Effect of improved feeding and housing, Friesian blood level and parity on milk production of Ankole x Friesian cows

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Effect of improved feeding and housing, Friesian blood level and parity on milk production of Ankole x Friesian crossbred cows

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ABSTRACT

In North Kivu, D.R. Congo, cattle are raised in extensive systems based on local breeds and crossbreds. This farming method affects the performance of dairy animals and mortgages the level of milk consumption in population. An improved farming system, including feed supplementation, Friesian cross-breeding and the sheltering of animals in stalls at night, was studied to evaluate its effect on milk production by Ankole x Friesian crossbreds. The study was performed in Beni, D.R. Congo, on two groups of 15 animals (control group-CoG and improved group-IG), homogeneous according to Friesian blood and parity levels. The improved system, Friesian blood and parity levels increased significantly milk production (P<0.001). Farming system increased milk production by 1.6 l/d (5.2 l/d *vs* 6.8 l/d respectively in CoG and IG). Milk production ranged from 5.3±0.04 l/d to 6.6±0.02 l/d and from 4.9±0.02 l/d to 7.2±0.02 l/d according, respectively, to Friesian blood level and parity. A significant interaction was observed between farming system and Friesian blood level, and between farming system and parity (P<0.001). The two groups were characterized by a fair adaptation to forage availability associated to climatic factors. The study showed the importance of genetic and environmental factors on the milk production of crossbred dairy cows of the region.

Keywords: Ankole x Friesian, cattle, housing, milk production, parity, supplementation

INTRODUCTION

In D.R. Congo, cattle performance is structurally poor owing to endemic parasitic diseases, low technical skills of breeders, poor genetic level of local breeds and insufficient adaptation of crossbreds to environment. In addition, a cyclical deficit is associated to political insecurity resulting in a sharp reduction in livestock in the North Kivu Province.

Actually, the region includes about 50,000 cattle *vs* 300,000 in 1992, and imports large amounts of milk products, causing an outflow of foreign currency. In North Kivu, breeding is mainly extensive, predominantly based on Ankole, sometimes crossed with dairy breeds (Kibwana *et al*., 2012). The feeding of cattle is mainly based on natural pastures, with poor dietary supplementation and housing. The age at first calving shows a wide variability and calving interval is long. At the age of about three months, males are generally castrated, and sold at about 2 years for cash income. Sires are thus scarce and shared and herd's turnover is low.

This extensive system results in low milk yield. Moreover, bioclimatic constraints of Kivu and Ituri, such as drought or high temperature, reduce the cow productivity. The main improved practices include improved nutrition and infrastructures, as well as cross-breeding with dairy cattle. Increased feed intake can rely on the use of fodder or anti-erosion crops and of by-products of agriculture. Housing improvement could increase milk production by reducing the effect of these constraints (Usman *et al*., 2012).

This study was designed to evaluate, in Beni region, the impact of improved diet and housing, as well as Friesian blood and parity levels on milk production of Ankole x Friesian crossbred cows.

MATERIALS AND METHODS

Description of the study area: This study was conducted in Vitolu/Misugho farm extension, Southwest of Beni, North Kivu Province, D.R. Congo. The average temperature in the region is 23°C and annual rainfall between 1000 and 2000 mm, with minimum 60 mm per month. The low precipitations are recorded from mid-January to mid-February and mid-July to mid-August, the maxima being observed in September-October and March-April.

Animals: Thirty Ankole x Friesian crossbred cows - mean body weight and age at parturition 240±50 kg and 5.8±1.9 years, respectively, parity ranging from 2 to 4 - were used. They born from a cross between an F1 Ankole x Friesian sire carrying 50% of Friesian genes and back cross (BC) 1, BC2 and BC3 mothers with respectively 0, 25 and 38% Friesian blood. The experimental females presented thus 25, 38 and 44% of Friesian blood.

Methods: In April 2006, heats were induced and synchronized and mating was performed with a least 50%-Friesian sire. Grouped calving was thus obtained during the dry season in the next year.

During the first months of pregnancy, all cows grazed freely from 8 a.m. to 5 p.m. and staid in kraals at night. From the eighth month, cows were randomly allocated to two homogeneous groups, according to the Friesian blood level (25, 38 and 44%) and parity (2^{nd}, 3^{th} and 4^{th}). The control group (CoG) kept on to be managed as previously. The improved group (IG) received in addition, a diet based on fresh *Leucena leucocephala*, *Tripsacum laxum* and *Medicago sativa*, bean tops, peanut and soybean shells, dry leaves of maize, palm tree oilcake, rice bran and rock salt. It was maintained at night in a barn, until 8 a.m.

Supplementation was given at 7 a.m. and at 6 p.m., respectively before and after grazing. Treatments were carried out from the two last months of gestation to the end of the lactation's period. This supplementation aimed at preventing excessive weight loss that is classically observed in the region during the dry season (personal observation). **Table 1** shows the composition of the daily regimen feed offered to cows.

Cows were hand-milked twice a day, in the morning after supplementation and in the evening before its distribution. Individual milk production was recorded daily for 254 days. The cows were weighed at fasting 48 hours after calving and the calves, within 24 hours of birth.

Data analysis: The birth weights of calves were compared between groups using a Student's t-test. Using the SAS software (Statistical Analysis System, version 9.1.3), data on average daily milk yield were analyzed using a general linear model (proc glm), including the effects of treatment group, parity, Friesian blood level and the interactions between these effects. Differences were considered significant at P<0.05. The following model was tested:

$Y_{ijkl} = \mu + a_i + b_j + c_k + ab_{ij} + ac_{ik} + bc_{jk} + abc_{ijk} + e_{ijkl}$

In which Y_{ijkl} is the daily milk yield, μ the overall mean, a_i the effect of treatment group i (i= CoG-IG), b_j the effect of the parity (j= 2, 3, 4), c_k the effect of Friesian blood level (k= 25%, 38%, 44%), ab_{ij}, ac_{ik}, bc_{jk}, abc_{ijk} the respective interactions between the main effects and e_{ijkl} the random residual effect. The indicators of variation were expressed as standard error.

RESULTS

The average live weight of cows after calving was similar between groups, respectively at 230±41 kg in CoG *vs* 250±57 kg in IG (NS). The supplementation had no significant effect on birth weight of calves, although the average weight from IG was slightly higher than in the CoG (24.8±0.7 kg *vs* 23.7±0.7 kg). The supplementary feedstuff theoretically contained 4657 kJ/kg DM (Table 1).

Daily milk yields were significantly higher in cows from IG reaching a mean of 6.8±0.02 l/d (*vs* 5.2±0.02 l/d in CoG, P<0.001). The additional 1.6 l obtained was allowed by 4.95 kg of dry matter supplemental intake, i.e., 14409 kJ/l of milk.

Milk production was significantly (P<0.001) influenced by the Friesian blood level: 5.3±0.04 l/d were obtained in the 25% Friesian blood levels group, *vs* 6.2±0.01 and 6.6±0.02 l/d in the 38% and 44% levels groups. The increased was thus linear with the increase in level of Friesian blood. A significant interaction was observed between treatments and Friesian blood levels (P<0.001). Milk production was 4.8±0.04, 5.5±0.02 and 5.4±0.02 l/d in the groups 25, 38 and 44% Friesian blood levels, respectively, in CoG *vs* 5.8±0.09, 7.0±0.06 and 7.8±0.08 l/d, respectively, in IG. The increase with Friesian blood level reached thus a plateau in CoG while it was linear in IG. Differences in milk production between treatment groups were strongly dependent on Friesian blood level: 1.0±0.05, 1.5±0.04 and 2.4±0.06 l/d by ascending levels. The relationships was considered to as exponential (r^2= 0.93).

The parity significantly and linearly influenced daily milk yield (P<0.001), the highest value being observed in the fourth parity (4.9±0.02, 6.0±0.03 and 7.2±0.02 l/d, respectively in the second, third and fourth parity, i.e., about 1.1 l more milk per increase in parity level). A significant interaction was observed between treatment groups and parity (P<0.001). In CoG, milk production was the highest in the fourth parity (6.8±0.03 *vs* 4.2±0.01 and 4.7±0.02 l/d in the second and third parity, respectively) and increased appeared merely exponential. In IG, the increased reached a plateau (5.7±0.08, 7.2±0.09 and 7.2±0.08 l/d, in respective parities). The difference in milk production between groups was the highest in the third parity and the lowest in the fourth (1.5±0.07, 2.5±0.07 and 0.4±0.05 l/d, respectively in the second, third and fourth parities).

Table 2 reports milk production according to Friesian blood level and parity as obtained in the literature. Figure 1 shows the milk production curves, parallel to ombrothermic profiles. Peaks were observed around the 79th and 96th days of lactation in IG and CoG groups, respectively. There was a sharp production increase in the late lactation, parallel to the beginning of the short rainy season. The IG group also demonstrated a better persistence of milk production after the peak of lactation. The gap between two groups showed an increase at the third and sixth months, respectively in the middle of the long rainy season and at the beginning of the short one.

DISCUSSION

The observed calves weights at birth was lower than 28.9 kg reported by Manzi *et al*. (2012) in Ankole x Friesian crossbred calves in Rwanda. The difference can be attributed to the quality of pasture or to the Friesian blood level. The lack of supplement effect on calf's growth may be due to the late supplementation of the mothers, only two months before parturition, and possibly to a lack of nutritional constraints during the late gestation, but this cannot be ascertained. The non-significant influence of diet on live weight of cows is not in agreement with results of Gebrehawariat *et al*. (2010) but it should be noted that the weight of cows before supplementation was not measured. Similar reasons to that reported for lack of calf weight effect also could be suggested.

Improved management and housing resulted in higher milk yields in Ankole x Friesian crossbreds under field conditions in Beni. Feed supplementation plays a major role in this improvement. Indeed, better diet quality preceding and during lactation is known to be crucial to productive and reproductive performance (Grazul-Bilska *et al*., 2009). The shelter enjoyed by the treated group should be considered as playing a role in this improvement (Usman *et al*., 2012). The use of exotic high-producing breed is often seen as a rapid means to increase dairy production in Beni, as in other developing countries. Nevertheless, the poor availability or quality of concentrates limits the expression of genetic potential from European breeds. The low and variable quality of pastures is also a constraint to such an improvement through genetic substitution or crossbreeding.

This study illustrates the level of performances that may be reached by crossbred cows, under improved management conditions on tropical rangelands. Let us note, however, that a relatively low milk production was observed in both groups in this study. This may be ascribed to the lack of history of supplementation in the animals' lifetime besides the lactation period (Kibwana *et al*., 2012).

The difference in milk production between the two groups averaged 1.6 liters, theoretically supported by 14409 kJ/l of milk. Madalena *et al*. (1990) observed in Brazil a response to improve management close to 2.2 l with ½Guzera x ½Holstein-Friesian cows. Compared to milk yields achieved in intensive systems with crossbred Friesian cows (Duguma *et al*., 2012) and Ankole (Kugonza *et al*., 2011), the present increase may be deemed modest, suggesting that supplemented animals kept on pastures are still subject to nutritional constraints. This raises the question of whether it is appropriate to adapt exotic cows to equatorial environments (Grimaud *et al*., 2007). Selective breeding based on local breeds should be considered as a needed parallel longer-term strategy, being complementary to the rapid increase allowed by cross-breeding.

Half of the supplement distributed in the morning before the herd grazed could have led to some food substitution, and therefore, to a reduction in grass intake. Alternatively, the dairy merit of the cows was rather low so that the extra-energy was deposited as body fat, as indicated by a better body condition state after the supplementation's period.

The Friesian blood contributed to improve the milk production of local breeds (Ahmed *et al*., 2007), while Ankole blood provided rusticity genes improving the adaptation of cows to their environment. However, the higher is the dairy blood proportion, lower is effective the improved management in crossbred dairy cows (Madalena *et al*., 1990, Tadesse and Dessie, 2003, Demeke *et al*., 2004, **Table 3**). In our experiment, the increase was exponential with the dairy blood proportion but remained weak.

The positive interaction between parity and treatment group observed in this study shows the significant influence of these factors on milk production (Amasaib *et al*., 2011).

The highest milk production observed in 4th parity in this study is in agreement with those observed in Sudan by Ahmed *et al*. (2007) in Zébu x Friesian crossbreed. This increase can be attributed to the physical development of the young females and to the gradual adaptation of cows to their environment (Tadesse *et al*., 2010). This suggested also that the production potential, although small, is well preserved over the age of dairy cows. Similar improving of milk production observed in cows of parity 3 and 4 in the IG is consistent with results observed by Ahmed *et al*. (2007) and Tadesse *et al*. (2010) respectively in Zebu x Friesian crossbred and in Holstein-Friesian cows, and this may be due to the fact that animals entered early in reproduction and/or at an intermediate age, keeping thus a good dairy potential.

In dairy breeds, lactation peak usually appears within first month after calving. In this study, this peak was observed late in the third month and thereafter, and the curves showed atypical profiles, namely, a spread and delayed peak, corresponding to the heavy rains, since births occurred during the dry season (**Fig. 1**). There was a drop in production during dry season and an early recovery at the onset of the rainy season. This highlights the close dependence between milk production and the rainfall regime related to ombrothermic diagram and therefore forage availability and breeding management, although the availability of forage was not described and quantified in this study. This lactation pattern in response to environmental fluctuation further suggests an adequate persistence of lactation, with cows adapting their production to forage availability and therefore, having less risk of drying after a feed shortage.

CONCLUSION

The results obtained in this study show the effect of improved nutrition, crossbreeding and parity on milk production of Ankole x Friesian crossbred cows. Ankole x Friesian crossbred cows from Beni best expressed their milk production when forage availability was large, i.e., at the rainfall peak. The dietary supplement amplified partially, the phenomenon, suggesting a racial adaptation needing to be further explored. Increasing milk production in the region, which is rich in grazing areas, is probably a slow process that requires the study of the impact of a range of technologies, including housing, forage management, restocking, improved reproductive management and veterinary care. The knowledge of pedigree should further allow for a better genetic management and improvement of both the local breed and crossbreds. Milk production can become a profitable business in the country. However, this approach requires the dissemination of improved farming techniques, availability of veterinary inputs, organization of the milk market as well as training and technical support for farmers.

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Table 1: Estimated composition of the daily regimen offered per cow exposed to improved management in Beni (North Kivu, DR Congo) (calculated from Pozy *et al*., 1995, Methu *et al*., 2001, Urbano and Dávila, 2003, Niwińska *et al*., 2005, Arbouche *et al*., 2008, Arigbede *et al*., 2008, Chingala *et al*., 2013).

Ingredients	FM kg	DM kg	NE kJ	CP	Ca	P	Na
				g			
Leucena leucocephala	1.0	0.244	1641	78.6	3.2	0.4	-
Tripsacum laxum	1.0	0.28	1371	20.4	0.6	0.3	-
Medicago sativa	0.8	0.73	4001	182.0	3.6	2.4	-
Bean tops	1.0	0.91	5810	105.9	11.0	1.4	-
Peanut shells	0.5	0.46	798	82.8	2.4	4.6	-
Soybean shells	0.5	0.42	733	34.2	2.5	0.8	-
Dry leaves of maize	0.5	0.44	1191	32.9	0.5	0.1	-
Palm tree oilcake	1.0	0.91	4141	132.7	1.8	4.6	-
Rice bran	0.5	0.44	3368	51.9	0.2	4.2	-
Rock salt	0.3	0.12	0	0	-	-	48.0
Total	7.1	4.95	23054	721.4			

Legend: FM-Fresh Matter, DM-Dry Matter, NE-Net Energy, CP-Crude Protein, Ca-Calcium, P-Phosphorus, Na-Sodium.

Table 2: Daily milk production based on management, Friesian blood level and parity, as reported in the literature

Factors	Breed	Daily milk production (l/d)		Country	Source
		Management			
		Control	Improved		
Pure management effect			3.7	Uganda	Grimaud *et al*. (2007)
	Sanga x Friesian	1.4		Ghana	Darfour-Oduro *et al*. (2010)
	Zebu x Holstein-Friesian		8.5	Ethiopia	Duguma *et al*. (2012)
Friesian blood level (%)					
25	Zébu x Friesian		7,21[a]	Sudan	Ahmed *et al*. (2007)
37,5			7,99[a]		
50			9,77[b]		
62,5			9,57[b]		
75			10,17[b]		
87,5			9,09[ab]		
50	Friesian crossbreed		6.0	Tanzania	Bee *et al*. (2006)
62			6.8		
75			7.0		
Parity					
2nd	Zébu x Friesian		8,04[b]	Sudan	Ahmed *et al*. (2007)
3th			9,4[c]		
4th			9,65[c]		
5th			10,24[c]		
6th			10,29[c]		
2nd	Sanga x Friesian		1.58_a	Ghana	Darfour-Oduro *et al*. (2010)
3th			1.55_b		
4th			1.39_c		
5th			1.36_d		
3th	Holstein-Friesian		12.4_a	Ethiopia	Tadesse *et al*. (2010)
4th			12.3_a		
5th			12.3_a		
6th			12.5_b		

Within an author, numbers affected by different letters (a, b, c, d: effect of Friesian blood or parity levels) are significantly different at P<0.05.

Table 3: Daily milk production of local and crossbred cows in different climatic zones and management in tropical areas.

Breed	Milk production (l/d)	Management	Climatic zone	Country	Sources
Ankole	2.2	Agropastoral system	Temperate of altitude	Uganda	Kugonza *et al*. (2011)
	2.4	Crop livestock			
	2.1	Pastoral system			
Boran	2.7	-	Highland	Ethiopia	Demeke *et al*. (2004)
Ankole x Friesian	3.7	Semi-intensive	Temperate of altitude	Uganda	Grimaud *et al*. (2007)
[25-87.5%] Zebu x Friesian	8.96	Grazed on pasture of *Sorghum bicolor* and *Clitoria macrophylla* grasses and supplemented with ground nut cake, sorghum grains and wheat bran	Arid to tropical wet-and-dry	Sudan	Ahmed *et al*. (2007)
Zebu x Friesian	8.5	Intensive management system	Highland	Ethiopia	Duguma *et al*. (2012)
½Guzera x ½HF	9.5	High management	Tropical wet	Brazil	Madalena *et al*. (1990)
½Guzera x ½HF	7.3	Low management			
¼Guzera x ¾HF	4.6	Low management			
¼Guzera x ¾HF	4.6	High management			
½Boran x ½HF	4.5	On station	Highland	Ethiopia	Demeke *et al*. (2004)
¼Boran x ¾HF	4.5				
F2 Boran x Hostein-Friesian	3,6				
½ Barca x ½ Holstein-Friesian	3.5	On station	Tropical wet/dry	Ethiopia	Tadesse and Dessie (2003)
¼ Barca x ¾Holstein-Friesian	3.4				
1/8 Barca x 7/8Holstein-Friesian	3.3				

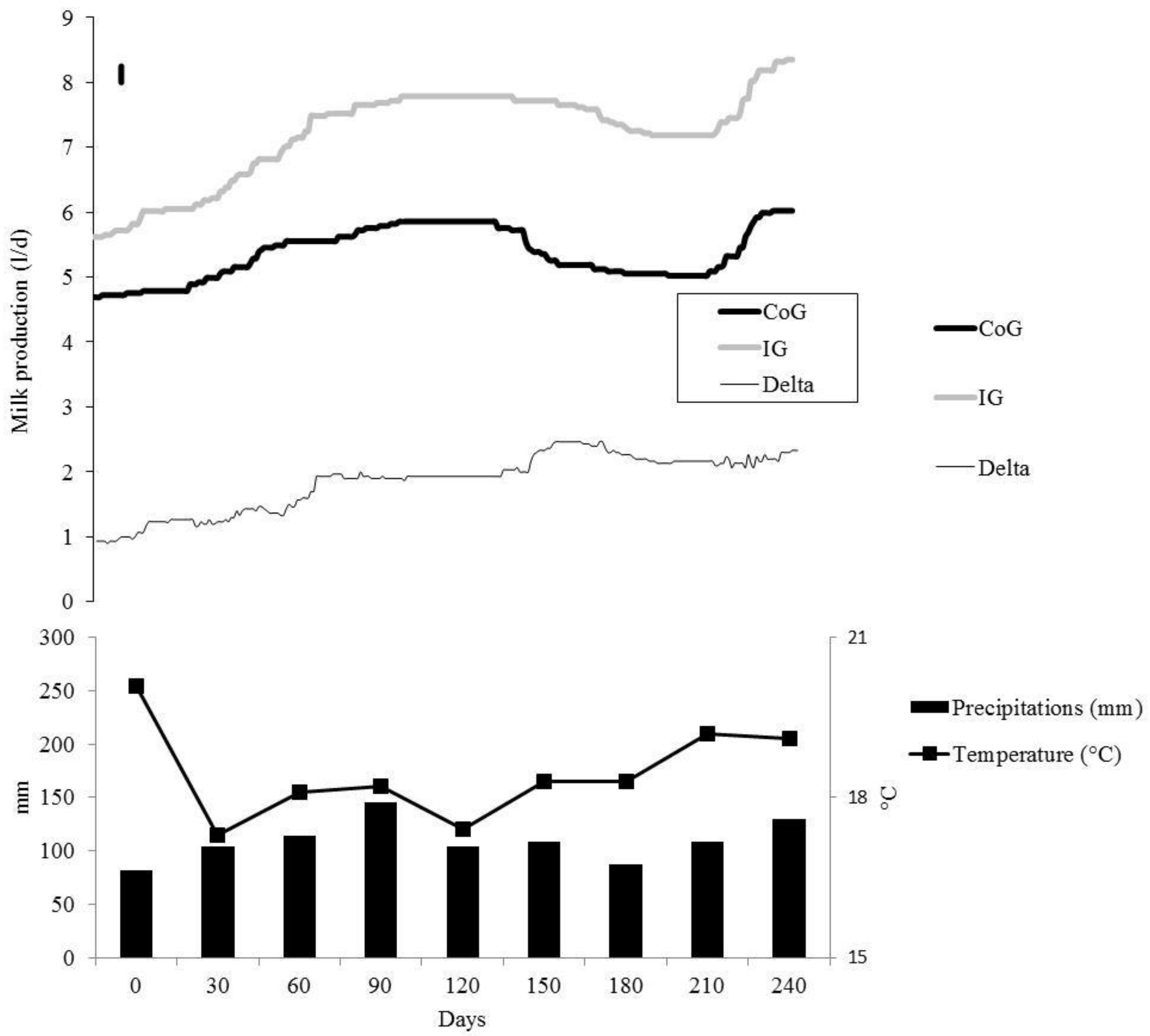

Fig. 1: Evolution of daily milk yield of cows exposed to conventional or improved breeding conditions in Beni (North Kivu, DR Congo), and correspondence with presumed ombrothermic conditions prevailing during the experimentation. The bar indicates the SEM of the model.