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Constraints to the Development of Turkey Farming in Southern Benin

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ABSTRACT

The turkeys are reared throughout the national territory of Benin, but their breeding is less developed than other poultry species, such as chickens and ducks. The current study aimed to characterize turkey farming in Southern Benin to identify the constraints associated with the farming practice that limit its development. A survey was performed in 104 turkey farms in the Atlantic, Ouémé, and Zou departments. The frequencies of qualitative variables and average quantitative variables were calculated and compared across departments. The investigated variables included turkey housing, feeding practices, reproduction management, health management, difficulties encountered, marketing of animals, and farm products. It was found that the housing, feeding, health monitoring, and constraints varied from one department to another. The turkeys were raised in fence-run buildings in the Ouémé (76.7%), modern poultry houses in the Atlantic (75%), and traditional habitats (42.9%) with a free range in the Zou. The free range prevented farmers from separating the turkeys from other poultry species. The poultry species present with turkeys on studied farms were chickens, ducks, and guinea fowl. The turkeys were fed more with commercial feed in the Atlantic (100%) and Ouémé (92.7%) regions and with cereals and agricultural by-products in Zou (82.1%). The prophylaxis consisted of deworming the birds, vaccinating them against Newcastle disease, controlling bacterial infections with antibiotics, and giving them vitamins in drinking water. The farmers vaccinated more turkeys in Zou than in Atlantic and Ouémé. The vaccination and administration of antibiotics do not prevent the introduction of disease into farms due to poor farm biosecurity, resulting in animal deaths. In conclusion, this study identified the obstacles that limit the development of turkey farming by region in Southern Benin. These barriers are primarily related to housing, feeding, mating, and marketing. Scientific research could potentially solve some of these issues, notably those concerning feeding and mating success. However, housing and marketing concerns would necessitate support from the authorities.

Keywords: Constraint, Feeding, Prophylaxis, Turkey

INTRODUCTION

Benin's poultry industry operates under two main systems, including traditional and modern, with local species being reared in the traditional system and exotic species in the modern system (Guezodje, 2009; FAO, 2015). In rural areas, traditional poultry farming is particularly prevalent as it serves various cultural, social cohesion, and economic purposes. These include the production of income for women, the use of local breed chickens and white-shelled eggs in traditional ceremonies and ethnopharmacology, and the production of meat and eggs for consumption and sale (Guezodje, 2009). The poultry species reared in Benin are chickens, guinea fowl, ducks, and turkeys. These birds' poor performance in this system prevents farmers from meeting customer demands. The relative studies have indicated that the poor performance of animals in this system is due to technical problems related to the lack of housing, the low genetic potential of the breeds reared, insufficient feed, and lack of health monitoring (Youssao et al., 2010, Boko et al., 2013; Houessionon et al., 2020). These mentioned studies have focused on chickens, ducks, and guinea fowl, and do not include turkeys. The results obtained have made it possible to improve the production methods of the species concerned, to provide farmers with many feed formulas, and to improve the performance of local breeds by crossbreeding with foreign breeds (Dahouda et al., 2009; Youssao et al, 2010; Boko et al., 2013). After the improvement of the birds' performance, the quality of their meat has been evaluated and improved to reassure consumers and facilitate their marketing (Tougan et al., 2013; 2018). Insufficient attention to turkey farming in Benin means that the meat production of this species decreases year after year, despite the efforts made by the farmers. It is therefore necessary to find ways and means to improve national turkey meat production to increase local production and productivity on farms. To achieve this, it is necessary to understand the characteristics of turkey farming. For this purpose, typology studies have been conducted in the north (Ouaké only) and south of the country (Dèdéhou et al., 2018; Dotché et al., 2021). These studies carried out in the north of the country (Benin), did not take regional variations into account, which prevented identifying problems by region and better organizing improvement work. This study aimed to investigate the regional variation of turkey farming in Benin and to identify the problems that hamper the development of turkey farming in the study area.

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MATERIALS AND METHODS

Ethical approval

The research protocol has been approved by the ethics committee of the Laboratory of Animal Biotechnology and Meat Technology of Benin (N°214 DPSA/LBATV/D).

Study area

Data were collected from August 2018 to August 2019 in the departments of Atlantic, Ouémé, and, Zou in Benin (Figure 1). The Atlantic department is located in the south of Benin and covers an area of 3233 km². It extends from Godomey to the edge of Sèhouè. It has eight communes and in the present study, data were collected in the communes of Abomey-Calavi and Allada. Atlantic Department has a four-season sub-equatorial climate (two rainy and two dry seasons) with an annual rainfall of 1060 mm (Dotché et al., 2021).

With nine communes, the department of Ouémé has a total area of 1865 km². This department has a four-season climate with 900-1500 mm of rainfall and is located in the sub-equatorial zone. Activities were conducted in this department's communes of Porto-Novo, Akpro-Missérété, Avrankou, and Sèmè-Podji (Dotché et al., 2021).

Zou covers an area of 5,243 km² with 9 communes and has a climate of transition between the sub-equatorial climate and the humid tropical Sudano-Guinean climate of northern Benin. The annual precipitation ranged from 900 mm to 1200 mm on average. There are two rainy seasons and two dry seasons in Zou. The research was conducted in this department's communes of Bohicon and Djidja (Dotché et al., 2021). The communes chosen in each department were those where several turkey farmers were located.

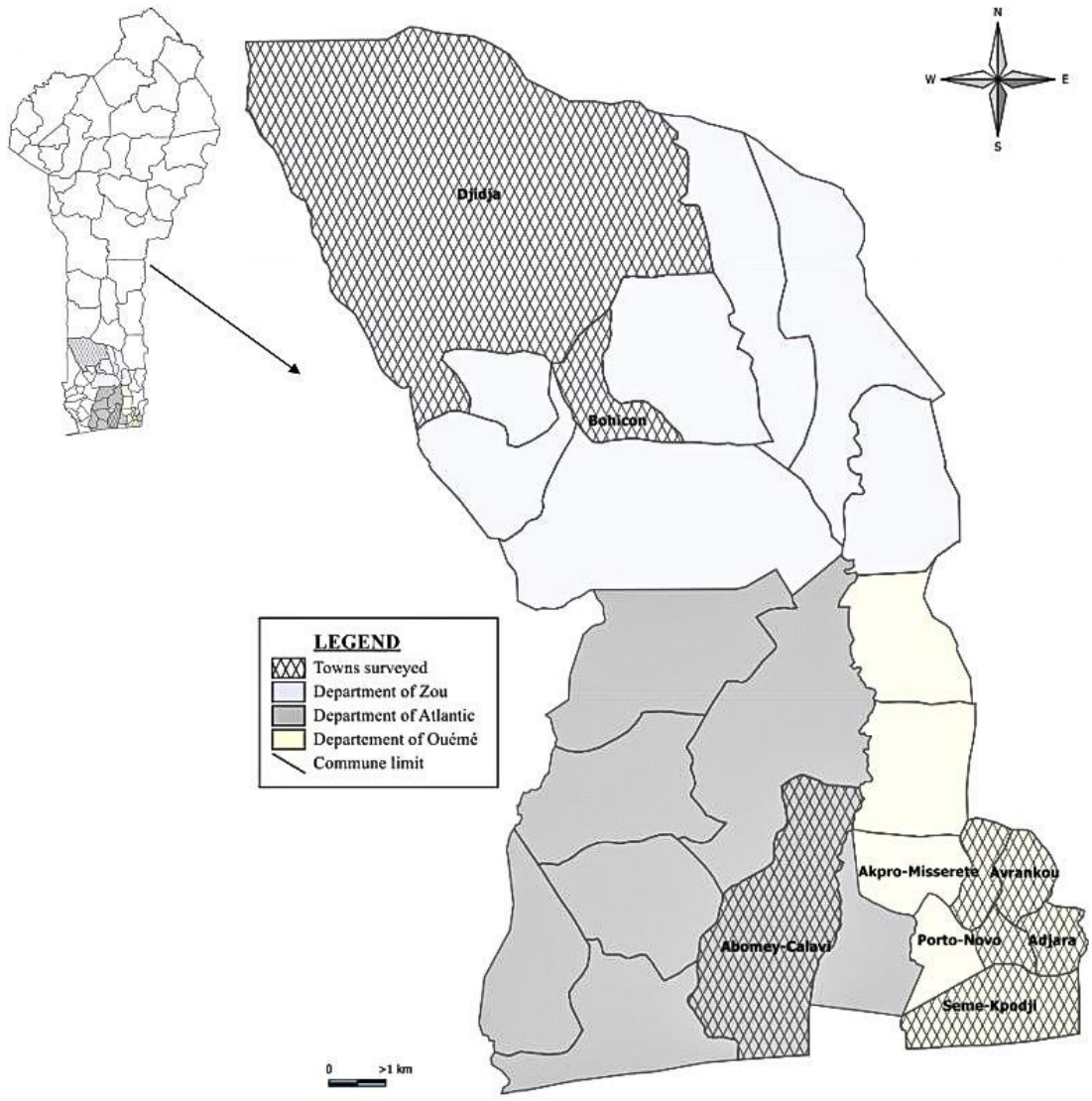

Figure 1. Study area in Benin (2018-2019)

Methodology

The methodology used for data collection was a retrospective survey through direct interviews with the farmers. This survey collected information on the breeders and the characteristics of their farms. The data were collected in 104 farms of the Ouémé, Atlantic, and Zou departments. In the absence of a list of breeders, it was necessary to contact the territorial agricultural development agencies to get into contact with the first farmers. Next, the "snowball" method was used to find the others (Goodman, 1961). All the farmers found by this method were interviewed. The number of turkeys per farm averaged 22.3 in the Atlantic, 14.3 in Ouémé, and 36.7 in Zou. A multiple-choice survey form was used for data collection from farmers. The questions were open-ended and included the identification and education of breeders, habitats, production objectives, modes of animal acquisition, utilization of livestock products, identification of birds, selection of reproducers, breeding constraints, and marketing of livestock products.

Statistical analysis

The data collected were analyzed using SAS software (SAS Institute Inc., Cary, NC, USA, 2013). The SAS Proc GLM procedure was used to conduct an analysis of variance for the quantitative variables (herd structure, product selling prices). The department impact was the only variation component taken into account in the analysis of the variance model. Where this factor (department) had an effect, comparisons between department averages were made two by two using the student t-test ($p < 0.05$).

The frequencies observed for the qualitative variables (study level, habitats, pathologies, and limitations) were determined using the SAS Proc Freq method. The bilateral Z test was used to compare the relative frequencies between the two departments and the Chi-square test was used to assess the department's impact on frequencies. For each relative frequency, a 95% confidence interval (CI) was calculated according to Formula 1 (Rousson, 2013).

$$IC = 1{,}96\sqrt{\frac{P(1-P)}{N}} \quad \text{(Formula 1)}$$

Where, P denotes the relative frequency and N is the sample size. The Correspondence Analysis (CA) function of the FactoMineR package of R4.1.3 was used for the Factorial Correspondence Analysis to explore the criteria used for the selection of reproducers by departments.

RESULTS

Profile of farms

The majority (95.29%) of the turkey farmers surveyed were married men. The farmers were composed of educated (81.4%) and uneducated (18.6%) people. Educated people have primary (21.18%), secondary (41.18%), and university (10.59%) levels (Table 1). The gender, education level, and marital status of respondents did not vary significantly from one department to another. The activities of the respondents were diversified. These activities were households, livestock, agriculture, fishing, handicrafts, trade, and state functions. Households were reported only in Atlantic (16.7%). The proportions of those engaged in animal husbandry as their main activity in the Atlantic (73.8%) and Zou (71.4%) were significantly higher than those in Ouémé (15.2%, $p < 0.001$). In contrast, the proportions of traders and artisans keeping turkeys were significantly lower in the Atlantic and Zou regions than in Ouémé. For these traders and artisans, turkey rearing was a secondary activity. Those holding state functions were met only in the Atlantic (14.3%) and Ouémé (18.2%) departments.

The main motivation of the breeders for this breeding was its profitability for the majority of the interviewed people in the three departments (Table 2). Other reasons that motivated respondents to invest in turkey breeding were the ease of rearing, its hardiness (they appreciate its rusticity), and the pleasure (only in the Zou) of the species. The people who rear turkeys for pleasure are those who do it because they love it, not for profit. The proportion of people motivated by the hardiness of the species in the Atlantic (36.8%) was significantly higher than in Ouémé (9.1%) and Zou (7.1%, $p < 0.001$). To start breeding, all the breeders in Atlantic and Ouémé purchased the turkeys (Table 2). In Zou, 96.4% bought the turkeys to start rearing and 3.6% inherited them from their parents. The turkeys raised by the respondents were animals of local genetic type. The production objective on the majority of the surveyed farms was meat production. The other production objectives were eggs and young turkey production. The proportion of farmers producing eggs for marketing in Atlantic (60.4%) and Zou (60.7%) was significantly higher than that of Ouémé (21.2%, $p < 0.001$). Young turkey production was more reported in Zou than in Atlantic and Ouémé ($p < 0.05$). The products resulting from breeding were sold by the majority of respondents in all three departments. Besides sales, some breeders used the products for family consumption. Those who used the products for family consumption were more encountered in Zou (50%) than in Atlantic (2.3%) and Ouémé (3%, $p < 0.001$).

Turkeys habitat

The majority (93.8%) of breeders had habitat for turkeys. The proportion of farmers who had habitat for turkeys in Zou (100%) was significantly higher than that in Ouémé (81.8%, $p < 0.05$). The habitats used were hen houses, buildings and runs, and traditional habitats. Chicken houses were more used in the Atlantic (75%) than in Ouémé (13.3%) and Zou (28.6%, $p < 0.001$). The Ouémé breeders (76.7%) used a fenced area (where the turkeys had a building with a run) more than the breeders in Zou (25%) and Atlantic (2.8%, $p < 0.05$). Traditional habitats were used more in Zou than in the Atlantic (15%, $p < 0.05$). Traditional habitats were not used in Ouémé farms (Table 3). These traditional habitats used in

Zou (42.9%) and Atlantic (25%) are constructed of clay, wood, straw, and mosquito netting. The turkeys were housed separately from other poultry species on the majority of surveyed farms in the Atlantic (88.2%) and Ouémé (55.7%) departments. The proportion of breeders performing this separation in the Atlantic was significantly higher than those in the Ouémé and Zou departments (35.71%, $p < 0.05$). The poultry species present with turkeys on studied farms were chickens, ducks, and guinea fowl (Table 3). Chickens were recorded in the majority of farms (97.6% in the Atlantic, 90.6% in Ouémé, and 95.4% in Zou). Ducks were recorded on the majority of farms in Ouémé (53.1%). The guinea fowl were more encountered in the Atlantic (70.7%) than in Ouémé (31.3%) and Zou (22.7%, $p < 0.001$).

Turkey feeding

The turkeys were fed with commercial feeds, cereals, agricultural by-products, kitchen waste, and forages (Table 4). The commercial feeds were used more in Ouémé (100%) and Atlantic (92.7%) than in Zou (67.9%, $p < 0.001$). On the other hand, cereals and agricultural by-products were more used in Zou (82.1%) than in Ouémé (51.5%) and Atlantic (53.7%, $p < 0.05$). The breeders in Ouémé used more kitchen leftovers to feed the turkeys than those in the Atlantic. The fodders were used only in Zou (17.9%) and Atlantic (7.3%, $p < 0.01$). Cereals used in turkey feed were corn and sorghum. The agricultural by-products used in turkey feed were corn bran, rice bran, palm kernel meal, and soybean bran. The fodder used to feed the birds was the leaves of *Ipomoea batatas*, *Moringa oleifera*, *Tridax procubens*, and *Manihot esculenta*. The feed was served twice a day (morning and evening). The quantity served to turkeys is estimated by the breeder. This quantity is not measured. The breeder estimates it by taking into account the number of animals available and their age.

Table 1. Profile of turkey farms surveyed in Southern Benin during 2018-2019

Variable	Atlantic (n = 43)		Ouémé (n = 33)		Zou (n = 28)		Significance
	(%)	CI	(%)	CI	(%)	CI	
Sex							
Men	93[a]	7.6	93.9[a]	8.1	96.4[a]	6.9	NS
Women	6.9[a]	7.6	6.1[a]	8.1	3.6[a]	6.9	NS
Level of education							
Out of school	18.6[a]	11.6	30.3[a]	15.7	21.4[a]	15.2	NS
Primary	30.2[a]	13.7	21.2[a]	13.9	17.9[a]	14.2	NS
Secondary	37.2[a]	14.4	36.4[a]	16.4	53.6[a]	18.5	NS
University	13.9[a]	10.4	12.1[a]	11.1	7.1[a]	9.5	NS
Main Activity							
Homemaker	16.7[a]	11.1	0[b]	0	0[b]	0	**
Breeder	73.8[a]	13.1	15.2[b]	12.2	71.4[a]	16.7	***
Farmer	21.4[a]	12.3	18.2[a]	13.2	25[a]	16.0	NS
Fishermen	2.4[a]	4.6	3.0[a]	5.8	0[a]	0	NS
Artisan	2.4[b]	4.6	30.3[a]	15.7	3.6[b]	6.9	***
Employee	14.3[a]	10.5	18.2[a]	13.2	0[a]	0	NS
Merchant	2.4[b]	4.6	18.2[a]	13.2	0[b]	0	**

n: Sample size, %: Percentage of surveys; **: $p < 0.05$; ***: $p < 0.001$; NS: Not significant; CI: Confidence Interval, [ab] the percentages of the same row followed by different letters differ significantly at the threshold of 5%.

Table 2. Production objective, origin of the turkey, and motivation of breeding in Southern Benin (2018-2019)

Variable	Atlantic (n=43)		Ouémé (n=33)		Zou (n=28)		Chi² Test
	(%)	CI	(%)	CI	(%)	CI	
Production target							
Meat	90.7[a]	8.7	100[a]	0	100[a]	0	NS
Egg	60.4[a]	14.6	21.2[b]	13.9	60.7[a]	18.1	***
Young turkeys	2.3[b]	4.5	0[b]	0	14.3[a]	12.9	**
Product uses							
Consumption of family	2.3[b]	4.5	3.0[b]	5.8	50[a]	18.5	***
Sale	97.7[a]	4.5	100[a]	0	96.4[a]	6.9	NS
Origin of animals at the start of the farm							
Purchase	100[a]	0.0	100[a]	0	96.4[a]	6.9	NS
Heritage	0[a]	0.0	0[a]	0	3.6[a]	6.9	NS
Motivation for turkey farming							
Ease of breeding	21.1[a]	12.2	9.1[a]	9.8	14.3[a]	12.9	NS
Rusticity	36.8[a]	14.4	9.1[b]	9.8	7.1[b]	9.5	**
Profitability	81.6[a]	11.6	96.9[a]	5.8	89.3[a]	11.4	NS
Pleasure	0[b]	0	0[b]	0	25[a]	16.1	***

n: Sample size, %: Percentage of surveys; ** : $p < 0.05$; *** : $p < 0.001$; NS: Not significant; CI: Confidence interval, [ab] the percentages of the same row followed by different letters differ significantly at the threshold of 5%.

Table 3. Turkey habitat in Southern Benin during 2018-2019

Variable	Atlantic			Ouémé			Zou			Significance
	n	(%)	CI	n	(%)	CI	n	(%)	CI	
Habitat for turkeys										
Available	36	94.4^{ab}	7.5	33	81.8^{b}	13.2	28	100^{a}	0	**
No habitats	36	5.6^{ab}	7.5	33	18.2^{a}	13.2	28	0^{b}	0	**
Types of housing										
Chicken house	36	75^{a}	14.1	30	13.3^{b}	12.2	28	28.6^{b}	16.7	***
Building and route	36	2.78^{c}	5.4	30	76.7^{a}	15.1	28	25^{b}	16.0	***
Traditional	36	25^{a}	14.1	30	0^{b}	0	28	42.9^{a}	18.3	***
Separation of turkeys from other birds										
Yes	34	88.2^{a}	10.8	29	55.7^{b}	18.1	28	35.7^{b}	17.7	***
No	34	11.8^{b}	10.8	29	44.3^{a}	18.1	28	64.3^{a}	17.7	***
Species present										
Duck	41	43.9^{a}	15.2	32	53.1^{a}	17.3	22	22.7^{a}	17.5	NS
Chicken	41	97.6^{a}	4.7	32	90.6^{a}	10.1	22	95.5^{a}	8.7	NS
Guinea fowl	41	70.7^{a}	7.5	32	31.3^{b}	16.1	22	22.7^{b}	17.5	***

n: Sample size; %: Percentage of surveys; ** : $p < 0.05$; *** : $p < 0.001$; NS: Not significant; CI: Confidence Interval, ^{ab} the percentages of the same row followed by different superscript letters differ significantly at the threshold of 5%.

Table 4. Types of feed used for turkey farms in Southern Benin during 2018-2019

Variable	Atlantic (n=41)		Ouémé (n=33)		Zou (n=28)		Significance
	(%)	CI	(%)	CI	(%)	CI	
Cereals and agricultural by-products	53.7^{b}	20.3	51.5^{b}	17.1	82.1^{a}	14.2	**
Commercial feed	92.7^{a}	8.3	100^{a}	0	67.7^{b}	17.3	***
Kitchen scraps	31.7^{b}	18.8	69.7^{a}	15.7	46.4^{ab}	18.5	**
Fodder	7.3^{ab}	0	0^{b}	0	17.9^{a}	14.2	**

n: Sample size, %: Percentage of surveys; ** : $p < 0.05$; *** : $p < 0.001$; CI: Confidence interval, ^{ab} the percentages of the same row followed by different superscript letters differ significantly at the threshold of 5%.

Management of reproduction in farms

Mode of reproduction

The mating was followed by the majority of farmers in Ouémé (67.74%) and Zou (57.14%). The proportions of breeders who followed matings in the Ouémé and Zou were significantly higher than those in the Atlantic (16.7%, $p < 0.001$). The number of eggs laid on Atlantic farms (13.89) was significantly higher than in Ouémé (11.97) and Zou (11.79). All the farmers in Ouémé, Zou, and the majority of those in the Atlantic (90.9%) practiced natural incubation. Besides natural incubation, some breeders practice artificial incubation (Table 5). The natural incubation was performed by a turkey or hen. Some breeders collect eggs from turkeys and give them to the hens to incubate. Incubation in turkey was practiced by the majority of respondents (87.5% in the Atlantic, 96.8% in Ouémé, and 85.7% in Zou). Incubation under the hen was more performed in Zou (57.1%) than in the Atlantic (21.9%) and Ouémé (3.23%, $p < 0.001$). The proportion of farmers using the hen to hatch eggs in the Atlantic was also significantly higher than that in Ouémé ($p < 0.05$). In comparison to Zou, the Atlantic, and Ouémé had significantly higher egg hatching rates ($p < 0.05$).

The age of entry into the reproduction of males in the Atlantic (9.15 months) was significantly higher than that reported in Ouémé (8.1 months), which was in turn higher than that observed in Zou (6.04 months, $p < 0.05$). The same observation was made for the age of entry into reproduction of females (Table 6). The number of eggs laid per hatching was greater in the Atlantic than in Ouémé and Zou ($p < 0.05$). The number of young turkeys alive at hatching in the Atlantic Department (12.4) was significantly higher than that of Ouémé (8.6), which was also higher than the number of young turkeys alive at hatching in Zou (3.1, $p < 0.001$). The same finding was made for the number of weaned turkeys.

Choice of reproducers

The breeders have the criteria to select the best reproducers on the farms (Table 7). The criteria used to select male reproducers were mating ability, size (larger than females), health status, age (older than females), and hardiness (rusticity). Size was the criterion used by the majority of breeders in the three departments. The proposition of the breeders using the ability to mount in Zou (60%) was significantly higher than that of Ouémé (18.2%) and Atlantic (0%, $p < 0.001$). The health and feather status (shiny) was used more in Atlantic (76.9%) than in Zou (32%) and Ouémé (4.5%, $p < 0.001$). Correspondence factor analysis (CA) indicated that Zou breeders mainly used the mating ability

criterion to select males; while Atlantic breeders employed health, feather, and hardiness criteria (Figure 2). The farmers of Ouémé considered mainly the age and size of animals (Figure 2).

The criteria used to select female reproducers were laying ability (good layer), incubation ability (good incubator), maternal ability (good mother), aplomb, health status, color, and acceptance ability of the male. According to poultry farmers, a good layer was a turkey that could lay more eggs per laying season, and a good incubator could hatch all the eggs laid. A good mother was a turkey who could bring all her young to weaning. She had to be able to defend her offspring against predators. The criteria, such as egg-laying, hatching, and maternal ability, were assessed through the performance of the mother of the subject to be selected, as these future mothers have not yet laid eggs to be judged on their own performance. Rearing ability and maternal ability were used more in the Atlantic and Ouémé than in Zou ($p < 0.001$). In contrast, hatchability, plumage color, and ease of acceptance of males during mating were more used in Zou than in Ouémé and Atlantic ($p < 0.05$). Health status was used only in the Atlantic. The results of the CA showed that Zou breeders mainly consider plumage color, aplomb, hatchability, and ease of male acceptance to select female reproducers (Figure 3). The Atlantic breeders mainly consider maternal ability and health status to selecting females and those of Ouémé consider egg-laying ability (Figure 3).

Table 5. Reproduction mode of turkey farms in Southern Benin (2018-2019)

Variable	n	Atlantic		Ouémé (n=31)		Zou (n=28)		Significance
		(%)	CI	(%)	CI	(%)	CI	
Mating assistance								
Yes	36	16.7^{b}	12.2	67.7^{a}	16,5	57.1^{a}	18.3	***
No	36	83.3^{a}	12.2	32.3^{b}	16.5	42.9^{b}	18.3	***
Type of incubation								
Artificial	33	18.2^{a}	13.2	3.2^{a}	6.2	10.7^{a}	11.5	NS
Natural	33	90.9 ^{a}	9.8	100^{a}	0	100^{a}	0	NS
Natural incubation								
Under turkey	32	87.5^{a}	11.5	96.8^{a}	6.2	85.7^{a}	12.9	NS
Under hen	32	21.9^{b}	14.3	3.2^{c}	6.2	57.1^{a}	18.3	***
Type of reproduction								
Seasonal	15	33.3^{a}	23.9	6.5^{b}	8.6	3.6^{b}	6.9	****
Non-seasonal	15	66.7^{b}	23.9	93.6^{a}	8.6	96.4^{a}	6.9	****

n: Sample size, %: Percentage of surveys; *** : $p < 0.001$; NS: Not significant; CI: Confidence interval, ^{ab} the percentages of the same row followed by different superscript letters differ significantly at the threshold of 5%.

Table 6. Age of breeders and laying performance of turkeys in Southern Benin (2018-2019)

Variable	Atlantic			Ouémé			Zou			Significance
	n	Mean	SE	n	Mean	SE	n	Mean	SE	
Age of male breeders (months)	23	9.15^{a}	0.36	24	8.13^{b}	0.36	28	6.04^{c}	0.33	***
Age of female breeder (months)	22	8.84^{a}	0.44	23	7.61^{b}	0.44	28	5.91^{c}	0.39	***
Number of eggs laid per turkey	19	13.89^{a}	0.72	32	11.97^{b}	0.55	28	11.79^{b}	0.59	**
Number of eggs hatching	10	12.37^{a}	0.78	32	9.72^{ab}	0.55	28	3.08^{b}	0.59	**
Number of series of laying per year	10	2.10^{b}	0.46	27	3.37^{a}	0.28	26	3.81^{a}	0.28	**
Number of turkeys at hatching	16	12.37^{a}	0.73	32	9.72^{b}	0.51	25	3.08^{c}	0.58	***
Hatching rate (%)	10	89.06^{a}	14.80	32	81.20^{a}	13.69	28	26.12^{b}	16.44	**
Number of turkeys weaned	12	11.67^{a}	0.79	32	8.63^{b}	0.48	26	2.19^{c}	0.54	***
Number of dead turkeys	12	1.75^{a}	0.34	32	1.09^{a}	0.23	25	0.84^{a}	0.26	NS
Age at culling of breeding stock (months)	10	28.20^{a}	2.79	23	20.70^{a}	1.83	25	21.84^{a}	1.76	NS

n: Sample size, %: Percentage of surveys; **: $p < 0.05$; *** : $p < 0.001$; NS: Not significant; SE: Standard Error; ^{abc} Means of the same row followed by different superscript letters differ significantly at the threshold of 5%.

Table 7. Criteria for selection of reproductive male and females turkeys in Southern Benin (2018-2019)

Variable	Atlantic		Ouémé		Zou		Chi² Test
	(%)	CI	(%)	CI	(%)	CI	
Criteria for choosing reproductive males							
n	13		22		25		
Skills for mating	0[b]	0	18.2[b]	16.1	60[a]	19.2	***
Large size	76.9[a]	22.9	72.7[a]	18.6	60[a]	19.2	NS
Feathers and health status	76.9[a]	22.9	4.5[c]	8.7	32[b]	18.3	***
Male older than female	0[a]	0	4.5[a]	8.7	0[a]	0	NS
Hardiness	7.7[a]	14.5	0[a]	0	0[a]	0	NS
Criteria for the selection of reproductive females							
n	12		15		22		
Good layer	66.7[a]	26.7	66.7[a]	23.9	0[b]	0	***
Good incubator	8.3[b]	15.6	6.7[b]	12.7	45.5[a]	20.8	**
Good mother	66.7[a]	26.7	33.3[a]	23.9	4.5[b]	8.7	***
Aplomb	8.3[a]	15.6	13.3[a]	17.2	40.9[a]	20.5	NS
Good health	16.7[a]	21.1	0[b]	0	0[b]	0	**
Color	8.3[b]	15.6	6.7[b]	12.7	45.4[a]	20.8	**
Ability to accept the male	0[b]	0	0[b]	0	27.3[a]	18.6	**

n: Sample size, %: Percentage of surveys; ** : $p < 0.05$; *** : $p < 0.001$; NS: Not significant; CI: Confidence interval. [ab] the percentages of the same row followed by different letters differ significantly at the threshold of 5%.

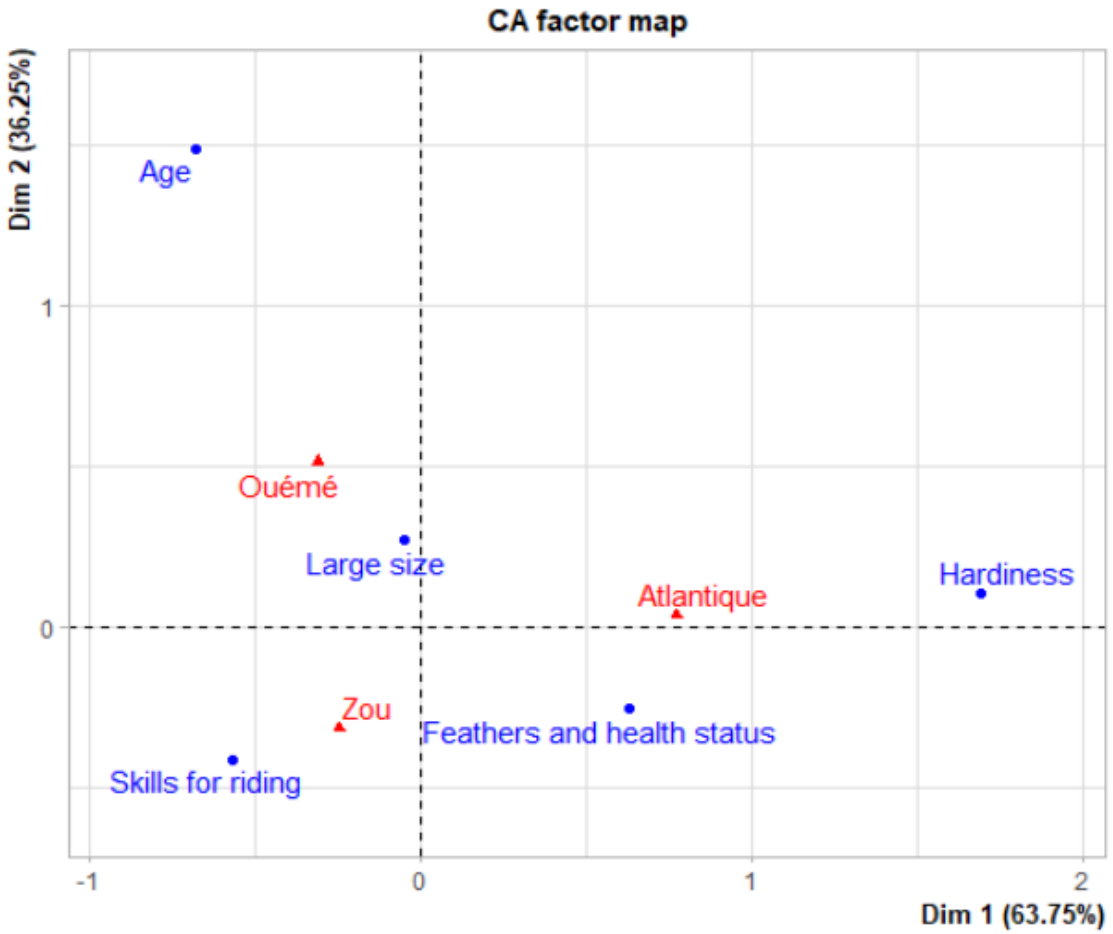

Figure 2. Distribution of selection criteria of reproducer males by region in Southern Benin (2018-2019). For the selection of males, breeders in the Zou region take their skills for riding into account. Breeders in the Atlantic region considered the feathers, health status and hardiness (rusticity) and breeders in the Ouémé region considered the large size.

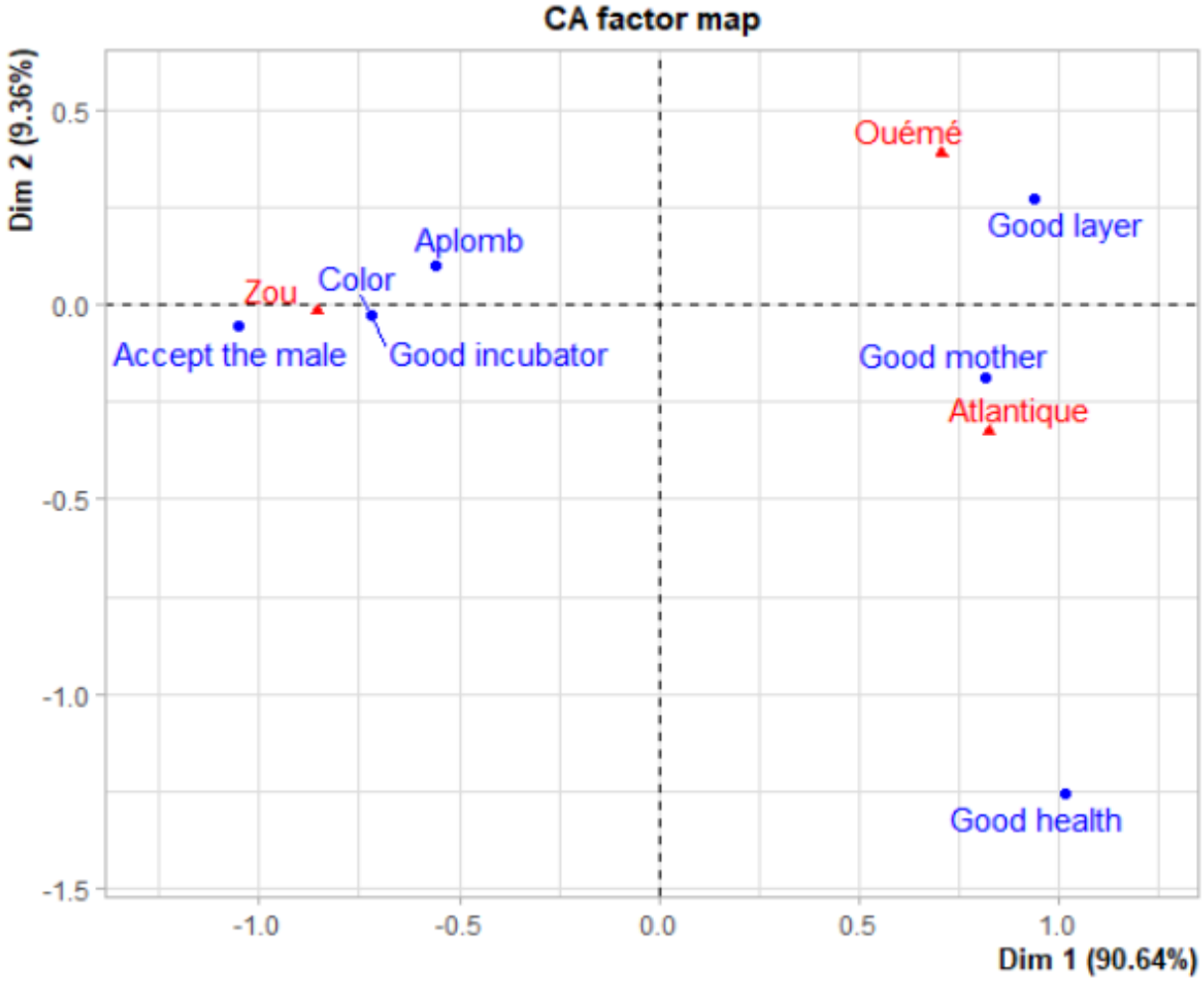

Figure 3. Distribution of selection criteria of reproducer females by region in Southern Benin. The criteria used to select reproductive females in Zou were included of color, aplomb, appropriate incubator and acceptance of male, good mother, and health in the Atlantic and good layer in Ouémé.

Health monitoring and pathologies encountered

The sanitary monitoring of the farm was focused on the cleaning of breeding materials and medical prophylaxis. The prophylaxis applied consisted of deworming the birds, vaccination against Newcastle disease, control of bacterial infections with antibiotics, and administration of vitamins (Table 8). The treatments for bacterial infections are not targeted at specific bacteria, as breeders do not have the necessary knowledge to make the diagnosis. The proportion of those who dewormed the birds did not differ significantly between departments. On the other hand, the administration of antibiotics and vitamins to birds was more common in Ouémé and Zou than in the Atlantic ($p < 0.05$). The farmers vaccinated more turkeys against the Newcastle disease in Zou (75%) than in Atlantic (34.5%) and Ouémé (35.3%, $p < 0.05$). These precautions did not stop diseases from entering farms. The pathologies encountered by farmers are Newcastle disease, smallpox (an infectious disease caused by *variola* virus), respiratory diseases, coccidiosis, scabies, Gumboro disease, and bronchitis (Table 8). Fowl plague was more reported in Ouémé (57.7%) than in Atlantic (11.5%) and Zou (3.8%, $p < 0.001$). Smallpox and scabies were more recorded in Zou farms than in the Atlantic and Ouémé ($p < 0.001$). Respiratory diseases were reported only in the Atlantic (15.4%).

The farmers treated diseases when they appeared with modern or traditional medicine. Some of them combine both treatments (modern and traditional). The majority of farmers in all departments used modern medicine for the treatment of diseases because of its high efficacy (Table 8). The reasons for using traditional medicine were its low cost in Atlantic, efficacy in Ouémé, and efficacy, low cost, and reduction of bacterial resistance in Zou.

Difficulties encountered

The difficulties encountered by the farmers were disease, mortality, theft, lack of a market for sale, and high production costs (Table 9). The proportion of farmers reporting high disease and mortality as difficulties in Ouémé (64.3%) and Zou (66.7%) was significantly higher than that of Atlantic farmers (15.8%, $p < 0.001$). High morbidity was recorded between hatching and the age of entry into reproduction in the majority of farms. The causes of morbidity do not vary from one department to another. These causes were lack of hygiene, pathogens, inadequate food, rain, wind, and coolness. The diseases sometimes lead to the deaths of the affected subjects. Other causes of bird deaths were accidents,

predators, and seasons (rainy seasons). The turkeys died much more in the rainy season, mainly in the Zou department. The mortality rate was highest in young turkeys that have not been weaned. The proportion of Atlantic farmers (100%) reporting mortality at this age was significantly higher than that of Ouémé (64.3%) and Zou (66.7%).

No Atlantic farmer has reported predators as a cause of death of turkey poults before weaning. The diseases are more reported as causes of mortality of turkey poults in the Atlantic (75%) and Ouémé (93.3%) than in Zou (36.4%, $p < 0.05$). Predators were more implicated in the mortality of turkey poults in the Ouémé (93.3%) than in Zou (50%, $p < 0.05$). These predators kill more weaned turkeys in Ouémé and Zou than in the Atlantic ($p < 0.05$). The cases of accidents of weaned turkeys were reported only in Ouémé (52.2%). Disease remains the only cause of mortality of turkeys at reproductive age in the Atlantic. Accidents and predators were the main causes of mortality at this age in Ouémé and Zou. Thefts were reported only in Ouémé (57.14%). The absence of a market for the sale was reported more by farmers in Zou (37%) than in the Atlantic (15.8%) and Ouémé (3.6%, $p < 0.05$). The high cost of production (especially feed) was more reported in the Atlantic (73.7%) than in the Ouémé (7.1%) and Zou (14.8%, $p < 0.001$).

Marketing of livestock products

The sales opportunities for livestock products were very diverse (Table 9). The end-of-year feast period was the period chosen by the majority of farmers to sell turkeys for slaughter. The proportion of Ouémé farmers who sell during this period in Ouémé (100%) was significantly higher than that of the Atlantic (64.3%) and Zou (74.1%, $p < 0.05$). Turkeys were sold more at the age of slaughter, during the children's back-to-school period, in the case of family care, and in the case of death in Ouémé than in the other departments (Table 11). The farmers in Ouémé (74.1%) and Atlantic (57.1%) sold more turkeys when they stopped laying than in Zou (14.8%, $p < 0.001$).

Turkey poults are sold at a higher price in the Ouémé (5904 F cfa [the franc of the financial community in Africa]) than in Zou (3722 F cfa) and Atlantic (3279 cfa ($p < 0.001$). On the other hand, adult males for slaughter are more expensive in the Atlantic (28,058 F cfa, the franc of the financial community in Africa) than in Ouémé (22,433 F cfa, $p < 0.05$). The selling price of adult females for slaughter follows the same trends as that of adult males, but the difference between the price of Zou and Ouémé was significant ($p < 0.05$). The price of reproducer males does not vary from one department to another (Table 10). On the other hand, reproducer females are more expensive in the Atlantic (23,708 F cfa) than in Ouémé (12,857 F cfa) and Zou (17,071 F cfa, $p < 0.001$). The selling price of breeding turkeys in Zou was also significantly higher ($p < 0.05$) than in Ouémé. The market price of turkeys is used by farmers in Ouémé (87.1%) and Zou (81.5%), while those in Atlantic (54%) use the customer's profile to set the selling price (Table 11). Thus, a customer who appears richer may buy a more expensive animal than one who appears poorer.

Table 8. Health monitoring and pathologies encountered on turkey farms in Southern Benin (2018-2019)

Variable	Atlantic			Ouémé			Zou			Significance
	n	(%)	CI	n	(%)	CI	n	(%)	CI	
Prophylaxis										
Internal parasites control	29	65.5^{a}	17.3	34	82.4^{a}	12.8	16	75^{a}	21.2	NS
Vaccination	29	34.5^{b}	17.3	34	35.3^{b}	16.1	16	75^{a}	21.2	**
Antibiotic	29	58.6^{b}	17.9	34	82.5^{a}	12.8	16	93.8^{a}	11.9	**
Vitamins	29	62.1^{b}	17.7	34	85.3^{a}	11.9	16	93.8^{a}	11.9	**
Diseases encountered										
Newcastle disease	26	11.5^{b}	12.3	26	57.7^{a}	18.9	26	3.8^{b}	7.4	***
Smallpox	26	46.2^{b}	19.2	26	46.2^{b}	19.2	26	92.3^{a}	10.2	***
Respiratory disease	26	11.5^{a}	12.3	26	0^{b}	0	26	0^{b}	0	**
Coccidiosis	26	42.3^{a}	19	26	3.9^{b}	7.4	26	11.5^{b}	12.3	**
Scabies	26	11.5^{b}	12.3	26	0^{c}	0	26	38.5^{a}	18.7	***
Gumboro, bronchitis	26	3.8^{a}	7.4	26	3.8^{a}	7.4	26	7.7^{a}	10.2	NS
Modes of treatment										
Traditional treatment	33	54.6^{a}	17.0	30	26.7^{b}	15.8	28	50^{a}	18.5	**
Modern treatment	33	78.8^{b}	13.9	30	96.7^{a}	6.4	28	78.6^{b}	15.2	**

n: Sample size, %: Percentage of surveys; **: $p < 0.01$; ***: $p < 0.001$; NS: Not significant; CI: Confidence interval, ^{abc} the percentages of the same row followed by different superscript letters differ significantly at the threshold of 5%.

Table 9. Causes of morbidity and mortality in Turkeys of Southern Benin during 2018-2019

Variable	Atlantic			Ouémé			Zou			Significance
	n	(%)	CI	n	(%)	CI	n	(%)	CI	
Difficulties encountered										
High diseases and mortality	19	15.8^{b}	16.4	28	64.3^{a}	17.7	27	66.7^{a}	17.8	***
Theft	19	0^{b}	0	28	57.1^{a}	18.3	27	3.7^{b}	7.1	***
Lack of market	19	15.8^{b}	16.4	28	3.6^{b}	6.9	27	37.0^{a}	18.2	**
Expensive breeding	19	73.7^{a}	19.8	28	7.1^{b}	9.5	27	14.8^{b}	13.4	***
High mortality period										
Before weaning	20	100^{a}	0	20	75^{b}	18.9	25	68^{b}	18.3	**
Between weaning and laying	20	5^{b}	9.6	20	65^{a}	20.9	25	40^{a}	19.2	**
From the age at first laying of the turkey	20	0^{a}	0	20	5^{a}	9.5	25	0^{a}	0	NS
Causes of pre-weaning mortality										
Accident	20	55^{b}	21.8	15	93.3^{a}	12.6	22	45.5^{b}	20.8	**
Predator	20	0^{c}	0	15	93.3^{a}	12.6	22	50^{b}	20.9	***
Disease	20	75^{a}	19	15	93.3^{a}	12.6	22	36.4^{b}	20.1	**
Season	20	30^{a}	20.1	15	13.3^{a}	17.2	22	22.7^{a}	17.5	NS
Causes of mortality between weaning and laying age of the turkey										
Accident	6	0^{b}	0	24	50^{a}	20	8	0^{b}	0	**
Predator	6	16.7^{b}	29.8	24	87.5^{a}	13.2	8	62.5^{a}	33.5	**
Disease	6	66.7^{a}	37.7	24	75^{a}	17.3	8	37.5^{a}	33.5	NS
Season	6	16.7^{a}	29.8	24	8.3^{a}	11.1	8	37.5^{a}	33.5	NS
Causes of mortality from the age at first laying of the turkey										
Accident	4	0^{ab}	0	24	54.2^{a}	19.9	13	23.1^{a}	22.9	**
Predator	4	0^{b}	0	24	87.5^{a}	13.2	13	76.9^{a}	22.9	***
Disease	4	100^{a}	0	24	0^{b}	0	13	0^{b}	0	***
Season	4	0^{a}	0	24	8.3^{a}	11.1	13	7.7^{a}	14.5	NS

n: Sample size, %: Percentage of surveys; **: $p < 0.05$; ***: $p < 0.001$; NS: Not significant; CI: Confidence interval, ^{ab} the percentages of the same row followed by different superscript letters differ significantly at the threshold of 5%.

Table 10. Sale period of turkeys in Southern Benin (2018-2019)

Variable	Atlantic			Ouémé			Zou			Significance
	n	(%)	CI	n	(%)	CI	n	(%)	CI	
Adult selling period										
Of slaughterable age	14	50^{b}	26.2	27	88.9^{a}	13.7	27	11.1^{c}	11.8	***
Back to school for children	14	7.1^{b}	13.5	27	48.1^{a}	18.9	27	0^{b}	0	***
Family Care	14	7.1^{b}	13.5	27	37.0^{a}	18.2	27	0^{b}	0	***
Bereavement	14	0^{ab}	0	27	14.8^{a}	13.4	27	0^{b}	0	**
Laying stop	14	57.1^{a}	25.9	27	74.1^{a}	16.5	27	14.8^{b}	13.4	***
End of the year party	14	64.3^{b}	25.1	27	100^{a}	0	27	74.1^{b}	16.5	**
Any time	14	0^{b}	0	27	0^{b}	0	27	22.2^{a}	15.5	**
Definition of the selling price										
Market price	21	42.7^{b}	21.2	31	87.1^{a}	11.8	27	81.5^{a}	14.7	***
Weight and size of the animal	21	0^{a}	0	31	9.7^{a}	10.4	27	0^{a}	0	NS
Client's head	21	54.14^{a}	21.3	31	9.7^{b}	10.4	27	62.9^{a}	18.2	***

n: Sample size; %: Percentage of surveys; **: $p < 0.05$; ***: $p < 0.001$; NS: Not significant; CI: Confidence interval, ^{ab} the percentages of the same row followed by different superscript letters differ significantly at the threshold of 5%

Table 11. Selling price in the African Financial Community (CFA france) for turkeys and eggs in Benin (2018-2019)

Variable	Atlantic			Ouémé			Zou			Significance
	n	Mean	SE	n	Mean	SE	n	Mean	SE	
Young turkeys	24	3279.2^{b}	357.7	26	5903.8^{a}	343.7	18	3722.2^{b}	322.4	***
Adult male	26	28057.7^{a}	1180.4	30	22433.3^{b}	1098.9	27	25055.6^{ab}	1158.34	**
Adult female	26	20292.3^{a}	837.9	30	11883.3^{c}	780.12	27	14703.7^{b}	822.3	***
Egg	22	943.2^{a}	51.9	8	912.5^{a}	86.2	24	1008.3^{a}	49.7	NS
Male reproducer	20	26500^{a}	2013	7	25428.6^{a}	2406	14	28428.6^{a}	1701.3	NS
Female reproducer	12	23708.3^{a}	951.6	7	12857.1^{c}	1245.9	14	17071.4^{b}	881	***

n: Sample size; **: $p < 0.05$; ***: $p < 0.001$; NS: Not significant; ES: Standard Error; ^{abc} Means of the same row followed by different superscript letters differ significantly at the threshold of 5%

DISCUSSION

Profile of farms

The majority of turkey farmers are men. Most male involvement in turkey farming has been previously reported in Cameroon and Nigeria (Ngu et al., 2014; Amao et al., 2017). In contrast to this study, Bakoji et al. (2012) report the majority involvement of women in turkey farming in Bauchi State, Nigeria. There are several reasons for the low involvement of women in turkey farming in Benin. These include a lack of resources and a lack of a market for the meat. Indeed, turkey meat is very expensive, which limits its consumption by the population, whereas women are often more active in the trade of products that are easily sold (Dotché et al., 2021). The majority of breeders are educated people and this finding contrasts with that reported by Dèdéhou et al. (2018) in the commune of Ouaké in northern Benin that some farmers are out of school as reported by the majority of farmers in this study. The lack of schooling among these farmers is an obstacle to controlling the performance of livestock. As a result, because farmers are not educated, they are unable to record weights, and calculate egg-laying and profitability rates for their activity. The main production objective of the farmers is meat production for consumption. The same observation was made by Ngu et al. (2014) in Nigeria. The turkey farming has social, cultural, and economic importance for the surveyed farmers. This economic and cultural importance of turkey farming in Benin has already been reported in Southern Benin by FAO (2015).

Constraints of the development of turkey farming

The farmers in the Atlantic used chicken housing and those in the Ouémé used buildings and fenced areas because they had less space to practice extensive farming characterized by free-range and traditional housing, as in Zou, where farmers are in a rural environment with a high availability of space. The traditional housing is built with precarious materials such as straw and rammed earth and prevents farmers in Zou from separating turkeys from other poultry species (chickens, ducks, and guinea fowl). This type of farming has already been reported in the commune of Ouaké in the north (Attakpa et al., 2011). An important number of farmers in Ouémé (44%) cannot separate turkeys from other poultry because the birds are kept on the range for a long period of the day, during which time they live with other species of birds such as local chickens, ducks, and guinea fowl, which are often reared on a free-range. This cohabitation of several species and age groups represents a biosecurity problem. Certain species have the capacity to harbor pathogens without becoming ill and spread them to other vulnerable species (Conan et al., 2012; Pauly et al., 2019; Correia-Gomes and Sparks, 2020). This is the case of H5N1 avian influenza, whose transmission increases with the mixing of several species (Conan et al., 2012). In the same sense, older birds that already have stronger immune systems can harbor pathogens and transmit them to younger birds (Conan et al., 2012). Therefore, farmers in Zou need to improve turkey housing to be able to separate them from other species and reduce the liberty of the birds as recommended by these authors (Conan et al., 2012). The improved housing in Zou would also provide more protection for the birds as traditional housing does not provide enough protection and exposes them to the weather (high wind and rain) and predators (Nyoni et al., 2019; Nyoni et al., 2021; Desta, 2021). This exposure is expressed in the high mortalities observed by farmers in younger and more fragile animals (Otte et al., 2021). The Ouémé farmers may focus their breeding on a single species, particularly turkeys, to reduce cohabitation between several species.

Constraints related to turkey feeding

Commercial feed is used more in Ouémé and Atlantic than in Zou, where farmers mainly use cereals and crop by-products; this is related to the accessibility of these resources by farmers. Thus, in the department of Zou, agriculture is more developed and farmers in this area have more access to these products than farmers in the Atlantic and Ouémé. The feed resources used in Zou have already been reported in turkey farms in Ouaké (Attakpa et al., 2011; Dèdéhou et al., 2018) because the breeders in this commune are also farmers who rear birds in a system like that in Zou. The two forms of feed (commercial feed and agricultural by-products) have insufficiencies in terms of quality and quantity.

The deficiencies associated with feed quality relate to the imbalance between the intake and the needs of the animals. The agricultural by-products used in Zou are often unbalanced feeds and do not cover all the needs of the turkeys. The consequences of using only such a feed resource in poultry are decreased zootechnical and laying performance (Markos and Abdela, 2016). Some of these feeds, like cereal bran, can become contaminated during handling and transmit pathogens to the birds, as they are not treated (heated, for example) before being fed to the turkeys (Abdisa and Tagesu, 2017). The pathogens that untreated agricultural by-products can transmit to birds are Newcastle disease, avian influenza, salmonellosis and parasitosis (Abdisa and Tagesu, 2017; Sun et al., 2021). The available commercial feeds in Benin are well treated to prevent the transmission of pathogens, but they are unbalanced because they are made for chickens and not for turkeys. The farmers could use commercial turkey feed. Unfortunately, commercial turkey feed is not available in Benin. This forces some farmers to use chicken feed for

turkeys. As a result, these chicken feeds do not cover the needs of the birds equally, forcing farmers in the Atlantic and Ouémé departments to give a very high quantity of feed to the birds, thus increasing their production costs. This solution fund by the farmers isn't the appropriate one because it increases the food costs. The best solution is to formulate feeds that consider the needs of the turkeys and their physiology. To achieve this, farmers need the assistance of researchers to have balanced formulas for the turkey, because these farmers often do not have the necessary qualifications for the formulation of feed.

The deficiencies in quantity are found in the lack of measurement of the quantities of feed provided to the turkeys. As a result, farmers cannot know if the quantity provided is appropriate or not. The lack of performance recording is a contributing factor in that the farmer cannot judge the effectiveness of the feed used. Thus, if the farmers kept accurate records of the performances, they would be able to determine how much the quantity or the quality of the feed used was inadequate. In fact, the nutrient composition and quantity of feed given to turkeys should vary according to the animal's status (reproducer, cull, fattened), age (young, adults) and weight.

Constraints related to the management of reproduction

Natural mating is the most common method of reproduction, in extensive and semi-extensive poultry farms in Benin (Youssao et al., 2013). This mating method's failure results from the females' frequent inability to bear the weight of the males, which forces them to move around a lot during mating and causes ejaculation outside of the female's genitalia. The same finding was reported by Chowdhury et al. (2014) in many Asian countries. These difficulties in successful natural mating have also been reported in turkey farming in Nigeria (Adebisi and Ewuola, 2019). To correct this problem, farmers in the Atlantic and Ouémé choose heavier males whose weight may prevent the females from making enough movements. Unlike these farmers, those in Zou and Ouémé assist the female during mating. The farmers' assistance consists of keeping the female in place to allow the male to perform a complete and effective mating. These two methods ensure mating but have negative consequences (aggression to females and biosecurity problems linked to assistance) for breeding. Thus, choosing heavier males results in terrifying the female and injuring her (Chowdhury et al., 2014; Ferrante et al., 2019). The female's assistance during mating could cause biosecurity issues because, in traditional poultry farms, hygiene is insufficient and farmers can contaminate females through their hands. In addition, the assistance of the female during mating increases labor time for the farmer. In order to solve the challenges associated with mating in Zou, farmers select males who are proficient mounters and females who readily accept males for reproduction. Artificial insemination is a method that could solve this problem (Chowdhury et al., 2014; Mohan et al., 2018; Adebisi and Ewuola, 2019). The semen of turkeys can be collected, analyzed, and used to inseminate females. In Southern Benin, incubation occurs naturally. The hatching rate in Atlantic and Ouémé is higher than in Zou, indicating that the farmers in this area do not provide adequate conditions for bird mating, resulting in infertile eggs. This finding agrees with the results of Adebisi and Ewuola (2019) who reported a low egg fertility rate in naturally mated turkeys compared to artificially inseminated turkeys. Indeed, after laying, only fertilized eggs can hatch following incubation (Leborgne et al., 2013). This fertility problem in Zou is confirmed by the very low number of mean young turkeys hatching (3 young turkeys) in this department compared to those in the Atlantic (12 young turkeys) and Ouémé (10 young turkeys). The farmers do not know the causes of this low fertility and attribute it to the incubation ability of the females, which leads them to choose good incubating females for reproduction and perform incubation under the hen. These efforts have not improved egg fertility in Zou. The farmers in the Atlantic and Ouémé departments, in contrast to those in Zou, were more focused on the quantity of poults hatching and weaning than on egg fertility. As a result, they selected females from mothers who lay a lot of eggs and wean a lot of poults.

Constraints related to health monitoring and mortality

The primary challenges faced by the farmers in Ouémé and Zou were diseases, as the animal housing in these two departments is insufficient to protect them. Thus, these animals are exposed to pathologies in the wild through contact with sick animals and contaminated objects (Conan et al., 2012; Samanta et al., 2018). The most common pathogens are viral diseases such as Newcastle disease (in Ouémé), smallpox (in Zou), and parasitic diseases (scabies). These diseases are already reported in poultry farms in Benin generally (Boko et al., 2012; Youssao et al., 2013; Houessionon et al., 2020) and especially in turkeys (Attakpa et al., 2011). Farmers in these two departments treat birds against bacterial diseases, deworm them, and vaccinate them (particularly in Zou) in an effort to reduce disease. The farmers in these two departments also deworm their animals. These dewormings (the fight against internal parasites) are also practiced in the more developed farms of the Atlantic because these farmers are also confronted with parasitic diseases.

The diseases that breeders face on their farms are the main reasons why the youngest birds die, especially before they are weaned, as their immune systems are still developing and cannot fight off the illnesses. The same observation has already been made in turkey farms in the north of the country (Attakpa et al., 2011). The vaccination would increase

the immunity of the birds (Samanta et al., 2018; Otte et al., 2021) but young turkeys are not vaccinated by the respondents for financial reasons. Farms need to implement biosecurity protocols in order to preserve poults. Apart from diseases, predators and accidents are responsible for the deaths of turkeys in free-range farms. The same finding has already been made in free-range poultry (Otte et al., 2021). The farmers who use this method of rearing birds must build housing to limit the birds' mobility because adult mortality is also linked to predators and accidents. Reducing bird mobility will actually result in fewer accidents, diseases, predations, and deaths because it will confine turkeys and prevent them from contracting diseases from other free-ranging animals or accidentally coming into contact with predators (Conan et al., 2012; Samanta et al., 2018; Otte et al., 2021), but this reduction must consider the financial capacity of the farmers to avoid the elimination of their activity. The best way to raise turkeys is not to transform all the farms over to the better system used in the Atlantic, which would require expensive feed and building costs for new housing. It is necessary to consider a semi-free-range system, similar to that practiced in the Ouémé Department, but exclusively for the rearing of turkeys. The system requires separating the animals based on their age.

Constraints related to the marketing

The main difficulty in marketing turkeys is the lack of an outlet market in Zou since turkeys are expensive for the population of the surveyed area, which is commonly rural. One strategy that could be used to facilitate the marketing of turkeys in this department is the installation of a slaughterhouse to sell turkey cuts. Currently, the main period for turkey sales in this department is the Christmas and New Year period, as the festive period is an occasion for high meat consumption. The sale of turkey during the year-end festive period has also been reported by FAO (2015) in Benin and by Ouedraogo et al. (2015) in Burkina-Faso. In the other two departments, the existence of demand means that turkeys are sold on various occasions. Selling during the children's school year, for family care, and at funerals shows that turkey farming plays an economic and social role for farmers.

The price of turkeys was higher in the Atlantic than in Ouémé and Zou because the cost of production is higher in this department due to investments in housing and feed. In the Atlantic, farmers use improved poultry houses and turkeys are better monitored, while in the Ouémé, turkeys are reared in small fences, and in the Zou in traditional housing.

CONCLUSION

The study performed from August 2018 to August 2019 on constraints to the development of turkey farming in Southern Benin shows that turkey farming is carried out with improved techniques in the Atlantic region, with traditional techniques in the Zou region, and with more or less improved techniques in the Ouémé region. There are several obstacles standing in the way of this farming sector's growth including the high cost of food in the Atlantic; pathological issues (diseases from contact with other poultry species); social problems (theft cases) in the Ouémé; and pathological issues and insufficient markets in the Zou. The improvement of turkey meat production should be by attention to these difficulties in the study regions. Improving the biosecurity of some farms and implementing it in others is necessary to reduce disease rates and young turkey mortality. To improve turkey production in Benin, the difficulties faced in each region must be addressed. Further studies are needed to focus on developing feed formulas specifically adapted to the needs of turkeys to rectify feeding issues. There is also a need for artificial insemination to overcome the mating difficulties identified by the breeders. Finally, the authorities should support this farming activity by providing financial assistance to breeders to enable them to build housing for their animals.

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Aailability of data and materials

All data of the current study are available in this article.

Authors' contributions

Dotche Ogoudanan Ignace and Youssao Abdou Karim Issaka designed and planned the study, supervised data collection and analyzed the data. Adebo Nasser, Okambawa Lionel, and Koffi Monique collected data and drafted the first version of the manuscript. Agbokounou Aristide, Baba Loukyatou Issimouha, and Dotche Ogoudanan Ignace wrote the final version of the document and carried out the critical review. Youssao Abdou Karim Issaka corrected the document. All authors read and approved the final version of the article.

Competing interests

The authors declare that they have no conflict of interest.

Ethical considerations

The authors took ethical concerns and farmers' consent into account prior to the surveys. This article was originally written without copying from other articles.

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