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Characterization and typology of goat farm production systems in Benin

Milognon Boris BEHINGAN	Laboratoire de Zootechnie, École des Sciences et Techniques de Production Animale, Université d'Abomey-Calavi, Bénin
Pascal Venant HOUNDONOUGBO	Laboratoire de Zootechnie, Université d'Abomey-Calavi, Bénin
Géorcelin Goué ALOWANOU	Laboratoire d'Ethnopharmacologie et de Sciences Animales, Université d'Abomey-Calavi, Benin
Delphin Olorounto KOUDANDE	Laboratoire des Recherches Zootechnique, Vétérinaire et Halieutique, Institut National de Recherches Agricole du Bénin, Benin
Archille Armand Mahussé Christophe CHRYSOSTOME	Laboratoire de Zootechnie, Université d'Abomey-Calavi, Benin

In Benin, goat farming is a key livelihood for farm households and is mainly practiced by smallholders. This study was conducted to characterize the production system of goat farms. A total of 496 farmers from the three climatic zones of the country were interviewed using a questionnaire. Descriptive statistics, chi-square test, Kendall's concordance test, factorial analysis of mixed data, and hierarchical cluster analysis on principal components were used for data analysis. Results show that income from the sale of livestock products is the primary objective of the farmers. The herd is dominated by adult females and future breeding does and bucks are selected based on their body conformation and the performance of their parents. The multivariate analyses revealed three distinct clusters. The two first is oriented towards meat production while the last one is oriented milk production. Such results can be used as a basis for programs to improve the productivity of goats and the living conditions of farmers.

Keywords: production system, typology, goat, Benin

INTRODUCTION

In developing countries, goat farming is one of the most important sectors of agriculture (Skapetas and Bampidis, 2016). In these countries, goats are raised in a variety of agroecological zones and are held primarily by smallholders (Casey and Webb, 2010; Mataveia et al., 2018). In Benin, about 66% of farm households practice livestock production and 38.4% of them raise goats (DSA, 2021). The national herd is estimated at 2,362,001 heads, representing 37% of the ruminant herd, and consists mainly of Djallonké goats with a few Sahelian, Saanen, Maradi and Alpine goats (Hounzangbe-Adode et al., 2010; DSA, 2021; Behingan et al., 2022). Their goat farming requires little initial investment and they can be easily sold compared to large cattle (Manirakiza, 2020). Not only they provide farmers with milk and meat for consumption, they also provide an important income from the sale of livestock products (Boogaard et al., 2012; Boogaard and Moyo, 2015). Socio-culturally, goats are used in traditional ceremonies, religious events and many other cultural events (Boogaard et al., 2012).

Despite the multiple advantages of goat farming, few efforts have been made in Benin to improve its production. However, the improvement of goat productivity could be effective with the implementation of a genetic improvement program. But before that, a characterization of the current production system and a typology of goat farms is essential. This will contribute to the

implementation of sustainable development strategies for goat breeding and facilitate the implementation of genetic improvement and conservation programs. It is in this perspective that the current study was initiated.

MATERIALS AND PROCEDURE

Study area

This study was conducted in sixteen communes in the three climatic zones of Benin (Figure 1): Sudanian zone (Gogounou, Kandi, Kérou, Kouandé, Malanville, N'Dali, and Péhunco), Sudano-Guinean zone (Bantè, Djidja, Glazoué, Parakou, and Savè), and Guinean zone (Bohicon, Kouékanmey, Lalo, and Zogbodomey). These communes were chosen because of their importance in terms of the goat population. The climatic characteristics of each zone are presented in table 1 (Mensah et al., 2014).

Data collection

Data were collected between July and August 2019. In each commune, two villages were randomly selected. Then about 15 goat breeders were interviewed per village based on a questionnaire with the presence of an interpreter, if necessary. Oral consent was sought from the breeder before the interview was conducted. The final sample size was 496 herders. Household characteristics (ethnicity, level of education, main activity, age, household size and training), reasons for raising goats, herd size by breed, sex, and age category (kid: 0-3 months, young: 3-6 months, adult: 6 months and older), criteria for selecting breeding does and bucks, castration practice, breeding system (extensive, semi-intensive, intensive) and management were the data collected. In this study, the breeding system is said to be extensive if the animals are kept in a free grazing mode, without any habitat and any supplements. However, it is said to be intensive when the animals are raised in zero grazing mode with daily quality mineral and concentrate supplements. The system is called semi-intensive when the extensive system is improved with the presence of a habitat where the animals spend the night and occasional supplementation.

Statistical analysis

The data were analyzed using descriptive statistics (sum, frequency, and mean), the Chi-square test, the Kendall concordance test, and a generalized linear Poisson model. The typology of goat farms was carried out in two stages. The first step consisted of a dimension reduction using a factorial analysis of mixed data (FAMD) on data such as: climatic zone, household characteristics, rearing system, supplementation, household size, breed, and herd size. In the second step, a hierarchical cluster analysis on principal component was performed based on the FAMD results. These analyses were performed in R software (R Core Team, 2021) using the FactoMineR package (Le et al., 2008, Kassambara et al., 2020). Apart from the typology graphs, the age pyramid was performed with the Plotrix package (Lemon, 2006) and the remaining graphs were drawn using ggplot2 (Wickham, 2016).

RESULTS AND DISCUSSION

Reasons for raising goats

There are several reasons why farmers keep goats. Income from goat rearing was the primary objective of farmers in all rearing areas, followed by meat and culture (Table 2). Income is derived from the sale of the animal, or from milk and its by-products. Goats are thus a source of income that the farmer uses for household needs (food, health, schooling, school supplies, etc.) or to ensure the veterinary care of the herd. Similar reasons have been reported by several authors Abdulkadir et al. (2012); Boogaard et al. (2012); Kadi et al. (2014); Boogaard and Moyo, (2015); Gnanda et al.

(2016) and Laouadi et al. (2018) for whom goat rearing is a source of household income, especially for women, through the sale of live animals, milk and milk products to purchase agricultural inputs, school supplies, and food, especially during the lean season. Apart from income, meat for consumption is the second most important reason for raising goats. This indicates that goat rearing is not only for income but also to contribute to the satisfaction of the household protein needs.

Flock structure

Four breeds were found in the study area. These were Djallonké or West African Dwaft (WAD), Sahelian, Saanen and Maradi goat breeds (Figure 2). The majority of the goat population was female, regardless of breed. Moreover, from one breed to another the proportion of adult females was significantly ($p < 0.05$) higher than that obtained with the other age categories. The proportion of adult Maradi goats was higher (87.5%) than that of Djallonké (40.5%), Saanen (37.8%), and Sahelian (32.9%). About males, Djallonké adults represented 12.9% and 11.0% for Sahelians. The lowest proportion of males was observed among the Maradi goat (4.2%) and Saanen (5.4%). The high number of females and the low number of males in the herd are related to the fact that females are kept in the herd to ensure herd renewal and males are sold to control reproduction as pointed out by Ndiaye et al. (2019). The high proportion of adult females is in line with the work of Abegaz et al. (2013) who found 47.8 and 51.8% of adult females in the Western Lowlands and Abergelle regions of Ethiopia respectively. In this study, the flock structure is characterized by the dominance of adult females and a low proportion of adult males which indicates a breeder type husbandry. Ndiaye et al. (2018) had reported similar results in Senegal where this type of breeding is widespread.

Selection criteria and breeding practices

Body conformation, parents performance and animal temperament were the main selection criteria for breeding males and females (Table 3). However, for breeders in the Guinean zone, parents performance was the primary selection criterion, followed by body conformation and animal health for the choice of males. In the case of females, breeders in the Guinean and Sudanian zones based their selection first on the performance of the parents, followed by body conformation and animal temperament. In contrast, in the Guinean and Sudano-Guinean zones, the animal's body conformation came first, followed by parents performance and animal temperament. The probable reason for the choice of body conformation and parents performance could be related to the fact that the main objective of the farmers is the income obtained by selling the animals. Animals with good body conformation often had the best prices on the market and parents with good production performance could produce productive animals which will probably improve the productivity of the herd and thus their income. These results corroborate those of Laouadi et al. (2018) in Algeria. Indeed, these authors reported that conformation and parents performance are the criteria for choosing male and female goats for breeding. However, apart from conformation, breeders in Ethiopia reported other selection criteria such as multiple parturitions, maternal capacity, and lamb growth (Abegaz et al., 2013). For Kebede et al. (2012), selection criteria may vary with the farm, the size of the flock, the production system, and the marketing opportunities available. It is probably for these reasons that the selection criteria in this study are not the same as those of Abegaz et al., (2013).

Less than half of the herders practiced male castration in the Sudanian zone (42.8%), in contrast to the Guinean and Sudano-Guinean zones where castration was more common (Figure 3). However, the proportion of farmers practicing castration was higher in the Guinean zone (97.6) than one in Sudano-Guinean zone (77.2%). Castration is a practice used by farmers to get a better market price for castrated animals. This is due to the improved productivity of castrated animals that lose their libido. Thus, their reproductive needs are used to grow, which favors their fattening. Another important criterion for castration is the control of reproduction. This allows them to avoid mating with non-performing males and between related subjects. Another reason for castration is the loss or theft of males recorded by breeders. Indeed, as the animals are in free grazing, the males follow

females from other farms to satisfy their libido and do not return in the evening. Similar cases have been reported by Kouato et al. (2020). Uncastrated males are either sold or left in the herd for breeding to ensure herd renewal. These results are in agreement with those of Abegaz et al. (2013) who reported that castration prevents mating by unwanted males. The low proportion of breeders practicing castration in the Sudanian zone is probably linked to religion, as Muslims only use non-castrated animals for religious events, particularly Tabaski.

In the Guinean zone, this castration was performed first to control reproduction, then to improve the animal's growth, and finally to control the animal's mobility (Table 4). However, in the Sudano-Guinean zone, castration was performed first to improve the animal's growth, then to control its mobility and finally to control reproduction. In the Sudanian zone, the first three reasons given by the farmers were growth improvement, mobility and reproduction control. However, other reasons such as odor and bad temperament were mentioned by breeders. The reasons for castration reported by the breeders in this study are the same as those reported by Abegaz et al. (2013) in Egypt.

Farming system and management

The goats were mostly kept in an extensive system (Figure 4) where animals are in free grazing mode with no habitat and slept in the open air. Apart from the extensive system, the intensive system was found in the Sudanian (0.51%) and the Sudano-Guinean zone (0.59%). In this system, animals were kept in zero grazing mode and fed by receiving mineral and concentrate supplements. The semi-intensive system was found among a few farmers. It was practiced by 8.0% of farmers in the Guinean zone, compared to 4.71 and 1.54% in the Sudanian and Guinean zones respectively, where the animals had a habitat and received mineral and concentrate supplements occasionally. For Almeida (2006), the extensive farming system predominates in low-tech farms where resources are limited, it is the case in the northeastern of Brazil for sheep and goats. This probably explains the dominance of the extensive system in the study area. The intensive system practiced in the Sudano-Guinean and Sudanian zone is linked to the presence of dairy goats, whose breeding requires more technical skills and means than the extensive system.

Regarding management (Table 5), the animals were mostly in free grazing mode (96.6%) during the dry season. These results support the work of Jaitner et al. (2001), who found that the animals are in free grazing, exploiting natural pasture and crop residues during the dry season. However, during the rainy season, free grazing was practiced (39.3%) as well as staking (39.3%) and zero grazing (21.4%). The practice of free grazing in the rainy season contradicts the work of Jaitner et al. (2001) and Almeida and Cardoso, (2008). Indeed, these authors report that in the rainy season, animals are kept on stakes on fallows and roadsides to avoid damage to crops. The practice of free grazing in the rainy season by the farmers in this study could be explained by the fact that the crops are not close to the concessions where the animals are in free grazing. The practice of staking or zero grazing during the rainy season by the farmers avoids crop damage by the animals, as well as conflicts between farmers and herders.

Typology of goat farms

The results of the factorial analysis of mixed data (Figures 5 and 6) showed that the first three components concentrated 32.5% (13.0%; 11.1% and 8.4% respectively).The hierarchical classification performed on the FAMD showed three types of farms (Figure 7).

The first group of farmers (214 farmers) was mainly Peulh (52.8%) and Bariba (36.0%) with a high concentration in the Sudanian zone (88.3%). They had no formal education (84.1%) and had received almost no training in animal husbandry (2.8%). In these farms, the Djallonké breed was the dominant breed (89.2%), with a few Sahelian (7.0%) and Maradi goats (0.93%), which were reared in an extensive system (99.1%) where the practice of complementation was low (4.67%). Raising goats was not the main activity for the majority (80.5%) of the farmers in this group. They

had an average herd size of about 15 heads.

The second group (274 herders) was made up of herders mainly in the Sudano-Guinean (52.5%) and Guinean zone (45.6%). Most of them were Fon (44.5%) and Yoruba (33.6%). At least half (50.7%) of them had no formal education and only 14.2% of them had received training in animal breeding. On the farms in this group, Djallonké (93.4%) and Sahelian (9.5%) goats were the most common breeds. They were raised in a semi-extensive system (66.9%) with the practice of supplementation (66.4%).

The third group (02 breeders) included herders whose minimum level of education was secondary and who had goat raising as the main activity. They were located in the Sudanian (50%) and in the Sudano-Guinean zone (50%) and had been trained in livestock rearing. Their herd consisted mainly of Maradi and Saanen goats, which were raised in an intensive system with the practice of supplementation (100%). In this group, the average herd size was higher than those of groups 1 and 2 (95 compared to 15 and 16 heads respectively).

Of the three types of farms, the two first types are meat-oriented, with the dominance of Djallonké and Sahelian which are meat producing goats. The first type is a traditional type where the inputs provided by the farmers are almost non-existent, which justifies the high proportion of the extensive system practiced and the low level of supplementary inputs observed. The animals are left to free grazing around the concessions where they obtain their feed. However, in type 2, even though most farmers keep animals in an extensive system, supplementation is more pronounced. The results of this study corroborate the work of Bankolé et al. (2005). According to these authors goat rearing in Benin is traditional with little or no input. The last type of farming differs from the two first in terms of production objectives. Indeed, the aim of the farmers in this category is milk production. This justifies the presence of dairy goats (Maradi and Saanen goats) in the herd. In these farms, the animals are kept in permanent confinement, fed with forage produced by the farmers themselves and supplemented. However, the low number of farmers in this category is linked to the fact that raising dairy goats requires a certain technical skill and financial means that are not available to most farmers. The three types of farming identified in this study are similar to the results of Kouato et al. (2020). By conducting a survey of goat rearing systems in the commune of N’Dali in Benin, they identified three types of goat farm, two of them are oriented towards meat production and one towards milk production. The study area considered in this study encompasses the commune of N’Dali in which the survey was carried out.

CONCLUSION

This study highlighted the goat production systems as well as the typology of the farms in Benin. The study showed that goats are raised mainly for the income derived from the sale of the animal or milk. The herds are dominated by the presence of does with the practice of castration to control reproduction. The typology highlighted three types of goat farming that differ from each other in terms of production objective, breeds, feeding system and practice. The results of this study can serve as a basis for the implementation of programs to improve goat productivity and the living conditions of smallholders.

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