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ANALYSIS OF MUSCOVY DUCK (*CAIRINA MOSCHATA*) PRODUCTION SYSTEMS IN AN URBAN SETTING IN KORHOGO, CÔTE D'IVOIRE

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ABSTRACT

Background: The Muscovy duck (*Cairina moschata*) is an important local poultry resource in Africa, yet urban production systems remain poorly documented in Côte d'Ivoire.

Methods: A questionnaire survey was conducted among 100 duck farmers across 15 neighborhoods of Korhogo. Data was analyzed using descriptive statistics and chi-square tests, followed by multiple correspondence analysis (MCA) and hierarchical clustering.

Results: Farmers were mostly adult men (87%, 86%) working in the informal sector (57%). Management was traditional: rudimentary housing (96%), no health monitoring (97%), natural incubation, and feeding based on food scraps. Theft (87%) and accidents (80%) were the main constraints, and 85% of farmers raised ducks for both household consumption and sale. MCA (27.9% of inertia over four axes) and clustering identified two groups (n = 33 and n = 67) differing in farming experience ($p < 0.001$), origin of breeding stock ($p = 0.04$) and feeding ($p = 0.012$).

Conclusion: Urban Muscovy duck farming in Korhogo follows a subsistence logic with sale of surpluses, and would benefit from improved shelter security, health support and farmer training.

Keywords: *Cairina moschata*, Muscovy duck, Production systems, Urban livestock, MCA, Korhogo, Côte d'Ivoire.

1 INTRODUCTION

Small-scale poultry farming plays a major role in food security and household income in sub-Saharan Africa, where it requires few inputs and remains accessible to vulnerable groups [1, 2]. While chickens dominate these systems, other local species, notably the Muscovy duck (*Cairina moschata*), are gaining importance because of their hardiness and

economic value [3]. Under smallholder conditions, this species tolerates heat, fluctuating feed resources, and endemic diseases better than commercial breeds [3], and it adapts to a wide range of management practices, from free-range to partially confined rearing [4].

Despite this interest, the Muscovy duck remains insufficiently characterized in tropical regions, which hinders the design of strategies for the selection and sustainable management of this local genetic resource [3]. In Côte d'Ivoire, duck farming is still described as rudimentary. In the forested south, the dominant system is extensive, free-range family farming (88.62% of farmers), with high duckling mortality [5]. To our knowledge, however, existing studies focus on the forest zone and mainly on rural settings, and information on the northern part of the country, particularly on urban areas, is scarce.

Livestock keeping in urban and peri-urban areas follows its own logic. Space is limited, free-range scavenging is constrained by coexistence with neighbors and by public health concerns, and feed relies largely on food scraps and purchased resources [6]. Urban farmers are also more diverse in age, occupation, education, and experience than their rural counterparts. Korhogo, a major city in northern Côte d'Ivoire undergoing rapid population growth [7], is a relevant setting for studying these systems. Yet little is known about feeding, housing, breeding, and health management practices in its duck farms, about the constraints farmers face, or about how these factors combine into distinct farming systems.

Characterizing production systems is a prerequisite for any support program. It identifies practices that need improvement, helps target interventions, and contributes to preserving local populations, which are threatened by uncontrolled crossbreeding and replacement by exotic breeds [3]. Because survey data on farming practices are mostly qualitative, multivariate methods such as multiple correspondence analysis (MCA) followed by hierarchical clustering are well suited to summarizing the diversity of practices into usable farmer typologies.

The general objective of this study was therefore to analyze the Muscovy duck production systems in urban Korhogo, Côte d'Ivoire, in order to provide baseline information for improving their productivity and sustainability. More specifically, the study aimed to:

- describe the socioeconomic profile of duck farmers;
- characterize farming practices (origin of breeding stock, feeding, housing, incubation, and health monitoring);
- identify the constraints faced by farmers and their production objectives; and
- establish a typology of farmers using MCA followed by hierarchical clustering and identify the factors that discriminate among the resulting groups.

2 MATERIAL AND METHODS

2.1 Study Area

The city of Korhogo constituted the study area. It is located in northern Côte d'Ivoire and serves as the capital of the Savanes District and the Poro Region (Figure 1). The population of the commune of Korhogo has experienced significant growth in recent years, reaching 850,000 inhabitants by 2024 [7]. The local climate is of the Sudanese type, with a wet season from June to September and a dry season from October to May. It is characterized by small temperature variations, with an average of 30 °C. Annual rainfall ranges from 900 to 1,500 mm/year [8, 9]. The vegetation of the Savanes District, of which the municipality of Korhogo is a part, consists of wooded savanna. It is characterized primarily by trees and shrubs, generally ranging in height from 8 to 12 m. Vegetation cover density is approximately 25 to 35 percent. The topography of the study area is plateau-like, with elevations averaging between 300 and 400 m. The soils are of the ferrisol type [10].

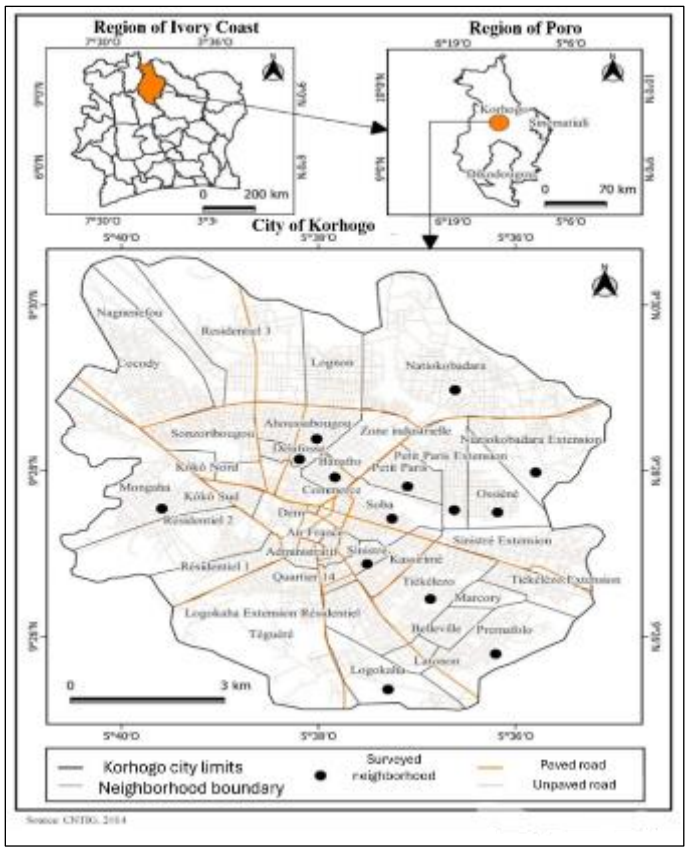


Figure 1: Map of the study area

2.2 Methodology

2.2.1 Identification of Duck Farmers and Selection of Sites

Surveys were conducted using a questionnaire designed to identify and select duck farmers. Identification and selection criteria were developed for this purpose. These included, among others, the accessibility of the farmer's farm, a flock size of at least five (5) ducks, and at least 1 year of experience in duck farming. A total of 100 farmers were considered across 15 neighborhoods in the city of Korhogo known for their duck farms. The breeders were selected based on their availability to host the study on their farms.

2.3 Data Processing and Statistical Analysis

Data collected through questionnaires were entered into a Microsoft Excel spreadsheet, checked, and coded prior to analysis. All analyses were performed using R software version 4.6.1.

All variables were treated as categorical; quantitative variables (age and years of experience) were grouped into classes. Results are expressed as counts and as percentages of the total sample (N = 100). For each variable, the distribution of categories was compared to an equal distribution using Pearson's chi-square goodness-of-fit test. An exact test (Fisher's exact test or Monte Carlo simulation) was used when expected counts were below 5.

To describe the structure of the farming systems, a multiple correspondence analysis (MCA) was performed on twelve active categorical variables: gender, age class, years of experience, education level, occupation, origin of breeding stock, feeding, housing type, health monitoring, incubation method, constraints, and farming objectives. The relationship between each variable and the factorial axes was measured by the correlation ratio (η^2). Eigenvalues and percentages of inertia were used to determine the number of axes retained.

Farmers were grouped by hierarchical clustering on principal components (HCPC) of the MCA, using Ward's criterion and Euclidean distances. The optimal number of clusters was determined from the inertia gain and the relative inertia of the dendrogram, and the partition with the lowest relative inertia was retained.

2.3.1 Characterization of the Livestock Farming System

2.3.1.1 Socioeconomic Profile

Table I presents the socioeconomic profile of the duck farmers. Duck farming in the municipality of Korhogo is primarily carried out by men. In fact, 87% of duck farmers are men, compared to only 13% who are women; this difference is highly significant ($p < 0.05$). In terms of age groups, most duck farmers fall into the adult category (86%), whereas young people and the elderly account for only 9% and 5%, respectively, of each age group. A significant difference ($p < 0.05$) was observed, reflecting the strong involvement of adults in duck farming within the adult population.

Regarding experience in duck farming, the largest group consists of farmers with 5 to 10 years of experience (49%), followed by those with 0 to 5 years of experience (35%), while those with more than 10 years of experience represent the smallest group (16%). In terms of experience, significant differences were observed between the various groups at a 5% significance level.

In terms of educational attainment, 36% of farmers had received no formal education. Primary, secondary, and university education levels accounted for 22%, 27%, and 15%, respectively, of the farmers surveyed. The differences observed between educational levels were statistically significant ($P = 0.02$) at the 5% significance level.

Finally, regarding the occupations of livestock farmers, workers in the informal sector accounted for the largest share at 57% of the workforce, followed by salaried employees, who represented 14% of respondents. Farmers who also raise livestock accounted for 16% of the workforce, while schoolchildren and college students accounted for 7%. The unemployed constituted the smallest group, at 6%. This distribution showed a significant difference ($p < 0.05$), revealing a higher proportion of workers in the informal sector among the livestock farmers surveyed.

Overall, the socioeconomic profile of the livestock farmers surveyed was characterized by a predominance of adult males, varying levels of experience in the activity, a low level of education, and a strong presence in the informal sector (Table I)

Table 1: Socioeconomic Profile of Livestock Farmers

Variables	Characteristics	Frequency (N=100)	P. value
Gender	Male	87% (87)	$1.362\times10^{-13***}$
	Female	13% (13)	
Age Groups	Youth	9% (09)	$2.2\times10^{-16***}$
	Adults	86% (86)	
	Seniors	5% (05)	
Expérience	(0-5)	35% (35)	$2.25\times10^{-4***}$
	(5-10)	49% (49)	
	+10 years	16% (16)	
Education Level	None	36% (36)	$0,02^{*}$
	Elementary	22% (22)	
	High School	27% (37)	
	University	15% (15)	
Occupation	Employee	14% (14)	$2.2\times10^{-16***}$
	Informal worker	57% (57)	
	Farmer/rancher	16% (16)	
	Student	7% (7)	
	Unemployed	6% (6)	

The numbers in parentheses () indicate the sample size for each category: "* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; NS: not significant"

2.3.1.2 Characteristics of Duck Farming

There are two ways to acquire ducks: through donation or purchase. The method preferred by farmers was purchasing ducks (60% of farmers). This distribution of origins shows a significant difference at the 5% significance level. The diet of Muscovy ducks consisted mainly of food scraps (FS) and grain supplements (GS), primarily corn. This feeding practice was observed in 57% of the farms surveyed. Farms that fed their animals only food scraps (FS) accounted for 34% of the total flock, while those that supplemented food scraps and grain with additional feed (AF) accounted for 9%. The distribution of feeding methods also showed a statistically significant difference at the 5% significance level compared to an independent distribution. In terms of housing, nearly all farms (96%) used traditional structures, compared to only 4% that had improved housing.

Furthermore, health monitoring also appeared to be insufficient. In fact, 97% of farmers did not conduct any health monitoring, while only 3% of farms received veterinary care. The incubation method used by Muscovy duck farmers in the municipality of Korhogo was primarily natural incubation, accounting for 99% of the flock, compared to % who practiced artificial incubation.

Muscovy duck farming in Korhogo is subject to significant constraints ($p < 0.001$). Only 13% of farmers reported encountering no constraints. Theft was the most frequently cited difficulty: it was cited as the sole constraint by 7% of farmers and in combination with other constraints by 80% of them, for a total of approximately 87%. This was followed by accidents, mentioned by 80% of farmers, 51% of whom cited them in conjunction with theft. Rain and disease are cited by 12% and 17% of farmers, respectively. These constitute minor constraints.

The objectives are highly skewed ($p < 0.001$). Most farmers (85%) raise their ducks both for family consumption and for sale; 13% raise them exclusively for family consumption, and only 2% raise them exclusively for sale. Thus, 98% of farmers use all or part of their production for their own consumption, and 87% sell a portion of it. Duck farming is therefore driven by a subsistence model with the sale of surplus production, rather than by a specialized commercial model.

Table 2: Characteristics of farming practices, constraints, and objectives of Muscovy duck (*Cairina moschata*) farmers in urban areas of Korhogo

Variables	Characteristics	Frequency (N=100)	P. value
Origin of Breeding Stock	Purchase	60 % (60)	0.04^{*}
	Donation	40 % (40)	
Feeding	FS	34% (34)	$6.7\times10^{-08***}$
	FS ; GS	57 % (57)	
	FS ; GS ; AF	9 % (9)	
Housing Type	Traditional	96 % (96)	$2.2\times10^{-16***}$
	Improved	4 % (4)	
Health Monitoring	None	97% (97)	$2.2\times10^{-16***}$
	Veterinary	3 % (3)	
Incubation Method	Natural	99 % (99)	$2.2\times10^{-16***}$
	incubator	1% (1)	
Constraints	Nothing	13% (13)	$3.045\times10^{-13***}$
	Theft	7% (7)	
	Theft; accident	51% (51)	
	Theft; accident; rain	12% (12)	
	Theft; accident; medical condition	17% (17)	
Objectives	Retail	2% (2)	$2.2\times10^{-16***}$
	Household consumption	13% (13)	
	Household consumption and retail	85% (85)	

The numbers in parentheses () indicate the sample size for each category: "* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; NS: not significant"

2.4 Multiple Correspondence Analysis (MCA)

2.4.1 Eigenvalues

Multiple correspondence analysis (MCA) performed on the sample reveals a cumulative variance corresponding to 27.9% of the total variance. Axis 1 has an eigenvalue of 0.24, representing 8.1% of the total variance. Axis 2 has an eigenvalue of 0.21, representing 7.1% of the total variance. Axes 3 and 4 have eigenvalues of 0.19 and 0.18, respectively. These values account for 6.4% and 6.3% of the total variance, respectively (Table III).

Table 3: Eigenvalues and inertia percentages for the first five axes

Parameter	Axis 1	Axis 2	Axis 3	Axis 4
Eigenvalue	0.24	0.21	0.19	0.18
Percentage of Inertia (%)	8.1	7.1	6.4	6.3
Cumulative percentage of Inertia (%)	8.1	15.2	21.6	27.9

2.4.2 Contribution of Variables to the Construction of the Axes

Figure 2 presents the contribution of the twelve active variables to the construction of the first four axes of the MCA (Multiple Correspondence Analysis). Each axis is structured by a distinct set of variables.

Axis 1 describes health and technical practices, as well as constraints. This first axis is driven by constraints (0.61), health monitoring (0.55), and the incubation method (0.51). Education level (0.40), gender (0.32), and farming objectives (0.20) also make notable contributions. Other variables specifically age, length of experience, feeding, and type of housing contribute very little (< 0.06). This axis contrasts farmers who employ improved practices (such as veterinary oversight and controlled incubation) who also tend to have higher levels of education with farmers who follow traditional practices; it is associated with the types of constraints encountered and the farmer's gender.

Axis 2 describes experience and education. This second axis is dominated by education level (0.71) and length of experience in farming (0.67). Farming objectives (0.21) and housing type (0.18) play a secondary role, while variables related to health, incubation, and constraints have almost no impact. This axis distinguishes farmers based on their human capital, that is, their training and experience independent of their technical practices.

Axis 3, meanwhile, describes professional profile and sourcing. This third axis is structured by profession (0.40), the origin of breeding stock (0.31), gender (0.24), and farming objectives (0.23), with a smaller contribution from length of experience and education (ranging from 0.16 to 0.19). It reflects how professional activity and the channels for sourcing breeding stock (through purchase or donation) combine with the purpose of the livestock operation.

Axis 4 describes housing and the purpose of the operation. This fourth axis is primarily defined by the type of housing (0.40) and the breeding objectives (0.35). Education, age, and length of experience contribute only modestly (0.19 to 0.21).

The differentiation among breeders is based first on sanitary and technical practices as well as constraints (Axis 1), followed by education and experience (Axis 2), professional profile and the origin of breeding stock (Axis 3), and finally, housing and objectives (Axis 4). Age and feeding practices contribute little to any of the axes, while gender is a factor primarily on Axes 1 and 3.

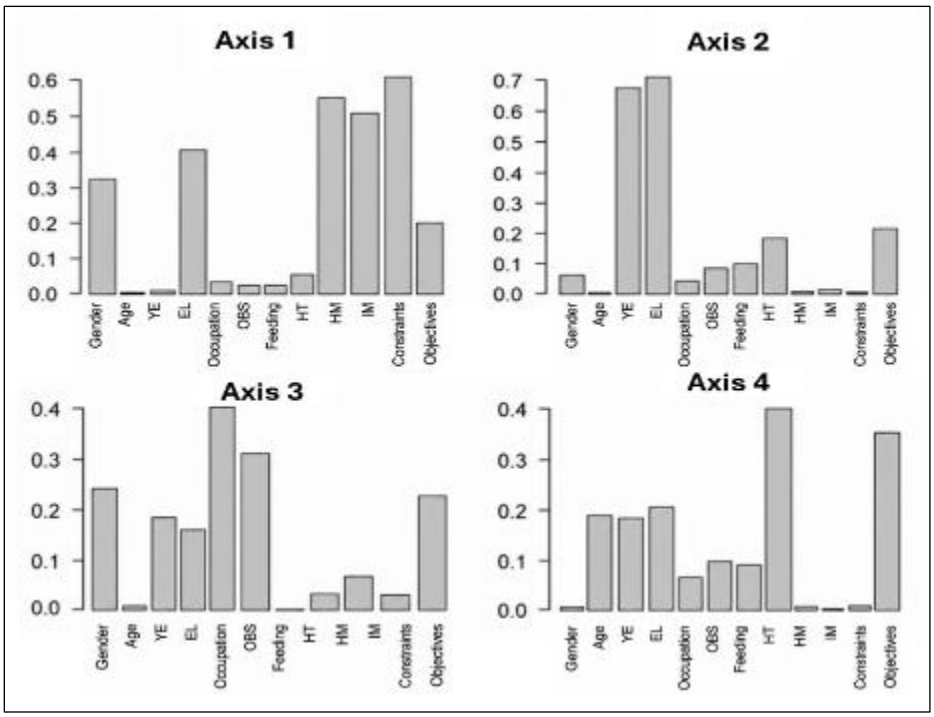


Figure 2: Contribution of the variables to the first four factorial axes.

YE: Years experience, EL: Education Level, OBS: Origin of Breeding Stock, HT: Housing Type, HM: Health Monitoring, IM: Incubation Methods,

The determination of the optimal number of groups is shown in Figure 3. The number of groups was determined based on the evolution of the HCA's inertia (Figure 3-A). The loss of inertia is greatest when moving from one to two groups; thereafter, the decline becomes gradual, with no clear break beyond that point. This result is confirmed by the relative inertia (Figure 3-B), whose lowest value (≈ 0.949) is observed for a partition into two groups. This value then increases before stabilizing beyond 15 groups. A two-class partition was therefore selected as optimal. It offers the advantages of parsimony and ease of interpretation, even though the gain in inertia remains moderate, indicating a differentiation of farmer profiles that is gradual rather than strictly distinct.

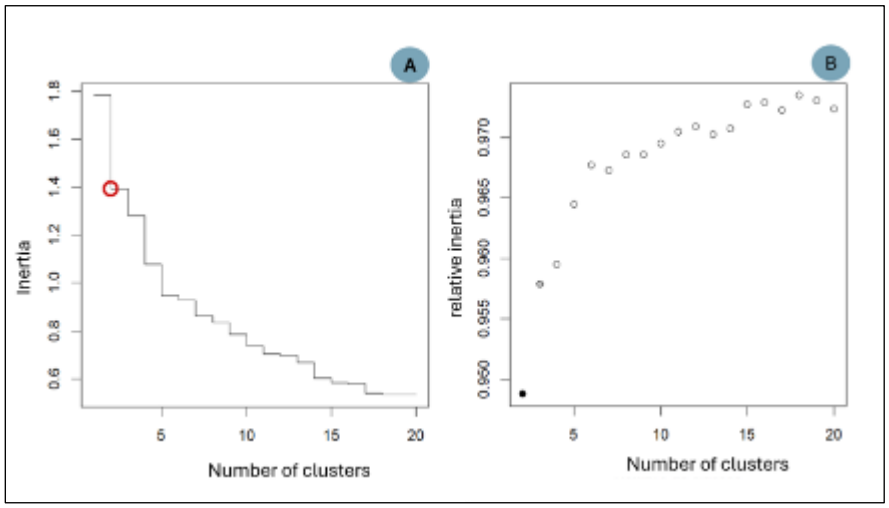


Figure 3: Determination of the optimal number of groups using the relative inertia loss method

Figure 4 displays the individuals from our sample on the 1–2 (A) and 3–4 (B) factorial planes of a Multiple Correspondence Analysis (MCA), with a partition into two groups. The ellipses represent 95% confidence intervals around the barycenters of each group.

The 1–2 factorial plane (A) accounts for approximately 15% of the total inertia (8.1% for axis 1 and 7.1% for axis 2). The two groups are primarily separated along axis 2. Group 1 (in red) is in the upper part of the plane, while Group 2 (in blue) occupies the central and lower sections. The barycenters are close to one another, and the ellipses partially

overlap, indicating a real but moderate separation between the groups. Group 2 contains more individuals and is more compact; its members are concentrated around the origin, reflecting profiles that are close to the sample's average profile. Group 1, which is smaller, is more dispersed along axis 1, with a few highly outlying individuals (notably one individual positioned at the far right of the plane). These atypical individuals exhibit rare combinations of categories and contribute significantly to the inertia of axis 1.

Factorial plane 3–4 (B). On the 3–4 plane (accounting for 6.3% and 6.4% of the inertia, respectively), the two groups overlap extensively: the barycenters are nearly coincident, and the ellipse for Group 1 is contained within that of Group 2. Consequently, axes 3 and 4 do not contribute to the discrimination between the groups, which remain driven by the first two axes. Group 2, by contrast, exhibits greater internal heterogeneity, with individuals distributed in all directions across the plane.

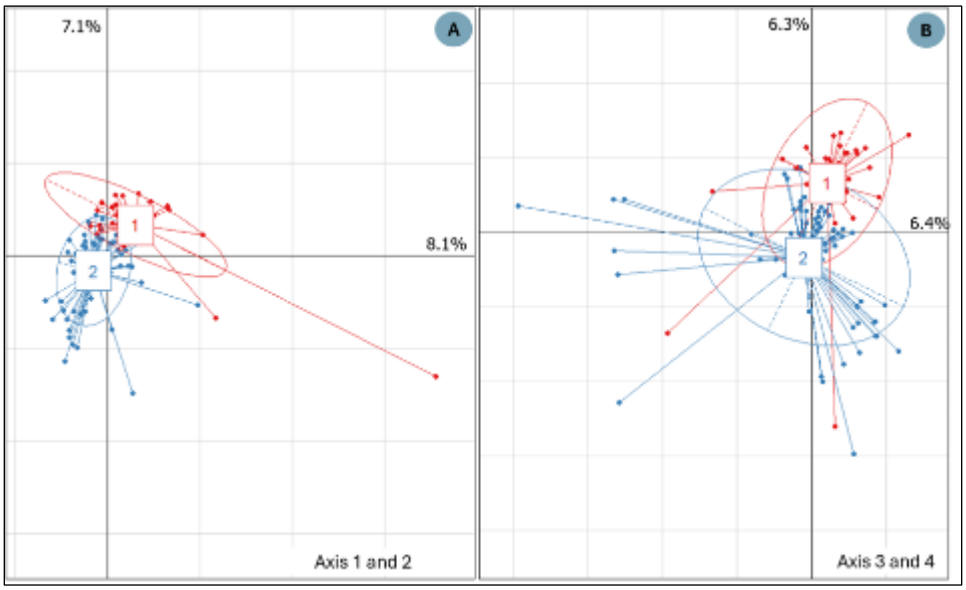


Figure 4: Presentation of the different groups obtained through partitioning using the Multiple Correspondence Analysis (MCA) method; plane A of the MCA accounts for 15.2% of the total variability, compared to 12.7% for plane B.

Table IV presents the composition of the two groups resulting from the classification (cluster 1: n = 33; cluster 2: n = 67) based on three variables, all of which differ significantly between the groups.

Years of experience is the most discriminating factor ($p < 0.001$). Cluster 1 consists almost exclusively of breeders in the [5–10] years category (96.97%), whereas cluster 2 is dominated by the [0–5] years category (71.64%) and also includes 23.88% of breeders with more than 10 years of experience. No breeder in cluster 1 belongs to the latter category. Cluster 1 is therefore homogeneous, while cluster 2 is more heterogeneous.

Regarding the origin of breeding stock, the difference is significant ($p = 0.04$). Purchasing is the predominant method in cluster 1 (75.76%), while receiving animals as gifts is significantly more common in cluster 2 (47.76% versus 24.24%). This reflects more market-oriented supply channels in the first group and more informal ones in the second.

As for feeding, practices differ between the groups ($p = 0.012$), though both rely on food scraps. Cluster 2 is characterized primarily by a combination of food scraps and grain (67.16% versus 36.36%), whereas cluster 1 makes greater use of food scraps alone (48.48% versus 26.87%) and a more comprehensive feeding regimen that includes supplementation (15.15% versus 5.97%).

Table 4: Composition of the different groups in relation to the main discriminating factors

Variables	Category	Cluster 1 (n=33)	Cluster 2 (n=67)	P-Value
Année d'expérience	[0-5]	3.03% (1)	71.64% (48)	$2.2\times10^{-16***}$
	[5-10]	96.97% (32)	4.48% (3)	
	[10 et plus [	0% (0)	23.88% (16)	
Origin of Breeding Stock	Purchase	75.76% (25)	52.24% (35)	0.04*
	Donation	24.24% (8)	47.76% (32)	
Feeding	FS ; GS	36.36% (12)	67.16% (45)	0,012*
	FS ; GS ; AF	15.15% (5)	5.97% (4)	
	FS	48.48% (16)	26.87% (18)	

FS: food scraps; GS: grain-based feed; AF: dietary supplementation, The numbers in parentheses () indicate the sample size for each category: "* p < 0.05; ** p < 0.01; *** p < 0.001; NS: not significant"

3 DISCUSSION

Muscovy duck farming in Korhogo is an activity carried out primarily by men (87%) and adults (86%), mostly by individuals working in the informal sector (57%) with low levels of formal education (36% have no formal schooling). This male predominance is more pronounced than in Benin, where participatory surveys found that 77.78% of duck farmers were men [3, 11], and in other West African regions where female participation varies [12, 13, 15]. This may reflect specific characteristics of the urban environment in northern Côte d'Ivoire, such as access to space, capital, and purchasing networks, though this hypothesis remains to be tested. The significant presence of the informal sector confirms the role of livestock farming as a supplementary activity for households with irregular incomes, consistent with the role of family-based poultry farming within African rural and peri-urban economies [1, 2]. Furthermore, studies across Nigeria and West Africa similarly highlight that indigenous poultry rearing serves as an accessible economic buffer for informal urban and rural households [13, 14, 18, 20].

The systems observed are largely traditional: they involve rudimentary housing (96%), a lack of veterinary or health monitoring (97%), and natural incubation (over 95%). The birds are fed on food scraps either alone (34%) or combined with cereals (57%). This pattern aligns directly with that described in the forested southern region of Côte d'Ivoire, where 88.62% of farmers practice extensive, free-range rearing, with birds provided with shelter at night in 98% of cases, and high mortality rates among ducklings [5, 12]. It also mirrors duck farming practices documented in the urban environment of Dolisie (Congo) [4], as well as in southern Benin [3, 11, 16] and Nigeria [6, 14, 17, 19, 21], which are consistently characterized by free-roaming daytime scavenging, household waste feeding with minimal grain supplementation, and rudimentary nighttime shelter. Practices in Korhogo thus appear similar to those in other African cities, characterized by a very low level of technical improvement and heavy reliance on scavenging feed resources.

The urban context is clearly reflected in the constraints: theft (reported by 87% of farmers) and accidents (80%) are the primary issues, while diseases are cited by only 17% of farmers. This contrasts with the high duckling mortality rates and disease/parasitic pressures reported in southern Côte d'Ivoire [5, 12] and other West African regions [14, 16, 21]. The lack of veterinary oversight suggests that health issues may be underreported or misidentified by farmers; actual mortality rates should be measured directly through longitudinal surveys. High exposure to theft and accidents is consistent with animals roaming freely in a densely populated urban environment and the use of poorly secured or makeshift shelters.

For 85% of farmers, ducks are raised both for family consumption and for sale; only 2% raise them exclusively for sale. The activity is therefore driven by subsistence-based logic, with any surplus being sold rather than following a specialized commercial model. This aligns with the fundamental role of small-scale family poultry farming in ensuring household food security and income stability [1, 2]. Similar multi-purpose objectives (meat/egg production and emergency financial reserve) have been reported for Muscovy ducks across various agro-ecological zones in West Africa, including Benin, Cameroon, and Nigeria [13, 15, 16, 20].

Multiple Correspondence Analysis (MCA) accounts for 27.9% of the inertia across four axes, a typical result for this type of exploratory multidimensional analysis, though one that warrants caution. The first axis contrasts health and technical practices against constraints; however, these practices are nearly uniform across the sample (with 96–97% of respondents following traditional methods). This axis is therefore likely driven by a small minority of farmers who have adopted improved practices, rather than by a continuous gradient. The second axis reflects human capital (education

and experience). Classification into two groups ($n = 33$ and $n = 67$) reveals a moderate differentiation, with overlapping ellipses; this suggests a continuum of profiles rather than two distinct, clear-cut types. Group 1 consists of farmers with intermediate experience (5 to 10 years) who are more likely to purchase their breeding stock (75.76%). Group 2, dominated by beginners (71.64%), relies more on receiving stock as gifts (47.76%) and on feeding practices combining food scraps with cereals (67.16%). These differences point to a more market-oriented approach in Group 1, compared to more informal exchange networks in Group 2.

3.1 Limitations

(i) The purpose of the sample (100 farmers across 15 neighborhoods) does not allow for generalization to the entire city of Korhogo. (ii) The survey is cross-sectional and based on self-reported data, with no objective measurement of performance (e.g., mortality, egg-laying, or growth rates). (iii) Statistical tests comparing the groups are based on the same variables used to construct the classification, which renders the resulting p-values overly optimistic. (iv) Several categories have very small sample sizes.

3.2 Implications

Securing animal shelters, implementing basic health monitoring, and providing training for farmers, especially newcomers, emerge as priority interventions. Furthermore, the need to preserve local populations, which are threatened by uncontrolled crossbreeding [3, 11], underscores the importance of future phenotypic, morphometric, and genetic characterization in northern Côte d'Ivoire, as has been highlighted in recent characterization studies across West Africa [13, 15, 17, 18, 19, 20, 21].

4 CONCLUSION

This study provides the first description of Muscovy duck production systems in the urban environment of Korhogo. Rearing is primarily carried out by adult men with limited formal education, who work within the informal sector. The systems employed are traditional, characterized by rudimentary housing, natural incubation, a diet based on food scraps, and an almost complete lack of veterinary oversight. Theft and accidents are the primary constraints, and production is intended for both household consumption and sale. Multiple Correspondence Analysis (MCA), followed by cluster analysis, identifies two groups of farmers differentiated mainly by their length of experience, the source of their breeding stock, and the feeding practices used though the separation is moderate, reflecting a continuum of profiles. These findings offer a foundation for support initiatives tailored to an urban setting (such as securing shelters, providing veterinary guidance, and offering training). Further research is warranted regarding zootechnical performance, mortality rates, and the genetic diversity of local populations.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no conflicts of interest.

Statement of informed consent

Informed consent was obtained from all duck farmers who agreed to participate in this study. Before data collection, the objectives, nature, and procedures of the study, as well as the intended use of the information collected, were clearly explained to each participant. Farmers were informed that their participation was entirely voluntary and that they could decline to answer any question or withdraw from the study at any time without any adverse consequences.

Author contributions

SKA: literature review, data collection, statistical analysis, and manuscript drafting. KHMK: literature review, statistical analysis, and manuscript drafting. WGMT, SB, and SDP: contribution to the drafting of the manuscript. DPS: general supervision, manuscript revision, editing, and finalization.

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