.5 (28)	15.9 (18)	4.4 (5)	3.5 (4)	15.1
M7GI	10	20.0 (2)	10.0 (1)	0.0 (0)	10.0 (1)	13.3
Overall	233	55.1	31.2	8.2	5.6	100

H1G1 = Holstein x Gudali (F1), H3G1 = Holstein backcross; H7G1 = Holstein x Holstein backcross; HGF2 = Holstein x Gudali (F2); M1G1 = Montbeliard x Gudali (F1); M3G1 = Montbelliard backcross; M7G1 = Montbeliard x Montbeliard backcross; () = number of dead calves; Overall = Contribution of each genotype or age group to total mortality; *** = P<0.001

The distribution of mortality rates amongst the four age categories (Tables 3) indicate significantly (P<0.001) difference. The rates reduced steadily with increase in the age of the calf and ranged from 5.3 % (nine to yearling age) to 25.30 % (birth to three months of age). Younger calves seemed less able to withstand attacks by both the abiotic and biotic agents.

The interactions between age categories and the calf genotypes significantly affected (P<0.001) mortality rates (Table 4).

Mortality rates decreased with increase in the age of the calf irrespective of the genotype. This may be indicative that irrespective of genotype, there relationship between age (0 to 12 months) and mortality rate is negative. However, the best performance (low mortality) was registered by the 87.5 % Holstein blood genotypes with mortality rate ranging from 0 % to 12.5 % with an overall contribution of 4.2 % to the overall mortality.

The deductions above may not be very conclusive because the mating design as well as the husbandry management systems were not initially aimed at isolating and quantifying some of the constraints of upgrading and factors affecting mortalities in crossbred dairy calves between the ages zero (birth) and 12 months. Also, in many of the comparisons, different genetic groups were unbalanced. Consequently, the results may have deviated from the general trends due to small population size, given that for reliable statistical appreciations, the minimum sample size should not be less than 30. The trends may, therefore, be simply indicative and could need further detail investigation.

CONCLUSION

The sire and dam genetic group, level of exotic blood, month and year of calving and age category of the calf and age category by genotype interaction significantly affected mortality rates in crossbred dairy calves. Holstein-sired crosses in all levels of upgrading showed lower mortality and therefore better trends for adaptability and lesser susceptibility to the prevailing environmental conditions than was the case with Montbeliard crosses. Also, calves with higher degree of crossbred heterozygosity tended to die less, also indicating higher level of adaptability and lower susceptibility. However, this may not be the case with crosses of 87.5 % Holstein and Montbeliard blood with lowest trends and therefore indicating the best adaptability compared to other Holstein and Montbeliard blood levels. Consequently, in addition to environmental factors that affect mortality in crossbred dairy calves, from zero (birth) to 12 months of age, the level of additive genetic superiority and heterosis in the sire, dam and calf genotypes must be seriously considered in estimating mortality rates in crossbred dairy calves.

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