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Assessment of the reproductive traits of Saanen, Red Maradi goats and their crossbreeding the Sudano-guinean zone of North Benin

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Abstract

The study was conducted at the farm of the Non-Governmental Organization (NGO) "Fermiers Sans Frontière" to assess the reproductive performance of Red Maradi, Saanen goats and their crossbred F1 and F2 (backcross) in an intensive livestock farming system in northern Benin. The reproduction data were collected on 238 goats. The Red Maradi first reached age at conception and first kidding, followed by F1, Saanen and F2 ($P<0.05$). On the other hand, the average weight at mating was significantly higher in Saanen, followed by F1, F2 and Red Maradi. Goats born in the rainy season had better reproductive performance than the others born in the dry season. Similarly, single-born goats had the shortest period ($P<0.05$) for some reproductive performances (age at conception, age at first kidding, kidding interval and gestation period). The Red Maradi breed was superior in all reproductive traits indicating better reproductive performance of this breed compared to Saanen and F1 and F2. The effect of the season on most traits indicates the need for supplementation of goats during the dry season when the pasture condition is very poor for better reproductive performance.

Key words: Dairy goat; age at first; kidding interval; gestation period; crossing; reproduction.

Introduction

In West Africa, goat farming, because of its potential and multifunctionality, can play a great role in the fight against poverty and food insecurity, particularly in animal products (Peacock, 2005). Goats are known to have distinct economic and managerial advantages over other livestock because of its less initial investment, low input requirement, higher prolificacy, early sexual maturity, and ease in marketing (Kumar et al, 2010). However, the increasing human population, urbanization and rising incomes associated with changing consumer preferences are creating increased demand for these animals and their products (Kosgey and Okeyo, 2007). Improvement programs are therefore needed to increase and maintain goat productivity. However, to develop good goat improvement programs, research efforts must be made to study the reproductive and production performance of native goat breeds. Native goats are disease and parasite tolerant, have good group instinct, are able to travel long distances foraging and are highly tolerant of adverse climatic conditions, with high resistance to drought and low availability and fluctuating in nutrients (Kosgey et al., 2008). Thus, the national demand for dairy products is far from being satisfied and the foreign exchange value of the deficit filled by imports is nowadays of unsustainable proportions: these dairy products imports have risen from 4 to nearly 12 billion CFA francs from 2001 to 2011 (FAO, 2019).

However, the average consumption of milk in Benin, still low or alarming, hardly exceeds 20 kg per capita and per year against 34 kg on average for developing countries and 50 kg recommended by The World Health Organization (WHO). To approach this threshold of consumption, it will be necessary to triplicate the national production. Benin has a rich diversity of goat genetic resources (Dossa et al, 2007) distributed under extensive agro-climatic conditions, conserved for the purpose of food source, income generation, socio-cultural wealth and other valuable non-food products such as skin and manure. The last estimate of the goat population in Benin is 1,795,000 head in 2015 (MAEP, 2018).

With the aim of diversifying milk production still essentially based on cattle, Saanen and Red Maradi dairy goats had been imported at the NGO ‘‘Fermiers Sans Frontière” breeding farm in northern Benin since 2012. Therefore, it is imperative to know the reproduction and production characteristics of these goats, which can provide essential information to understand their potential using locally available resources. On the other hand, few works have focused on the evaluation of the reproductive and production parameters of goats in Benin. The objective of this study was to assess the reproduction parameters of the Red Maradi goats, Saanen, and their F1 crossbred and F2 backcross. It also highlights some non-genetic factors influencing these parameters.

Methodology

Study area

The farm "Fermiers sans Frontière" is located in the village of Bahounkpo in the district of Ouénou about 27 km from the town of N'Dali in northern Benin. The farm is on an area of 110ha. The climate of this zone is tropical. A long rainy season is observed from April to October and a long dry season from November to March. The main soil types are tropical ferruginous. The average temperature in N'Dali is 26.2 ° C. The average annual rainfall is 1084 mm. The average annual temperature of the farm "Fermier Sans Frontière" varies between 26°C with a maximum of 32°C in March and goes down around 23°C in December and January. The vegetation is composed of wooded savannahs, trees and shrubs.

Thanks to the friendship with the Belgians, the farm has bought Saanen dairy goats imported from Belgium. On September 28, 2012, these Saanen goats entered Benin Republic with a herd of ten heads including seven females and three males at a three-month age. These animals were imported in order to increase the milk production of the farm in particular but also of Benin in general, and to improve the milk production of the red goats of Maradi.

Farming system

The breeding system of the farm of the NGO "Fermier Sans Frontière" is of the intensive system type. The animals are housed in buildings and divided according to age, sex and physiological stage. The animals are fed according to their physiological stages. Each morning at 7 am the animals receive food supplement consisting of a mixture of (soy pulp, rice bran, *Parkia biglobosa* powder) and then fodder (*Leucaena leucocephala, Panicum maximum C1, Andropogon gayanus, Moringa oleifera,* and others). Note that water and salt lick (salt and mineral supply) were available *ad libitum*. Goats are fed of 2 to 3 kg of feed through feed containers. The goats of choice also receive a complementation of about 0.2 kg per goat at the end of gestation and at the beginning of lactation. The dietary supplement is composed of grain corn, brewer's dough, *Parkia biglobosa* powder and roasted soybean. During the dry season, keeping fodder trees trimmed (*Afzelia Africana, Khaya senegalensis and Pterocarpus erinaceus*) and crop residues contribute to the feeding of animals at the farm of the NGO "Fermier Sans Frontière”.

Health monitoring

The animals were identified at birth. A hygiene plan was rigorously applied by the farm technician. Parasitic diseases in young and mastitis in lactating females were the most reported. The goat shed was regularly

sprayed with insecticides and disinfected with frequent litter changes. As for the animal prophylaxis program, young animals and adults were vaccinated against contagious diseases such as foot-and-mouth disease, brucellosis and sheep and goat plague. Preventive treatments against trypanosomosis, internal and external parasites were applied twice a year.

Reproductive performance of goats

Data collected on reproductive parameters were: date of birth, birth type, birth weight, parity and sex of kids were recorded within 24 hours. Age at conception and age at first kidding were considered for animals. The age at first kidding was calculated as the difference in days from birth to the date of first kidding. The kidding interval was calculated as the difference in days between two consecutive kidding. The litter size was defined as the total number of kids born by kidding per goat. All data was saved and managed in the Excel spreadsheet. The number of goats used to evaluate reproductive performance was 156, 135, 131, 96 and 131 animals, respectively, for age at conception, age at first kidding, kidding interval, gestation period and the weight at mating. Weight at mating corresponds to weight recorded on the day of mating in the farm.

Statistical analysis

The following general linear model was ajusted to the data to test the effect of the fixed variation factors using the R.3.3.3 software (R Core Team, 2018).

$$Yijkl = \mu + Ai + Bj + Ck + eijkl$$

Or:

Yijkl = Observation on breed, season, and litter size

μ = Overall mean

Ai = Fixed effect of the breed (i = 1 to 4)

Bj = Fixed effect of the birth season of the goat (j = dry season, rainy season)

Ck = Fixed effect of the litter size (k = Single, Twin, Triplet)

eijk = Random error term

The effect of different breeds, seasons and litter size on the variability of different important reproductive traits was estimated by analysis of variance. Significantly different means were separated using the Tukey's Honestly Significant Difference (HSD).

Results

Effect of the breed

Table 1 shows the average reproductive performance of Saanen, Red Maradi, F1 crossbred and F2 backcross goats. The breed had a significant effect ($P<0.05$) on the different reproductive performance of goats. The Red Maradi goat has had the lowest age at conception and age at first kidding. The shortest gestation period and the shortest kidding interval were also obtained in Red Maradi. On the other hand, the average weight at mating was significantly higher in Saanen goats.

Table 1: Mean ± SE of the reproductive performance of Saanen, Red Maradi and F1 and F2 BC.

Reproductive performance	n	Saanen	n	Red Maradi	n	F1 Crossbred	n	F2 Backcross
Age at conception, days	33	247^{b} ± 4.66	42	215^{c} ± 4.04	41	235^{b} ± 3.34	40	326^{a} ± 4.01
Age at first kidding, days	31	428^{b} ± 3.36	37	333^{d} ± 4.54	35	366^{c} ± 4.50	32	497^{a} ± 5.24
Gestation period, days	25	180^{a} ± 1.60	39	117^{d} ± 1.30	34	131^{c} ± 1.38	33	171^{b} ± 1.14
Kidding interval, months	20	15.1^{a} ± 0.23	28	8.6^{d} ± 0.20	26	10.6^{c} ± 0.10	22	12.6^{b} ± 0.16
Weight at mating, kg	30	35.4^{a} ± 0.33	37	26.8^{c} ± 0.29	32	29.2^{b} ± 0.24	34	32.1^{a} ± 0.29

a, b, c: the mean values on the same column with the different letters are significantly different at 5% (p<0.05).

Effect of the season

The least squares means and the standard error (SE) of the reproductive performance of Saanen goats, Red Maradi goats, and F1 and F2 Back-cross (BC) mixed-breeds in different seasons are shown in Table 2. Birth season of goats had a significant effect (P<0.05) on age at conception, age at first kidding, kidding interval and average weight at mating. However, the season did not have a significant effect (P>0.05) on the duration of gestation. Young female goats of the Saanen, Red Maradi, and crossbred F1 and F2 breeds born on the rainy season were more effective in reproductive performance (Table 2).

Effect of the litter size

Significant variation (p<0.05) among the different litter sizes was observed with age at conception and first kidding, between kidding interval and average weight at mating. Whereas for the duration of gestation, the variation was not significant (P>0.05). Age at conception and age at first kidding were recduced in single-born goats in the four genetic types. The reproductive cycle was later in triplets and twin goats had intermediate values (Table 3). Similarly, the average weight at mating was higher in single-born goats regardless of the breed.

Table 2: Least Squares Mean and Standard Error (SE) of reproductive performance of Saanen, Red Maradi and F1 crossbred and F2BC in different seasons.

Reproductive trait	Dry season								Rainy season							
	n	Saanen	n	Red Maradi	n	F1	n	F2 BC	n	Saanen	n	Red Maradi	n	F1	n	F2 BC
Age at conception	1 3	250^{a} ± 6.7	1 8	218^{a}±7 .8	1 9	241^{a} ±7.0	1 5	327^{a} ±5.5	2 0	240^{b} ±6.6	2 4	208^{b} ±4.7	2 2	235^{b} ±4.9	2 5	320^{b} ±4.2
Age at first kidding	1 2	433^{a} ± 7.4	1 6	338^{a} ±7.8	1 5	374^{a} ±8.7	1 1	498^{a} ±6.1	1 9	421^{b} ±7.4	2 1	322^{b} ±5.6	2 0	365^{b} ±5.3	2 1	488^{b} ±4.7
Gestation period	1 0	183^{a} ±2.0	1 7	120^{a} ±2.1	1 4	133^{a} ±2.3	1 3	171^{a} ±1.6	1 5	181^{a} ±2.3	2 2	114^{a} ±1.7	2 0	130^{a} ±1.6	2 0	168^{a} ±1.5
Kidding interval	8	15.5^{a} ±0.30	1 3	8.7^{a} ±0.35	1 0	10.8^{a} ±0.31	8	13.1^{a} ±0.20	1 2	12.2^{b} ±0.33	1 5	6.8^{b} ±0.24	1 6	8.5^{b}± 0.25	1 4	10.1^{b}± 0.21
Weight at mating	1 2	34.4^{b} ±0.44	1 4	24.2^{b}± 0.52	1 1	28.1^{b} ±0.50	1 1	30.8^{b} ±0.37	1 8	35.5^{a} ±0.50	2 3	28.1^{a} ±0.35	2 1	30.2^{a} ±0.37	2 3	33.3^{a} ±0.31

a, b: mean values on the same line with the different letters are significantly different at 5% (p <0.05).

Table 3. Least Squares Mean and Standard Error (SE) of Reproductive Performance of Saanen Goats, Red Maradi Goats, and F1 and F2 BC crossbred by Parity

Reproductive trait	Simple								Twin								Triplet			
	n	Saanen	n	Red Maradi	n	F1	n	F2 BC	n	Saanen	n	Red Maradi	n	F1	n	F2 BC	n	Saanen	n	Red Maradi	n	F1	n	F2 BC
Age at conception	13	247^{b} ± 6.2	11	208^{b} ± 6.8	10	228^{b} ± 6.22	10	318^{b} ± 5.3	15	248^{b} ± 8.2	18	216^{a} ± 5.4	19	236^{ab} ± 6.0	20	325^{ab} ± 4.8	5	253^{a} ± 13.8	13	214^{a} ± 15.4	12	244^{a} ± 12.5	10	330^{a} ± 10.8
Age at first kidding	11	425^{b} ± 7.5	10	323^{b} ± 8.1	8	357^{b} ± 7.4	10	486^{b} ± 6.4	14	428^{b} ± 8.8	15	333^{ab} ± 5.8	16	367^{ab} ± 6.3	13	496^{ab} ± 5.1	6	436^{a} ± 14.6	12	338^{a} ± 13.0	11	376^{a} ± 11.9	9	503^{a} ± 10.3
Gestation Period	9	178^{a} ± 2.0	11	115^{a} ± 2.2	8	129^{a} ± 2.40	10	168^{a} ± 2.2	11	180^{a} ± 3.0	15	117^{a} ± 1.9	16	131^{a} ± 2.1	14	171^{a} ± 1.7	5	183^{a} ± 3.7	13	124^{a} ± 4.1	10	133^{a} ± 3.4	9	174^{a} ± 2.9
Kidding interval	8	12.5^{a} ± 0.3	9	7.7^{a} ± 0.3	8	9.7^{a} ± 0.30	6	10.7^{b} ± 0.2	8	15.4^{a} ± 0.4	8	8.6^{a} ± 0.27	10	10.6^{a} ± 0.30	8	12.5^{a} ± 0.24	4	16.2^{a} ± 0.35	11	9.25^{a} ± 0.4	8	11.16^{a} ± 0.3	8	13.7^{a} ± 0.2
Weight at mating	11	35^{a} ± 0.4	11	28.1^{a} ± 0.5	10	31.3^{a} ± 0.4	11	34.3^{a} ± 0.4	11	33.1^{ab} ± 0.5	15	26.6^{a} ± 0.3	12	29.5^{a} ± 0.3	13	32.3^{a} ± 0.31	8	31.2^{b} ± 0.86	11	24.1^{b} ± 0.9	10	26.1^{b} ± 0.7	10	28.5^{b} ± 0.6

a, b, ab: mean values on the same line with the different letters are significantly different at 5% (p <0.05).

Discussion

Age at first kidding

The birth season had a significant effect on age at conception and first kidding. Young female born during the rainy season have early estrus compared to those born during the dry season. This may be due to the quality and quantity of food available during the rainy season, which confirms that puberty depends on body weight rather than age (Zeshmarani et al 2007, Bushara and Abu Nikhaila 2012).

The lowest reproductive performance was observed in Saanen goats. This can be explained by the seasonal sexual activities in Saanen goats. In fact, the Saanen goats on the farm recorded a high calving rate between March and August resulting from a strong sexual activity between November and March. These results are similar to those reported in Switzerland in their country of origin by some authors Baril et al. (1993) and Hanzen (2010) who reported seasonal sexual activity in Saanen goats. The rest of the year sexual activity is stopped (no activity). Similarly in Algeria, Sutherland (1988), Charallah (1994), all reported that these same goats showed significant sexual activity from August until the end of February, but the rest of the year the continuous activity (with a low intensity). The best performance of crossbred goats denote a genetic progress obtained through crossbreeding and the crossbred inherited the performances of Red Maradi goats.

Kidding interval

The lowest kidding interval was observed in Red Maradi goats. According to some authors, three kiddings in two years are often observed. Shorter intervals (215days and 207 days) were reported for the same breed by Awemu et al., (1999) and Abubakar et al. (2014) respectively. Thus the differences observed show that the kidding interval varies according to the environment and the mode of livestock management. In addition, the Red Maradi goats are much earlier because the age at the start of reproduction is lower in these Red Maradi goats (215 days). These results are similar to those obtained in the Sahel where puberty occurs between 7 and 8 months, but can go beyond 12 months depending on whether this period coincides with the period of food abundance (Tillard et al., 1997; Moulin, 1993, Clement, 1999, Faugere et al., 1990, Degaldillo et al., 1997, Lapo et al., 2005).

The type of birth has significantly affected the kidding interval. These single-born goats had a shorter interval than those of twin and triplet. This could be due to the fact that the twins and triplets need to produce a lot more milk to feed their kids, resulting in poor physical condition, mainly during the dry season. The birth season was an important source of variation in the kidding interval. This may be due to the greater amount of forage available for consumption during the rainy season compared to the dry season. This result is congruent with other studies (Dadi et al 2008, Taye et al 2013). Obviously, it takes better feeding before and after birth to have a better physical condition and for the goat to return quickly in estrus.

Weight and age at reproduction

The weight and age at reproduction achieved in Saanen goats were close to those obtained in their home countries. Similar results have been reported by the Breeding Institute in France, which states that at reproduction time at 7 to 8 months, Alpine must weigh at least 32 kg and Saanen 35 kg. On the other hand, in the hot desert zones, females of the European breeds are less precocious than in their environment of origin, it is observed only between 12 and 20 months in animals of temperate breeds reared in the tropics (Legal and Planchenault, 1993). These parameters therefore depend on their management conditions (food, barn and health) as well as the climate (Legal and Planchenault, 1993). The behavior, as well as the seasonally reproduction of European breeds, would have been transmitted in part to the crossbreds, which would have resulted in an increase in the kidding interval of F1 females with regard to local females. These results are consistent with those observed by Legal and Planchenault (1993) who indicate that, for most cases, in F1 females, the age at first kidding and the kidding interval, are intermediate between those of

parental breeds. The poor reproductive performance of Saanen goats can also be explained by the livestock management. Indeed, the longer lactation duration in Saanen goats is a factor that influences the kidding interval and consequently the number of kidding per year, the kidding rate and the prolificacy rate. However, the reproductive performance of the breeding male can also influence these parameters. On the other hand, the Red Maradi goats showed the best reproduction performances because they reproduce all the year. This confirms their good adaptation to the climatic conditions and intensive farming conditions used on the farm.

Conclusion

On the whole, current results indicate that the reproductive performance of Red Maradi goat is better than that of other breeds. However, the F1 crossbred obtained intermediate values of these reproductive performances. The non-genetic factors studied, however, had a major effect on reproductive performance of goats, indicating that these factors should be taken into account in the development of rational breeding programs to increase production.

Author Contributions

OFFOUMON OTF and ASSANI AS conceived the original idea and co-write the paper. WOROGO SSH, BASSOSSA BAGUIMA AM and SOULE F carried out the field work. ASSOGBA B and GBANGBOCHE AB read and corrected the paper and ALKOIRET IT supervised the work.

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