Cameroon Journal of Experimental Biology (2022) Vol. 16, N°01, 44-52. DOI: https://dx.doi.org/10.4314/cajeb.V16i1.6

CAFOBIOS Cameroon Forum for Biological Sciences

Cameroon Journal of Experimental Biology

Available Online at http://www.ajol.info/browse-journals.php

CaJEB

Husbandry and breeding features of Fulani sheep in the Chari-Baguirmi and Mandoul provinces of Chad

Herbert Bamare Djomtchaigue [1,2,*], Mian-Oudanang Koussou [1], Vounparet Zeuh [3], Julius Awah-Ndukum [2], Félix Meutchieye [2,*]

[1] Institut de Recherche en Elevage pour le Développement Po Box. 433. N'Djamena, Chad.
[2] University of Dschang, Faculty of Agronomy and Agricultural Sciences, Department of Animal Science, Biotechnology and Bioinformatics Research Unit, PO Box 188. Dschang-Cameroon.
[3] University of N'Djamena, Faculty of Exact and Applied Science, Department of Biology, Chad.

Keywords

Breeding;
Husbandry;
Sheep;
Sudano-sahelian region;
Chad

Historic

Received : 29 August 2022
Received in revised form : 29 September 2022
Accepted : 2 October 2022

Abstract

A cross-sectional and retrospective survey was conducted from September 2021 to January 2022 in the provinces of Chari-Baguirmi and Mandoul (Chad) aiming at analyzing the husbandry and breeding features of *Fulani* sheep. A total of 144 sheep keepers owning the *Fulani* sheep breed were surveyed on the basis of their willingness to freely participate. Results show that the respondents belong in majority to Arab and Fulani ethnic groups. Youths and adults were the major groups of keepers (74.98%) followed by the group of above 50 years old (25%). The majority of respondents were married (98.1%). Monogamous families were more represented (63.19%) followed by polygamous families (34.72%). Large majority did not attend formal instruction level (61.80%), followed by 38.20% (either in Arabic or in French). Small family to medium family sizes were more represented (73.91%) compared to larger family size (27.07%). The main activity was livestock husbandry (91.66%), followed by crop production (69.44%) as a secondary activity. Inheritance and purchase constituted the mode of acquisition of *Fulani* sheep. Mobility was largely based on transhumance (95.48%) for pastoral lands (61.80%) and water sources (40.97%). About 93.75% of sampled herders were homeless and about 6.24% of them stock their flocks in paddocks made up of thorns. Natural carbonate soda source known as "Lime" was used as a mineral supplement in the rainy season by 45.76% of respondents (August-September). Groundnut cake (23.3%), cereal bran (18.21%) and cottonseed cake (11.86%) were used during the lean season (March-May) as supplementary feeds. Combined prophylaxis (vaccination and deworming) and deworming was practiced respectively by 55.54% and 15.6% as opposed to 26.48% who were reported to be without prophylaxis. Keeping the *Fulani* sheep was provided by family labor 54.5% followed by permanent employees who were mostly *Fulani* shepherds (29.72%). In terms of exploitation, reproduction (85.02%) was the main source to maintain flocks, where sales (40%), mortalities (29.4%) and slaughtering (19.5%) were the main factors affecting decrease in flock size. This study provides a better perception on the farming and breeding practices of the *Fulani* sheep of Chad. Thus, the sustainable use and enhancement of this sheep genetic resource require a better understanding of both phenotypic and molecular characteristics.

1. Introduction

Chadian livestock sector, which represents 53% of the GDP of the rural sector and which supports about 40% of the rural population, is the backbone of the national economy [1]. It constitutes a key element within farming systems, as a means of mitigating risks in agrosystems [2]. Pastoral system are based on the extensive use of spontaneous pastures. Pastoral systems thrive with difficult, arid and semi-arid environments [3]. The livestock is estimated in 2021 was as follows (in heads according to general census figures): Cattle: 33,948,190; Sheep: 41,771,900; Goats: 43,735,600; Horses: 1,379,160; Donkeys: 4,115,100; Pigs: 3,312,300; Camels: 9,401,900; Poultry (general speaking): 36,650,100 [4]. Although the production orientation is 80% based on a very diversified mobile pastoral systems and largely dependent on renewable natural resources, livestock represents about 50% of exports. The production systems (transhumant, nomadic and sedentary), of sheep fit well with the three major ecological zones (Saharan, Sahelian and Sudanian) of Chad [5]. The native sheep populations are *Fulani*, *Arab*, *Mayo Kebbi*, *Kerdimi* and *Kababish*. *Fulani* sheep breed is the most widespread in the country and display better adaptation abilities to all ecological conditions of Chad. The *Fulani* sheep which is transboundary has been reported in studies were exploited, as in Senegal by [6], in Nigeria by [7-8], in Niger

*Corresponding authors : *Institut de Recherche en Elevage pour le Développement Po Box. 433. N'Djamena, Chad. University of Dschang, Faculty of Agronomy and Agricultural Sciences, Department of Animal Science, Biotechnology and Bioinformatics Research Unit, PO Box 188. Dschang-Cameroon.*
Emails: dbamare@gmail.com & fmeutchieye@gmail.com

by [9] in particular on breeding practices and morphological description. In Chad, despite its socio-economic importance, the *Fulani* sheep has been not extensively investigated. There are little available and reliable data on its breeding strategies. In the current alarming and changing context, sheep farming faces challenges such as climate change effects, the growing demand for sheep and multiple crossbreeding under random mating with genetic admixture [6]. The general objective of this study is to gather influent knowledge on *Fulani* sheep breeding features in the Sahelian and Sudanian zones. More specifically to describe the socio-cultural characteristics, breeding and husbandry practices.

2. Materials and methods

2.1. Study area

This study was conducted in Chari-Baguirmi (11°7598'5514'' Northern and 15°1503'8405'' Eastern) and in Mandoul (8°9418'5169'' Northern and 17°4818 '1465'' Eastern). The choice of these provinces is justified by the relative density of *Fulani* sheep herders. The climate of the province of Chari-Baguirmi is of the tropical Sahelian type characterized by two seasons; a very short rainy season from May to September and a long dry season from October to May with average annual temperatures of 40°C. Annual rainfall varies from 200 to 600mm and the vegetation is generally savannah grassland and pseudo-steppe dominated by *Acacia raddiana*, *Balanites aegyptiaca*, *Ziziphus mauritania*, *Calotropis procera*, and on the other hand by herbaceous cover with the following species : *Panicum turgidum*, *Aristida mutabilis*, *Cenchrus biflorus*, *Eragrostis tremula* and *Andropogon gayanus*. The climate of Mandoul province (which is southern to the above mentioned one) is of the Sudanian tropical type characterized by two seasons: a rainy season from May to November and a dry season from November to April with an average temperature of 40 °C. The annual rainfall varies from 800 to 1200 mm. The vegetation is characterized by open forest and woody savannah, a mixture of legumes *(Parkia biglobosa* and *Vitellaria paradoxa)* and *Combretaceae (Anogeissus leiocarpa, Guiera senedalensis, Combretum collinum, Combretum glutinosum, Combretum nigricans, Terminalia avicennioides, Terminalia glaucescens, Terminalia laxiflora et Terminalia macroptera)*. The herbaceous layer is continuous with a predominance of perennial grasses among which *Andropogon gayanus*, *Vitex doniana* and *Cymbopogon giganteus* [10].

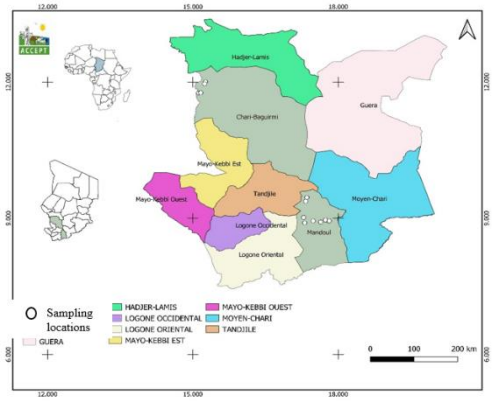
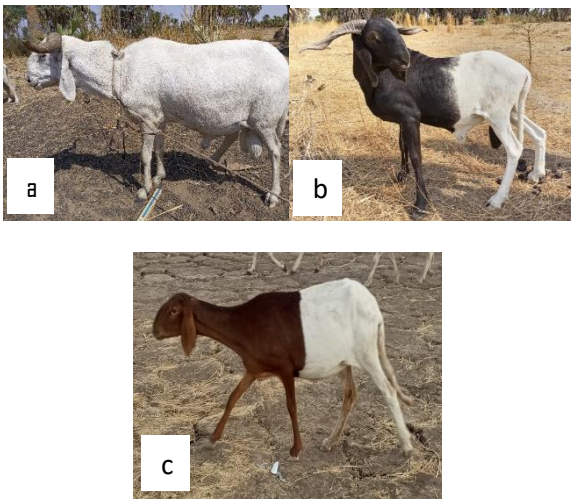


Figure 1 : Study area map

2.2 Sampling method

The sheep breed considered is made up of two genetic type of Fulani sheep: monochromic (white or black called Waila) and bicolor or bichromic type (named Oudah).



a) Monochromic *Waila* sheep; b,c) Bichromic Oudah sheep

Figure 2 : Fulani sheep

2.3. Data collection

The data was collected through an on-farm survey. The survey took place from September 2021 to January 2022 in Chari-Baguirmi and Mandoul provinces. The simple random methods used for the sampling. The respondents were chosen following these criteria: being the head of household, presence of *Fulani* sheep in the flock and readiness to answer questions. The questionnaires were designed on a digital software (Kobocollect), installed on a tablet and administered in each farm in the form of an individual interview. A total of 144 breeders distributed in the four divisions were surveyed. The questions were focused on the socio-professional aspect of breeders and *Fulani* sheep breeding practices (Table I).

Table I: Breakdown of respondents by area

Province	Division	Number breeders	Frequency
Chari-Baguirmi	Chari	73	50.69
Mandoul	Taralnass	20	13,88
	Mandoul Oriental	34	23,61
	Mam	17	11,81
Total		144	100.00

2.4. Statistical analysis

The data obtained were extracted from the Kobocollect server (CIRAD) in an Excel file and analyzed using SPSS 22.0 software. The quantitative variables were expressed as mean and standard deviation while for the qualitative variables, frequencies of the different modalities were calculated. The chi-square test was used

to determine the links between the variables and the ethnic groups of the breeders or between the variables and the breeding departments. Cramer's V test was used to assess the strength of association between the different variables. The significance level was set at $p < 0.05$.

3. Results

3.1. Socio-cultural features of Fulani sheep keepers

The socio-cultural characteristics are represented in Table 2. During the survey two ethnolinguistic groups were represented, namely the Arab and the Fulani. The breeders surveyed were of the Muslim faith (100%). Young people and adults were in the majority with 74.98% against 25% of respondents over 50 years old. The majority of breeders surveyed were males (97.21) followed by females (2.77%). A total of 97.91% were married. Monogamous households were more represented with 63.19% compared with 34.72% of polygamous families. Non formal educated respondents (neither Arab nor French) were in the majority with 61.8% followed by 31.93 educated (Arabs) and 6.24% educated (French). The size of the family with 3 children in charge was 47.91% against 25% of medium families with 4 to 6 children and 27.07% large family with more than 7 children in charge. In most households, the number of people living under the roof of 5-10 (54.86%) followed by more than 10 (25%). The main activity of the breeders surveyed was livestock keeping (91.66%), followed by agriculture (69.44%) as a secondary activity (Table 2).

3.1. Fulani sheep acquisition

Figure 3 presents the modes of acquisition of Fulani sheep. The majority of breeders surveyed acquired Fulani sheep by inheritance (60.72%) followed by purchase (35%) and gift (3%) mainly among Arab respondents.

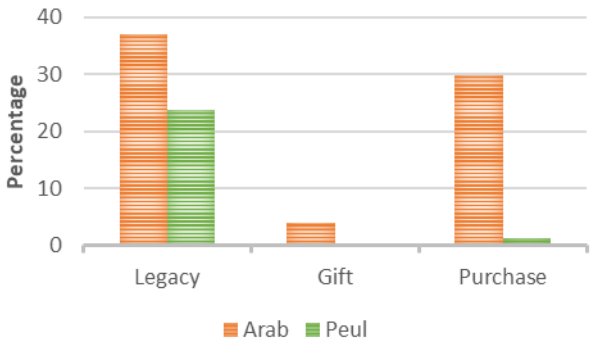


Figure 3 : Mode of acquisition of Fulani sheep in the Chari-Baguirmi and Mandoul provinces of Chad

3.3. Animal diversity on farms

Figure 4 presents the structure of the herd in the households. According to the respondents, the majority had cattle-sheep-goats with 54.30% followed by cattle-sheep 33.74% and sheep-goats 7.27%. This diversification of species in farms shows the adaptation practices of farmers while confronted to the effects of climate change (drought, floods, etc.).

Table 2: Socio-cultural features of respondents according to ethnic group in the Chari-Baguirmi and Mandoul provinces of Chad

Variable	Modality	Ethnic group %(n)		Chi-2	Cramer's V value
		Arab	Fulani		
Age group	Young [15-35]	27.08(39)	9.72(14)	0.54^{ns}	0.06
	Adult [36-50]	29.16(42)	9.02(13)		
	Old [51 +]	17.36(25)	7.64(11)		
Sex	Female	2.77(4)	0(0)	1.47^{ns}	0.10
	Male	70.83(102)	26.38(38)		
Marital status	Single	1.38(2)	0.69(1)	0.07^{ns}	0.02
	Married	72.22(104)	25.69(37)		
Number of wifes	Monogamous	42.36(61)	20.83(30)	8.08^{ns}	0.23
	Polygamous	29.86(43)	4.86(7)		
Educational level	Unschooled	38.19(55)	23.61(34)	17.03^{s}	0.34
	Primary	4.86(7)	0(0)		
	Secondary	1.38(2)	0(0)		
	Koranic school	29.16(42)	2.77(4)		
Family size	Small family (0-3)	36.11(52)	11.80(17)	5.91^{ns}	0.20
	Medium family (4-6)	14.58(21)	10.41(15)		
	Large family (7 - +)	22.91(33)	4.16(6)		
Number of people in charge	[0 – 5]	14.58(21)	5.55(8)	0.10^{ns}	0.02
	[5 – 10]	40.97(59)	13.89(20)		
	[10 - + [	18.05(26)	6.94(10)		
Religious belief	Muslim	73.61(106)	26.39(38)	0.00^{S}	1.00
	Christian	0(0)	0(0)		
Main activity	Crop production	6.94(10)	0(0)	4.69^{ns}	0.18
	Livestock keeping	65.27(94)	26.39(38)		
	Public service	1.38(2)	0(0)		
Secondary activity	Crop production	58.33(84)	11.11(16)	38.92^{s}	0.52
	Livestock keeping	13.88(20)	14.58(21)		
	Trading	1.38(2)	0.69(1)		

^{S} : significant (P<0.05), ^{ns} : no significant (P>0.05), size and percentage in brackets

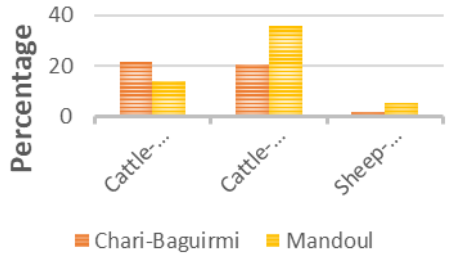


Figure 4 : Animal diversity on households in the Chari-Baguirmi and Mandoul provinces of Chad

3.4. Structure of *Fulani* Sheep in Households in the Chari-Baguirmi and Mandoul provinces of Chad

Table 3 presents the average per household and per gender in province disputes. Fulani sheep are numerically important in households regardless of the division. The average per household was 50.67 ± 20.85 ewe and 19.25 ± 16.38 ram. The maximum varies from 100 ram to 300 ewes. Considering ethnic groups, the average is similar among Arabs and Fulani of 47.83 ± 45.16 ewe and 16.74 ± 14.88 ram (Table 3).

Table 3: Mean, minimum and maximum numbers on small ruminant farms in the Chari-Baguirmi and Mandoul provinces of Chad

Study zones	Sex	Mean ± sd	Mini	Maxi
Chari	Ewe	43.43 ± 31.51	2	300
	Ram	16.74± 14.88	0	100
Mam	Ewe	50.67 ± 20.85	18	80
	Ram	24.67 ± 11.00	7	41
Mandoul Oriental	Ewe	46.73 ± 29.11	1	118
	Ram	19.25 ± 16.38	0	70
Taralnass	Ewe	40.00 ± 39.23	6	170
	Ram	17.77 ± 13.19	1	44
Ethnic group				
Arab	Ewe	43.43 ± 31.51	3	180
	Ram	16.74 ± 14.88	1	70
Fulani	Ewe	47.83 ± 45.15	2	300
	Ram	16.39 ± 19.39	0	100

3.5. *Fulani* sheep husbandry practices in the Chari-Baguirmi and Mandoul provinces of Chad

Table 4 presents Fulani sheep husbandry practices. Mobility is done by transhumance with 95.84% or 70.14% among Arabs and 25.70% among Fulani. In terms of housing, 93.75% are homeless against 6.24% with thorns' enclosures. The main reason for mobility in the dry season was the search for pasture (61.80%) and water (40.97%) against 2% for the Sedentary. In the rainy season, pastoralists return to their home area (61.80%) in order to cultivate their fields and part of their family transhumance in search of pasture (31.93%) on the northern axis (Barh El Gazal). The camp leaders were the main decision makers of this mobility (86.80%) followed by the herders (13.19%). During this mobility, part of the transhumant nuclear family with the herd (91.66%) against the whole nuclear family, thus 8.33% (Table 4).

3.6. Pathology and health monitoring of animals in the Chari-Baguirmi and Mandoul provinces of Chad

In terms of pathology, according to the breeder surveyed, PPR is more frequent (65.28%), followed by enterotoxemia (21.52%) and external parasites (8.33%). Prophylaxis was ensured at 55.54% for combined prophylaxis (Vaccination and deworming); about 27.77% of farmers do not practice prophylaxis and (16.65%) did deworming. In terms of health monitoring, most breeders monitored their herds themselves with 82.63% against 15.96% of monitoring carried out by livestock attendants in areas close to public veterinary field offices (Table 5).

3.7. Watering in the Chari-Baguirmi and Mandoul provinces of Chad

Watering in the rainy season was provided in ponds with 64.57% followed by rivers/streams (34.91%). The frequency of watering during this period was based on the needs of the animals. In the dry season, watering was provided in the rivers/permanent streams in the Mandoul valley and the *yaerés* of Chari-Baguirmi with 61.58% followed by traditional wells (16.65%), boreholes (9.02 %) as shown in Table 5.

Table 4: Fulani sheep herding practices according to ethnic group in the Chari-Baguirmi and Mandoul provinces of Chad

Variable	Modality	Ethnic group %(n)		Chi-2	Cramer's V value
		Arab	Fulani		
Mobility	Sedentary	3.47(5)	0.70(1)	0.30^{ns}	0.04
	Transhumant	70.14(101)	25.70(37)		
Type of accommodation	Thorns enclosure	3.47(5)	2.77(4)	1.61^{ns}	0.10
	No housing	70.14(101)	23.61(34)		
Reason of mobility in dry season	Protection against insect's bite	0 (0)	0(0)	3.18^{ns}	0.15
	Search for pasture	45.83(66)	15.97(23)		
	Water search	30.55(44)	10.42(15)		
	Home land	0 (0)	0 (0)		
Reason of mobility in the rainy season	Insecurity	3.47(5)	0 (0)	3.24^{ns}	0.18
	Protection against insects' bite	4.86(7)	0 (0)		
	Search for pasture	26.38(38)	5.55(8)		
	Water search	0.70(1)	0.70(1)		
	Home land	41.66(60)	20.14(29)		
Mobility decision maker	Camp leader	65.97(95)	20.83(30)	7.45^{s}	0.17
	Breeder	7.64(11)	5.55(8)		
Family group on the move	Whole nuclear family	6.94(10)	1.39(2)	5.41^{s}	0.14
	Part of nuclear family	66.66(96)	25.00(36)		

^{s} : significant (P<0.05), ^{ns} : no significant (P>0.05), size and percentage in brackets

3.8. Feed in the Chari-Baguirmi and Mandoul provinces of Chad

Figure 5 shows supplementation of the animals. The feed is mainly based on driving the animals to pasture on natural rangelands. Thus, under the responsibility of the shepherd, the animals are driven all day to areas of natural pasture and in the evening, they bring them back to the village or camp (Ferrick).

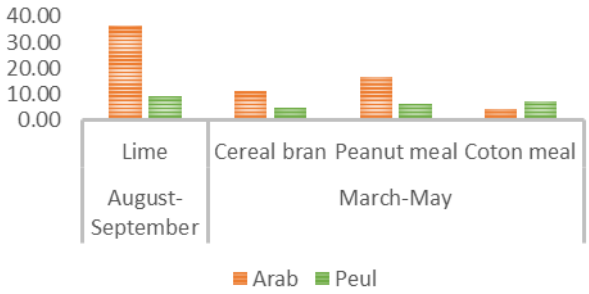


Figure 5: Mineral and food supplement according to period and food by ethnic group in the Chari-Baguirmi and Mandoul provinces of Chad

This mode of driving is adopted by 90% of Arabs and 53.01% of Fulani. It was exclusively of the transhumant type among the Arab

and the Fulani. These herders leave the cropping areas, especially during the rainy season, for the pastoral areas and only return after the harvest, when the fields are freed. The main mineral supplement used is Lime (45.76%) in the rainy season called Harif (August-September) in Arabic. Groundnut cake (23.3%), cereal bran (18.21%) and cottonseed cake (11.86%) are food supplements used during the lean season called Sef (March-April-May) in Arab.

Table 5: *Fulani* sheep herding practices according to ethnic groups in the Chari-Baguirmi and Mandoul provinces of Chad

Variable	Modality	Ethnic group % (n)		Chi-2	Cramer's V value
		Arab	Fulani		
Dominant pathology	Enterotoxemia	11.80(17)	9.72(14)	10.06^{ns}	0.20
	FMD	0.69 (1)	0 (0)		
	External parasite	6.94(10)	1.39(2)		
	Internal parasite	2.08(3)	0.69(1)		
	PPR	50.70(73)	14.58(21)		
	Trypanosomosis	1.38(2)	0 (0)		
Health prophylaxis	None	20.83(30)	6.94(10)	14.35^{s}	0.24
	Combined (Vaccination and Deworming)	38.88(56)	16.66(24)		
	Deworming	13.88(20)	2.77(4)		
Health monitoring mode	Livestock auxiliaries	13.19(19)	2.08(3)	16.51^{s}	0.26
	Breeders	60.41(87)	22.22(32)		
	Public veterinarian	0 (0)	2.08(3)		
Watering in the raining season	River / Stream	27.77(40)	6.94(10)	1.56^{ns}	0.12
	Drilling	0.69(1)	0 (0)		
	Pond	40.27(58)	18.75(27)		
	Pastoral well	0.69(1)	0.69(1)		
	Traditional well	0.69(1)	0 (0)		
Watering in the dry season	River / Stream	43.05(62)	21.52(31)	11.87^{s}	0.29
	Drilling	7.64(11)	1.38(2)		
	Pond	6.25(9)	1.38(2)		
	Pastoral well	1.38(2)	0.69 (1)		
	Traditional well	15.27(22)	1.38(2)		

s : significant (P<0.05), ns : no significant (P>0.05), size and percentage in brackets

Figure 6: Herding management of Fulani sheep in the Chari-Baguirmi and Mandoul provinces of Chad

3.9. Mobility related activities

Associated with this mobility, the breeders developed an adaptation strategy which consisted of carrying out agricultural activities. Regarding the mode of access to land, 62.49% of breeders owned inherited property, followed by purchased property 13.88% and borrowed 11.97%. Rain fed croppings was practiced at 80.78% by breeders against market gardening at 7.28%. The main objective of this production was for home consumption 65.28%, followed by sales 21.52%. The type of crop growing were mainly cereals (millet, maize and sorghum) with 51.38% against legumes (peanuts, cowpeas) and sesame for 28.46% (Table 6).

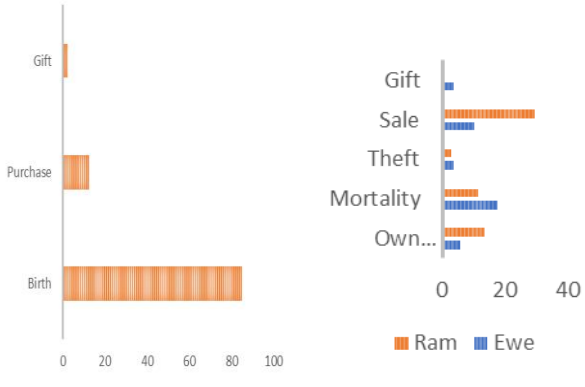
Table 6: Mobility-related activities by ethnicity in the Chari-Baguirmi and Mandoul provinces of Chad

Variable	Modality	Ethnic group % (n)		Chi-2	Cramer's V value
		Arab	Fulani		
Mode of access to land	Loan	10.41(15)	1.56(2)	21.02^{ns}	0.23
	Lease	1(1)	0(0)		
	Property purchased	9.72(14)	4.16(6)		
	Inheritance property	52.77(76)	9.72(14)		
Cultivation method	Rain fed crops	65.97(95)	13.88(20)	56.49^{s}	0.66
	Market gardening	7.64(11)	0 (0)		
Production target	Home-consumption	54.86(79)	10.42(15)	31.33^{ns}	0.28
	Sale	18.75(27)	2.77(4)		
Type of crops	Cereals (millet, maize et sorghum)	41.66(60)	9.72(14)	47.19^{s}	0.35
	Legumes (cowpea, groundnut, sesame)	24.30(35)	4.16(6)		
	Market gardeners	7.64(11)	0 (0)		

s : significant (P<0.05), ns : no significant (P>0.05), size and percentage in brackets

3.10. Exploitation

Animal movements (entries and exits) in sheep herds according to respondents over the last twelve months are expressed as a percentage. The modes of entry, according to the breeders surveyed, births (85.02%) and purchase (12.54%) are the main mode of entry of animals into the farms. The exit modes consist of theft, mortality and own consumption 40%, 29.4% and 19.5%, respectively.



a) Incoming b) Exit

Figure 7: Animal movement

3.11. Breeding practices in the Chari-Baguirmi and Mandoul provinces of Chad

Regarding breeding practices, meat production (95.13%) is the main objective of Fulani sheep breeding. The breeding criterion is conformation (83.33%) linked to adaptation (93.05%) to extreme conditions as preferences according to the breeders surveyed. The most common reproduction mode is random mating (99.99%) which is observed in flocks with a permanent presence of the parent. No castration practice (100%) was observed in the farms. The litter size was two lambs (88.19%) (Table 7).

Table 7: Breeding practices of Fulani sheep in the Chari-Baguirmi and Mandoul provinces of Chad

Variable	Modality	Ethnic group % (n)		Chi-2	Cramer's V value
		Arab	Fulani		
Objective	Milk	4.16(6)	0.69(1)	0.93^{ns}	0.07
	Meat	69.44(100)	25.69(37)		
selection	Aptitude	2.08(3)	0.69(1)	3.02^{ns}	0.10
	Conformation	59.72(86)	23.61(34)		
	Resistance	11.80(17)	2.08(3)		
Preference	Market	4.86(7)	2.08(3)	0.60^{ns}	0.06
	Adaptation	68.75(99)	24.30(35)		
Reproduction	Free	73.61(106)	26.38(38)	-	-
	Semi controlled	0(0)	0(0)		
	Controlled	0(0)	0(0)		
Castration	No	73.61(106)	26.30(38)	-	-
	Yes	0(0)	0(0)		
Birth	Simple	9.02(13)	1.38(2)	8.17^{ns}	0.16
	Twice	64.58(93)	23.61(34)		
	Triple	0(0)	1.38(2)		

s : significant (P<0.05), ns : no significant (P>0.05), size and percentage in brackets

3.12. Labour in the Chari-Baguirmi and Mandoul provinces of Chad

Keeping the *Fulani* sheep daily work was provided by household labor 54.5%. Permanent employees who were mostly Fulani herders 29.72%. It was provided mainly by men 91.77% and by women (9.86%). The workforce of the 15 to 35 years old age group was more represented with 72.03% followed by 25% of the 8 to 14 years old class. The majority of the labor was uneducated (89.14%). According to the breeders, the type of contract was full-time 77.3% against 22.69% part-time. Labor tasks were mainly watering and guarding with 85.84% against agricultural activities 13.48% in the rainy season (Table 8).

4. Discussion

4.1. Socio-cultural features of surveyed herders in the Chari-Baguirmi and Mandoul provinces of Chad

The perception survey on the features of *Fulani* sheep breeding among respondents provided a better understanding of the breeding practices for this sheep breed in Chadian environment. The surveyed regions, namely Chari and Mandoul, are known to be transition stocking areas for Fulani sheep during transhumance. The ethnolinguistic groups mainly encountered in this study, the Arabs and the Fulani, are the main breeders and shepherds of *Fulani* sheep in Chad.

Table 8: Labour features in the Chari-Baguirmi and Mandoul provinces of Chad

Variable	Modalities	Ethnic group %(n)		Chi-2	Cramer's V value
		Arab	Fulani		
Gender	Woman	7.56(23)	2.30(7)	1.82^{ns}	0.078
	Man	65.46(199)	26.31(80)		
Age class	under 8 years	0.66(2)	0.33(1)	10.18^{ns}	0.18
	8 to 14 years	16.45(50)	8.55(26)		
	15 to 35 years	56.57(172)	15.46(47)		
	over 35 years	0.98(3)	0.98(3)		
Education level	Coranic school	5.26(16)	2.63(8)	1.25^{ns}	0.06
	Unschooled	67.43(205)	21.71(66)		
	Primary	1.97(6)	0.98(3)		
Type of labor	Family	37.50(114)	16.77(51)	14.13^{s}	0.21
	Permanent worker	22.04(67)	7.89(24)		
	Part time employee	15.13(46)	0.66(2)		
Type of contract	Part time	21.71(66)	0.98(3)	20.77^{s}	0.26
	Full time	52.96(161)	24.34(74)		
Wage mode	Others	25.65(78)	11.84(36)	3.97^{ns}	0.11
	Nature	25.98(79)	6.58(20)		
	Salary	23.02(70)	6.90(21)		
Labour activities	Attending and watering	63.15(192)	22.69(69)	5.30^{ns}	0.13
	Care	0.32(1)	0(0)		
	Agricultural	11.18(34)	2.30(7)		

s : significant (P<0.05), ns : no significant (P>0.05), size and percentage in brackets

This study has shown that the acquisition of initial stock is mainly done in three ways: inheritance 60%, purchase 35% and lastly, donation 3%. These results are similar to those reported by [11] who had shown that cattle were often acquired through inheritance, purchase, and gift. On the other hand, [9] observed two ways in Niger: inheritance among women and heads of farms and gift among men and children of the household.

Livestock is practiced by relatively young people, adults and the elderly alike, but only men were heads of farms or heads of households. The high rate of married category (98%) among respondents reflects the level of social responsibility and the experience of breeders in the management and conduct of animals. On the other hand, young people and adults (74.98%) play an important role in the knowledge transfer from one generation to the next. This observation testifies to the strong involvement of young people and adults who move seasonally and cyclical with the animals in the perpetual quest for water and pasture on natural routes and the gradual withdrawal of the elderly. These elderly people, considered as patriarchs, are generally the heads of farms while the responsibility for livestock management remains the task

of the family head. These results are similar to those found in *Fulani* sheep in Niger [9]. The strong involvement of young people and adults in *Fulani* sheep rearing observed in this our study is in contradiction with the results of [12] who reported that for the case of *Koundoum* sheep farming in Niger young people and adults are less involved in the management of the animals because of the rural exodus on the one hand and the social organization of households in the Niger River valley, or the neglect of the *Koundoum* breed on the ohter.

The stockbreeders' capital experience would compensate for the effect of their illiteracy and their low level of education, as was also observed in the study by [9] and [13] unlike urban breeders, the large majority of whom were educated [14-15]. Small and medium sized families were more represented (72.91%) compared to large sized families (27.07%). Similar values were obtained on small and medium family (80.9%) and large family (19.0%) in *Fulani* sheep farms in Senegal [9].

4.2. Mobility and feed complementation of *Fulani* Sheep on Farm in the Chari-Baguirmi and Mandoul provinces of Chad

This study has shown that mobility (transhumance or nomadism) concerns 95.84% of *Fulani* sheep farming. During this mobility, the elderly settle in the stocking areas (*yaeré* and/or camp) keeping a few nuclei (pregnant ewes, having given birth and a few males) while the young move with the rest of the herds in the plains of Mayo Kebbi, Tandjilé, Chari and Mandoul. These results are similar to those observed in Niger on Fulani sheep [9], in Senegal [6], in Mali [16]. The main activity of the respondents was livestock keeping (91.66%), followed by agriculture (69.44%) as a secondary activity in the home areas. Similar results were obtained by [17] in Burkina Faso. The main objective of this production was home consumption 65.28%, followed by sales 21.52% of the surplus production. The type of crop was mainly cereals (millet, maize and sorghum) with 51.38% against legumes (peanuts, cowpeas, sesame) 28.46%.

According to [18], the settlement of the habitat and the allocation of land encouraged these families to develop the cultivation of cereals, the basis of their diet, any surplus of which is easily marketed. Indeed, the practice of transhumance has long been an effective strategy for adapting to climatic hazards for the majority of Sahelian herders. Transhumance is also considered as an opportunistic system of exploitation of pastoral resources in the face of seasonal fodder crises, taking advantage of ecological diversity and the complementarity between the different agro-climatic zones of the country [19-18]. This breeding mode explains the absence of shelter or housing (93.75%) for the animals revealed in the present study. These results are similar to those of [9] in Niger but different from those found by [6] on the study of Fulani-Fulani sheep keeping in Senegal for which habitats are built but consist of enclosures made of branches of thorny shrubs and devoid of a roof. The search for pastures (61.80%) and water for watering herds (40.97%) are the main reasons for mobility in the dry season. [17] observed similar results added the research of salted licks in Burkina-Faso. According to [20], herd mobility is a necessary condition for the viability of these systems, to access water and grazing resources whose spatial distribution varies during the year.

The average number per household was 50.67 ± 20.85 ewes and 19.25 ± 16.38 rams. The maximum varies from 100 rams to 300 ewes. Considering the ethnic groups, the average was similar among the Arabs and the Fulani of 47.83 ± 45.16 ewes and 16.74 ± 14.88 rams. This value is higher than that found by [21] in Togo with 7 to 8 ewes, by [22] in Cameroon with an average number of 8.2 heads, by [23] in Senegal with an average number of 14 heads and [24] in Benin with 2 to 10 heads. In Niger, [9] got a higher number (72 heads). These differences can be explained by the fact that in pure pastoral systems, the size of the herd is obviously larger than in agro-pastoral systems [25]. In the different herds, the numbers of ewes are higher than those of rams because of the heavy exploitation of the latter through sales and slaughter. This observation was made by [22] in Cameroon and by [23] in Senegal. Lime, cottonseed cake and groundnut cake were used for supplementation according to the respondents. They are locally produced and come from local agricultural or agro industrial by-products. They are purchased on local markets and/or come from the stock of fodder reserves of agro-pastoralists.

4.3. Farm labour in the Chari-Baguirmi and Mandoul provinces of Chad

The driving of the Fulani sheep was ensured by family labour 54.5%. Permanent employees who are mostly Fulani shepherds 29.72%. The similar result is observed in the Fulani sheep in Niger [9], Ladoum in Senegal [23] or the goat in the Sahel in Niger [13]. It is provided mainly by men (91 .77%) and by women (9.86%). The labor of the age group of 15 to 35 years was more represented (72.30%) followed by the class of 8 to 14 years (25%). These results corroborate those found by [14] in urban and peri-urban farms in Niamey in Niger and those of [17] in Burkina-Faso. According to the breeders, the type of contract was full-time 73.30% against 22.69% part-time. Labor tasks were mainly watering and watching (85.84%) against agricultural activities (13.48%) in the rainy season. *Fulani* sheep are most often herded without association with other sheep breeds among Fulani herders. This practice is favorable for the purity or homogeneity of this breed, the two variants of which are jealously guarded by breeders [26]. In the current study, Arabs drive sheep and goats together. This grazing system is known to promote on the one hand the state of health (by reducing the parasitic infestation of the animals) and the performance of the animals and on the other hand a good composition of the forage species in the environment [27-29]. On the other hand, among Arab herders, herd management is largely wage-based and is entrusted to Fulani herders. In Senegal, it is family and/or salaried with a shepherd for Fulani-Fulani sheep [6]. According to [18], the practice of agriculture has encouraged the use of salaried shepherds since the owner of the herd wishes to stay close to the villages (home territory) and his cultivated plots in order to ensure their management.

4.4. Health follow-up and reproduction of Fulani sheep in the Chari-Baguirmi and Mandoul provinces of Chad

In terms of frequent diseases, according to sheep keepers, PPR is more frequent with 65.28%, followed by enterotoxemia 21.52% and external parasites 8.33%. Health prophylaxis was provided to 55.54% for combined prophylaxis (Vaccination and deworming), 27.77% of farmers do not practice prophylaxis (None) and 15.96% did deworming. A higher value of about 76% [12] was observed from farmers deworming *Koundoum* sheep in Niger. Indeed, the State of Chad organizes free vaccination campaigns every year. The health monitoring method was carried out by the breeders (82.63%) given the inaccessibility of veterinary posts which are far from transhumance areas. During vaccination campaigns against PPR organized by state services, livestock attendants (15.96%) and public veterinarians (2%) carried out health monitoring according to transhumant breeders around the Chari *yaerés* near major centers. This practice does not comply with production hygiene rules and can promote the development of resistance of pathogens to different drug molecules, the presence of drug residues in animal products if the withdrawal time is not respected.

Regarding breeding practices, meat production (95.13%) is the main objective of *Fulani* sheep breeders. The breeding criterion was conformation (83.33%) linked to adaptation (93.05%) to extreme conditions as preferences according to the breeders surveyed. The free mode of reproduction (99.99%) is observed in farms with a permanent presence of the parent. No castration practice (100%) was observed in the farms. The litter size was two lambs (88.19%). Castration was absent (100%) according the farms surveyed. Similar results were obtained by [6] but a rate of castrated males (12.5%) observed in farms in Senegal.

4.5. *Fulani* sheep farming in the Chari-Baguirmi and Mandoul provinces of Chad

In terms of exploitation, according to the breeders surveyed, births (85.02%) and purchases (12.54%) constitute the main mode of entry of animals into farms. Exits consist of sale, mortality and slaughter respectively 40%, 29.4% and 19.5%. Similar values were observed concerning herd growth through birth (70%) [9], purchase (11.92%) and exits made up of sales (46.90%) and mortalities (28.1%).

Conclusion

It appears from this study that *Fulani* sheep are found in all the surveyed agro-ecological zones of Chad to which they are adapted. The keeping system for this sheep breed is the traditional extensive type, based essentially on the exploitation of natural rangelands and reproduction was done by random mating within herds, but with selected rams. They were in most cases driven alone without association with another livestock species and/or breed of sheep, however Arab breeders associated them with Arab sheep thus creating crossbreed sheep genotypes. The size of the herds was variable. Without housing, the herds were led by mainly family labour. Rivers, ponds and wells are the main sources for watering. The Fulani and the Arab people were the main ethnic groups that breed this sheep breed. In the past, Fulani sheep were exclusively kept by ethnic Fulani herders. This change highlights the adaptation of breeders to the effects of climate change. It also emerges from this study that these breeders lead the herds of the two variants of Fulani sheep from Chad in the same way (bicolor/Oudah or white/Waïla). However, the choice of parents favours the homogeneity of the two variants. The basic herd is often formed by inheritance, purchase and/or donation. In terms of exploitation, births are the factors for replenishing herds on farms, sales, mortality and slaughter are the main factors in exploitation. Mineral and food supplementation, animal health (vaccination and deworming) and reproduction are known and practiced by breeders to adapt to natural constraints and maintain better breeding. The extension of fields and the establishment of gardens in transhumance areas (*yaerés*, river banks) constituted the main constraint to access to resources (pasture and water). The phenotypic and molecular characterization would allow a better valorization and conservation of this genetic resource that may also need some standardization.

Conflict of interest

The authors declare that there is no conflict of interest related to this study.

Author contributions

DBH ensured the development of the research protocol, the collection, the processing of the data and the drafting of the manuscript under the guidance and supervision of ANJ, MF and KM; ZV contributed to the proofreading of the different versions to improve the scientific quality of the manuscript.

Acknowledgements

Our sincere thanks to the Coordination of the Project Adapting access to agro-pastoral resources in a context of mobility and climate change for pastoral livestock farming in Chad (ACCEPT) for its support in the organization of data collection. We also thank the decentralized livestock services, the traditional authorities and the breeders for their frank collaboration during the investigation.

References

1. Ministère de l'Elevage et des Productions Animales (MEPA). 2021. Rapport statistique du Cheptel Tchadien. 80p.
2. Zoundi J.S., Nianogo A.J., Sawadogo L. 2003. Effet de la complémentation avec des blocs multi nutritionnels sur la dégradabilité des fourrages pauvres utilisés dans l'alimentation des ovins du plateau central au Burkina-Faso. *Agronomie Africaine* 15 (2): 77-92.
3. Toutain B., Ickowicz A., Dutilly-diane C., Reid R.S., Diop A.T., Taneja V.K., Gibon A., Genin D., Ibrahim M., Behnke R. and Ash A. 2010. Impact of Extensive Livestock Systems on terrestrial Ecosystems. In H. Steinfeld, H. A. Mooney, F. Schneider, and L. E. Neville [eds.], Livestock in a Changing landscape. Island Press, London.
4. Recensement Général de l'Elevage. 2021. Rapport sur l'estimation du cheptel Tchadien. 35p.

5. Mopaté L.Y., Tellah M., Adoum Y. et Souleyman M.S. 2020. Rendement carcasse des ovins sahéliens dans la Province du Guera au Centre-Est du Tchad www.m.elewa.org/journals/on 29thFebruary 2020https://doi.org/10.35759/JABs.v146.10.
6. Ndiaye B., Diouf M.N., Ciss M., Wane M., Diop M., Sembène M. 2018. Morphologie et pratiques d'élevage du mouton Fulani-Fulani du Sénégal. *Inter. J. Adv. Res.* 6(5): 727- 738. DOI:10.21474/IJAR01/7089.
7. Yakubu A., Raj A.D. and Omeje J.N. 2010. Genetic and phenotypic differentiation of qualitative traits in Nigerian indigenous goat and sheep populations. *ARPN J. Agric. Bio. Sci.* 5(2): 58-66.
8. Yunusa A.J., Salako A.E. and Oladejo O.A. 2013. Morphometric characterization of Nigeria indigenous sheep using multifactorial discriminant analysis. Vol. 5(10), pp. 661-665, October2013.DOI:10.5897/IJBC2013.0592.ISSN2141243-X©2013.Academic, Journalshttp://www.academicjournals.-org/IJBC.
9. Yaye B.H., Dayo G.K., Issa M., Mani M., Idi I. et Marichatou H. 2019. Etude des pratiques d'élevage des moutons Fulanih du Niger : le Fulani blanc et le Fulani bicolore. Available online at http://www.ifgdg.org. DOI: https://dx.doi.org/10.4314/ijbcs.v13i1.8.
10. Sougnabé P. 2013. La sédentarisation comme moyen d'adaptation aux baisses de la pluviométrie chez les éleveurs Fulanis en Savane tchadienne. *VertigO* 13(1). DOI: 10.4000/vertigo.15404.
11. Dicko M.S., Djitèye M.A. et Sangaré M. 2006. Les systèmes de production animale au Sahel. *Sécheresse* 17(1-2): 83-97.
12. Hamadou I., Moula N., Siddo S., Marichatou H., Issa M., Leroy P. et Moussiaux A.N. 2015. La race de mouton Koundoum au Niger : étude morphobiométrique et description du système de production. *JARTS* 116(1): 49-58.
13. Mani M. 2013. Caractérisation phénotypique et zootechnique de la chèvre du Sahel élevée au Niger. Doctorat Unique, Université Cheikh Anta Diop de Dakar, Université Abdou Moumouni de Niamey, p. 160.
14. Lawal A.M., Chaibou M., Mani M., Garba M. et Gouro A. 2018. Pratiques d'éleveurs et résultats économiques d'élevage dans les exploitations urbaines et périurbaines de Niamey. *Int. J. Biol. Chem. Sci.* 12: 294- 309.
15. Sanon H., Some S., Obulbiga M., Oubda F. et Bamouni I. 2018. Analyse de la structure et du fonctionnement de la filière fourrage dans les villes de Ouagadougou et Bobo-Dioulasso au Burkina Faso. *Int. J. Biol. Chem. Sci.* 12: 1247-1259. DOI: https://dx.doi.org/10.4314/ijbcs.v12i3.14
16. Ham F., Metais T., Hoorelbeke P., Fillol E. and Crahay, P. 2011. One horn of the cow: an innovative GIS-based surveillance and early warning system pastoral areas of Sahel. *ACF, FAO*, p. 2.
17. Kiema A., Tontibomma B.G. et Zampaligré N. 2014. Transhumance et gestion des ressources naturelles au Sahel : contraintes et perspectives face aux mutations des systèmes de productions pastorales.VertigO – la revue électronique en sciences de l'environnement, 14(3).DOI : https://id.erudit.org/iderudit/1034947ar.
18. Kossoumna L.N., Dugué P. et Torquebiau E. 2010. Sédentarisation des éleveurs Mbororo et évolution de leurs pratiques au Nord Cameroun. *Cah. Agric,* 19(1) : janvier-février 2010.
19. FAO 2013. Caractérisations phénotypiques des ressources génétiques animales. Directives FAO sur la production et la santé animale, *Rome* 11 : 152.
20. Vall E., Salgado P., Corniaux C., Blanchard M., Dutilly C. et Alary V. 2014. Changements et innovations dans les systèmes d'élevage en Afrique. In : Numéro spécial, Quelles innovations pour quels systèmes d'élevage ? Ingrand S., Baumont R. (Eds). *INRA Prod. Anim.* 27, 161-174.
21. Amegee Y. 1983. Le mouton de Vogan (croisé Djallonké x Sahélien) au Togo. *Rev. Elev. Méd. vét. Pays trop.* 36 (1): 79-84.
22. Thys E. et Ekembe T. 1992. Elevage citadin des petits ruminants à Maroua (Cameroun). *Cahiers Agric.* 1(4): 249-255. http://dspace.itg.be/handle/10390/3939
23. Ousseini H. 2011. Analyse socioéconomique des élevages du mouton Ladoum dans les communes de Thiès/Sénégal. Master 2 de Productions Animales et Développement Durable Option : Economie et Politiques d'Elevage. Université Cheikh Anta Diop, Sénégal.
24. Rade M.C. 1994. Contribution à l'étude des caractéristiques morphologiques et zootechnique des petits ruminants en Afrique tropicale : Synthèse bibliographique. Thèse de Doctorat Vétérinaire, Université Cheikh Anta Diop, Sénégal, p. 130.
25. Dayo G.K., Alfa E., Talaki E., Soedji K., Sylla S. et Dao B. 2015. Caractérisation phénotypique du mouton de Vogan du Togo et relation avec le mouton Djallonké et le mouton sahélien. *Animal Genetic Resources* 56: 63-78.
26. Hoste H., Guitard J. et Pons J. 2003. Pâturage mixte entre ovins et bovins intérêt dans la gestion des strongyloses gastro intestinales. *Fourrages* 176, 425-436.
27. Meisser M., Frey C., Deléglise C. and Mosimann E. 2013. Pâturage mixte bovins-ovins en moyenne montagne : trois années d'essai dans le Jura suisse. *Fourrages* 216 : 305-311.
28. Alexis S., Angeon V., Arquet R. et Boval M. 2015. Les systèmes mixtes d'élevage de petits ruminants et de bovins: Une alternative pour améliorer les performances animales au pâturage. *Innovations Agronomiques* 43: 19-28.
29. Hounzangbe Adote M.S., Azando E. et Awohouedji Y. 2011. Biodiversité dans les zones d'élevage des petits ruminants mammifères domestiques Benin. *In* Atlas de la Biodiversité de l'Afrique de l'Ouest, Sinsin B. & Kampmann D. (eds) : pp.506- 518.