



## Effect of Genotype on the Milk Production of Crossbred Cows in the Peri-urban Area Farms of N'Djamena, Chad

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**Abstract** | The objective of this study was to analyze the effect of genotype on the performance of crossbred cows in the peri-urban area of N'Djamena, in order to better guide the cattle breeders for dairy production. The study was conducted by survey in eleven (11) farms having two hundred and forty-three (243) crossbred cows. Data on breeder identification, dairy cow genetic types, quantity of milk produced, herd management, animal health and access to insemination services were collected and analyzed using XL-STAT software. Sixteen genotypes of crossbred cows were identified and their milk production compared. The analysis showed that the crossbred cows from exotic bull breeds (Holstein, Montbeliard and Jersey) and local breeds (Kuri and Bokolodji) have proved to be the most favorable to improve milk production in the peri-urban area of N'Djamena. Nevertheless, the type choices of crossbred cows should be clarified after the monitoring of milk productions and their reproductive performance (age at first calving and calving interval). Moreover, poor livestock management (health, grazing and the transhumance monitoring), difficult access to artificial insemination services by breeders and poor management of crossbreeds are noted to be obstacles of bovine milk production improvement in Chad.

**Keywords** | Crossbred cows, Milk Production, Peri-urban Area, N'Djamena, Chad.

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## INTRODUCTION

Chad has a significant bovine potential. The estimates done in 2018 based on the 2015 general livestock census (MEPA, 2015) indicate a cattle population of 29.1 million heads. This number contributes to population's food security and generates a significant income for the country and producers. However, meat production and especially milk production remain very limited due to the poor performance of local cows. They produce 1 to 3 liters of milk per day during 6 months of lactation, with a first calving age of 47 months and a calving interval of about 16 months (Tellah, 2015a; 2015b). The Kuri cow, the most successful milk producer, produces an average of  $5.33 \pm 2.12$  liters per

day during 10 months of lactation (Zeuh et al., 2014). This low productivity is not in line with the population growth rate and the multiple uses of milk and its products by urban consumers in the Sahel (Duteurtre et al., 2003; Kousou, 2008). The most popular alternative to overcome this milk lack remains the powdered milk importation, which most often a burden on the national economy. This double pressure has led to the multiplication of dairy cattle farms around N'Djamena with the improving milk production option by using crossbred cows as in other tropical countries. In these countries, artificial insemination has been a vector for significant and sustainable improvement of milk production through the crossbreeding adapted to local conditions in tropical areas (Senoussi, 2008; Khan, 2014,

Lawrence et al., 2015; Goni et al., 2016; Singh, 2016). The daily milk production of crossbred cows varies on average from  $4.3 \pm 1.1$  to  $17.6 \pm 0.2$  liters during  $232.1 \pm 2.4$  to  $338.72 \pm 58.88$  days of lactation. Then, it varies following the cattle breeds used in the cross (Ouedraogo 1995, Keita, 2005; Kibwana et al., 2012; Habimana, 2013; Sokouri et al., 2014; Tadesse et al., 2015; Genzebu et al., 2016; Rahman et al., 2016; Singh, 2016). However, since the last decade there are the lacting crossbred cows in the peri-urban area of N'Djamena and yet, there were less documented studies on their different genetic types and nor their milk production.

Hence, the objective of this study is to analyze the effect of genotype on the milk production of crossbred cows in the peri-urban area of N'Djamena in order to guide the breeders to choose cattle breeds for crossbreeding and to get improvements in milk production.

## MATERIALS AND METHODS

### STUDY AREA

The study was conducted in peri-urban area of N'Djamena that is located between  $12^{\circ}13'$  latitude north and  $15^{\circ}03'$  longitude east and within a radius of 80 Km. A total of 11 livestock farms covered by this study are divided into four axes starting from N'Djamena:

- two farms in East (Klessoum and Linia);
- two farms in West (Mara and Guilmeiy);
- four farms in South (Etena, Raf, Mandéliea and Oundouma);
- three farms in North (two farms at Massaguet) and one in Djarmaye.

The study area is characterized by two distinct seasons: a dry season from October to June and a rainy season from July to September. The annual rainfall is between 300–600 mm. In terms of temperature, the warmest period is between March and June (beyond 45 degrees) and the coolest between December and February. The rainy season is a period of abundant forage resources. The hot dry period corresponds to the period when food resources on the range lands are poor and very limited. In order to avoid a decrease in production performance of cows, farmers supplement their animals during the lean season. The vegetation consists mainly of thorns and grasses. The rivers encountered in the peri-urban area of N'Djamena are mainly the Chari and Logone rivers from which, most cattle drink when they go to the pasture. The demand in recent years in milk has led to the development of dairy cattle farms in this area.

### SAMPLING AND HERD MANAGEMENT

The study conducted on eleven (11) cattle farms among

thirty-eight (38) in the peri-urban area of N'Djamena. These farms have an average of  $15.73 \pm 5.04$  crossbred calves (from artificial insemination). The study involved 243 lactating crossbred cows (F1). The herds are taking to the natural pasture every day by the herdsmen in the same way as the local breeds. The supplementation of the suckling cows depends on the financial capacity of the farmer (frequency and variable feed). The most commonly used supplements are grains, cake, bran and sometimes the feed. Some farms also did seasonal transhumance to avoid biting insects and flooding. The proximities of these farms to N'Djamena is an asset for health and zootechnical monitoring: either through personal initiative (owner) or State support. State veterinary agents for the public farms and contractors to private farms carry out health monitoring. The same applies to conduct of reproduction, which based more on artificial insemination. The choice of breed improvers depend on the breeder's preference for a particular breed or another.

### DATA COLLECTION

The study was conducted by survey from July 15<sup>th</sup> to December 15<sup>th</sup>, 2016, in two phases in the peri-urban area dairy cattle farms of N'Djamena. First phase was dedicated to farm identifications and sample determination to help guide the preparation of survey sheets. The second phase was reserved for the actual survey and this operation was used sheets, which have served maintenance guides. The information sought by survey are presented in the Table 1.

**Table 1:** Information sought during milk production survey of crossbred cows in the peri-urban area of N'Djamena.

Parameters	Sought Information /modalities
Profile of the breeders	Name, first Name, Age, education level, etc.
Qualification of breeders	Businessperson, Military officers, Civil servants, Private or State Farm.
Grazing Livestock Management	Grazing alone, grazing plus supplement, forage cultivation, transhumance, water source
Milk production of Crossbred cows	Calving date, dry date, quantity of milk produced (total and daily) and lactation duration
Farm management	Herd management status, heat detection, food and sanitation management

The milking is done manually by the cattlemen or their women twice a day with a transparent plastic buckets graduate allowing an assessment on site the treaty milk produced amount before be mixed either for sale or to be consume. The treaty quantity obtained does not take into account the part of calf milk consumed. These data are saved in the farm herd registries.

**Table 2:** Genotypes of F1 lactating Crossbreed cows identified in the peri-urban farms of N'Djamena.

		Exotic Breeds (improvers)				
		Montbeliard (MT)	Brown Swiss (BS)	Holstein (HL)	Jersey (JS)	Tarentaise (TA)
Local Breeds	Arab (AR)	MTxAR	-	HLxAR	JSxAR	TAxAR
	Kuri (KU)	MTxKU	BSxKU	HLxKU	JSxKU	-
	M'Bororo (MB)	MTxMB	BSxMB	-	JSxMB	TAxMB
	Bokolodji (BK)	MTxBK	-	HLxBK	JSxBK	TAxBK

**Table 3:** Crossbred Cow Milk Production (liter/day) According to the Genotypes in the Peri-urban Area Farms of N'Djamena.

Local Breeds*	Exotic Breeds**				
	MT	HL	JS	TA	BS
AR	7.00 ± 0.7 <sup>a</sup>	9.33 ± 1.1 <sup>a</sup>	9.20 ± 0.8 <sup>b</sup>	5.00 ± 0.1 <sup>a</sup>	-
MB	6.50 ± 0.5 <sup>a</sup>	-	6.00 ± 0.1 <sup>a</sup>	7.00 ± 0.5 <sup>a</sup>	9.00 ± 1.0 <sup>b</sup>
BK	13.00 ± 1.0 <sup>b</sup>	12.50 ± 2.5 <sup>b</sup>	12.00 ± 0.4 <sup>c</sup>	-	6.00 ± 0.2 <sup>a</sup>
KU	12.50 ± 2.5 <sup>b</sup>	14.00 ± 0.6 <sup>b</sup>	12.00 ± 0.1 <sup>c</sup>	-	10.00 ± 0.2 <sup>c</sup>

a, b, c- Means with different superscript in a column vary significantly (P < 0.05)

\* AR: Arab; MB: M'Bororo; BK: Bokolodji; KU: Kuri

\*\* MT: Montbeliard; HL: Holstein; JS: Jersey; TA: Tarentaise; BS: Brown Swiss

### DATA ANALYSIS

The data was analyzed using XL-STAT software (6.1.9.). The descriptive analysis provided the dispersion parameters (mean, standard deviations and extremes). The quantity of milk produced was compared between the different genotypes of the crossbreed cows. Variance analysis was performed using Newman-Keuls multiple test at 5% significance level.

## RESULTS AND DISCUSSION

### PROFILES OF BREEDERS AND FARMS SURVEYED

The average age of the breeders was 49.5 ± 4.04 years and have an education level ranging from secondary (18.18%) to higher (81.82%). Among these breeders there are agro-pastoralists (27.27%), traders (9.09%), civil servants (54.55%) and with only one public farm. This observation indicates that in the peri-urban area of N'Djamena, it is the older men who are interested in dairy cattle breeding. Dairy cattle farms in the peri-urban area of N'Djamena are businesses that require significant investment. As the result, young people without financial means are the less represented in this speculation. Thus, improved livestock farms are mainly owned by civil servants and senior managers of the State and a lesser extent by those secondary levels. The age of farmers was higher than previously reported in the same area with 70.5 per cent of 20 to 45 years (Aboulmali, 2005). On the other hand, it was under of 57 years reported in Senegal (N'diaye, 2006).

### GENOTYPES OF THE IDENTIFIED CROSSBRED COWS

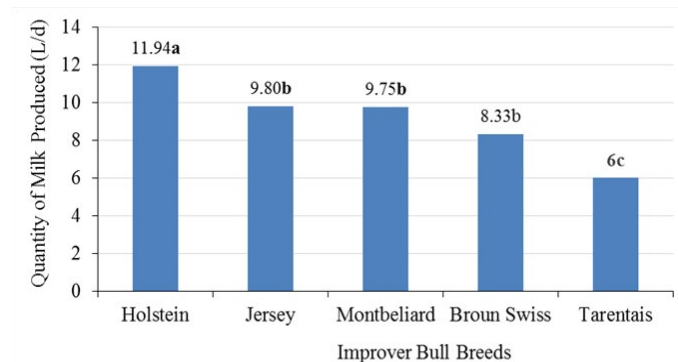
Sixteen (16) types of F1 lacting crossbreed cows were identified in the peri-urban area farms of N'Djamena (Table 2).

Kuri and Bokolodji crossbred cows had the highest milk production (p<0.05) and M'Bororo and Arab crossbred cows the lowest. The crosses using Montbeliard and Jersey semen's were the most numerous (4/16 each), followed respectively by those using semen's of Holstein (3/16 each), and Tarentaise and Brown Swiss (2/16) the least. This would explained by the diversity of the local and improving breeds used in the crossing. This linked to the free choice of breeds to be cross by farmers according to their preferences. These different genotypes of crossbred cows are the result of crossbreeding by artificial insemination (AI) between local breeds namely Arab, Kuri, and M'Bororo, Bogolodji and the exotic breeds that produce high milk, namely Holstein, Montbeliard, Jersey and Tarentais. This diversity of crossbred cows suggests that the dairy actors in Chad are looking for new types of cows that can be produce milk in order to satisfy the growing needs linked to the mutation of urban dwellers' eating habits in this protein (Koussou, 2008). The genetic diversity of crossbreed cows has been more varied than that reported in peri-urban areas of other African cities (Keita, 2005; Kalandi, 2011; Ouedraogo, 2013). These authors report three dominant genetic types of crossbred cows in Senegal and in Burkina Faso.

### CROSSBRED COW MILK PRODUCTION

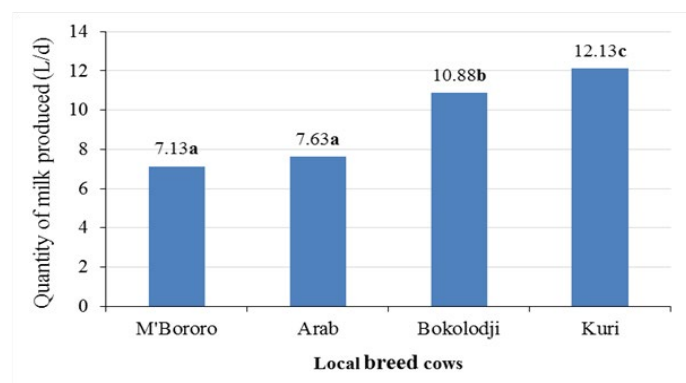
In the peri-urban area of N'Djamena, the average milk yield was 9.44 ± 2.49 liters per day for 9.45 ± 0.24 months (7-12 months) of lactation duration or 2 676.24 ± 705.92 liters per year. The amount of milk produced daily varied with Genetic Types of Crossbred Cows (Table 3).

The crossbreds cows: HLxKU, MTxBK, MTxKU, HLxBK, JSxBK, JSxKU and BSxKU had the highest milk production; the crossbreds cows:TAxBK, MTxAR, BSxBK, JSxAR, HLxAR had intermediate milk production and the crossbreds cows:TAxAR, JSxMB, BKxBS, MTxMB had the lowest milk production. Themilk production of the crossbred cows varied according to the breed of the bull improver (Figure 1).



**Figure 1:** Milk Production of Crossbred Cows inseminated by the exotic Bull Breeds in the Peri-urban Area farms of N'Djamena. a, b, c- Means with different superscript vary significantly ( $P < 0.05$ ).

The crossbred cows from Holstein had the highest milk production, those from Jersey, Montbeliard, Brown Swiss, had the intermediate milk production, and crossbred cows from Tarentaise produced significant less milk ( $p < 0.05$ ). The crossbred cows produced milk according to the inseminated local breed cows (Figure 2).



**Figure 2:** Milk Production of Crossbred Cows Inseminated by the local bull breeds in the Peri-urban Area farms of N'Djamena. a, b, c- Means with different superscript vary significantly ( $P < 0.05$ ).

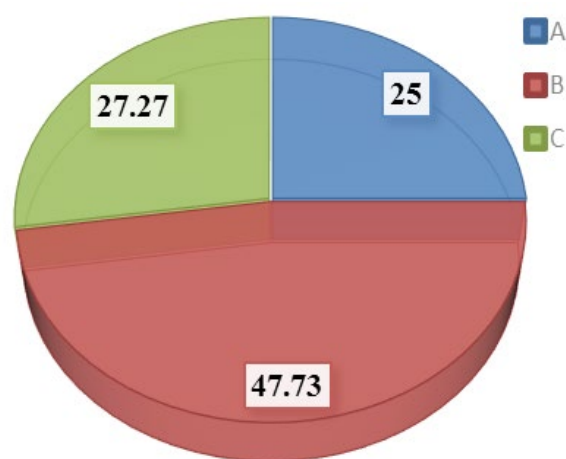
Crossbred cows from Kuri and Bokolodji breeds produced significantly ( $p < 0.05$ ) more milk yield than those from Arab and M'Bororocows. The average daily milk yield of crossbred cows was of  $9.44 \pm 2.49$  liters lower than that reported in other countries :  $17.6 \pm 0.2$  liters in Bangla-

desh (Rahman et al., 2016),  $10.03 \pm 1.47$  liters and  $11.6 \pm 3.1$  liters in Ethiopia (Tadesse et al., 2015; Genzebu et al., 2016). It was not very different from  $9.9 \pm 9.6$  liters reported in Senegal (Habonimana, 2013) but beyond  $4.3 \pm 1.1$  liters in Côte d'Ivoire (Sokouri et al., 2014),  $5.2 \pm 0.2$  liters in Congo (Kibwana et al., 2012) and  $6.28 \pm 2.29$  liters in India (Singh, 2016).

The analysis of milk production showed that some crossbred cows produced more milk than others did. This difference was related to the different breeds involved in the crossing. This result was in line with Singh's (2016) observations in India on milk production of different types of crossbred cows. According to the crossbred cows (breeding bulls), the crossbreds from Holstein bulls produced more milk than those from the bulls of breeds: Jersey, Montbeliard, Brown Swiss and Tarentais. This superiority of the Holstein and the Montbeliard breeds is recognized everywhere in crossbreeding to improve milk production (Boulton et al., 2015; Lawrence et al., 2015; Rahman et al., 2016; Ronzeau, 2016). The possibility of crossbred cow's milk production externalization from their original environment testifies that these breeding breeds are adapted to the various breeding environments. For local breeds, the Kuri and the Bokolodji cows were more favorable to improving milk production than the Arab and the M'Bororo breeds. In addition, just under half (7/16) of the crossbred cows produced at least 10 liters of milk per day. This indicates that some types of crossbred cows have greater genetic potential and are more suitable for dairy production than others are in this production system. This also show that some breeds are suitable for crossing with others. Hence, the need to choose the breeds to be crossed based on their milk potential. The effect of genotype on production was real with the variation of the quantity of milk produced following the breed of the bull improver. As a result, the milk quantities produced by the Holstein and Montbeliard crossbred cows were higher than those reported in Senegal (Keita, 2005). However, these two breeds have in most cases been used to improve milk production around the world. The lactation duration of  $9.45 \pm 0.24$  months was intermediate between  $232.1 \pm 2.4$  and  $338.72 \pm 58.88$  days depending on the crossbred genotypes (Ouedraogo, 1995; Keita, 2005; Kibwana et al., 2012, Habimana, 2013; Sokouri et al., 2014; Boulton et al., 2015; Tadesse et al., 2015; Genzebu et al., 2016; Rahman et al., 2016; Singh 2016).

**CONSTRAINTS TO GENETIC IMPROVEMENT**

The constraints to the application of bovine artificial insemination (AI) application in peri-urban area linked to access to insemination services, management of crossbredcows, herd managements and milk marketing. These constraints were specifically associated to farms and their proportions were different (Figure 3).



**Figure 3:** Constraints identified for the reduced Milk Production in the Peri-urban Area farms of N'Djamena.

A: Artificial insemination access + Crossbreed Health + Finance; B: Artificial insemination access + Livestock Management; and C: Artificial insemination access + Milk Trade.

Access to artificial insemination services and herd management have been major obstacles according to the breedersto the expansion of AI in the peri-urban area of N'Djamena. This is due to the high cost of the operations, the unavailability of the semens and liquid nitrogen on site, the poor management of crossbred cows (transhumance) but also the very limited number of inseminators. In addition, the lack of a national breeding scheme opens up possibilities for breeders to import the semen of breeding bulls of their choice and to exchange crossbred bulls or sometimes the transhumance of crossbreeds. These practices are considered by [Senoussi \(2008\)](#) as the failure to control the zootechnical management of dairy cattle. These same observations are reported in Kenya ([Lawrence et al., 2015](#)). The exchange of crossbreed bulls between farms has been reported in Burkina ([Lakouetene, 1999](#)) and in overseas departments of France ([Naves et al., 2009](#)) but this practice is the genetic erosion source of local breeds. Therefore, [Singh \(2016\)](#) makes it clear that improving bovine milk production is not only about crossing of animals but also about controlling herd management at the same time as artificial insemination. In the absence of favorable production conditions, [Khan \(2014\)](#) reports the negative influence of the macroclimate on the milk production of the crossbred cows in the tropical areas. For example, [Poivey \(2007\)](#) recommends stopping the circulation of crossbred bulls to preserve local breeds from genetic drift. To improve milk production in the tropical areas in a sustainable way, the improvement plan must be defined in advance, to be applied by adopting rigorous crossbreed managements ([Singh, 2016](#)).

## CONCLUSION

The analysis of dairy performance showed that the quan-

tity of milk produced varied according to the genotype of crossbred cows. The crossbreeding of exotic bulls (Holstein, Montbeliard and Jersey) and local breeds (Kuri and Bokolodji) are more favorable to improve milk production in the peri-urban area of N'Djamena. Nevertheless, the type choices of the dairy cattle crosses should be specified after monitoring of the milk production of crossbreed cows and their reproductive performances (age at first calving and interval between calving's). Furthermore, poor livestock management (heath, food and transhumance monitoring), difficult access to artificial insemination services by farmers and poor management of crossbred cows are to be noted as themajor constraints of bovine milk production in Chad.

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## CONFLICT OF INTEREST

The authors declare that there are no conflict of interest.

## AUTHORS' CONTRIBUTION

Madjina Tellah assured the survey formulary preparations, the data analyses, the manuscript-writing plan and submission. Assadi Michel was done the farm identifications and the data collection. Issa Youssouf Adoum and Mahamat Seid Souleyman were associated in the manuscript drafting and review. Mopaté Logténé Youssouf validated the manuscript-writing plan and approved the manuscript before its submission.

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