Research Article

Diversity of Geese (*Anser* spp.) Farming Systems in Northern Benin, West Africa

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Abstract | Goose farming is less developed in Benin compared to chicken and guinea fowl. The objective of this study was to characterize goose farms in northern Benin through the socio-demographic profile of the goose farmers, the modes of operation of the farms, and their constraints. Data were collected through a retrospective survey from 102 farms in four agro-ecological zones (AEZ) of northern Benin: the far northern zone of Benin (FNZB), the cotton zone of northern Benin (CZNB), the food-producing zone of southern Borgou (FZSB), and the West Atacora zone (WAZ). Multiple correspondence analysis (MCA) and ascending hierarchical clustering (AHC) identified three groups of goose farmers. Group 1 was composed of primary and secondary level goose farmers whose main activity was trade (56.1%); group 2 was composed of secondary level herders whose main activity was agriculture (59.38%); and group 3 included public servants (27.59%) with university-level education. As for the feeding of the geese, Group 3 fed more feed than Groups 1 and 2, where the majority of farmers used cereals, agro-industrial by-products, and food waste ($p<0.05$). The farming method and the total number of birds varied between rearing groups ($p<0.05$). The identification of these animals through their size and silhouette was more noticeable in Group 3 (58.62%) than in Groups 1 (46.34%) and 2 (50%). The production objective of all farmers was the production of meat for consumption. All geese farmers face almost the same difficulties, such as diseases, mortality, theft, and predators. Goose farming in northern Benin was therefore family-based, with a diversity in the activities of the goose farmers, the type of farming, and the diet. The results of this study will contribute to the implementation of programs to improve goose farming in Benin.

Keywords | Typology, goose, Housing of poultry, Breeding method, Constraint, Benin

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INTRODUCTION

Local breeds of animals have a great adaptability aptitude to tropical climatic conditions and high productivity potential (Naves et al., 2011). These types of animals constitute an element of wealth for farmers and a policy of meeting the animal protein needs of the population for the authorities (Berger et al., 2013). Family poultry farming thus becomes a significant source of protein for peasants (Guèye, 1998). In 2018, the supply of poultry product in Benin was 14,561 tons of meat compared to 15,355 tons of eggs (FAOSTAT, 2019). This production is provided by local and modern poultry species such as chickens, guinea fowl, ducks and turkeys (Siéwé Pougoué et al., 2019;

Houessionon et al., 2020). Most of the work done on these different animals to improve national production of this sector has focused on the characterization of poultry farms (Idrissou et al., 2018; Dotché et al., 2021) and genetic improvement of guinea fowl (Vignal et al., 2019). Other authors have worked on their diet and health (Agodokpessi et al., 2016), and on the organoleptic and nutritional quality of chicken meat and eggs (Tougan et al., 2013). However, the farming of other poultry species such as ducks and turkeys is gaining momentum, and unfortunately, little work has been done on them (Houessionon et al., 2020; Dotché et al., 2021). On the other hand, geese continue to be marginalized. Goose farming is now widespread throughout the country. The most raised goose species in Benin remains *Anser* spp. still called Landaise breed (FAO, 2015). Geese are generally found in rural areas of tropical and subtropical countries where they are usually raised by the poor peoples of the said areas (Islam et al., 2016). They are present in the North of Benin which constitutes the zone where the breeding of goose was high than in the south of Benin where the geese were absent in almost all the poultry farms (Houessionon et al., 2020). Geese are among the poultry species that have a rapid growth rate and a very fast protein deposition, which are generally raised for meat, large edible eggs. Despite its importance in the socio-economic development of the populations, domestic geese have not enjoyed the same commercial exploitation. Goose production has lagged behind the industry of other avian species for various reasons (Akin and Çelen, 2022). Currently, through several studies conducted around the world, there are multiple systems that allow goose production following various production objectives (Arroyo et al., 2012). The use of these farming systems varies depending on climatic, economic conditions, farming traditions, standards of care and market demand for goose meat (Boz, 2015; Sarı et al., 2021). To better understand possible areas of improvement, an initial study to characterize goose farms in northern Benin is important. Characterization and inventory of poultry genetic resources are needed in countries where poultry breeds have yet to be identified; therefore, well-designed scientific studies on domestic goose breeds should be prioritized (Tixier-Boichard et al., 2008). Given the above facts, the present study aims to establish, through retrospective surveys, a typology of goose farms in four agro-ecological zones of northern Benin and to make suggestions for its improvement. This typology highlighted the different modes of operation of these farms.

MATERIALS AND METHODS

Study area

The study on the characteristics of goose farms was carried out in the agro-ecological zones (AEZ) of northern Benin, namely: the far northern zone of Benin (FNZB), the cotton zone of northern Benin (CZNB), the food-producing zone of southern Borgou (FZSB) and the West-Atacora zone (WAZ) (Figure 1).

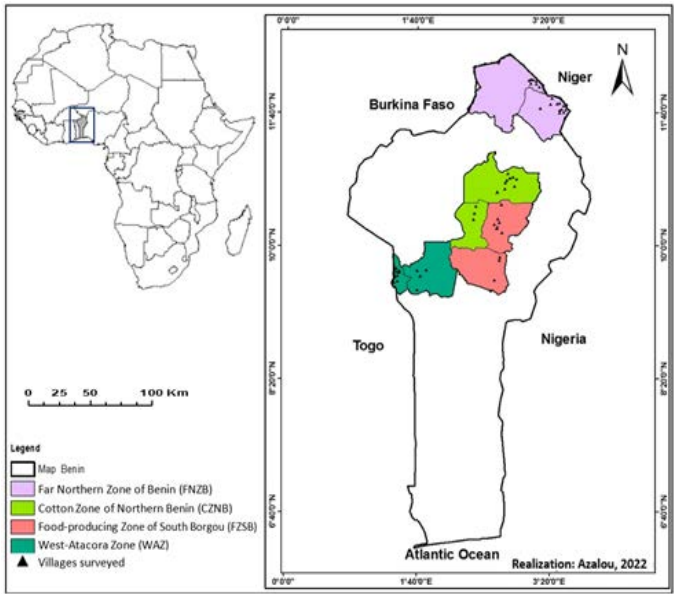

Figure 1: Map showing the area of investigation of goose farms in northern Benin

The study was conducted between January and July 2021. Located in West Africa, between the equator and the Tropic of Cancer, Benin lies between parallels 6°30' and 12°30' North latitude and meridians 1° and 30°40' East longitude. These four AEZ cover the municipalities of Malanville, Karimama, Gogounou, Sinendé, Bèmbèrèkè, N'Dali, Ouaké and Djougou. This study area is characterized by a sub-humid climate with two seasons, a rainy season from May to October and a dry season covering the months of November to April. The average annual rainfall recorded varies between 909 mm and 1450 mm during 61 rainy days. The average temperature hovers around 26-27°C (Boko, 1992). The local economy is dominated by agriculture, livestock and fishing, which employ the bulk of the working population.

Data collection

Interviews with goose farmers and field observations were the approaches used. The methodology used for data collection was that of a retrospective survey by direct interview with the farmer in the different agro-ecological zones. The data collected from breeders for the identification of breeding types was linked to their socio-demographic profiles, herd structure and management. (Table 1). It calls upon the memory of the farmers, while reconstructing the different stages of goose farming. Using an interview guide, information were collected on the farmer (ethnicity, age, gender, level of education, main activity, motivations for raising geese, other poultry species raised). It also concerned the history of the farm (year of start-up, number

Table 1: Variables and modalities describing the basis for the identification of types of goose

Variable	Sex	Marital status	Age (years)	Family size	Ethnic group	Education level	Principal activity
Modality	Male	Single	< 30	≤ 10	Bariba	None	Crop farmer
	Female	Married	30 – 50	> 10	Lokpa	Primary	Livestock farming
		Divorced	> 50		Dendi	Secondary	Trader
		Widowed			Boo	Higher education	Craftsman
					Fulani		Civil servant
					Zarouman		Professional Private

of founder animals, mode of acquisition) as well as on the conduct of the farm (flock structure, feeding, reproduction and production, type of production) and their operation (Mahmoudi et al., 2015; Assani et al., 2016; Fall et al., 2017; Azalou et al., 2017; Houessionon et al., 2020). Constraints related to goose farming were also identified during this study (Ayssiwede et al., 2013). Thus, a total of 102 goose farms spread across the four agro-ecological zones of northern Benin were surveyed. Goose farmers were selected based on accessibility and their availability to provide information. Local guides were used to interpret and explain the questionnaire in the local language to farmers who could not read and write French.

Data Processing Methods

The collected data were reviewed, coded, and stored in a database designed with Excel spreadsheet. After tabulation and coding, the data were analyzed with R software (version 4.1.2) (R Core Team, 2021). The Proc mean procedure was used for descriptive statistics to determine the general characteristics of the identified poultry farms. Frequencies were calculated by the Proc freq procedure and comparisons between relative frequencies were made by the Chi-square test and/or the two-tailed Z test. For each relative frequency, a 95% confidence interval (CI) was calculated using the formula:

$$CI = 1.96\sqrt{\frac{[P(1-P)]}{N}}$$

where P is the relative frequency and N is the sample size. The mean and standard deviation of the quantitative variables (age of the farmer, herd size, etc.) were calculated and followed by an analysis of variance (ANOVA). A multiple correspondence analysis (MCA) was used to highlight the relationships between the qualitative variables (Diatta et al., 1998). A hierarchical ascending classification (HAC) based on the characteristics of the goose farms on the most significant components of the MCA was performed (the first three axes).

RESULTS

Socio-professional characteristics of goose farmers surveyed in northern Benin

The present study showed that geese breeding is a predominantly male activity (84.31 %) while very few women (15.69 %) were involved in the different agro-ecological zones (Table 2). The proportion of women who engage in this activity in the West-Atacora Zone (9.52 %) remains lower than in the other AEZ. These breeders are mostly married men (76.47 %). They are more represented by the Bariba ethnic group in the CZNB and FZSB (69.23 and 66.67%) followed by the Dendi in the FNZB and WAZ (48.39 % and 47.62 %). Goose breeders carry out other activities such as agriculture (46.15%) in the CZNB followed by trade (42.86 %) and (41.94 %) respectively in the WAZ and FNZB. More than half of the respondents (61.89 %) are aged between 30 and 50 years and include a high proportion having primary or secondary education regardless of the agro-ecological zone. Likewise, non-schooled breeders were more numerous in the CZNB. They are therefore differently educated and have not all received training in breeding (Table 2).

Typology of goose farms in northern Benin

In order to define more precisely the types of goose farms from the MCA examination, a Hierarchical Ascending Classification was carried out with all the data (Figure 2). This enabled to distinguish three types of herders in the four agro-ecological zones of northern Benin. The best projection of the herders was obtained on the factorial axes 1 and 2 (Figure 2). These data enabled to identify three types of goose farming (Figure 3): "Type I: Improved traditional farming", "Type II: Extensive traditional farming" and "Type III: Semi-improved farming". Three axes were retained for the interpretation of the results of the multiple correspondence analysis and the hierarchical ascending classification. Each axis corresponds to a group of farmers and each group corresponds to a type of goose farmer surveyed. The Figure 2 presents the different groups of farms projected in the first factorial axis constituted by the first two dimensions (Dim 1 and Dim 2).

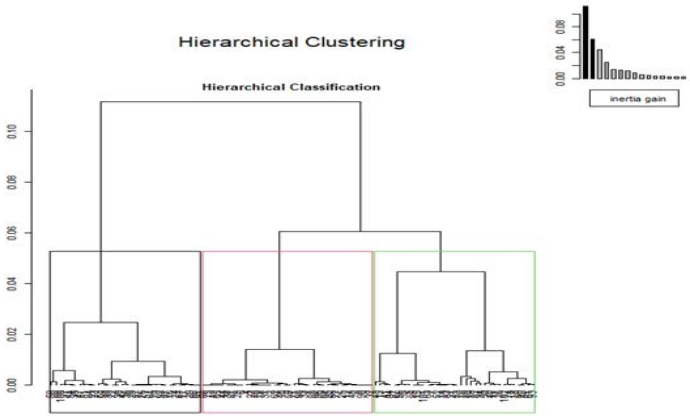

Figure 2: Dendrogram of herder groups or Hierarchical Ascending Classification (HAC).

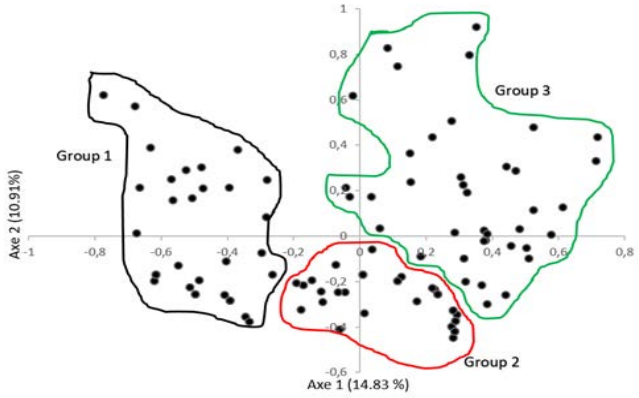

Figure 3: Projection of the goose farms surveyed in North Benin on factorial axes 1 and 2.

Tables 3, 4, 5 and 6 provide information on the three groups of goose farms identified through their socio-economic profile, the history of their farms, their production objectives, their motivation, the structure of their farms and, finally, their farming methods.

Breeder Profiles

The majority of breeders were male (Table 3). The number of females was significantly higher ($p < 0.01$) in group 2 (34.38%) than in groups 1 (9.76%) and 3 (3.45%). Marital status thus varied between groups ($p < 0.05$) with more single men in group 3 than in groups 1 (12.2%) and 2 (3.13%). Most of the goose farmers speak Bariba and this is more noticeable in groups 2 (65.63%) and 3 (63.52%). The number of Dendi-speaking goose farmers was significantly higher ($p<0.05$) in group 1 (48.78%) than in groups 2 (18.75%) and 3 (13.79%). Age of goose farmers did not differ between groups ($p>0.05$). The majority of the goose farmers had a family size of less than 10 people respectively 73.17%, 75% and 86.21% in groups 1, 2 and 3. The majority of goose farmers in northern Benin had a primary or secondary level of education. The level of education did not vary significantly between groups ($p>0.05$). Most of them were crop farmers in group 2 (59.38%) and shopkeepers in group 1 (56.1%). In group 3, they were farmers (20.69%), stockbreeders (20.69%), public service (27.59%) and private professional (24.14%).

Production objective and uses of geese

The animals at the creation of the flocks came from purchases as well as gifts and inheritances (Table 4). Thus, their origin did not vary from one group to another. The production objective was meat for the majority of the goose farmer's surveyed ($p>0.05$). Hardiness in addition to growth and profitability are the main sources of motivation for breeding geese although no significant difference was observed. It continues to be bred for prestige by few breeders and in small numbers. The products of the goose farm are used more for self-consumption and sale. The proportion of use of different products did not vary significantly between groups ($p>0.05$).

Structure of goose farms in northern Benin

The number of geese on the farms encountered in northern Benin remains variable. Thus, the average number of total geese is lower in group 2 (12.62) than groups 1 and 3 (20.71 and 21.62 respectively) and varied significantly ($p < 0.05$). The average number of breeding females exceeded that of breeding males regardless of the identified breeding group (Table 5). The total number of spawners differed significantly between groups and was higher in group 3 and 1 than in group 2. The number of growing males and females differed between groups ($p<0.05$). This was more noticeable in group 1 (3.24 and 5.07) and group 3 (3.58 and 4.38) farms. In general, the total number of growing geese was significantly higher ($p<0.05$) in group 1 (8.31). The average number of goslings varied significantly between groups.

Rearing, feeding and housing of geese

Based on the results of the survey, the majority of the animals are raised in a free-range system. Roaming was the most common rearing method in groups 1 and 2 (68.29% and 62.5%) compared to group 3 (86.21%) with a significant difference ($p<0.05$). Thus, many of the animals are raised in traditional (group 1 and 2) and semi-modern (group 3) housing types ($p > 0.05$). Cereals in addition to Agro-Industrial By-Products (SPAI) and food wastes are the most used feed types (Table 6). The proportion of feed used was higher ($p < 0.05$) in group 3 (48.28%) than in group 1 and 2, respectively 4.88% and 9.38%. The proportion of cereals and SPAI was 100% in group 2 and higher in group 1 (90.24%) than in group 3 (75.86%). Food waste was used less in group 3 (5.52%) than in groups 1 and 2 ($p<0.05$). Forages were used by all goose farmers in different proportions. Green fodder was used more in the diet of birds in group 1 (46.34%) than in the other groups. The proportions of feed types varied very significantly within groups ($p<0.001$).

Table 2: General characteristics of goose farmers surveyed in northern Benin with regard to agro-ecological zones

Variables		Agroecological zones				
		CZNB	FZSB	WAZ	FNZB	Pooled
		%	%	%	%	
Sex	Male	84.62	83.33	90.48	80.65	84.31
	Female	15.38	16.67	9.52	19.35	15.69
Marital status	Single	15.38	16.67	19.05	12.9	15.69
	Married	76.92	75	76.19	77.42	76.47
	Divorced	3.85	0	0	3.23	1.96
	Widowed	3.85	8.33	4.76	6.45	5.88
Ethnic group	Bariba	69.23	66.67	0	25.81	41.18
	Lokpa	0	0	42.86	0	8.82
	Dendi	3.85	16.67	47.62	48.39	29.41
	Boo	19.23	4.17	0	0	5.88
	Fulani	3.85	8.33	4.76	0	3.92
	Zarouman	3.85	4.17	4.76	25.81	10.78
Age (years)	< 30	7.69	8.33	9.52	6.45	7.99
	30 – 50	73.08	62.5	57.14	54.84	61.89
	> 50	19.23	29.17	33.33	38.71	30.11
Family size	≤ 10	80.77	75	90.48	67.74	78.49
	> 10	19.23	25	9.52	32.26	21.5
Education level	None	19.23	12.5	9.52	6.45	11.76
	Primary	30.77	33.33	33.33	45.16	36.27
	Secondary	30.77	37.5	33.33	38.71	35.29
	Higher education	19.23	16.67	23.81	9.68	16.67
Principal activity	Crop farmer	46.15	29.17	9.52	16.13	25.49
	Livestock farming	23.08	25	23.81	16.13	21.57
	Trader	7.69	4.17	42.86	41.94	24.51
	Craftsman	11.54	8.33	0	6.45	6.86
	Civil servant	11.54	12.5	9.52	6.45	9.8
	Professional Private	0	20.83	14.29	12.9	11.76

CZNB: cotton zone of northern Benin; FZSB: food-producing zone of southern Borgou; WAZ: west Atacora zone; FNZB: far northern zone of Benin.

Table 3: Socio-economic profile of goose farmers according to the three groups identified in northern Benin

Variables		Group 1 (n=41)		Group 2 (n=32)		Group 3 (n=29)		Chi^2	P-value
		%	CI	%	CI	%	CI		
Sex	Male	90.24^a	9.08	65.63^b	16.46	96.55^a	6.64	12.85	0.001^{**}
	Female	9.76^a	9.08	34.38^b	16.46	3.45^a	6.64		
Marital status	Single	12.2^a	10.02	3.13^a	6.03	34.48^b	17.3	16.57	0.011^{*}
	Married	82.93^a	11.52	81.25^a	13.52	62.07^a	17.66		
	Divorced	0^a	0	6.25^a	8.39	0^a	0		
	Widowed	4.88^a	6.59	9.38^a	10.1	3.45^a	6.64		
Ethnic group	Bariba	4.88^a	6.59	65.63^b	16.46	65.52^b	17.3	55.21	0.000^{***}
	Lokpa	21.95^b	12.67	0^a	0	0^a	0		
	Dendi	48.78^a	15.3	18.75^b	13.52	13.79^b	12.55		
	Boo	0^a	0	9.38^a	10.1	10.34^a	11.08		

	Fulani	4.88[a]	6.59	0[a]	0	6.9[a]	9.22		
	Zarouman	19.51[a]	12.13	6.25[a]	8.39	3.45[a]	6.64		
Age	< 30 years	4.88	6.22	3.13	6.44	13.79	12.52	7.01	0.135[ns]
	30 – 50 years	53.66	12.47	75	16.76	62.07	17.23		
	> 50 years	41.46	10.54	21.88	15.13	24.14	13.25		
Family size	≤ 10	73.17	22.13	75	25.10	86.21	19.54	3.06	0.216[ns]
	> 10	26.83	22.13	25	25.10	13.79	19.54		
Education level	None	9.76	10.74	55.63	11.59	10.34	9.53	10.94	0.090[ns]
	Primary	41.46	16.4	34.38	15.88	31.03	15.32		
	Secondary	36.59	17.73	3.75	4.25	24.14	13.59		
	Higher education	12.2	6.42	6.25	9.7	34.48	16.54		
Principal activity	Crop farmer	2.44[a]	4.72	59.38[b]	17.02	20.69[b]	14.74	71.12	0.000[***]
	Livestock farmers	19.51[a]	12.13	25[a]	15	20.69[a]	14.74		
	Trader	56.1[a]	15.19	6.25[b]	8.39	0[b]	0		
	Craftsman	7.32[a]	7.97	6.25[a]	8.39	6.9[a]	9.22		
	Civil servant	4.88[a]	6.59	0[a]	0	27.59[b]	16.27		
	Professional Private	9.76[a]	9.08	3.13[a]	6.03	24.14[b]	15.57		

CI: confidence interval; NS: not significant; * p<0.05;** p<0.01; *** p<0.001;a, b percentages on the same line followed by a letter do not differ at the 5% threshold.

Table 4: Farming history, objective and motivation for goose farming by group in northern Benin

Variables		Group 1		Group 2		Group 3		Chi²	P-value
		%	CI	%	CI	%	CI		
Origin of the animals at creation	Heritage	7.32	7.97	9.38	10.1	3.45	6.64	3.04	0.55[ns]
	Purchase	70.73	13.93	68.75	16.06	86.21	12.55		
	Gift	21.95	12.67	21.88	14.32	10.34	11.08		
Production objective	Meat	87.8	10.02	84.38	12.58	82.76	13.75	0.65	0.95[ns]
	Eggs	17.07	11.52	12.5	11.46	20.69	14.74		
	Other	17.07	11.52	18.75	13.52	17.24	13.75		
Motivation to raise geese	Hardiness + Growth	85.37[a]	10.82	84.38[a]	12.58	86.21[a]	12.55	5.08	0.532[ns]
	Prestige	1.32[a]	7.97	6.25[a]	8.39	13.79[b]	12.55		
	Profitability	92.68[a]	7.97	93.75[a]	8.39	14.66[b]	11.08		
	Own initiative	9.76[a]	9.08	3.13[a]	6.03	20.69[a]	14.74		
Use of the products	Self-consumption	92.68	7.97	93.75	15.22	68.97	16.84	4.03	0.67[ns]
	Sale	90.24	9.08	93.75	15.22	89.66	11.08		
	Babysitting	9.76	9.08	6.25	8.47	10.34	11.08		
	Culture	21.95	12.67	6.25	8.47	17.24	13.75		

CI: confidence interval; NS: not significant; a, b percentages on the same line followed by the same letter do not differ at the 5% threshold.

Table 5: Size and composition (number of heads) of the flock on goose farms in northern Benin

Livestock structure	Group 1	Group 2	Group 3	P-value
	Mean ± SD	Mean ± SD	Mean ± SD	
No. of breeding males	2.46 ± 0.25	1.94 ± 0.24	2.65 ± 0.39	0.224 [ns]
No. of breeding females	4.53 ± 0.57[b]	2.43 ± 0.34[a]	4.96 ± 0.89[b]	0.008**
Total number of breeders	7 ± 0.77[ab]	4.37 ± 0.54[a]	7.62 ± 1.25[b]	0.0203*
No. of growing males	3.24 ± 0.38[b]	1.84 ± 0.56[a]	3.58 ± 0.31[b]	0.005**

No. of growing female	5.07 ± 0.57[b]	2.72 ± 0.45[a]	4.38 ± 0.69[ab]	0.0094**
Total number of growing geese	8.31 ± 0.89[b]	4.81 ± 0.72[a]	7.96 ± 1.23[b]	0.005**
No. of goslings	5.39 ± 0.51[ab]	3.68 ± 0.59[a]	6.03 ± 0.83[b]	0.029*
Total number of goose	20.71 ± 2.05[b]	12.62 ± 1.61[a]	21.62 ± 3.2[b]	0.008**

SD: standard deviation; NS: not significant; No. = Number; * p<0.05; ** p<0.01; a,b means on the same line followed by the same letter do not differ at the 5% threshold.

Table 6: Type of rearing, housing and feed used on goose farms by group (G) in northern Benin

Variables		Group 1 (n=41)		Group 2 (n=32)		Group 3 (n=29)		Chi²	P-value
		%	CI	%	CI	%	CI		
Breeding mode	Claustration	31.71[a]	14.24	37.5[a]	16.77	86.21[b]	12.55	11.87	0.002**
	Divagation	68.29[a]	14.24	62.5[a]	16.77	13.79[b]	12.55		
Type of housing	Semi-modern	7.32	7.97	0.0	0	67.79	19.52	5.61	0.229[ns]
	Improved	51.22	15.3	14.88	16.11	32.21	13.08		
	Traditional	41.46	15.08	85.12	18.51	0.0	0		
Breeding mode	Provend	4.88[a]	6.59	9.38[a]	10.1	48.28[b]	18.19	28.14	0.000***
	Cereals + SPAI	90.24[a]	9.08	100[a]	0	75.86[ab]	15.57		
	Food waste	92.68[a]	7.97	96.88[a]	6.03	5.52[b]	17.3		
	Green fodder	46.34[a]	15.26	25[a]	15	17.24[ab]	13.75		

CI: confidence interval; NS: not significant; ** p<0.01; *** p<0.001; a, b percentages on the same line followed by a letter do not differ at the 5% threshold. T. Improved = Improved traditional.

Table 7: Selection criteria and identification of geese by group (G) in northern Benin

Variables		Group 1 (n=45)		Group 2 (n=30)		Group 3 (n=27)		Chi²	P-value
		%	CI	%	CI	%	CI		
Goose identification	Cry	21.95	12.67	18.75	13.52	10.34	11.08	2.27	0.89[ns]
	Plastic ring	12.2	10.02	9.38	10.1	13.79	12.55		
	Size and silhouette	46.34	15.26	50	17.32	58.62	17.93		
	Plumage color	19.51	12.13	21.88	14.32	17.24	13.75		
Selection criteria for males	Conformation	39.02	13.25	31.25	12.23	48.28	12.33	8.36	0.39[ns]
	Fast growth	63.9	12.22	53.13	16.36	68.62	19.54		
	Health condition	31.22	12.56	28.13	10.58	37.93	13.55		
	Feather color	48.78	14.68	46.88	14.96	20.69	13.12		
	Age of sexual maturity	43.9	15.07	34.38	12.31	27.59	9.08		
Selection criteria for females	Conformation	60.98[a]	22.12	31.25[b]	14.36	44.83[b]	13.22	37.23	0.000***
	Fast growth	25.85[a]	12.89	35[a]	14.25	52.07[a]	15.92		
	Prolificity	73.17[a]	23.54	55.13[a]	17.06	78.17[a]	20.08		
	Feather color	29.27[a]	13.25	0[b]	0	27.59[a]	13.33		
	Precocity	2.44[a]	3.56	59.38[ab]	16.38	20.69[b]	14.71		
	Aptitude of brood-ing	51.22[a]	17.34	53.13[a]	15.59	65.52[b]	17.66		
Period of high mortality	Before weaning	24.63[a]	12.22	58.13[b]	18.44	55.38[b]	18.23	15.14	0.00***
	Between weaning and laying age	56.12[a]	17.22	30[b]	12.63	41.72[a]	12.88		
	Entry in laying	19.25[a]	13.52	11.88[a]	9.88	1.9[a]	3.52		

Cause of mortality of the animals	Humidity	36.59	12.76	37.5	16.32	51.72	21.24	2.38	0.66 ns
	Predator	24.39	13.84	28.13	13.54	17.59	14.22		
	Disease	9.76	11.41	28.13	13.54	30.69	13.65		
Difficulty encountered	Predation	19.51	14.11	18.75	12.84	13.79	14.42	6.99	0.32 ns
	Theft	17.07	12.63	31.25	14.22	41.38	14.63		
	High mortality	21.95	14.82	46.88	16.07	34.48	15.43		
	Cost of acquiring spawners	46.34	21.62	53.13	20.36	24.14	13.51		

CI: confidence interval; NS: not significant; *** p<0.001; a, b percentages on the same line followed by the same letter do not differ at the 5% threshold.

Goose identification and breeding management

To identify geese, breeders used call, plastic band, size and silhouette, and plumage color (Table 7). These signs used did not differ significantly between groups. However, the identification of these birds by size had higher proportions in all farms. Breeders had cues for selecting male and female breeders. These cues or criteria did not vary between groups for males, but the opposite was true for females (Table 7). The selection criteria for males were more rapid growth. For females, the selection criteria were based on conformation, fast growth, prolificacy, plumage color, precocity and broodability. The proportion of breeders using these criteria varied significantly between breeder groups, and this was most noticeable for earliness and conformation (p<0.001) in group 2. The proportion of the criterion related to earliness is higher in group 2 (59.38%) than in groups 1 (2.44%) and 3 (20.69%). Growth is faster in group 3 (52%) than in groups 1 (25.85%) and 2 (35%). Prolificity was higher in groups 1 (73.17%) and 3 (78.17%) than in group 2 (55.13%). The color of the plumage was totally absent and therefore was not used by the breeders of group 2 for the choice of breeding females.

Difficulties encountered on goose farms in northern Benin

Goose farming in northern Benin is facing a number of difficulties that were faced by the breeders. These include disease, theft, mortality, predation and the high cost of acquiring breeding stock. These difficulties did not differ between farms (p>0.05). Thus, the period of high mortalities was more noticed before weaning and between weaning and laying age. This period varied significantly between groups (p<0.01). The causes of mortality reported by the majority of respondents for domestic geese before weaning and between weaning and egg laying were in all cases moisture and predation. The mortality rate due to wetness was higher in group 3 (51.72%) than in groups 1 (36.59%) and 2 (37.5%). The mortality rate due to disease is higher in groups 2 (28.13%) and 3 (20.69%) than in group 1 (9.76%).

DISCUSSION

Education levels, age of goose farmers and household size did not differ between the two groups of farms. The results obtained for each of these characteristics on goose farms are close to those obtained by Houessionon et al. (2020) and Dotché et al. (2021) on muscovy ducks and turkeys, respectively, in southern Benin. Similarities on the level of education and age of farmers were also reported by Baruwa et al. (2018) in Nigeria on muscovy duck farming activities and Tshishi et al. (2021) in Congo on the local hen in the agro-ecological zone of Haut-Katanga. The present study showed that domestic goose farming is a predominantly male activity regardless of the type of farming practiced (84.31%). This male tendency is consistent with results obtained in poultry farming in Burkina Faso (Pindé et al., 2020), Benin (Dèdéhou et al., 2018; Dotché et al., 2021; Orounladji et al., 2022), Togo (Soara et al., 2020). Our results are, however, contrary to those obtained by other authors who argue that poultry farming (chicken and turkey) is traditionally female and practiced by about 80% of women and disadvantaged youth in most developing countries (Fosta et al., 2007; Bakoji et al., 2017). There are a number of reasons why women may not be involved in goose breeding in Benin, including lack of financial resources. In addition, the cost of a live goose is very high, which may also limit the purchase of a breeding pair, whereas women are more active in the trade of easily sold products. The proportion of traders and farmers engaged in goose farming is higher in group 1 and 2 respectively. This could be explained by the fact that agricultural production as in identified group 2, fills the daily food needs of the family and also generates significant cash income (Traoré et al., 2018). The goose farmers in group 3 carry out several types of activities. They are farmers, breeders, public service and private professional in the different areas studied. Goose farming in the majority of these households is therefore a secondary activity that provides the owners with a usual means of solving small problems. As a result, goose farming is not the only means of subsistence, but rather a complementary activity to the resources generated by the main activities. These results are similar to those reported on lo-

cal chicken farming in Benin (Youssao et al., 2013) and duck farming in Nigeria and Benin (Baruwa et al., 2018; Houessionon et al., 2020).

The main production objective of goose farmers is the production of meat for consumption in all identified farms. Thus, both local chickens and geese are produced for sale or for easily mobilized savings; this makes traditional poultry farming a source of monetary income or cash flow for most poor families (Ndayisenga, 2010). Similarly, farmers in northern Benin were motivated to raise geese for several reasons: hardiness, growth and profitability. Geese are also bred for prestige, which is one of the weakest motivations for some who breed this bird. This was most noticeable in group 3. This assertion corroborates with that of Nesseim et al. (2022) in the municipality of Thiès in Senegal, who pointed out that pigeon farmers are motivated by passion and/or attachment to the animals (75.4%), income generation (22.8%) and also self-consumption (1.8%). This same practice is also reported in the agro-ecological zones of Southern Benin (Houessionon et al., 2020) and in Southwestern Nigeria (Oguntunji, 2014).

It is also apparent from this study that the average total number of growing geese and growing females or males differed between groups. These numbers are similar to those of Houessionon et al. (2020) in southern Benin on the Barbary duck. Our results corroborate the observations made by Dotché et al. (2021) on turkeys, where small-scale goose farmers tend to have flocks of less than 10 heads, which is also noted in type 2 farms. The size of goose flocks encountered in northern Benin is lower than the guinea fowl numbers identified on farms in Côte d'Ivoire (Koné et al., 2017), which hover around 10 to 50 heads. This same trend is obtained among local chicken farmers in different agro-ecological zones of Burkina Faso (Pindé et al., 2020). Thus, the low average numbers of growing geese recorded in group 2 would be related to the socioeconomic profile, the difficulties of the breeders to access the goose pair or the breeding mode.

In the present study, the geese are reared on the one hand in an extensive free-range system where the birds roam the village in search of food throughout the day. This result is consistent with (Wilson and Yilmaz 2013) who point out that goose production is almost entirely free-range, backyard type and almost all production is for home consumption. Geese can even be successfully raised on pasture with little equipment and simple housing facilities, in areas with green grass almost year-round (Sarı et al., 2021). Birds are left to their own devices in this case, are not always monitored, and their diet consists mainly of "peckable" residual feed (Ouedraogo et al., 2015). In contrast, on group 3 farms, nearly half of the farmers give the birds a supplemental feed (feed). This may be due to the availability of commercial feed for other poultry species on some farms, which also benefited the geese. These farmers take better care of the birds in terms of food because apart from trade, they consume the geese and use them in various traditional ceremonies such as dowry, sacrifices and others as pointed out by the farmers in group 1 and 2. The same observations were made by Oguntunji (2014) in southwestern Nigeria. Most of the goose farmers surveyed have housing (chicken coop, kitchen, store, room) for their poultry. This is confirmed by Ayssiwede et al. (2013) in traditional or indigenous chicken farming in Senegal and Africa. In some flocks, there is no suitable habitat that provides good protection for the birds from weather and predators. Summary poultry houses were built from local materials (grass stems and straws, scrap metal, etc.) and are used for geese. Similar studies on traditional poultry housing show that these sketchy chicken coops based on precarious materials are otherwise poorly maintained, undisinfected, rarely cleaned; their roofs usually serve as dumping grounds for useless household items (Ouedraogo et al., 2015).

Breeding criteria for these birds varied among the breeding groups. Broodability, precocity, feather color, and conformation differentiated these breeding groups in females. In contrast, in males, rapid growth was the most used criterion for the choice of breeders in the three groups. The selection criteria for geese are similar to those obtained for the Muscovy duck in southern Benin (Houessionon et al., 2020). In most turkey farms in Nigeria, farmers rely on the weight of the birds (Amao et al., 2014). The choice for fast growth based on the use of goose size would therefore be related to the lack of weight data recording. The criteria of health, hardiness, fast growth and even prolificacy noted as motivations for choosing hens to raise were also reported by Fotsa et al. (2007) who thus concluded that this denotes the importance of birds in rural economies.

The various constraints most frequently cited by goose farmers are the high cost of purchasing breeding stock, disease, theft and predators. Numerous studies generally conducted in developing countries have also reported these constraints in poultry farming (Nahimana et al., 2016; Idrissou et al., 2018; Dotché et al., 2021). Thus, the record of high mortality before and during weaning can be explained by the lack of monitoring related to the precarious rearing conditions that breeders provide to the chicks. After hatching, these chicks face multiple environmental challenges (Amanidja et al., 2018). Similarly, high mortality rates could be explained by insufficient sanitary monitoring of goose farms and the non-existence or non-compliance of poultry houses (Pindé et al., 2020). Also, while roaming, the small birds are a prey for some predators. As far as hygiene rules are concerned, apart from sweeping the

pens and kitchen, no disinfection is done when the geese are roaming. This is more observed in group 2 farms. They are made only in the breeders having the animals in confinement. This is due to the presence of other commercial species found in some farms. Consequently, group 2 gooses farmers do not have a medical prophylaxis program and rely on self-medication when necessary.

CONCLUSION

Local poultry production contributes to food security and poverty alleviation through animal protein and income from goose meat and eggs. The most commonly practiced management system was the extensive system that was largely dominated by farmers, herders and traders, mainly men. The study on the characteristics of goose farms in northern Benin revealed three groups of goose farmers according to their farming practices. Breeding conditions were more satisfactory in Group 3 followed by Group 1. In Group 2, the more marked deficiencies in hygiene and biosecurity expose the farms to environmental challenges that affect productivity on the farms. Similarly, the poor organization of the goose farmers does not allow them to meet their feed costs. To develop goose farming in northern Benin, it is necessary to improve housing and feeding of poultry in Groups 1 and 2, to put in place strategies to control mortality and theft, and to facilitate access to markets for livestock products in all groups.

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CONFLICT OF INTEREST

The authors have no conflict of interest.

NOVELTY STATEMENT

This study was carried out for the first time in West Africa to show the situation of geese breeding in northern Benin through a typology.

AUTHOR CONTRIBUTION

Maximilien Azalou: Conceptualization, Data Curation, Methodology, Formal Analysis, Investigation, Software, Writing - original draft. **Claude Cocou Kpomasse**: Formal Analysis, Investigation, Supervision, Writing - original draft. **Alassan Seidou Assani**: Conceptualization, Data Curation, Methodology, Software, Supervision, Writing - original draft. **Ibrahim Traoré Alkoiret**: Conceptualization, Validation, Supervision, Writing - original draft, Visualization. **Wéré Pitala:** Methodology, Supervision, Validation, Writing - original draft, Visualization.

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