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Reproductive and Dairy Performance of Holstein-Azawak and Holstein-Goudali Crossbreeds in Comparison with the Local Goudali Breed in the Urban Area of Niamey

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Key words: Goudali, Holstein-Azawak, Holstein-Goudali, milk production, breeding, urban area, Niamey

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Abstract: In order to improve the performance of our local breeds, a cross was made through artificial insemination between the Holstein breed and two local breeds (Azawak and Goudali) in the urban area of Niamey. The aim of this work is to evaluate the reproductive and dairy performances of Holstein-Azawak; Holstein-Goudali and Goudali. It was carried out on 29 dairy cows for the reproductive parameters and 22 lactations for the dairy performances. The age at first calving, age at fertilization and calving interval of the 50% Holstein-Goudali and Holstein-Azawak crosses is lower than those of the 75% Holstein-Goudali crosses which is very different (lower) than that of the local Goudali breed. The daily milk production of the crossbreeds is (4) to (5) times higher than that of the local breed, respectively 8.61±1.01; 10.62±2.10 and 2.08±0.22 kg. The standard productions of the crossbreeds are significantly higher than those of the local Goudali breed. All this shows that the crossbreeding performed gives crossbreeds with performances in reproduction and lactation clearly above those of the local Goudali breed.

INTRODUCTION

In Africa, nearly 75% of the feed requirements of livestock farmers are met from milk revenues[1]. Cattle breeding is the one that provides the most wealth to families and the State, provided that it is well supported, supervised and accompanied in the process of its modernization. This is the sector that offers the most opportunities to rural populations in the Sudano-Sahelian regions, both because of the diversity of types of livestock (cattle, sheep, goats, poultry, etc.) and because of the multiplicity of activities that are increasingly developing in this sector. In fact, following an increasing demand for milk, dairy products and meat due to rapid demographic growth[2], Niger has opted, since, 2008 to crossbreed with other livestock species. Indeed, following an increasing demand for milk, dairy products and meat due to rapid population growth[2], Niger has opted since 2008 to crossbreed local breeds with breeds with high genetic potential from Europe and France[3], through artificial insemination. Thus, in the context of improving these latter factors, genetic improvement is to produce an animal with a genotype that allows it to produce as efficiently as possible and to maximize the breeder's profit while considering the constraints of the environment in which the animal produces[4]. Since, artificial

insemination is a tool to guide, achieve and control the development of breeding to help the breeder, a reproductive biotechnology most widely used in the world. It is applied mainly to ensure rapid and safe genetic improvement of domestic animals. It is in this sense, that the objective of this study is to evaluate the performance of reproduction and milk production due to the crossing of the foreign breed Holstein with the local breeds Azawak and Goudali in the urban area of Niamey. More specifically, to evaluate the reproductive parameters (age at first calving, age at fertile mating, age at first parturition, calving-calving interval, length of gestation) and milk production of Holstein-Azawak and Holstein-Goudali crossbreeds in comparison with the local Goudali breed.

MATERIALS AND METHODS

Materials: The study took place in the urban area (real environment) of the city of Niamey located on the banks of the Niger River in the western part of the country, between 2°10' and 2°14' East longitude and 13°33' and 13°36' North latitude. The climate is tropical, Sudano-Sahelian, characterized by an average temperature of 35°C with a maximum of 45°C in April, a minimum of 15°C in January and a low, variable and random rainfall of 574.5 mm. The strongest winds have a speed of 4.2 meters per second and blow in February. The vegetation is shrubby. The natural vegetation cover is subdivided into three parts: the plateaus which are covered by tiger bush, the shrub and tree savannah occupying the river terraces and the riverbed occupied by aquatic species largely dominated by herbaceous plants (*Aristida mutabilis*, *Aristida fenuculata*, *Cenchrus biflorus*, etc.) serving as grazing land for animals. The hydrographic network of the city of Niamey is marked mainly by the Niger River which crosses the city for about 15 km and to which are added a few permanent pools as well as numerous temporary pools[5]. The animals are in loose housing. The animals are mainly composed of the local Goudali breed and Holstein-Goudali and Holstein-Azawak crosses. The basic diet consists of rice straw, wheat bran, cotton seed cake and peanut cake with lickstones. They are vaccinated and receive care in case of diseases. The most common health problems encountered in these farms are due to parasites, deficiencies (lack of certain nutrients) and injuries (horns from other animals). The study included 24 crossbreeds (19 Holstein-Goudali and 5 Holstein-Azawak) and 5 Goudali for breeding parameters and 17 crossbreeds and 5 Goudali were used for milk production parameters.

Methods

Data collection

Data collection is done in two stages: 1st stage: it allows to collect information on the animals from the information sheets and registers; they concern the numbers of the cow, the mother, the father, the date of birth, the date of the first calving, the milk production of the cow, the date of the milk control, the quantity produced per cow per day; 2nd step: it is the milk control, it is done twice a month (the 15th and the 30th of the month) and twice the day of the control (in the morning at 7 am and in the evening at 5 pm). At each control, the procedure is as follows:

- Calves are separated from their mothers outside of milking and feeding times (morning and evening)
- At the time of the milking (in the morning and in the evening), we bring out the cub, so that, it joins its mother, we let it suckle 1 to 2 mn to stimulate the hormones which provoke the ejection of milk. Afterwards, we tie it with a rope around its neck to one of its mother's front legs; the two front legs of the mother will be tied with a rope

At the end of milking, the calf is untied to allow it to consume the remaining milk from the udder left by the milker.

Data processing: Excel software was used for data entry and calculation of means, standard deviations; lactation curves, total productions and peak lactations. SPSS version 20, XLSTAT 2016, SAS 2016 and MINITAB 16 software were used for the analysis of reproduction and milk production parameters as well as the significance level which is set at 5%. The difference is statistically significant when the $p<0.05$. Fertility parameters were calculated using the following formulas :

- Age at first calving (months) = date of first calving-date of birth
- Age at first fertile service (months) = age at first calving (months)-9 months of gestation
- Calving interval or calving to calving interval = date of last calving-date of previous calving

The milk production parameters were calculated from the following formulas. Average Daily Production (ADP): is deduced by the following formula:

$$ADP = ((A \times n1)+(A+B) \times n2/2)/\text{Number of days}$$

Total milk production per lactation: is calculated according to the Fleischmann's method: the quantity of milk produced is calculated separately for each interval, represented by the average of the two controls, multiplied by the length of the interval. It is given by the following formula:

$$PTL = (A \times n1) + (A + B) \times n2 / 2+, ..., + (X + Y) \times n / 2 + (Y \times 14)$$

PTL = Total milk production
A, B, ..., X, Y = The quantities of milk obtained during the consecutive controls (A for the 1st control and Y for the last)
n1 = Number of days between calving and the first test
n2 = Number of days between the first and the second test
n = Number of days between the second last and the last test

- Standard milk production = (PTL/Lactation length)*305
- The duration of lactation = the sum of the number of days between milk controls, from the beginning to the end of lactation
- The lactation curve: it is the graphical representation of the average daily production per month

Description of the lactation curve:
- Initial production: is the arithmetic average of the quantity of milk produced on the 4th, 5th and 6th day after calving
- Peak production: is the highest production value observed on the daily average of the quantities produced by the cow during the milk recording
- Month of peak lactation : corresponds to the month of peak lactation of the cow
- Persistence coefficient: is defined as the ability of a cow to maintain her production after the peak of lactation

RESULTS

Reproduction parameters

Age at first calving of crossbred cows and the local Goudali breed: The age at first calving of the crossbred cows and the local Goudali breed is reported in Table 1. Table 1 shows that the age at first calving of the 50% Holstein-Goudali and Holstein-Azawak crosses is lower than that of the 75% Holstein-Goudali crosses which is very different (lower) than that of the pure Goudali.

Ages at fertilization of crossbred cattle (Holstein-Goudali and Holstein-Azawak) and the pure Goudali local breed: Table 2 gives the age at fertilization of the crossbred and the local Goudali cattle breed.

From Table 2 it can be seen that the 50% Holstein blood (Goudali and Azawak) has a lower age at fertilization than the pure Goudali and the 75% Holstein blood.

Calving interval of crossbred and purebred Goudali cows: Table 3 shows the different calving intervals of pure Goudali cows and Holstein-Goudali crossbred cows according to blood degree.

From Table 3, it can be seen that the calving intervals of the crossbreeds are not different from each other but are lower and statistically different from that of the pure Goudali.

Milk production parameters

Average daily production of local Goudali breed and crossbred Holstein-Goudali and Holstein-Azawak (kg): Table 4 shows the average daily production of purebred Goudali and crossbred females.

Table 4 shows that the average daily production of the crossbreeds is higher than that of the pure Goudali; the daily production of the Holstein-Goudali is higher than that of the Holstein-Azawak. The Grubbs test shows that there is no significant difference between the two crossbreeds but that there is a very significant difference between the average daily production of the crossbreeds and that of the pure Goudali breed at the threshold of $p<0.05$.

Table 1: Age at first calving of crossbred cattle (Holstein-Goudali and Holstein-Azawak) and the local Goudali cattle breed

Degree	Holstein-Goudali		Holstein-Azawak		Goudali pure	
of blood (%)	Average	SD	Average	SD	Average	SD
75	N = 6 30,33a	7,71	-	-	-	-
50	N = 13 27,40b	5,03	N = 5 26,04b	2,02	-	-
100	-	-	-	-	N = 5 43,58c	8,84

N = Number of animals; a, b and c = Different letters in the same table indicate a significant difference at the $p<0.05$ threshold

Table 2: Ages at fertile mating (months) of crossbreeds (Holstein-Goudali and Holstein-Azawak) and the local Goudali breed

Breeds	Holstein-Goudali		Holstein-Azawak		Goudali pure	
blood (%)	Average	SD	Average	SD	Average	SD
75	N = 6 21,33a	7,71	-	-	-	-
50	N = 13 18,40b	5,03	N = 5 17,10b	1,05	-	-
100	-	-	-	-	N = 5 34,58c	8,84

a-c = Different letters in the same table indicate a significant difference at the $p<0.05$ threshold

Table 3: Calving interval (months) of crossbreed (Holstein-Goudali and Holstein-Azawak) and local Goudali cattle

Types of crossbreeding		Holstein-Goudali		Holstein-Azawak		Goudali pure	
blood (%)	No. delivered	Average	SD	Average	SD	Average	SD
75	8	13,50a	3,54	-	-	-	-
50	26	14,00a	2,45	13,12a	2,20	-	-
100	10	-	-	-	-	17,54 b	2,06

a, b = Different letters in the same table indicate a significant difference at the p<0.05 threshold

Table 4: Average daily production of crossbreeds (Holstein-Goudali and Holstein-Azawak) and Goudali

Categories	No. of females	Minimum	Maximum	Average daily production (kg)
Goudali pures	5	1,86	2,35	2,08±0,22a
Crossroads Holstein-Azawak	5	8,61	9,61	8,61±1,01b
Crossroads Holstein-Goudali	12	6,09	15,97	10,62±2,10b

a, b = Different letters in the same table indicate a significant difference at the p<0.05 threshold

Table 5: Total milk production of crossbred females and pure Goudali (kg)

Categories	No. of females	Minimum	Maximum	Average total production (kg)
Goudali	5	308,50	498,95	401,18±78,22*
Crossroads Holstein-Azawak	5	1577,34	2067,57	1597,46±452,12**
Crossroads Holstein-Goudali	12	1556,68	4290,31	2990,41±639,51***

Table 6: Standard milk production (305 of lactation) of crossbred cows and the local Goudali breed

Categories	No. of females	Minimum	Maximum	Average standard production (kg)
Goudali	5	566,82	717,83	633,71±67,29a
Crossroads Holstein-Azawak	5	2638,35	3179,03	2358,40±320,32b
Crossroads Holstein-Goudali	12	1858,76	4872,28	3240,45±640,35c

a-c = The averages of the same line with different letters are statistically different (p<0.05)

Table 7: Lactation duration of crossbred cows and the local Goudali breed (Days)

Categories	Number of females	Minimum	Maximum	Duration of lactation (days)
Goudali	5	166	212	191,00±20,00a
Crossroads Holstein-Azawak	5	263	264	263,26±2,20b
Crossroads Holstein-Goudali	12	168	485	288,62±57,99c

a-c = Means in the same line with different letters are statistically different (p<0.05)

Total milk production of crossbreed females and the local Goudali breed: Table 5 reports the total production of pure Goudali and crossbred females.

The Kolmogorov-Smirnov test on two samples shows that there is a significant difference between the total productions of pure Goudali of Holstein-Azawak and Holstein-Goudali crosses with a calculated p-value below the significance level alpha = 0.05 in all cases.

Standard milk production of crossbred cattle and the local Goudali breed: The standard milk production of the local Goudali breed, Holstein-Goudali and Holstein-Azawak crossbreeds are shown in Table 6.

From Table 6 it can be seen that, on the one hand, the standard production of the crossbred cows is significantly higher than that of the local Goudali breed and on the other hand, that of the Holstein-Goudali crossbred is higher than that of the Holstein-Azawak. The differences are significant according to the Kolmogorov-Smirnov Test at the p<0.05 threshold.

Lactation duration of Holstein-Goudali, Holstein-Azawak crossbreds and the local Goudali breed: The duration of lactation of the crossbred cows and the local Goudali breed is presented in Table 7.

The lactation length of the Goudali is significantly shorter than that of the Holstein-Azawak crossbred which in turn is shorter than that of the Holstein-Goudali.

Lactation curves of crossbred cows and the local Goudali breed: According to the normality test, the average productions of the crossbred cows and the local Goudali breed follow a normal distribution as shown in Fig. 1.

This allows the presentation of an average lactation curve by breed. Figure 2 shows the lactation curves of the Holstein-Goudali, Holstein-Azawak crossbreds and the local Goudali breed.

From Fig. 2 it is clear that the lactation curve of the Holstein-Goudali cross is clearly above that of the Holstein-Azawak which in turn is above that of the pure Goudali.

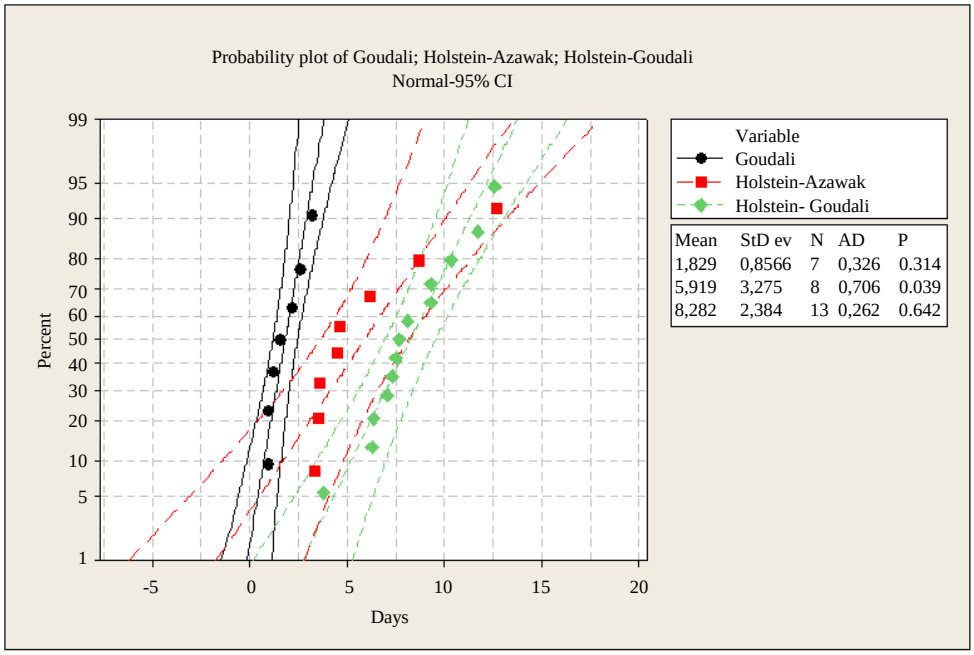

Fig. 1: Test of normalities of average daily production of crossbreeds and local breed

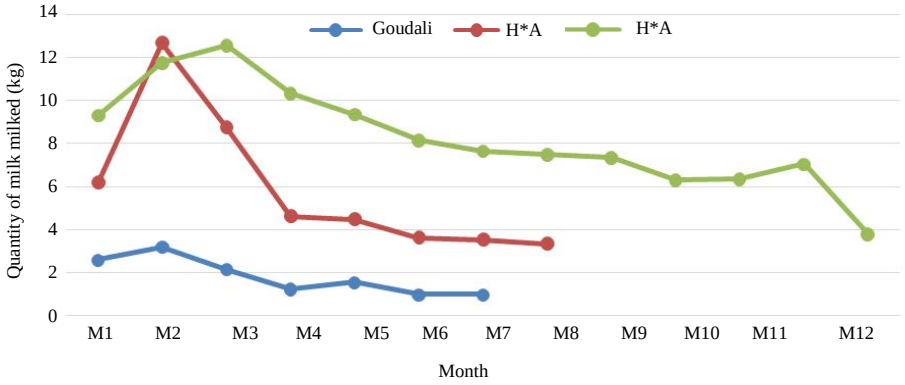

Fig. 2: Comparison curve between the three breeds (one purebred and two Holstein crosses); M = Month; H*A = Holstein-Azawak cross; H*G = Holstein-Goudali cross

Table 8: Average initial production of crossbred animals and the local Goudali breed (kg)

Categories	Number of females	Minimum	Maximum	Average initial production (kg)
Goudali	5	1,75	2,63	2.61±0,2a
Crossroads Holstein-Azawak	5	5,35	6,20	6,20±0,43b
Crossroads Holstein-Goudali	12	9,33	12,10	9,33±2,12c

a-c = Mean values in the same column with different letters are significant ($p<0.05$)

The initial production, the maximum production (peak lactation), the month of peak lactation and the Persistence Coefficient which are descriptors of the shape of a lactation curve, help to show this difference.

Initial production of crossbred cattle and the local Goudali breed: The initial production is as follows for the crossbreeds and the local breed (Table 8). The initial production of the crossbreds is three to four times that of the local breed.

Table 9: Maximum average production (kg)

Breeds	Maximum production (kg)
Goudali	3,21±0,53
Croisées Holstein-Azawak	12,70±0,00
Croisées Holstein-Goudali	13,67±2,09

Maximum average production of crossbreed and local Goudali breed: Table 9 shows the maximum average production of the crossbreds and the local breed. The maximum average production observed in crossbreeds is four times that observed in the local Goudali breed.

Table 10: Persistence coefficient (coef) of the crosses and Goudali

	Coefficient of persistence of lactation curves (%)					
Categories	Coef 1	Coef 2	Coef 3	Coef 4	Coef 5	Coef 6
Goudali	67,53	57,69	125,33	63,83	100,00	
Croisées Holstein-Azawak	69,20	53,14	96,77	81,11	97,26	94,36
Croisées Holstein-Goudali	90,44	87,38	93,08	98,25	93,25	86,08

Month of peak lactation for Holstein-Goudali, Holstein-Azawak and local Goudali crossbreeds: The month corresponding to the peak of lactation is the third (3rd) month in Holstein-Goudali crossbreds and the second (2nd) month in Holstein-Azawak and Goudali crossbreeds.

Persistence coefficient: The persistence coefficient is presented for the three genotypes in Table 10. The persistence coefficient for Holstein-Goudali crossbreds varies between 86 and 98%. In Holstein-Azawak crosses, it varies from 69-97% except for the first month after the peak which is 53%. Similarly, in Goudali, only the first month after the peak has a coefficient of 67%, the rest between 57 and 125%.

DISCUSSION

The genetic determinism of reproductive performance is classically recognized as strongly influenced by non-additive gene effects (gene interactions). Therefore, crossing two breeds allows to benefit from a favorable heterosis phenomenon on specific traits for reproduction and/or milk and meat production. Thus, our results found in Holstein-Goudali and Holstein-Azawak crossbreed cows made it possible to gain 12-16 months on the age at first calving (30.33 and 27.40 months against 43.58 months for the local Goudali breed). Our recorded values for age at first parturition of crossbreeds are close to those reported for pure breeds by Boujenane and Aissa[6] in Morocco (28.9 and 29.6 months for Holstein and Montbeliarde) and Haddada *et al*.[7] in Morocco (27.52 months for Holstein). The intervals between successive calvings are not different between the crosses (13.12-14 months) and are reduced compared to the local Goudali breed (17.54 months). This cross improves the fertility of the products obtained. In terms of average daily production over the entire lactation period, crossbred cattle are worth 4 to 5 times that of the local breed. Since, the animals in this experiment live on the same farm, under the same rearing conditions, the differences in production observed can be attributed to the breeds of the sires. Indeed, the Holstein (breed of the father of the crossbreeds) having a very high production compared to the local breeds Goudali and Azawak (breeds of the mothers of the crossbreeds), this allowed to have an intermediate milk production between those of the Holstein and the local breed (Goudali).

These crossbred data are similar to those obtained by Lucy[8] on animals with 50% Holstein genes with a production of 11.2 l/day, although a lower production of 10.4 l/day is recorded above this proportion. For the latter, it should be noted that the animals are raised on artificial pasture and supplemented with corn bran while our animals receive the supplement of cotton grains only in hard period of natural forage break. Also, our results are close to those of the pure breed Holstein in Cameroon which is 11.5 kg[1] but less than this same breed in Tunisia 14 kg obtained by Houchati *et al*.[9]. The productions of the crossbred cows in this study are far superior to other crossbred cows in Africa, including Holstein-Goudali in Cameroon (6.3 kg) and Holstein-Borgou in Benin (3l)[1, 10]. For the former, there is certainly the environment that is different from that of this study while for the latter there is the effect of the breed of the mother (Borgou) which produces less than our local breeds (Azawak, Goudali).

In terms of standard milk production, the results of the crossbreeds are significantly higher than those of the local Goudali breed. These data are close to those of the purebred Holstein in Tunisia reported by Houchati *et al*.[9] (3443-6483 kg) but lower (5900, 5900, 5517, 5441 and 5517 kg) than those of many other authors in Tunisia, (respectively Ben Salem *et al*.[11], Ajili *et al*.[12], Hammami *et al*.[13] and Bouraoui *et al*.[2]. Also, such results are far from the reference quantity of milk per lactation recorded in France for the Holstein breed which was 9155 kg. All this confirms that the potentialities of the crossbreed are intermediate between the breed of the mother (breed to be improved) and the breed of the father (improving breed). There is thus a gain due to the crossing.

In terms of lactation curves, it appears that the daily production is identical for the crossbred cows and (4) times higher than that of the local breed (3 kg against 12 kg). However, the persistence coefficients are satisfactory for the (3) genotypes.

CONCLUSION

The study allowed us to evaluate the reproductive and milk production performance of crossbred cows in the urban area of Niamey compared to those of the local breed. The results obtained showed a sexual precocity in the crossbreed (age at first fertilization and first parturition), a shorter interval between calvings, a milk

production (4) to (5) times higher than the local breed. There is a clear improvement in the productivity of the crossbred products, probably due to the breed of the male. Regarding the level of crossbreeding, there is no significant difference between the 75 and 50% Holsteins crossbreeds, concerning the parameters of reproduction and milk production. Therefore, it is recommended to stop at F1 (50%). To complete this study, it will be important to follow these crossbreeds during their entire breeding career in order to judge their adaptability to their environment.

Author contributions: Professor Marichatou Hamani; Professor Moumouni Issa et Doctor Abdou Moussa Mahaman Maâouiahave contributed to the field practice and writing of this work. Marichatou Hamani is the director of my thesis.

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