



Senegalese Ladoum sheep: phenotypic and zootechnical characteristics and husbandry practices

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Keywords: Husbandry practices, Ladoum sheep, Morphobiometric characteristics, Senegal

Submitted 22/07/2026, Published online on 30th September 2026 in the [Journal of Animal and Plant Sciences \(J. Anim. Plant Sci.\) ISSN 2071 – 7024](#)

1 ABSTRACT

Ladoum sheep farming is emerging in Diourbel, Senegal, but husbandry-related productivity and operational challenges may constrain the breed's zootechnical performance. This study, conducted via surveys of 20 Ladoum sheep farmers. It aimed to update knowledge about the Ladoum Sheep breed by analyzing its phenotypic, zootechnical characteristics and farming practices. The results showed that farming is carried out intensively with well-equipped sheep pens. It is a secondary activity practiced predominantly by men, who are often well-educated. However, the sheep are affected by various diseases that limit production performance. The study identified three types of Ladoum sheep based on morphobiometric characteristics. Males (type 1) exhibit the largest biometric traits (weight, body length, thoracic perimeter), confirming the strong sexual dimorphism. In contrast, females display higher variability (type 2) represent average sized reproductive stock kept for fertility and maternal qualities, while larger ewes (type 3) point to progressive selection. These characteristics reveal a diversity of individuals among females and young stock, whereas rams exhibit more uniform traits. The study suggests that the farmers' strategy is to produce large- framed animals by using high performing rams with a more diverse female population.

2 INTRODUCTION

Senegal, like most tropical developing nations, derives the bulk of its resources and livelihood from the primary sector, and more specifically from agriculture and livestock production. The national herd value is estimated at 847.48 billion CFA francs, of which nearly 585 billion CFA francs is attributed to ruminant livestock alone, according to the National Livestock Development Plan (PNDE, 2016). Macroeconomic indicators show a real term increase in livestock value added of 2.7% in 2018, following substantial growth rates of 3.5%

in 2017 and 8.7% in 2016. However, its relative weight within the primary sector experienced minor contractions between 2016 and 2018. Indeed, while representing 27.9% of the overall primary sector value added in volume in 2016, the share of the livestock sub-sector fell to 25.4% in 2017 and 23.7% in 2018, respectively. Similarly to the primary sector, the share of livestock in the national Gross Domestic Product (GDP) registered declines, shifting from 4.0% of nominal GDP in 2016 to 3.8% in 2017, then to 3.6% in 2018, before recovering to



4.4% in 2019. Meanwhile, the contribution of the broader agricultural sector to national value added was estimated at 24.3% in 2020 (Thioune *et al.*, 2022). In nominal terms, the value added created by the livestock sector stood at 460 billion CFA francs in 2018. During this same period, Senegal experienced a growing reliance on dairy imports, which increased by 2.8% from 29,773 tons in 2016 to 30,618 tons in 2017. This growth was mainly driven by powdered milk, which constituted the bulk of dairy imports at over 93% (Thioune *et al.*, 2022). Regarding small ruminant farming, it has taken on a prominent role within the animal production sector, actively contributing to rural and peri-urban household economies. Small ruminant production offers numerous advantages, such as ease of management without formal prior training and less demanding feeding requirements (Tchouamo *et al.*, 2005). Additionally, grazing animals stimulate plant vegetative growth, remove excess biomass, and contribute to nutrient cycling (Ndiaye, 2015). Despite these advantages, small ruminants have historically received limited scientific attention. Socio-economic research on traditional Senegalese livestock systems has long prioritized bovine production, which was perceived as more economically profitable (Diaw, 1995). However, the prolonged periods of drought during the 1970s and 1980s highlighted the critical role of small ruminants in reconstructing animal capital and securing livestock-based livelihoods in Sahelian Africa (CSE, 2007). This period also revealed the exceptional adaptation of small ruminants to hostile environments (Dia, 1979; Ndiaye, 2015; Sy *et al.*, 2022). Among small ruminants, sheep hold a central position in local livelihoods. They serve multiple purposes, ranging from immediate household meat supply

to religious and family ceremonies, particularly during the Tabaski festival (Ndiaye *et al.*, 2018). This species enjoys special attention, particularly in urban centers. Traditionally a rural activity, sheep farming has steadily expanded into urban and peri-urban environments to meet the rising demand for animal source foods and to secure secondary income sources. Urban sheep farming attracts diverse actors, with a growing preference for large-format breeds, foremost among which is the Ladoum breed (Sow and Sall, 2010). The commune of Diourbel has seen a remarkable emergence of sheep farming system, characterized by specialized production centered on the Ladoum breed. This dynamic can be compared to the trends observed in Thies. Empirical studies by Ousseini (2011) showed that Ladoum breeding is managed as a secondary activity by 94.3% of breeders in Thies due to their main professions. A significant proportion of these breeders (45.71%) are motivated by income generation, while others practice it for social prestige (25.7%) or as specialized operations for genetic selection and improvement (11.4%) (Ousseini, 2011). However, despite these opportunities, most breeders face major constraints in terms of productivity and herd management, which limit the expression of the breed's genetic potential, even though the Ladoum is recognized for its high zootechnical performance. Consequently, this study addresses the following research question: Do current management practices and techniques align with breeder objectives and the phenotypic and zootechnical characteristics of the Ladoum breed? This research aims to update knowledge on the Ladoum breed by analyzing its phenotypic and zootechnical characteristics as well as local breeding practices, using the Diourbel commune as a case study.

3 MATERIALS AND METHODS

3.1 Study Area: The study was conducted within the municipal boundaries of the Diourbel commune. Diourbel is a continental region characterized by the absence of a maritime coast or perennial rivers. Consequently, deep groundwater resources are substantial and serve

as the primary source of water supply for both the population and livestock (Sene *et al.*, 2012). The region lacks classified forests or natural wildlife habitats. Annual rainfall varies between 400 and 500 mm under a Sudano-Sahelian climate. Soils are primarily composed of sandy

and sandy clay sediments of eolian and alluvial origin. The region's economic activity is structured around agriculture, livestock, and trade, while handicrafts also represent a key sector. Agriculture is centered on cash crops (groundnuts, sesame, cassava, watermelon) and food crops (millet, sorghum, maize, cowpea). However, this sector faces major development constraints, including a drastic reduction in cultivated areas, poor seed quality, low agricultural mechanization, obsolete equipment, and irregular rainfall, which collectively cause low crop yields. Traditional pastoral livestock systems are also constrained by shrinking pastureland, constant degradation of vegetation

cover, high demographic and agricultural pressures, and an insufficient number of watering points. These constraints have driven the development of intensive, zero grazing urban sheep farming. Trade occupies a major place, facilitated by Diourbel's geographic location midway between the sylvo-pastoral production zone and main urban consumption centers (Dakar, Thiès, and Kaolack), leading to weekly livestock and agricultural markets. Finally, handicrafts represent a real asset; Diourbel is renowned for its traditional expertise, particularly in pottery and tanning (Sene *et al.*, 2012).

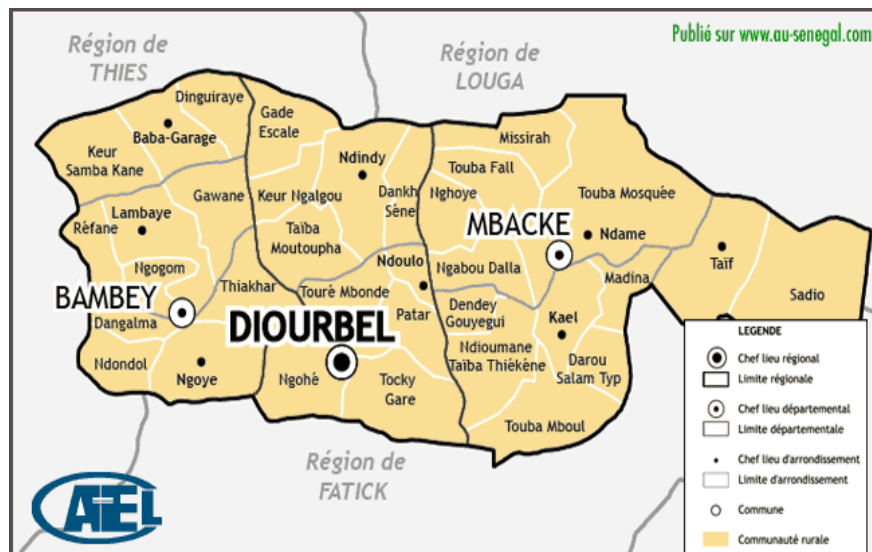


Figure 1 : Carte administrative de la région de Diourbel

3.2 Sampling: A stratified random sampling design was implemented. Neighborhoods and sheepfolds were randomly chosen. Within each sheepfold, up to four animals representing distinct demographic categories (one breeding ram, one breeding ewe, one male lamb, and one female lamb) were selected randomly. In smaller sheepfolds where the flock size was four or fewer, all animals present were included. The final study sample comprised 4 neighborhoods, 20 sheepfolds (5 sheepfolds per neighborhood), and 80 individual sheep.

3.3 Data Collection: Data collection combined structured interviews with breeders

and direct zootechnical measurements of the Ladoum Sheep (Figure 2). A barymetric tape was used to estimate the live weight of the sheep. Two types of data were collected:

- Breeder-related data: Socio-economic profiles, herd management practices, and production objectives.
- Animal-related data: Biometric parameters consisting of qualitative and quantitative phenotypic traits (chest/thoracic perimeter, body length, presence or absence of horns, horn shape, presence of wattles/pendeloques, tail length, and ear size).



Figure 2: Ladoum Sheep

3.4 Data Analysis: Collected data were compiled in Microsoft Excel and analyzed using XLSTAT (version 2020) and R (version 4.4.1). Statistical analysis included descriptive statistics of breeder profiles and measured morphometric

parameters, alongside multivariate analysis, specifically Multiple Correspondence Analysis (MCA), to identify distinct typologies of breeders and phenotypic groups of Ladoum sheep.

4 RESULTS

4.1 Breeder Objectives: The results show that breeders are primarily motivated by passion and love for the Ladoum sheep, which provides them with significant social prestige (80%). Meanwhile, 12% raise them for genetic selection and improvement, and only 8% operate with the primary goal of generating supplementary income.

4.2 Breeding Practices

4.2.1 Housing: Animal housing consists of managed sheepfolds equipped with appropriate fittings (troughs, waterers, and resting areas) for 80% of operations, while 20% rely on unmanaged open-air enclosures (Table 1). Most sheepfolds are integrated directly into residential properties, constructed in backyards or on rooftops. Additionally, 55% of breeders partition their facilities to separate animals based on their physiological stage.

Table 1: Animal housing infrastructure types in the studied sheepfolds

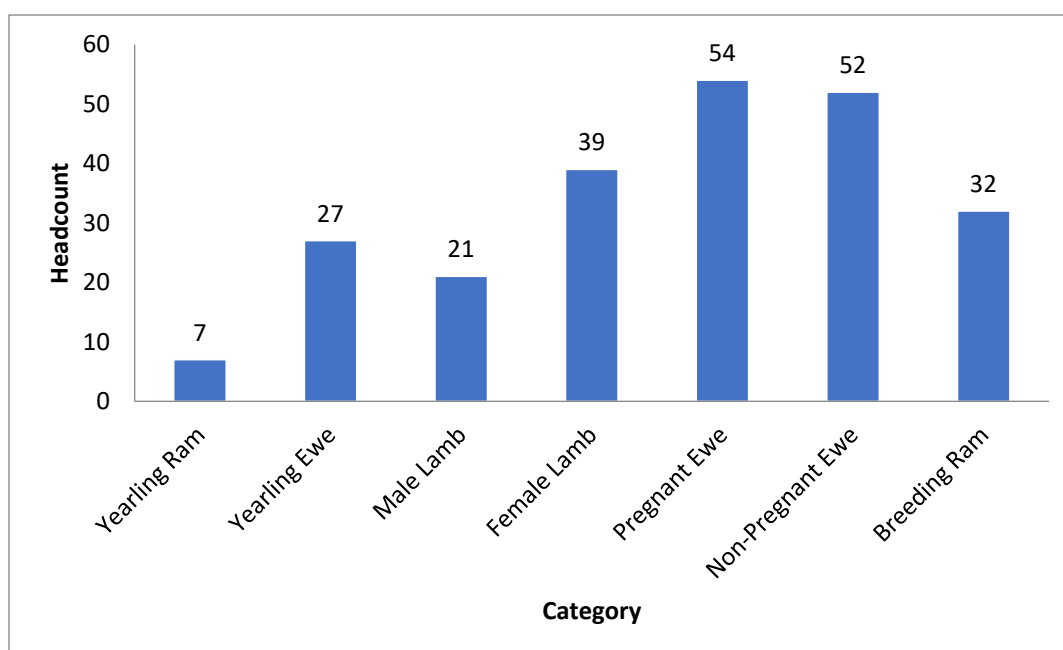
Housing Type	Sheepfolds (n)	Share of Total (%)
Simple improved sheepfold	5	25.0%
Complete improved sheepfold	11	55.0%
Basic enclosure	4	20.0%
Total	20	100.0%

4.2.2 Feeding management: The basal diet is groundnut haulms. This forage is fed as the sole feed by 65% of breeders, while 10% mix it with kitchen waste, maize, wheat bran, and cardboard, and 25% supplement it with commercial concentrate feeds. Concentrates are distributed daily by 55% of breeders, who adjust feed portions based on age, sex, and physiological requirements.

4.2.3 Health management: The most common pathologies recorded in the sheepfolds are foot rot (27.6%), mastitis (27.6%), diarrhea (13.8%), and respiratory infections (10.3%). Veterinary treatments are mostly handled by professional veterinary agents (85%), while only 10% of breeders practice self-treatment. Preventive healthcare remains a challenge, as only 25% of breeders vaccinate their flocks against Smalls Ruminants Pest.

4.2.4 Reproductive management: In all surveyed farms, mating and lambing dates are systematically recorded. Mating is controlled and/or assisted in 80% of the sheepfolds, and estrus synchronization using hormonal treatments is widely practiced. The age of first mating ranges between 9 and 12 months for 75% of operations. To source breeding rams, 50% of breeders use sires born within their own flock, 45% purchase external sires, and 5% lease them. Sires are selected primarily based on height at withers (39.50%), body length (30.20%), or pedigree (20.3%).

4.2.5 Flock structure: The overall demographic structure of the flocks consists of adult ewes (45.70%), young female lambs and hoggets (28.40%), active breeding rams (13.80%), and young male lambs (12.10%) (Figure 3).

**Figure 3:** Herd structure of the Ladoum sheep studied

4.3. Typology of farms: Multiple Correspondence Analysis (MCA) grouped the surveyed breeders into three distinct typologies (Figure 4):

- Group 1: The traders: Representing 50% of the sample, this group comprises traders of both sexes. They have not completed higher secondary or university level education, nor have they received formal animal husbandry training. Breeding is a secondary activity driven purely by passion. The average flock size is 11 animals, which are housed in sheepfolds and troughfed. Their basal diet is supplemented with commercial concentrates. They practice periodic vaccination and actively assist females during mating and lambing.
- Group 2: The official servants: Representing 25% of breeders, this group consists exclusively of men. They have university

educations but have not received formal training in animal husbandry. They practice breeding as a secondary activity motivated by social prestige. The average flock size is 16 animals, housed in sheepfolds with troughfeeding. They strictly control reproduction and vaccinate their flocks.

- Group 3: The laborers: Representing 25% of breeders, this group comprises men who have not completed higher education. However, some have received formal vocational training in livestock husbandry. Breeding is managed as a secondary activity to generate supplementary income. The average flock size is 10 animals, housed in simple enclosures. They practice basic healthcare, vaccinating only against tetanus, and utilize free mating on pasture/enclosures. The comparative management characteristics of these three breeder groups are detailed in Table 2.

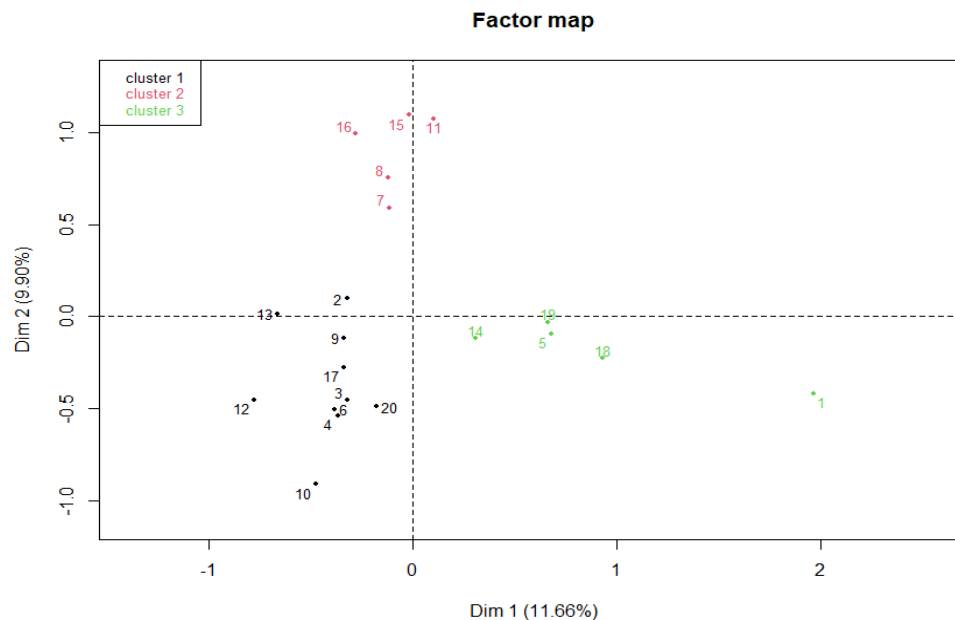


Figure 4: Typology of Ladoum breeders

Table 2: Breeders' Socio-professional profiles and management typology

Variables		Group 1: Traders (50%)	Group 2: official Servants (25%)	Group 3: Laborers (25%)
Gender	Men (%)	80	100	
	Women (%)	20	--	
Education Level (%)		upper secondary (90)	University (90)	upper secondary (60%)
Primary Activity: Livestock		No	No	No
Training in Husbandry		No	No	Yes
Production Goal		Prestige / Passion	Prestige	Prestige & Income
Average Flock Size		11	16	10
Housing Type		Sheepfolds	Sheepfolds	Enclosures
Feeding Method		Trough-fed	Trough-fed	Trough-fed
Supplementation		Yes	Yes	Yes
Healthcare Cover		Assured / Complete	Assured / Complete	Partial / Basic
Mating Method		Controlled / Assisted	Controlled / Assisted	Free mating

4.4. Morphobiometric Characterization :

The quantitative body measurements demonstrate substantial physical development and variation (Table 3). The individuals represent a wide range of age groups (70% diversity). However, despite this significant age diversity, measurements such as chamfer length, ear size, body length, and even thoracic

perimeter show little variation among the individuals. The animals differ by only 15.5%, 10.2%, 10.1%, and 11.5% for chamfer length, ear size, body length, and thoracic perimeter, respectively. In contrast, a notable difference is observed regarding animal weight (25.9%) and head length (23.8%).

Table 3:Quantitative Biometric Measurements of the Diourbel Ladoum Population

Biometric Parameter	Mean value	SD (σ)	Minimum	Maximum	Coefficient of variation (%)
Age (months)	18.7	13.1	1.0	60.0	70.0
Chamfer length (cm)	12.2	1.9	7.0	18.0	15.5
Head length (cm)	28.5	6.8	20.0	82.0	23.8
Ear size (cm)	16.6	1.7	13.0	20.0	10.2
Body length (cm)	98.3	10.9	67.0	122.0	11.1
Thoracic perimeter (cm)	97.2	11.2	65.0	123.0	11.5
Tail length (cm)	60.3	9.0	14.0	80.0	14.9
Live body weight (kg)	108.8	28.2	44.0	178.0	25.9

4.5 Phenotypic Correlations of Morphobiometric Characters: Animal age is positively correlated with chamfer length, body length, thoracic perimeter, and live weight. Chamfer length shows a positive correlation across all studied biometric variables. The strongest positive correlations are observed

between body length and thoracic perimeter (0,8), body length and live weight (0,8), and thoracic perimeter and live weight (0,9)) (Table 4). These strong correlations indicate that thoracic perimeter and body length are highly reliable indicators of live body weight in the field.

Table 4: Phenotypic correlation matrix of quantitative biometric variables

Biometric Trait	Age	Chamfer	Head	Ear	Body	Thoracic	Tail	Weight
Age	1.000	0.206	0.008	-0.023	0.307	0.468	0.076	0.506
Chamfer	—	1.000	0.028	0.233	0.521	0.647	0.427	0.596
Head	—	—	1.000	-0.017	0.091	0.063	0.046	0.079
Ear	—	—	—	1.000	0.132	0.120	0.254	0.099
Body	—	—	—	—	1.000	0.801	0.532	0.800
Thoracic	—	—	—	—	—	1.000	0.408	0.959
Tail	—	—	—	—	—	—	1.000	0.400
Weight	—	—	—	—	—	—	—	1.000

4.6 Correlation of qualitative variables and principal axes: MCA of qualitative traits indicates that the first two axes account for 35% of the total phenotypic inertia, with axis 1 explaining 21.78% and axis 2 explaining 13.27% of the variance. Axis 1 is strongly influenced by sex, demographic category, and horn morphology. Female traits, young female status (0.50), and black eye pigmentation (0.77) are positively projected on Axis 1, while male traits,

mature ram status, spiral horn shapes, and white eyes are negatively projected. On Axis 2, coat color, horn presence, and mucosal pigmentation are strongly correlated. Positive coordinates are associated with uniform white coats (0.21), polled (hornless) phenotypes (0.63), and pink mucosa (0.44), while negative coordinates are associated with black-and-white coats, lateral horn orientations, and white mucosa (Table 5).

Table 5: Correlation and significance of categorical phenotypic variables with axes

Variables	Categorical level	Axis 1 correlation	Degree	Axis 2 correlation	Degree
Sex	Female	0.65	***	-0.16	**
	Male	-0.65	***	-0.28	**
Category	Sheep female	0.63	***	-0.38	*
	Young female	0.50	*	-0.11	**
	Ram	-0.77	***	0.51	***
	Young ram	-0.88	***	-0.48	**
Coat Color	White	-0.09	*	0.21	***
	Black-and-white	-0.02	—	-0.21	**
Horn Presence	Horned	-0.62	***	-0.31	***
	Polled (Hornless)	0.48	***	0.63	***
Horn Shape	Lateral	0.04	—	-0.36	***
	Spiral	-1.00	***	0.33	***
Eye Color	White	-0.70	***	0.10	***
	Black	0.77	—	-0.35	***

4.7 Typological analysis of Ladoum phenotypes: MCA identified three distinct phenotypic groups within the studied population (Figure 5):

- Group 1: This cluster, consisting exclusively of males, represents 38% of the studied population, of which 84% are mature rams, 13% young rams, and 1% lambs. They

have a black-and-white coat, spiral horns, pink mucosa, and black (63%) or white (37%) eyes. They lack wattles and exhibit the largest skeletal measurements and body weights.

- Group 2: Comprising 42% of the population, this group consists exclusively of females (71% adult ewes and 29% young females). They feature a black-and-white coat,

lateral horns, black eyes, pink mucosa, and lack wattles.

- Group 3: Accounting for 20% of the studied population, this group consists entirely of females (81% adult ewes and 19% young

females). Most individuals (69%) exhibit a black-and-white coat, while 31% have a uniform white coat. They are hornless (polled), lack wattles, and have pink mucosa and black eyes.

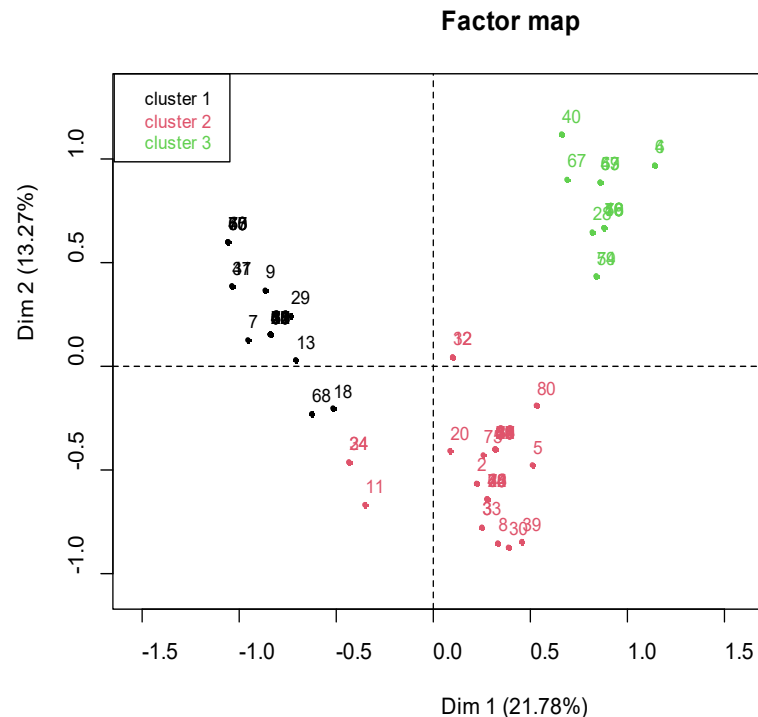


Figure 5: Typology of the studied Ladoum sheep populations

5 DISCUSSION

5.1 Socio-economic characteristics of breeders: Small ruminant farming in urban areas has transitioned into an active and highly developed practice run by diverse actors with varying socio-professional profiles and production goals. The activity is heavily dominated by men, which can be attributed to their greater financial capacity and physical strength relative to women. These findings are supported by Ousseini (2011) in Thies, who reported a herd ownership of 97.1% men and only 2.9% women. This higher financial capacity also explains the prominent role of traders in this sector, as they can readily mobilize the additional financial resources required to operate high-input intensive sheepfolds. These results align with Ousseini (2011) and Barry (2025), which highlight the growing interest of official servants

and private entrepreneurs in specialized Ladoum sheep farming. Most surveyed breeders in Diourbel are driven by personal passion and love for the Ladoum breed rather than pure financial profit. This contrasts with the findings of Ousseini (2011) and Fall *et al.* (2017), who argue that Ladoum farming is primarily driven by economic gain. This difference in objectives may stem from the local context in Diourbel, where breeders face high feed costs and difficulties in marketing their breeding stock. This passion driven objective explains why most breeders do not see the necessity of undergoing formal training to make their activity strictly commercial. For the majority of breeders, passion serves as the primary engine of their engagement, translating into a deep attachment to the Ladoum breed, which is widely perceived



as a symbol of high social prestige and success. On a zootechnical level, this strong motivation drives active genetic selection and high-quality care, including professional healthcare, targeted nutrition, and morphologic enhancement of the animals. This passion is also expressed through participation in local fairs and animal beauty contests, which showcase the aesthetic and genetic excellence of the Ladoum breed, further stimulating sector dynamics.

5.2. Farming typology and technical management: The intensive nature of urban Ladoum farming is well documented in previous studies, notably by Niasse (2021) and Ousseini (2011), which confirm a general trend toward zero grazing intensification. The high social prestige of these animals and the lack of grazing space in urban areas explain this trend. This intensive zero-grazing system requires a rich and varied diet, which is reflected in the local use of groundnut haulms, maize, commercial concentrates (such as "Superladoum" and "Jarga"), and custom feed mixes formulated by the breeders. However, this intensive feeding and confinement observed to the traders and official servants, are associated with specific pathologies, such as acidosis-induced acute diarrhea and foot rot caused by permanent wet bedding. The frequency of these pathologies is also linked to breeders' lack of formal animal husbandry training. Conversely, the relatively low incidence of infectious and parasitic outbreaks is due to periodic deworming, systematic vaccinations, and frequent use of professional veterinary services, matching the results of Niasse (2021). Assisted and controlled mating is the dominant reproductive practice of the traders and official servants, and most breeders actively synchronize estrus in ewes. This contrasts with Ousseini (2011), who reported that controlled mating was practiced by only 25.7% of breeders in Thies. Ewes are first mated between 9 and 12 months of age in 75% of operations. Interestingly, category of manual workers selects a replacement sire born within their own flock, mainly because they are unaware of the negative impacts of inbreeding and lack the financial resources to purchase expensive

external sires. This practice contrasts with the findings of Ousseini (2011) and Fall *et al.* (2017). To the three categories of breeders, the flock structure is heavily dominated by adult ewes, followed by young females and hoggets and few young male lambs, confirming the trends reported by Ousseini (2011) and Sall (2007). This demographic structure indicates that young males are quickly sold or slaughtered for religious and family ceremonies, such as the Tabaski festival and baptisms, while females are kept long-term for reproduction.

5.3 Typology and biometrics: The morphometric analysis of the Ladoum population in Diourbel reveals significant phenotypic variation, reflecting the combined effects of genetic diversity and intensive management practices. This variability represents a key asset for breeding programs as it offers opportunities for genetic progress. Bivariate analysis shows strong correlations among body measurements, confirming that physical morphology is a highly reliable field indicator of growth and weight potential. These results are consistent with prior biometric characterization studies on the Ladoum breed (Diack *et al.*, 2021). Strong positive correlations suggest that selecting for thoracic perimeter and body length can directly improve body weight, which is critical for breeders targeting large sized animals. However, the high uniformity observed for some traits suggests that breeders practice intensive empirical selection based on aesthetic (height, stance, head shape) and economic criteria. Over time, this focused selection could reduce genetic diversity if no national management policies are established, supporting the genomic findings of Sy *et al.* (2022). Multivariate analysis classified the studied population into three distinct phenotypic groups. This morphometric differentiation, also reported in other native sheep breeds (Traoré *et al.*, 2006), is shaped by both genetic background and empirical selection pressures. Males (Group 1) exhibit the largest biometric traits (weight, body length, thoracic perimeter), confirming the strong sexual dimorphism described by Diack *et al.* (2021). In contrast, females display higher



variability. Standard breeding ewes (Group 2) represent average sized reproductive stock kept for fertility and maternal qualities, while larger

ewes (Group 3) point to progressive selection towards the ideal breed standard (Sow and Sall, 2010).

6 CONCLUSION

Ladoum sheep breeding in the Diourbel commune represents a major opportunity to valorize local resources, generate employment, contribute to the genetic improvement of local sheep breeds, and provide substantial household income. This study has highlighted the key phenotypic, zootechnical, and management characteristics of this breed in an urban context. The findings confirm the growing socio-economic and cultural importance of this breed, valued for both its harmonious aesthetic traits and its superior zootechnical performance, with body weights and measurements far exceeding those of other local breeds. However, intensive empirical selection for purely aesthetic criteria may sometimes occur at the expense of productive and reproductive efficiency. While intensive zero grazing allows breeders to express the breed's growth potential, it remains constrained by high feed costs, limited technical training, and health challenges. Based on these findings, the following recommendations are proposed:

- Standardization of selection: Standardize breeding sire selection based on harmonized morphological criteria (stature, thoracic perimeter, head profile).
- Integrated index development: Associate quantitative morphometric traits with growth and reproductive records to develop reliable genetic selection indices.
- Genomic research expansion: Deepening genomic research to identify molecular markers associated with desired productive and aesthetic traits (e.g., Sembène *et al.*, 2023).
- National conservation policies: Establish a national conservation and genetic management program to monitor inbreeding, maintain paternal lineage diversity, and secure the sustainable development of the Ladoum breed as a strategic asset for Senegal's livestock sector as inappropriately influencing the representation or interpretation of the reported re-search results.

6 ACKNOWLEDGMENTS

The authors thank all the livestock farmers who agreed to participate in this study. They also thank the field surveyors. **Conflicts of Interest:** Authors must declare any conflicts of interest or

state, “The author(s) declare(s) no conflicts of interest.” This includes identifying and disclosing any personal circumstances or interests that may be perceived

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