

## Zootechnical Parameters and Zoo-Genetic Management of Goat Breeds Encountered in Benin: A Review

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### Review Article

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**Abstract:** In rural areas, goats contribute to the reduction of malnutrition through their production of milk and meat. A review of the zootechnical and reproductive performance of goat breeds in Benin was made from ninety (90) articles, papers and documents related to these goat breeds. The main data concern the taxonomy of goats, their origin, the importance of goat rearing, the description and zootechnical parameters of the goat breeds encountered in Benin. The main local goat breeds encountered in Benin were the dwarf or Djallonke, the Sahelian breed and the red goat of Maradi. The exotic breeds mentioned in this paper concern the Alpine and the Saanen breeds. The zootechnical and reproductive performances varied from one goat race to another, but satisfactory overall. It is worth to focus on the breeding of these short-cycle species in order to meet the ever increasing demand for meat products. Alternatives for improving the performance of local breeds in crossing with exotic breeds constitute some ways to explore in order to boost the production of milk and meat goats in Benin.

**Key words:** goat breeds, zootechnical performance, breeding performance, Benin.

### INTRODUCTION

In sub-Saharan Africa, livestock farming contributes around 50 to 80% of agricultural GDP and ensures food security for families, and is a tool for fighting poverty. Livestock farming is a capitalization that allows diversification of activities and represents a factor of economic and social integration [1]. It is an essential component of agricultural farming systems in sub-Saharan Africa as a means of mitigating risks in agriculture [2].

In Benin, animal and fish production is an important economic activity, contributing 6% of GDP [3]. The importance of animal production is also reflected in its contribution to the maintenance of activity in rural areas and its involvement in the quality of the environment. The multifunctionality of animal production has been widely described [4, 5]. Among all the farming systems practiced in Benin, small ruminants rearing is the most widespread and is characterized by its extensive mode and low productivity [6]. In this type of breeding, the number of animals is reduced, in Benin there are 2 to 4 heads of small ruminants per farm unit and in the North, the number varies between 8 and 15 heads of small ruminants per agricultural unit [6].

In Benin, the national herd was estimated in 2016 at 2,339,000 head of cattle, 1,836,000 head of sheep, 1,836,000 head of goat, 466,000 head of pigs and 20,002,000 head of poultry [7]. Despite this numerical

importance, we are witnessing the importation of meat products. This import has increased from 109,306 tons in 2008 to 198,387 tons in 2013 [7] and this phenomenon is likely to increase in the coming decades as the population grows.

Projections of demographic change and growth in individual consumption of animal products show that, by 2020, more than 100 billion tons of meat will have to be produced in sub-Saharan African countries, assuming that they will record economic growth [1]. To achieve this goal, animal production must be increased to meet the current requirements for animal protein. Breeding short-cycle species and subjects not directly competing with humans in food seems an interesting approach.

Small ruminants could constitute good animals in breeding because they are not very demanding and

their reproductive cycle is intermediate between those of monogastric food competitors of humans and cattle with excessively long cycle. Ruminants are indeed the best processors of coarse foods (milk, meat) for humans [8, 9] believe that in order to develop animal production, small animals should be used as a source of meat. They think that raising goats and rabbits is better suited to small farmers than cattle breeding. Therefore, in the rank of ruminants, the goat is the animal species whose breeding will be the most advantageous. Its behavioral and digestive characteristics combined with its rusticity and its socioeconomic and cultural role reinforce the reasons for this choice.

Despite this importance, goat farming has long been neglected politically and scientifically [10-12] for the benefit of cattle, thought to be the only ones capable to produce large tonnages of meat [13]. Some countries even advocated its elimination, accusing it of promoting desertification [11]. Despite a renewed interest in small ruminants in general [10, 14, 15], knowledge of the zootechnical and reproductive performance of major goat breeds encountered in Benin are still fragmentary. This is why the present study proposes to make a bibliographical synthesis on the zootechnical performances and reproduction of goat breeds met in Benin.

#### **Taxonomic hierarchy of goats**

Goats are mammals belonging to the family Bovidae (order Artiodactyla), they are herbivorous ruminants, and several subfamilies have been described by the authors [16]. In general, goats can be classified as follows:

**Kingdom:** Animalia  
**Subkingdom:** Bilateria  
**Infrakingdom:** Deuterostomia  
**Phylum:** Chordata  
**Subphylum:** Vertebrata  
**Infraphylum:** Gnathostomata  
**Superclass:** Tetrapoda  
**Class:** Mammalia  
**Order:** Artiodactyla  
**Family:** Bovidae  
**Subfamily:** Caprinae

**Genus:** *Capra* Linnaeus

**Species:** *Capra hircus*

[17, 18, 19] include six species in this genus: *Capra algargus*, *Capra ibex*, *Capra caucasica*, *Capra cylindricornis*, *Capra pyrenaica* and *Capra falconeri*.

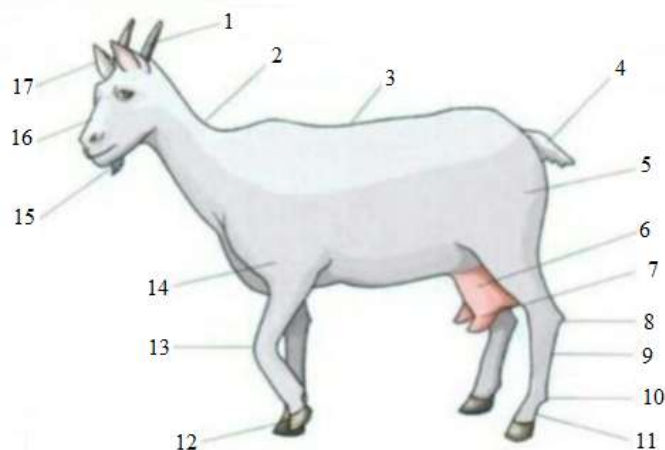
#### **Origin and geographical distribution**

Several authors such as [20-24] assure that the ancestor of the domestic goat is a "wild goat of the Near East", the goat (*Capra hircus*) is one of the first ungulates domesticated more than 10 000 years ago in the fertile crescent.

The history of domestication was tackled by the comparative analysis of the genetic diversity of domestic goats and that of its wild ancestor (*Capra aegagrus*), the joint study of the diversity of goats and their wild ancestors (the aegagres) provided information to reconstruct the history of domestication in a large area including eastern Anatolia, Zagros, Turkey, Central Iranian Plateau and northeastern Iran, [25]. The Fertile Crescent (Iran, Iraq, Turkey, and Palatine) is the center of domestication of goats because it is the origin of the agricultural civilization of Western Europe [26, 27].

#### **Description of the species**

The caprines have a robust body, stocky and provided with hairs, short and solid limbs, the neck is big, the head is relatively small, seldom pasted, has a variable profile according to the breeds, provided with a small goatee, a pointed snout and a narrow curved forehead, the triangular tail is devoid of hair on its ventral (below) and almost always straight, the feet are stronger than in the ovine, which, with a particular barrel bone Robust makes life easier on rough terrain. (Figure 1). The eyes are large and shiny, with a yellow or light brown iris, with transverse pupils, as in the ovines, but they do not have a teardrop, the ears often straight pointed, are very mobile, their ports are generally in relation with their size; Long and drooping ears, small erect ears, medium and horizontal ears, horns present in both sexes and may have different shapes. The horns of males are much more developed than that of females [16, 28, 29].



**Fig-1: anatomy of the goat [16]**

1 = Horn; 2 = neck; 3 = back; 4 = tail; 5 = flank; 6 = mamila; 7 = dug; 8 = ham; 9 = cannon; 10 = drag; 11 = pastern; 12 = clog; 13 = knee; 14 = elbow; 15 = goatee; 16 = muzzle; 17 = ear

### Importance of goat farming

#### Economic importance

Goats play an important role in the peasant economy and strongly contribute to family self-consumption [30]. Raised for their milk, leather, hair and meat, goats are considered as the "cow of the poor" [31]. They are self-consumed or sold to meet the daily needs of the family [32]. Goats also play a fundamental role in supplying urban markets with meat products, especially at the end of the dry season when meat of other species is scarce [33]. In rural areas, they contribute to the reduction of malnutrition through their milk production which can reach about three (03) liters of milk per day in certain populations [34]. Milk is mostly consumed in the dry season, when the other species are all dry. The goat is used for multiple purposes, the most important of which is the sale on foot [35]. It plays a leading role in the consolidation of livestock farmers' savings allowing them to access other types of animals such as cattle [36]. Through barter, they serve to reconstitute a herd of cattle at the rate of 7 goats for a heifer [35]. This economic importance of the goat is coupled with a socio-cultural importance that varies from one locality to another.

#### Socio-cultural importance

The social and cultural dimension of goats is closely linked to that of our cultures, our way of life, our know-how and our landscapes. In pastoral communities, the slaughter of animals that customarily punctuate the visits of foreigners to families, include goats [35]. Goats are able to thrive in difficult places, from the confines of the Sahara to the glacial mountain ranges of Asia, and are satisfied with bitter plants disdained by other species [37] cited by [38]. They have allowed the human race to live virtually everywhere. Such mobility has facilitated contacts and dialogue between populations [39]. In most countries, goat by-products are used to make things such as: leather goods, musical instruments using the skin, brushes from their

hairs. The examples in this section show that goats still play an important role in social cohesion in traditional West African societies [40]. In addition to this socio-cultural importance, the goat also plays a significant nutritional role in most families in West Africa.

#### Nutritional importance

The nutritional importance of the goat is linked to the quality of its meat and milk. Indeed, with a higher nutritional value than that of cow's milk, goat's milk is richer in vitamin A and is much more easily digested because of its high content of fatty acids [41]. Although cheese consumption is still very low, yogurt made from goat's milk is, on the other hand, increasingly popular and is beginning to spread in cities [42].

In countries of the Sahelian zone where protein-energy malnutrition is one of the main causes of mortality and morbidity, especially among young people, milk and goat meat often prove to be the only or one of the few sources of quality protein available [42]. Beside their socio-economic and nutritional role, goats also have considerable zootechnical importance.

#### Zootechnical importance

The goat is experiencing a revival of undoubted zootechnical interest. Indeed, the goat is a short-cycle species that can live in the rather difficult conditions of the Sahelian zone where the forage available rarely exceeds eight months in the year [39]. Goats are well adapted to the dry areas they have conquered thanks to their good resistance to rinderpest and heat stress [43]. In marginal areas where pastures and water sources are uncertain, their rearing is often the only way to promote the land [44]. The goat can feed all year round in woods, fields, fallow land and fallow land. Moreover, their short cycle of reproduction enables them to contribute effectively to the survival and restart of many pastoral populations [43]. Also, in relation to monogastric farming, goat farming is often

preferred because of the high cost of production in this sector [35].

In the Sahelian environment, goat milking is required when the dairy production of the cattle herd no longer ensures the coverage of family needs [45].

**Numerical importance of goat herds in Benin**

In Benin, the national herd of small ruminants was estimated in 2015 at 896,000 sheep and 1,795,000 goat heads [7]. The goat population has grown annually over the last 16 years by 2.43%, compared to 1.94% for sheep (Figure 2). The goat / sheep ratio is a criterion used by some authors to assess the relative importance of the two small ruminant species [46]. In Benin, it was in 2015 of 2.

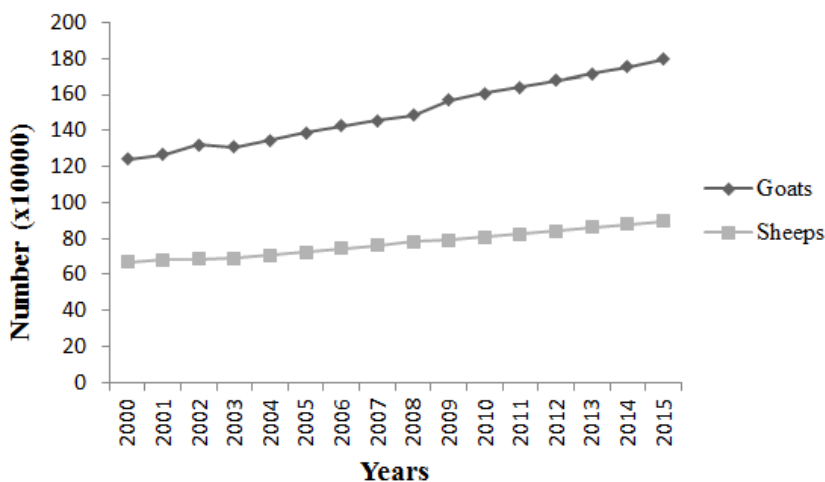


Fig-2: Evolution of goats and sheep in Benin [7].

**Description and zootechnical parameters of goat breeds encountered in Benin**

**Goats of local breeds**

**Dwarf goat or Djallonke**

**Description**

The description of the dwarf goat, southern goat (African dwarf variety), also called goat "kirdi" or "kirdimi" in Chad corresponds to that given by [47] for the Guinean goat or Fouta-Djalon goat. It is a straight (rectilinear) or concave animal with short, horizontal ears (Figure 3). The dress with short or short hairs is

very varied. As in other countries [48] there are fawn, gray, black or mixed-colored individuals. They are stocky and small animals. Males weigh on average 20-25 kg and have a height at the withers of  $53.25 \pm 4.5$  cm. Females reach an average of 15 to 25 kg and measure  $49.25 \pm 3.09$  cm at the withers. As you go down to the far south of the country, even smaller varieties are encountered. Their size is smaller than that of the Maradi red goat (55 vs 65 cm), but of the same size as those found in other Central African countries [48].



Fig-3: Dwarf goats or Djallonke

**Zootechnical performances**

The dwarf goat is bad dairy. Average production is around 35 kg, which is 4 to 5 times less

than the Maradi red goat, for a period of 2 to 4 months [49].

Despite its low weight, the dwarf goat has interesting beefing abilities [49, 50]. The birth weight is 1.2 to 1.5 kg, and the adult weight (3-4 years), 15 to 30 kg, but the carcass yields are high and oscillate between 48 and 50% for the females, and 50 to 60% among young castrates [49]. The meat is tasty and tender, and much appreciated by consumers. However, uncastrated old goats have an unpleasant smell that is often repugnant to consumers.

### **Reproductive parameters**

#### **Fecundity, prolificity**

Dwarf goats are precocious [51], with goats usually reaching sexual maturity at 6 to 7 months of age. The first parturition occurs at 11-13 months in traditional breeding [52, 53]. The average fertility rates are 164% [52]. With the food available, this breed can be fertilized more than once in the year. This fertility is well above that of the Maradi red goat (145%) and other dwarf goats in Central and Eastern Africa (124% to 155%).

All authors agree that these goats are the most prolific of all domestic ruminants in tropical and subtropical conditions [51-53]. Double spans are standard, triple spans are common, and quads are often observed [50]. The average prolificacy rate, from 165 to 175%, is similar to that of the Maradi red goat [50, 53]. It is higher than that reported in Nigeria (149%), but similar in Ivory Coast (162%), by [51].

Dwarf goats are able to reproduce throughout the year [51,54]. The highest percentage of kidding is in autumn (October-mid-December), which indicates intense breeding activity from mid-April to June. This period coincides with a certain food availability, but which is not yet optimal in the southern part of Chad. On the other hand, it coincides with the period of a growing photoperiod, even if the amplitude is not high, on average from 30 minutes to 1 hour 30 minutes [55]. This finding suggests that in addition to the usual environmental factors (diet, temperature, high humidity) that affect the breeding season of African dwarf goats [51,56], photoperiod must certainly play a role whose importance remains to be assessed.

#### **Gestation period**

In goats, gestation lasts an average of 5 months. Accurate data on the dwarf goat in Benin are scarce. However, generally in Central and West Africa, the 149-day gestation period is normal in goats (144 and 150.8 days). The weight of the kids, the type of

birth (single or twin) and the diet have an effect on the duration of gestation [51, 56, 57].

#### **Age at first kidding**

The average age at first kidding for the dwarf goat is  $426.7 \pm 13$  days [58]. Already in 1967, Robinet, quoted by [59] in station observed an interval of 10 - 14 months.

#### **Average Kidding interval**

It is less than one year  $283 \pm 59$  days for this breed in West Africa [53]. Three farrowings in two years are often observed, which reduces for these females this interval to not more than 8 months (240 days). An average interval of 227.6 days was reported for the same breed in Côte d'Ivoire [51].

### **Sahelian Goat**

#### **Description**

The phaneroptic characteristics of the Sahel goat have been reported by several authors [47, 53, 60]. It is a rectilinear and hypermetric animal, with longiline format and having a big size (80 to 85 cm at the withers in the males and 70 to 75 cm in the females) and weighs between 25 and 35 kg. It has a thin, triangular head with a straight profile and a slightly flat forehead, with thin lips, a shallow nose and a straight bevel (Figure 4). The neck is thin and long. The horns almost present in both sexes are fine in the female and strong in the male. In the male, the horns are annealed and spiraled when fully developed and are carried essentially straight and deviated slightly above. The ears are more or less long (11 to 21cm), broad and pendulous or semi pendulous [61]. The presence of appendages is frequent: the pendants exist in some males and females while the goats are encountered on three quarters of cases [62]. The neckline is always straight with a prominent spine. The rump is short and marked by a steep slope with a short, raised tail. The chest is down, narrow and long. The limbs are long and slender, suitable for walking. The udder is well developed, down to thick skin with two long teats well divided into bottle form.

The robe of the sahel goat is very variable [63], characterized by a single color coat, composed or conjugate: ranging from white or black uniform (very rare) to spotted black and white, passing through the uniform fawn with dorsal or spotted skate. The hairs are short and thin. The dominant dress is the white spotted with black or red. The mane exists in three quarters of the goats, but it is practically absent in the female goat.





Fig-4: Sahelian Goat [64]

**Zootechnical performances**

**Weight of kids at birth**

The birth weight of goats varies from 1.7 to 2.5 kg in Sahelian goats. Individual differences can be considerable given the fact that several factors may be involved [53]. Several studies show that males are always heavier than females [65]. There may be considerable differences between products of the same scope. Products from simple litters are always heavier than those from multiple litters [66].

**Dairy production**

The Sahel goat is particularly adapted to the environment, but the daily quantities of milk produced.

are quite low in comparison with the specialized breeds. The quantity of milk produced averages 70 kg per lactation, which lasts 120 days or even 180 days. Milk production is higher during the rainy season and during the first six weeks of lactation, and increases with the age of the goat. With a good combination of local food resources; the dairy production of the Sahelian goat can be significantly improved. This improvement becomes significant if there is an association of a mineral supplementation. The poor beef and dairy performance of Sahelian goats is due to constraints related to rearing conditions and climate [67].

**Table-1: Reproductive Parameters of the Sahelian Goat**

Parameters	References
Age at puberty 8 -14 months	[67].
Duration of the estrous and heat cycle Heat : 24- 48 h Cycle : 20-22 days	[63, 67] [67]
Age at first kidding 16.5 to 17.2 months 354 days	[63] [68]
Gestation 148 days 150 days	[63] [67].
Kidding Interval 354 days	[62]
Fecundity 171% 79.1% 103%	[53] [61] [62, 68]
Prolificity 112% 124%	[61] [62]
Fertility Real Fertility : 70,3% Apparent fertility: 83%	[61] [62]
Abortion rate 18.9%	[61]

### Reproductive parameters

The reproductive parameters of the Sahelian goat have been reported by several authors. These parameters are summarized in Table 1

### Maradi red goat

#### Description

According to [69], the Maradi goat is incorrectly described as red (Figure 5). The coat is uniform light brown in color with narrow hairs, shiny with mahogany reflection [53]. It is this phenotype that has been selected by the goat breeding center of Maradi as part of its selection and distribution. In the Sokoto region, the coat is usually deep red [70] with an upper line of the body from head to tail marked by a black stripe. The forehead, the tail, the extremities of the limbs is also dark. Opinions remain divided on the causes of these shades of the dress. Some advance genes in pigment synthesis. Others see it as the result of the interaction of genera and environment [71].



Fig-5: Maradi red goat [73]

### Zootechnical performance

The dairy abilities of the Maradi red goat are well known to farmers and in the village where the cow is lacking, the red goat Maradi takes over. The duration of lactation is 3 to 4 months after kidding according to the conditions of breeding and the annual milk production is 150 kg in 200 days corresponding to two lactations [74].

The slaughter yield (carcass weight in kg on live weight) varies from 50 to 55% for the castrated subject reported by [50]. Goat meat, in particular that of the Maradi red goat, is the basis of food for the populations of the region of Maradi and its surroundings.

### Reproductive parameters

In the Maradi red goat, twin births start from the 2nd row of lactation and continue until the age of 5 to 6 years. Triplets and quadruplets are not exceptional

In a dry environment, the hair lengthens, takes on a faded clear hue. In a humid environment, the dress tends to become darker. As an anecdote, in 1938, Roth gave the red goat of the time a pictorial description, in these terms: balance, finesse, harmony of form and color. It is medioline, eumetric and is of medium or small size (0.55-0.65 m); the head is fine, the forehead is prominent with a rather short profile and straight, slightly concave. The mucous membranes are black. With the crossbreeding, changes were observed at the level of the dress. But at the goat center of Maradi, the dress does not seem to have changed [72].

The neckline is short, slender and mobile. The chest is ample, the ribs and the rump are round. The back is straight, the shoulder and limbs are muscular. The udder is well developed which is an obstacle to long walks and makes the red goat a rather sedentary animal [69]. The horns are heavier in the male, who usually wears a longer, bushy and darker beard than the female. The adult goat carries a mane that extends to the shoulders. The look is imposing, almost threatening. The smell is strong and typical [69].

[69, 75]. There would be scope possibility of up to six [72]. Table 2 presents some zootechnical and reproductive parameters in the Maradi red goat.

### Exotic breeds of Goat

Several successful breeds have been introduced in Africa for adaptation trials or for improvement of local populations by crossing. In Benin, the main goats of exotic breeds encountered are: Alpine goat and Saanen goat

#### Alpine goat

##### Description

The Alpine goat (figure 6), is a strong dairy, native to the Alps and France. She is of medium size and size and short hair, all colors of dress: black, white, exist in this breed. Among the most common are: the color "burnt bread" or "chamoisée" with black legs and dorsal line and a polychrome with white spots in a black

or brown dress. The head, horned or not, with or without tassels, with or without a goatee, is of medium length with broad forehead and muzzle. His profile is concave; the ears are raised erect in a fairly closed horn,

the udder is voluminous, well fastened forward and backward, retracting well after milking, with thin and supple skin [78, 79, 80, 81, 82].

**Table-2: Some zootechnical and reproductive parameters in Maradi red goat**

Zootechnical and reproductive parameters				
Birth weight (kg)	2			
Age at puberty (month)	5 to 6			
Age at first kidding (month)		14.2	12.9	12.1
Gestation length (days)	145 to 155			
Single span (%)	60			
Double span (%)	36			
Triple span (%)	4			
Quadruple span(%)	Possibility			
Fertility rate (%)	95.5 to 98.7			
Fecundity rate (%)	122.2			
Prolificity		1.47	1.36	1.24
Interval kidding (days)		332.4	467.1	410.4
References	[75]	[76]	[77]	

Alpine goat is raised in Benin on a private farm in the plateau region in order to diversify milk

production still exclusively bovine. They have been raised on this farm since 2005.



**Fig-6: Alpine Goat [73]**

**Zootechnical performances**

The average weight of goats is 80 to 100 kg, and 50 to 90 kg for females [73]. The dairy qualities are an average milk production per lactation of 842 kg in 290 days, with a protein content of 31.5 g / kg and a high rate of 35.3 g / kg [83].

The average dairy production of this breed in Benin is 1.28 ± 0.03 kg, with a peak of 1.49 ± 0.39 at 41 ± 16 days of lactation (Vissoh *et al.*, 2015).

**Saanen Goat**

**Description**

Native from the Saanen Valley in Switzerland (Figure 7), it is an animal of strong development, deep,

thick, having a good bone structure, the coat and the hair are uniformly white, the hair is short, the head, with or without horns, with or without tassels, with or without a goatee, has a broad and flat forehead. The ears are worn at least horizontally, the chest deep, wide and long, the udder is globular, very broad at its upper part which gives it a stronger development in width than depth. The Saanen is a better producer of milk in the world, and gives especially excellent kids whose meat is very appreciable [78, 80, 81, 82, 84].

In Benin, thanks to the friendly relationship with the Belgians, the “Fermier sans Frontière” farm bought Saanen dairy goats imported from Belgium in September 2012.





Fig-7: Saanen goats

### Zootechnical performances

The average weight of male goats is 80 to 120 kg, and 50 to 90 kg for females [73]. The dairy qualities are an average milk production per lactation of 800 kg in 270 days, with a TP of 31.3 g / kg and a TB of 35.3 g / kg [83].

In Benin, weights at specific ages for kids were estimated at 3.58kg; 11.97kg; 21.83 kg and 31.84 kg respectively at 0; 1; 3 and 6 months age [85].

### Zoo-genetic management of goats

Genetic improvement trials have been conducted in West Africa, but most have failed [14]. But, some hopes are reborn, especially in dairy production given the genetic potential of the Sahelian breeds for this trait [86]. The quantities of milk can vary according to the breed and the period of lactation, but they can reach one liter per day. In addition, it is a milk of high technological quality because of the strong presence in local breeds of strong variants of the gene responsible for the synthesis of *αs1* casein. The heritability coefficients reported in European [87] and African [88] breeds are quite high, suggesting that genetic progress is even more important in goats generation is short and the selection intensity applicable is high [86]. The top down approach that has led to the implementation of breeding programs in West Africa and Benin with the mixed results that we know must be avoided [86]. Like in Mexico and Brazil, it will be necessary to implement breeding programs using basic community management with, on the one hand, selection objectives articulated around the real needs of pastoralists and opportunities and on the other hand, selection schemes adapted to the resources and capacities of livestock farmers [89].

In areas where rearing and market conditions are suitable, crossing may be considered. Candidate breeds are the South African Boer breed for beef, and the Alpine or Saanen breeds for milk production [86]. Sahel x Alpine or Sahel x Saanen goat crossbred goats

have a weight at two months higher than local goat kids [67, 85]. For [90], Alpine goat can produce 267.7 kg of milk in 300 days of lactation and is an interesting candidate breed for milk production in Benin.

### CONCLUSION

Demand for meat products in Benin is worrisome because of the increase in the human population and the low productivity of our local breeds. To fill the protein demand gap, raising short-cycle species seems a better alternative and better an improvement of their productivity through crosses with more productive exotic breeds. So, knowledge of the zootechnical performance of local and exotic breeds in Benin and their reproductive parameters are particularly important. Several short-cycle species exist in Benin, but the goat species has been the subject of this review because of several reasons. First of all, it is one of the species whose breeding has been neglected, but it is a very prolific species, very rustic and has an important socio-economic and cultural function. Regarding these reasons, it will be necessary to bet more on its breeding and better improve its productivity through crossbreeding with exotic breeds.

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