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Geographical distribution, distribution factors and conservation issues for the black-haired Sahelian sheep of Chad

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Abstract

The Black-Haired Sahelian Sheep (MSPN) is a hardy breed that plays a central role in livestock farming systems, both in terms of food security and income for rural households in arid and semi-arid areas. This study was conducted between July and November 2023 in 22 provinces of the country (with the exception of Tibesti). It focuses on geographical distribution, distribution factors and conservation issues in Chad. The methodology combined surveys (semi-structured questionnaires, direct observation grids, focus groups) with livestock farmers, traders, intermediaries, guarantors, local authorities and livestock agents.

The results reveal that the MSPN is mainly concentrated in the Sahelian provinces of Chad, particularly Barh-El-Ghazel and Kanem, but absent in the Sudanese zones. Three zones have been identified: the presence zone, where the MSPN coexists with other breeds; the exploitation zone, where homogeneous herds are maintained; and the marketing zone, which includes markets dominated by the sale of this sheep. The main factors influencing distribution are climatic, zootechnical, economic and sociocultural. The study shows that MSPN management is based mainly on customary community mechanisms, with strong involvement of ferrick chiefs in selection and pasture management. However, the absence of institutional conservation mechanisms and the threat of uncontrolled crossbreeding increase the risk of genetic erosion. The recommendations focus on the creation of reference pastoral areas, the establishment of a national in situ conservation programme, and the economic development of the breed to ensure its sustainability and contribution to pastoral development.

Keywords: Black-Haired Sahelian Sheep; Geographical Distribution; Farming Areas; Distribution Factors; Conservation.

1. Introduction

Chad has an estimated sheep population of 48.65 million in 2023 (MEPA, 2024), making it one of the Sahelian countries richest in pastoral resources. Sheep play a fundamental role in the culture and livelihoods of most Chadian communities, particularly in rural areas, where they are a source of income, food security and social prestige (Djalal, 2011; FAO, 2021).

Sheep farming plays a key role in the national economy and is practised across all of the country's agro-ecological zones, particularly in the Saharan and Sahelian regions, where production systems are mainly extensive and pastoral

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(Mahamat, Abakar & Djamouss, 2022). By contributing to food security and rural poverty reduction, sheep farming is a pillar of socio-economic development (Djalal, 2011; OECD/FAO, 2016; CIRAD, 2020).

Chadian sheep consist of several local breeds, including the Arab breed, which is widespread across much of the country (Djalal, 2011). The phenotypic characteristics of the Arab breed are very varied, including the Black-Haired Sahelian Sheep (MSPN). It is identified as a particular ecotype within the Sahelian group (FAO, 2018; Djonnewa et al., 2022). The latter is distinguished by its morphological and phenotypic characteristics: medium size, smooth or curly black coat, elongated tail, and slender build (ME, 2001; Djalal, 2023).

MSPN is renowned for its ecological resilience and ability to adapt to the extreme environmental conditions of the Sahel, characterised by limited pastoral resources, high climate variability and chronic water insecurity (FAO, 2018; ILRI, 2020). Its presence is documented in several countries in the Sahelian belt — from Mali to Chad, via Niger and Sudan — where it constitutes a genetic resource of major interest (Whannou et al., 2021; Da Silva et al., 2024).

Despite its economic and heritage importance, MSPN remains poorly studied and poorly characterised in Chad, both in terms of its geographical distribution and its intra-population diversity. For several decades, its distribution has undergone significant spatial and quantitative changes, due to the combined effects of climate change, pasture degradation, increased pastoral mobility, and socio-economic transformations affecting production systems (FAO, 2021; CIRAD, 2020; Ngarang et al., 2021).

In this context, up-to-date knowledge of the geographical distribution of the MSPN in Chad is of paramount importance. It provides an essential basis for developing strategies for the management, promotion and conservation of this emblematic breed. This study therefore aims to map the areas where MSPN is found, exploited and traded, to identify the factors influencing its distribution, and to analyse the management and conservation mechanisms implemented by local and institutional actors.

2. Materials and methods

2.1. Study area

This study was conducted in the twenty-two (22) administrative provinces of Chad, with the exception of Tibesti, which is difficult to access for security and logistical reasons. Chad covers an area of 1,284,000 km^2, stretching between 7° and 24° north latitudes and 13° and 24° east longitudes, making it the fifth largest country in Africa (MEPA, 2024).

The terrain of Chad consists mainly of vast plains surrounded by mountain ranges to the north and east, the highest of which are Mount Tibesti (3,265 m) and Emi-Koussi (3,415 m). The Chari (1,200 km) and Logone (1,000 km) rivers, which originate in the Central African Republic and Cameroon respectively, are the country's main waterways. In the west, Lake Chad is a major ecological and socio-economic area for pastoral and fishing activities (FAO, 2021; CIRAD, 2020).
Chad is ecologically and climatically very diverse, with a gradual transition from the hyper-arid Saharan climate in the north to a humid tropical climate in the south. This climatic diversity has a strong influence on the distribution of pastoral resources and the diversity of livestock farming systems (Mahamat, Abakar & Djamouss, 2022; ILRI, 2020).

2.2. Three major agro-ecological zones structure the territory

- The Saharan zone (≈ 780,000 km^2), receiving less than 300 mm of rainfall per year (23 mm in Faya-Largeau), is characterised by a desert environment, ephemeral pastures and a very low population density.
- The Sahelian zone (≈ 374,000 km^2), which receives between 400 and 700 mm of rainfall per year, is the preferred habitat of the Black-Haired Sahelian Sheep (MSPN), a hardy species particularly well adapted to high temperatures and drought (Ngarang, Koussou & Mahamat, 2021; ILRI, 2020).
- The Sudanese zone (≈ 130,000 km^2), with rainfall between 700 and 1,300 mm/year, is characterised by high population density, a predominantly agricultural economy and the presence of more sedentary mixed livestock farming (FAO, 2021).

Nearly 40% of the national territory consists of natural rangelands used for transhumance (FAO, 2021). Two major extensive livestock farming systems coexist: the pastoral system, based on mobility and multiple species (cattle, sheep, goats, camelids) in arid and semi-arid areas; and the agro-pastoral system, which is dominant in semi-humid areas and combines subsistence farming and sedentary livestock farming.

The main agricultural products are millet, sorghum, maize, cowpeas, groundnuts, sesame, rice and tubers, while cash crops (cotton, sugar cane) and gathering (gum arabic, shea nuts, honey) support the diversification of rural incomes (FAO, 2025). According to recent UNDP statistics, Chad's population is estimated at 15.16 million, of which 54% are women working in rural areas, reflecting their major contribution to pastoral production systems (UNDP, 2024).

1.2. Materials and methods

Materials used The materials used in this study include:

- Survey forms (semi-structured questionnaires, direct observation grids and interview guides for focus groups)
- A GPS device for geo-referencing survey sites and exploitation areas; - a digital camera for morphological documentation; - and a motorbike for travelling between sites. These tools were supplemented by digital media for data recording and management (laptop, data entry tablets).

2.2.1. Data collection methods

The study was conducted over a period of four (4) months, from 15 July to 22 November 2023. Two teams were deployed simultaneously to ensure comprehensive national coverage of the provinces surveyed, with the exception of Tibesti, which was considered difficult to access for logistical reasons.

The surveys combined quantitative and qualitative approaches in accordance with the methodology recommended by the FAO (2018) and ILRI (2020) for animal distribution studies. Three data collection tools were used: direct observation grids to identify and characterize animals in the field according to their phenotypes (black coat, short or curly hair, slender build); semi-structured questionnaires administered individually to stakeholders in the sector (breeders, traders, intermediaries, guarantors); and group interviews (focus groups) of 5 to 22 people (village chiefs, elders, traditional authorities) to gather local perceptions of the breed's evolution and management practices.

The data collected mainly concerned: the presence and spatial distribution of the MSPN between 1990 and 2023; areas of exploitation and marketing; factors influencing its distribution; and responsibilities for its management and conservation.

Each survey included GPS readings and detailed morphological observations, accompanied by descriptive reports documenting the actual presence of MSPN in the departments visited. Specific questions about the profile of the farmer and production objectives were asked of the farmers encountered who only had Black-Haired Sahelian Sheep.

2.2.2. Organization and conduct of surveys

The first survey covered nine (9) provinces: Ouaddaï (Abéché, Abdi), Wadi-Fira (Biltine, Arada), Batha (Ati, Ambassatna, Oum-Hadjer), Kanem (Mao, Michemiré), Barh-El-Ghazel (Chadara, Moussoro, Mandjoula, Salal) and Ennedi-Ouest (Kalaï).

The second round covered the thirteen (13) other provinces: Lac, Ennedi-Est, Mayo-Kebbi Est, Mayo-Kebbi Ouest, Tandjilé, Mandoul, Moyen-Chari, Logone Occidental, Logone Oriental, Guéra, Salamat and Sila. This phase was conducted in close collaboration with the veterinary services and provincial delegates of the Ministry of Livestock and Animal Production, who participated in the validation of the protocol and the logistical preparation of the surveys.

2.2.3. Data processing and analysis

The data were entered and cleaned in Microsoft Excel before being transferred to the Statistical Package for the Social Sciences (SPSS, version 21) software for quantitative analysis.

The analysis comprised three main stages: descriptive analysis of quantitative and qualitative variables (presence, exploitation, marketing); cartographic analysis of the current and retrospective distribution (1990–2023) of MSPN; and qualitative analysis of the content of focus group discussions, using a thematic approach (Braun & Clarke, 2019).

3. Results and discussion

3.1. Presence and geographical distribution of MSPN

3.1.1. National spatial distribution

The results indicate that the Black-Haired Sahelian Sheep is present in 15 of the 22 provinces surveyed, particularly in the regions of Batha, Barh-El-Ghazel, Borkou, Chari-Baguirmi, Ennedi East, Ennedi West, Guéra, Hadjer-Lamis, Kanem, Lac, N'Djamena, Ouaddaï, Wadi- and sila

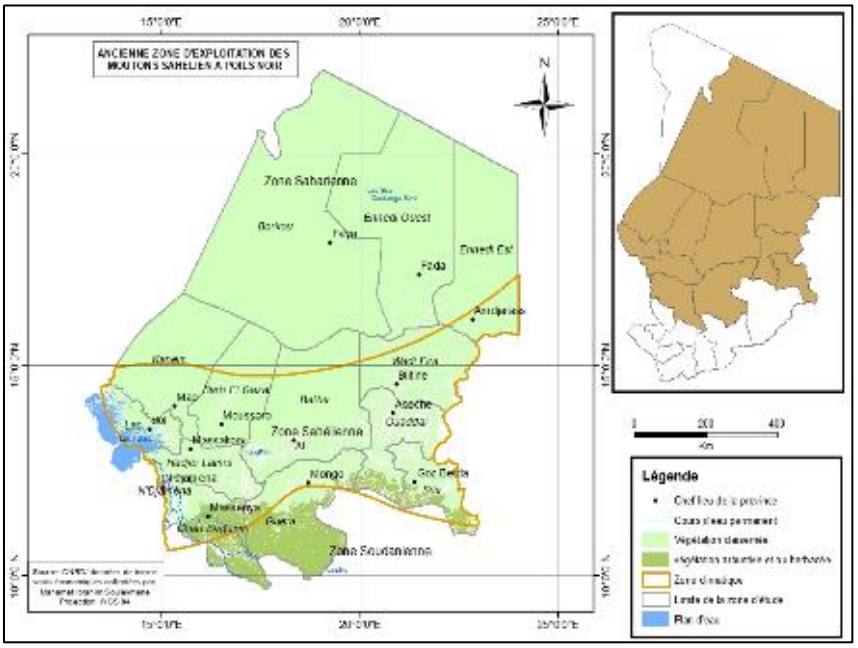

Figure 1 Former breeding area of the Sahelian Black-Haired Sheep (MSPN)

Morphological analysis has identified two main phenotypic types:

- MSPN with smooth or curly black hair: this is the most representative Sahelian type, characterised by a uniform black coat, fine or slightly curly hair, a slender head and elongated limbs. This type was observed in fifteen (15) of the twenty-two (22) provinces surveyed.
- MSPN with black curly hair and white tail tip: This particular phenotype, reported by several respondents, is concentrated in the province of Ouaddaï, notably Abeché Abdi and Abougoudam.

MSPN has not been reported in the Sudanese provinces (Western Logone, Eastern Logone, Mandoul, Eastern Mayo-Kebbi, Western Mayo-Kebbi, Middle Chari and Tandjilé). The vast majority of respondents in these provinces are unfamiliar with this breed, except for the Fulani transhumant herders interviewed, who say they prefer Fulani sheep and white-haired Arab sheep, which are better suited to the hot and humid climate of the south. According to their testimony, the MSPN cannot withstand the climate of these provinces, mainly due to its sensitivity to humidity and skin parasitic diseases that are common in these regions.

On the other hand, the black-haired curly-haired Sudanese sheep (more stock and with thicker hair) was found exclusively in the southern areas of Chad, particularly in the province of the Moyen-Chari (Moïssala and Sarh) and Mandoul (Koumra) regions, where homogeneous herds consisting solely of black-coated Sudanese sheep with curly wool were observed. The average historical recognition rate of the presence of MSPN (around the 1980s) varies according to province (Figure 1). The data show that the provinces of the Sahelo-Saharan strip recorded rates of over 67% confirmation of past presence, compared with less than 30% in the Sudanese provinces (Chari-Baguirmi, Guerra and Salamat). In the province of Salamat, the majority of participants (focus groups) did not confirm the presence of curly or smooth MSPN. Only 10.9% of the livestock farmers and traders surveyed said they had seen this type of sheep in the 1980s.

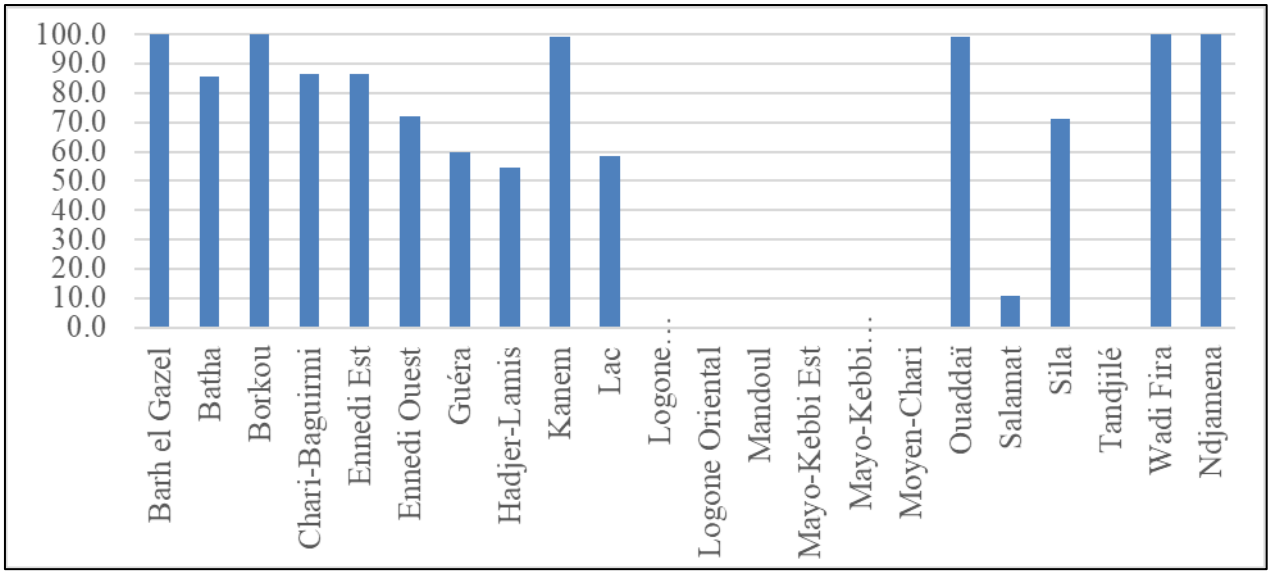

Figure 2 Average percentage of respondents confirming the presence of MSPN in the 1980s, by province

The surveys revealed a high concentration of MSPN in two provinces (Barh-El-Ghazel and Kanem) compared to the other provinces. In these areas, the breed accounts for more than 66% of the sheep observed in markets and domestic flocks. In addition, seven (7) homogeneous flocks consisting solely of MSPN were identified in the Ngoura department of Hadjer-Lamis province, specifically in the localities of Ngoura and Moïto. These flocks belong to transhumant pastoralists from the Chadara department (Bahr-El-Ghazal province).

3.2. Farming and marketing areas

The Surveys conducted throughout Chad have identified two major areas linked to the management and promotion of the Black-Haired Sahelian Sheep (MSPN): - the farming area corresponding to the areas where Sahelian flocks are produced and maintained; the marketing area, comprising the markets where this breed is traded to varying degrees.

3.2.1. Breeding area

The exclusive breeding area of the MSPN mainly corresponds to the provinces of Barh-El-Ghazel and Kanem, where homogeneous herds composed of MSPN have been observed. It is found in eight (08) departments in pure herds. However, in other localities, the herds encountered consist mainly of MSPN mixed with Arab, Peul and Kababish sheep.

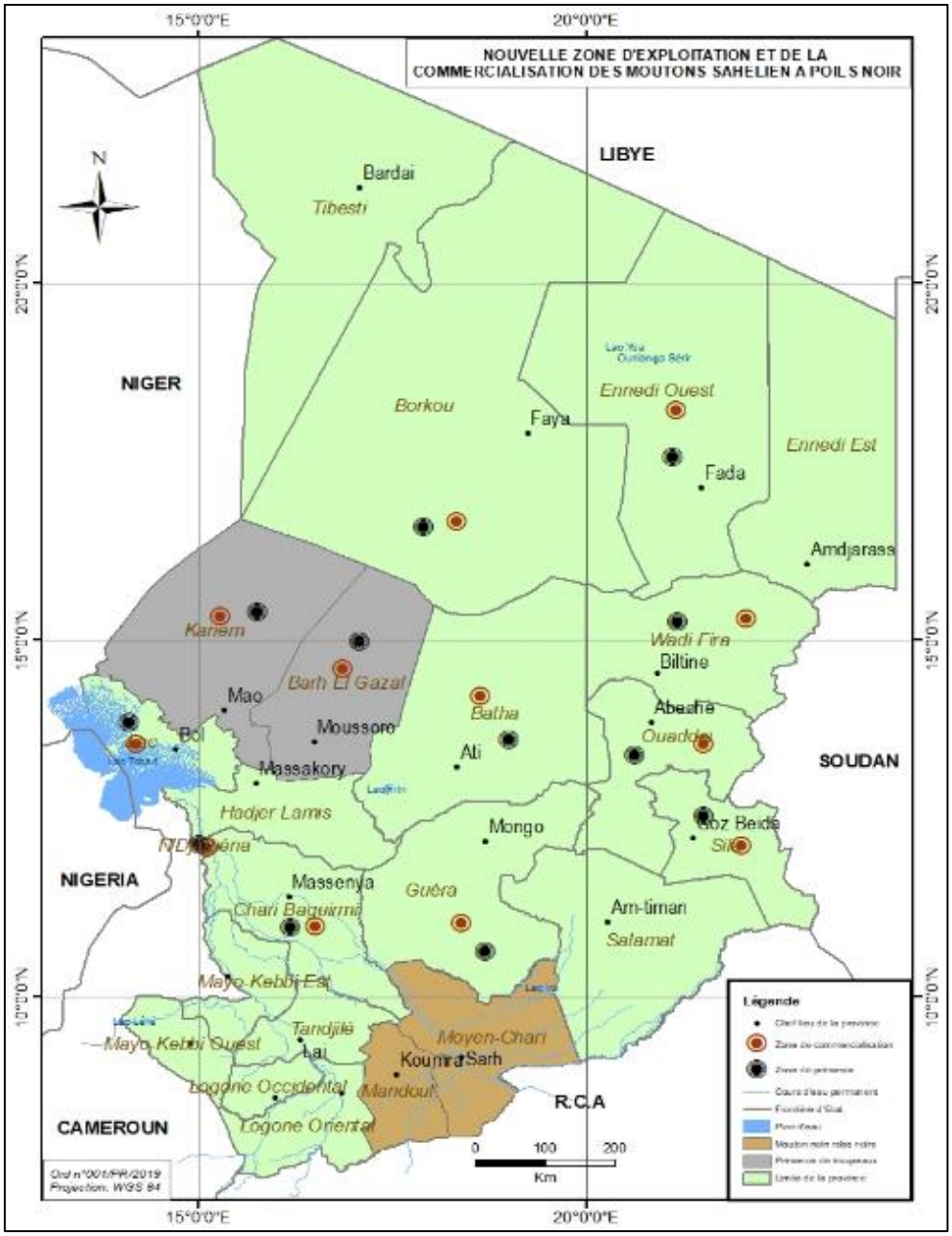

Figure 3 Area of exploitation and marketing of the Black-Haired Sahelian Sheep (MSPN)

Area of exploitation and marketing of the Black-Haired Sahelian Sheep (MSPN) Lac, N'Djamena, Ouaddaï, Wadi-Fira, and Sila) (Figure 2). It has not been observed in livestock markets in the south of the country, where Sudanese breeds dominate, followed by Fulani and Arab sheep.

The markets of Barh-El-Ghazel are distinguished by their monoculture of sheep, with MSPN being the only type sold on a large scale. In Kanem, it is dominant, while in Borkou and Wadi-Fira, it occupies a secondary position behind Arab and Fulani sheep.

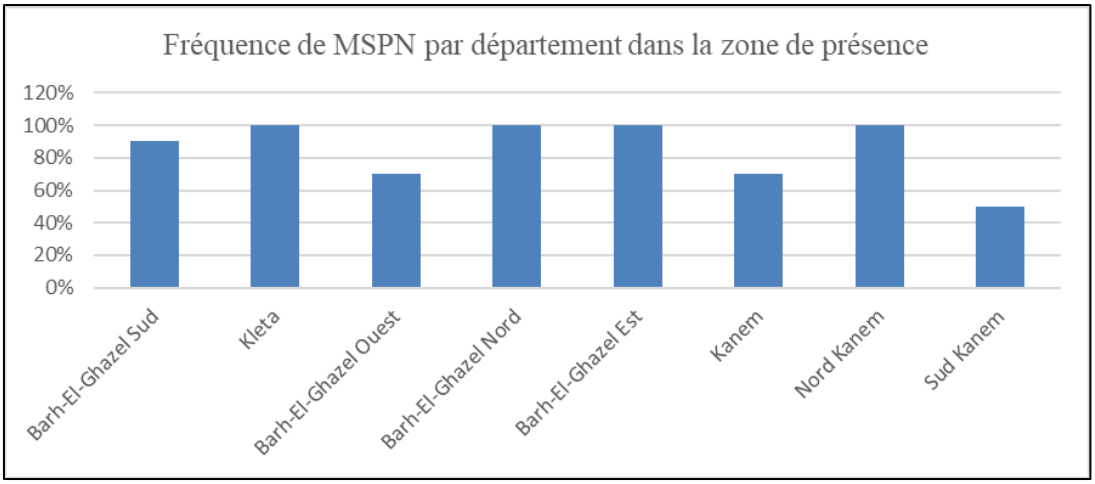

Figure 4 Frequency of homogeneous MSPN herds met in the department within the farming area.

The second farming area consists of eight (08) provinces (Batha, Borkou, Chari-Baguirmi, Lac, Guéra, Hadjer-Lamis, Ouaddaï and Wadi Fira) where there are on average three (3) to five (5) MSPN animals per sheep herd.

3.2.2. Marketing area

A total of 238 livestock markets were surveyed in the 68 departments visited. They are divided into four (4) categories according to their structure (Table I): 100 were identified as informal sales outlets, 76 as weekly community markets, 34 as permanent local markets, and 28 as interregional markets.

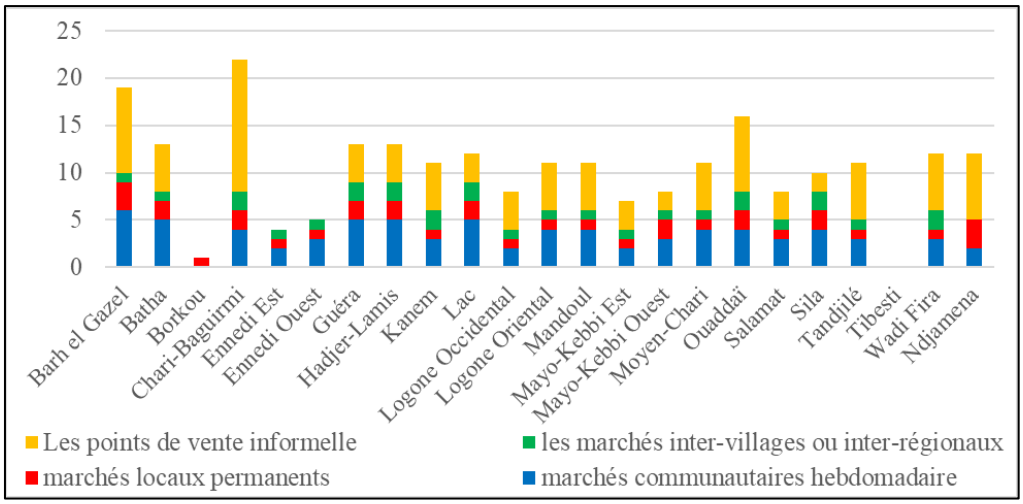

Figure 5 Number of different types of livestock markets surveyed by province

3.3. Factors influencing the distribution of MSPN

The study enabled us to list several factors that interact to determine the presence or absence of MSPN in the different provinces of Chad. According to the results of focus groups conducted in the departments, these factors include climatic factors (temperature, humidity, water), zootechnical factors (animal size, coat and colour), organoleptic (taste and tenderness of the meat), social (tradition, sources of protein and cultural and religious celebrations) and economic (lower cost, sources of income and job creation (crafts, transport)) factors have contributed significantly to defining the current distribution of the area where this sheep is farmed in Chad. Zootechnical (78.97%), social (89.98%) and economic (55.93%) factors have contributed to reducing the MSPN's area of exploitation.

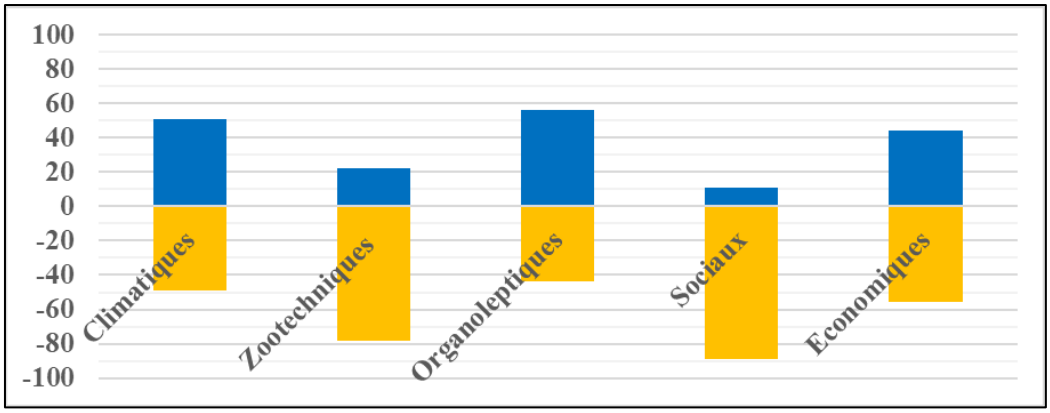

Figure 6 The rate of different factors influencing the geographical distribution of MSPN

3.4. Profile and objectives of MSPN livestock farmers

The farmers we met who have herds consisting exclusively of MSPN are men aged between 30 and 42 from transhumant Gourane communities. Breeders of pure MSPN flocks have a multifunctional view of livestock farming: self-consumption (food security); sources of economic income (regular sales of males at weekly markets cover family needs and transhumance expenses); and cultural value. The choice to farm and maintain pure MSPN is influenced by the environment (other types of sheep struggle to survive in this area) and its socio-economic importance: the importance of MSPN as precautionary capital (quick sale if necessary).

3.5. Management and conservation of the MSPN

The study conducted across Chad, particularly in the provinces of Barh-El-Ghazel and Kanem, highlighted that the management and conservation of the MSPN rely mainly on traditional community systems based on pastoral knowledge passed down from generation to generation. Ferrick chiefs play an important role in the selection and collective management of pastures and water points. At the institutional level, technical livestock services are mainly responsible for vaccination and animal health activities. There are no specific local and/or national programmes for genetic resource management, so the Ministry of Livestock does not have a genetic database or zootechnical performance records. According to several technicians interviewed, the MSPN has never been the subject of a complete genetic or morphological census.

Discussion:

The survey results have enabled the creation of an historical map of the presence and spatial distribution of the MSPN throughout Chad. The area of presence covers most of the Sahelian provinces, confirming its ecological roots in the Sahelian zone. Indeed, the distribution range of the black-haired Sahelian sheep also extends to other countries in the African Sahelian region, specifically Mauritania, Niger and Mali (Roussel, P. et al., 2011). This area corresponds to semi-arid environments where the Sahelian ecotype has historically been selected and maintained. It has low rainfall (300–600 mm/year) with a high average temperature (27–33 °C) and sparse herbaceous vegetation dominated by pastoral rangelands that favour extensive pastoral farming (FAO, 2021; ILRI, 2020). The survey results confirm that the MSPN has been maintained in these areas thanks to its high adaptability to semi-arid environments and its resistance to endemic diseases (FAO, 2021; ILRI, 2020).

In most provinces (Batha, Borkou, Chari-Baguirmi, Ennedi East, Ennedi West, Guéra, Hadjer-Lamis, Kanem, Lac, N'Djamena, Ouaddaï, Wadi-Fira, Wadi Fira and Sila), the MSPN is poorly represented (3 to 5 head per herd on average). It coexists with other local sheep breeds (Arabic sheep, Peul Kababich and Kirdimi). This results in a gradual dilution of the original phenotype, often due to uncontrolled crossbreeding (Nianogo & Somda, 2018). This fragmented presence reflects, on the one hand, the long history of sheep farming in certain localities and, on the other hand, the ancient and spontaneous spread of the breed, probably linked to interregional pastoral movements and the cross-border mobility of herds. This is confirmed by the seven transhumant pastoralists from the department of Chadara (Barh-El-Gazel) encountered in the province of Hadjar-Lamis. This situation is comparable to that described by Faye and Touré (2018) in Senegal and Mali, where the gradual genetic dispersion of Sahelian breeds is a direct consequence of transhumance and commercial exchanges of breeding stock. This distribution corresponds to that described in previous studies on Sahelian sheep breeds (Koussou, Ngarang & Mahamat, 2018; Faye & Touré, 2018), confirming that the MSPN is a typically Sahelian breed well adapted to aridity and long periods of transhumance.

However, cohabitation with other breeds sometimes encourages uncontrolled crossbreeding, threatening the genetic purity of the MSPN (Ngarang et al., 2021). This gradual dilution is one of the major challenges for conserving the breed in areas where it is widely distributed. The total absence of MSPN in the southern provinces (Logone, Mandoul, Moyen-Chari, Tandjilé) reflects an ecological and physiological limitation linked to its intolerance to humidity and certain tropical diseases (CIRAD, 2020; Ngarang 2021).

The exploitation zone corresponds to provinces where MSPN is predominantly high, sometimes in homogeneous herds, particularly in Barh-El-Ghazel and Kanem. The maintenance of purebred flocks in these areas demonstrates a capacity for community self-preservation (Ouédraogo & Sanou, 2017). These areas constitute the core of the MSPN, where livestock farming remains traditional, extensive and based on empirical selection of breeding stock by the farmers themselves. Field observations have shown that in these provinces, the MSPN is the main sheep breed raised by pastoralists and is an integral part of the local cultural and economic heritage. Livestock farmers justify its preservation on the grounds of its robustness, its resistance to long journeys and its ability to adapt to areas with low fodder availability.

These results confirm the findings of Koussou, Ngarang and Mahamat (2018), according to which the MSPN represents a breed of zootechnical interest for extensive pastoral systems in Chad. They also echo the conclusions of Dossa, Wollny and Gauly (2008), who emphasise that Sahelian sheep breeds are distinguished by their morphological plasticity and their ability to make use of poor forage resources. However, in the absence of a structured institutional and technical framework, this conservation relies exclusively on local knowledge and customary selection practices, which limits long-term genetic control (CIRAD, 2020; Nianogo & Somda, 2018).

The marketing area corresponds to the localities where MSPN is observed in their livestock markets. These markets are key hubs for interprovincial trade, where MSPN is sold live or for slaughter in urban centres. The results show that MSPN is the only dominant sheep breed in the markets of Barh-El-Ghazel, the majority breed in Kanem, and poorly represented in other provinces. The correlation between commercial integration and MSPN density shows that the economic viability of the breed depends largely on its market value. This commercial concentration illustrates regional specialisation, with these provinces ensuring production and distribution, while the other provinces are areas of consumption or transit. This configuration is part of the regional dynamics of Sahelian animal sectors described by CIRAD (2020) and Mahamat, Abakar and Djamouss (2022), where commercialisation is a factor in the economic survival and territorial expansion of local breeds. The analyses highlighted the importance of ecological conditions as the primary factor influencing distribution. MSPN develops preferentially in arid to semi-arid ecosystems, where pastoral mobility is an essential adaptation strategy.

This observation is consistent with the work of Tourrand and Hiernaux (2015), who emphasise that herd mobility in Sahelian areas helps to compensate for climate variability and maintain animal productivity. These groups (Gourane) are historically recognised for their mastery of extensive pastoralism and their role in the spread of Sahelian sheep farming (Mahamat, Abakar & Djamouss, 2022). Their cumulative experience, often passed down from generation to generation, provides empirical expertise in selecting, adapting and managing hardy herds. These findings confirm the work of Faye & Touré (2018) and Ouédraogo & Sanou (2017), who emphasise that practical knowledge of the environment is a key factor in the resilience of African pastoral systems. These results confirm that the economic and social function of MSPN goes beyond its simple market value. The animal is integrated into a pastoral moral economy where use value (consumption, prestige, reproduction) often prevails over exchange value (sale price), as described by CIRAD (2020) and FAO (2021). The fourth objective was to evaluate management and conservation mechanisms.

In Barh-El-Ghazel and Kanem, purebred herds are still maintained thanks to empirical selection practised by breeders, based on traditional morphological characteristics (black coat, slender build, long tail). These practices constitute forms of in situ conservation, confirming the observations of Ouédraogo and Sanou (2017) in Burkina Faso and Nianogo & Somda (2018) on the sustainable management of local animal resources. However, the absence of a national genetic conservation programme represents a major weakness.

Technical institutions, although active in vaccination and animal health, do not yet provide systematic morphobiometric monitoring. Pilot initiatives led by the FAO (2019) and ILRI (2020) in other Sahelian countries could serve as a model for establishing a national zootechnical registry in Chad.

Thus, sustainable management of the MSPN requires institutional strengthening, economic promotion of the breed, and recognition of its role in the heritage and identity of pastoral communities (Adoum & Ngarang, 2019; Mahamat, Abakar & Djamouss, 2022).

4. Conclusion

This work is the result of field research and bibliographic research supported by interviews with socio-economic partners directly or indirectly involved in Sahelian Black-Haired Sheep (MSPN) breeding.

Although preliminary, it allows us to identify the existing breeding area of the Black-Haired Sahelian Sheep (MSPN), its geographical location and the constraints to which it is subject. However, we cannot ignore the predominance of certain breeds in particular areas, such as the MSPN, whose range is steadily declining due to its specific adaptation to natural conditions and breeders' preferences. However, the flavour and tenderness of MSPN meat surpasses that of other meats consumed in Chad.

The MSPN is a highly resilient animal that enables pastoralists living in difficult areas to continue sheep farming in order to improve food security (animal protein intake) and household income. This sheep deserves special attention from decision-makers and livestock farmers in arid environments for its preservation and promotion, but also from scientists to establish more information and knowledge about this breed. We therefore suggest setting up a multidisciplinary, comprehensive, multisectoral research programme for the conservation of animal genetic heritage.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health,* 11(4), 589–597.

[2] CIRAD. (2020). Pastoralism and resilience in the Sahel: An integrated perspective. Montpellier : CIRAD.

[3] CIRAD. (2020). Pastoralism and resilience in the Sahel: An integrated perspective. Montpellier : CIRAD.

[4] Da Silva, A., et al. (2024). History and genetic diversity of African sheep. Animal Genetics. https://doi.org/10.1111/age.13488

[5] Djalal, A. (2011). Contribution to the study of sheep farming systems in Chad. University of N'Djamena.

[6] Djalal, A. (2023). Morpho-biometric characterization of the black-haired Sahelian sheep in Chad. Master's thesis, University of N'Djamena.

[7] Djonnewa, T., Ngadjadoum, T., & Mbaïndoum, A. (2022). Phenotypic diversity of sheep breeds in Chad. Revue Scientifique du Sahel, 10(2), 55–66.FAO. (2018). Country Pasture and Forage Resource Profile: Chad. Rome : FAO.

[8] FAO. (2018). Country Pasture and Forage Resource Profile: Chad. Rome : FAO.

[9] FAO. (2021). The State of the World's Animal Genetic Resources for Food and Agriculture – 2nd Report. Rome : FAO.

[10] FAO. (2021). The State of the World's Animal Genetic Resources for Food and Agriculture – 2nd Report. Rome : FAO.

[11] FAO. (2025). *Rapport sur l'état de l'agriculture et de la sécurité alimentaire au Tchad.* Rome : FAO.

[12] Faye, B., & Touré, M. (2018). Pastoral systems in transition: challenges and opportunities for sustainable livestock production in West Africa. Tropical Animal Health and Production, 50(7), 1481–1494.

[13] ILRI. (2020). Livestock and climate-smart development in drylands. Nairobi : ILRI.

[14] Mahamat, A. M., Abakar, O., & Djamouss, A. M. (2022). Land-use conflicts and pastoral resilience in eastern Chad. *Cahiers Agricultures,* 31(3), 202–215.

[15] ME (Ministry of Livestock). (2001). Annual Report on Animal Resources in Chad. N'Djamena: ME.

[16] MEPA (Ministry of Livestock and Animal Production). (2024). National Livestock Statistics 2023. N'Djamena: MEPA.

[17] MEPA (Ministry of Livestock and Animal Production). (2024). National Livestock Statistics 2023. N'Djamena: MEPA.

[18] Mernard, J.-L., & Corniaux, C. (2019). Valorization of local breeds and conservation strategies: lessons from Sahelian experiences. Revue Élevage et Développement Durable, 7(1), 61–72.

[19] Ngarang, R., Koussou, M. O., & Mahamat, A. M. (2021). Dynamics of sheep farming in Chad in the face of climate change. Revue Scientifique du Sahel, 9(2), 33–47.

[20] Ngarang, R., Koussou, M. O., & Mahamat, A. M. (2021). Dynamics of sheep farming in Chad in the face of climate change. Revue Scientifique du Sahel, 9(2), 33–47.

[21] Ngarang, R., Koussou, M. O., & Mahamat, A. M. (2021). Dynamics of sheep farming in Chad in the face of climate change. Revue Scientifique du Sahel, 9(2), 33–47. [22] Nianogo, A. J., & Somda, J. (2018). Sustainable management of local animal resources in arid and semi-arid zones of Africa. Cahiers Agricultures, 27(4), 1–10.

[22] Nianogo, A. J., & Somda, J. (2018). Sustainable management of local animal resources in arid and semi-arid zones of Africa. Cahiers Agricultures, 27(4), 1–10.

[23] OECD/FAO. (2016). African Agricultural Outlook 2016–2025. Paris: OECD/FAO.

[24] Ouédraogo, A.-G., & Sanou, J. (2017). Local knowledge in the selection of Sahelian sheep: a lever for in situ conservation. African Journal of Science and Technology for Development, 5(2), 79–93PNUD. (2024). Rapport national sur le développement humain du Tchad. N'Djamena : PNUD.

[25] Whannou, H. R. V., et al. (2021). Morphological variability within indigenous sheep populations (West Africa). PLOS ONE, 16(11), e0258761.

[26] Djalal Ardjoun Khalil et al. (2021) Impact of the Security Crisis on the Transhumant Pastoral System in the Province of Lac, Department of Mamdi (Chad) Ijsrm.Human, 2021; Vol. 18 (1): 10-26.

[27] Djalal Ardjoun Khalil , Mahamat Ibrahim Souleymane , Chaib Imran Ahmat , Madjina Tellah , Issa Youssouf , Hamidou Boly (2021). Evaluation of the practice and contribution of sheep breeding and camel milk to the income of camel drivers in the peri-urban area of N'Djamena (Tchad). GSC Advanced Research and Reviews, 2021, 09(01), 137–147 Article DOI: https://doi.org/10.30574/gscarr.2021.9.1.0249

[28] Djalal Ardjoun Khalil , Mahamat Ibrahim Souleymane , Issa Youssouf , Madjina Tellah , Mopate Logtene Youssouf and Abdelsalam Tidjani. (2021) Phenotypical characterization of Kababich breed in peri-urban zone of N'Djamena Chad Open Access Research Journal of Biology and Pharmacy, 2021, 02(02), 041–049 Article DOI: https://doi.org/10.53022/oarjbp.2021.2.2.0049

[29] Ardjoun Khalil DJALAL (2011): Effect of nutrition on reproductive and growth performance: Doctoral Thesis: POLYTECHNIC UNIVERSITY OF BOBO DIOULASSO.