The current state of camel herding in Chad

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Abstract

The dromedary camel, thanks to its resilience and hardiness, can add value to resource-poor rangelands. In Chad, camel herding has been practiced in arid and semi-arid zones for a long time. Nomadic or transhumance modes are typically used to take advantage of natural rangelands with variable forage resources that are dispersed in time and space. These modes involve mobility over medium and long distances. However, semi-intensive herding also is developing on the outskirts of the city of N'Djamena. The number of dromedaries in Chad has increased twelve-fold over the past four decades. This increase has been particularly remarkable in the Saharan part of the country. Furthermore, climate change, and notably the descent of isohyets, has allowed camel herding to extend towards the wetlands in the southern part of the country. However, camel herding in Chad has been little studied, and the information available is scattered and very localized. Although there are nearly 9 million camels in the country, they only produce 32 thousand tonnes of milk and 7 thousand tonnes of meat per year. This represents only 8.24% and 1% of the national volume of milk and red meat, respectively. Milk consumption is hence limited to 2 kg/inhabitant/year, and that of meat to 0.46 kg/inhabitant/year. Given the size of the country's camel population, the reported milk and meat production figures are much lower than could be expected. The export of camels to Libya and Egypt, which was once a thriving sector, also has been considerably hampered by the political unrest in Libya and Sudan. Despite the demographic importance of camel herding in Chad, it has not attracted the attention of public authorities, and it remains forgotten in livestock sector development projects. If it is to play an important role in ensuring food security, camel herding requires the support of a research-action programme.

Keywords: camel, Chad, herding system, performance, stock numbers

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Introduction

The dromedary camel (*Camelus dromedarius*) is recognized for its resilience, hardiness, and remarkable potential to add value to rangelands poor in pastoral resources (Kurtu, 2004). Camels can survive without drinking water for up to 5-7 days in summer and up to 50 days in winter (Faraz et al., 2019). Camel herding constitutes a major component of the economy and food security of arid and semi-arid zones (Jaji et al., 2017).

In Chad, "The dromedary is an essential part of identity in the northern regions although, with the episodes of drought that the country has experienced over the past few decades, slow progression towards the southern regions is indicated. Camel herding and breeding is in fact associated with populations occupying the arid and semi-arid zones of the country, roughly

speaking, beyond the 13th parallel, that is, more than two-thirds of the country: Arabs, Gorane, Zaghawa,…" (Faye, 2010). Camel herding is essentially based on long-distance mobility covering over 700 km (Aubague et al., 2011). It plays an important role in the livelihoods of pastoral populations by providing them with milk and meat, as well as transport services in remote areas. The export of live animals to neighbouring countries also helps to generate foreign currency income for the exporting country (Vounba, 2010).

Despite their nutritional and socio-economic importance in pastoral camel herding societies, camels have long been marginalized in comparison with other domestic animals. However, faced with changing climatic and ecological conditions in the Sahelian zone characterized by the movement of isohyets towards the south and erratic rain distribution, pastoralists have changed their pastoral strategies to include species with high drought tolerance, in this case the camel (Gonin, 2017).

Pastoral societies are renewing their interest in camel herding due to the camel's outstanding ability to adapt to constrained ecosystems and resist arid zone conditions (Martin et al., 1996a; Chaibou, 2005a). Camel are able to eat herbs and thorny plants that other animals cannot ingest (Faraz et al., 2019).

The camel population in Chad has experienced an explosive increase. The country has nearly 9 million heads, which is nearly 22% of all domestic ruminants as stated in TLU (FAOSTAT, 2020). This number of camels brings the ratio of camels to humans to nearly one camel per two people. Camels can be found in nearly every agro-ecological zone in the country, with the greatest concentration in the Saharan zone, followed by the Sahelian zone (MEPA, 2016).

Today, camels herding could play a leading role in improving the livelihoods of pastoralists through the production of camel milk and meat, but also as a means to constitute savings thanks to the camel's ability to adapt to adversity.

Although camels are very adaptable and camel products are highly nutritious, there is relatively little data on these animals in the literature. Compared to other species, such as cattle, sheep, and goats, camels have been overlooked in livestock sector development projects. The current bibliographic review takes stock of the situation and the challenges facing camel herding in Chad.

Importance of camel herding in Chad

In Chad, camel herding is a form of savings for cameleers. They find great satisfaction in maintaining their camel herds. The number of animals they own gives them a social rank. Camels also have become a safer investment than cattle following the recent episodes of drought in the country. Today, many community members are investing their money in dromedaries, a sign of wealth and financial security, but also of prestige (Vounba, 2010). In Somalia, pastoralists view dromedaries as a banking system or as a means of security against drought, disease and other natural disasters that affect other livestock more seriously (Farah et al., 2004). The camel is a highly versatile animal that provides considerable services to pastoral societies whose lives are intimately linked to the animal.

Environmental aspects

The camel is a rustic animal with an exceptional capacity to adapt and add value to rangelands which are poor in plant resources. The animal is known for its ambulatory grazing, which involves traversing vast distances to feed itself (Stiles, 1988; Dittmann et al., 2014; Ouologuem & Moussa, 2020). This mobility reduces the pressure placed on vegetation. The camel has a very varied and selective diet (consumption of leaves, flowers and woody fruits) (Faye et al., 2022; Tadesse et al., 2014). Unlike cattle and sheep, which graze at ground level, camels preserve the environments in which they live

and do not damage the soil. They can therefore contribute to slowing the advance of the desert (Stiles, 1988).

Moreover, Guerouali and Laabouri (2018) found that dairy camels emit just one third of the methane emissions of Holstein dairy cows kept under the same feeding and housing conditions (67 l/day, or 15.2 l/kg of dry matter ingested, for camels compared to 194 l/day, or 42.2 l/ kg of dry matter ingested, for cows). Furthermore, Dittmann et al. (2014) demonstrated that camels produce less methane (0.32 l/kg live weight) than other ruminants (0.58 l/kg live weight). However, when the amounts of digestible fibre ingested are compared, the difference is not significant (92.7 l compared to 86.2 l/kg in other ruminants).

Socio-cultural aspects

The camel occupies an important place in the life of Chadian pastoral societies. It serves many diverse functions, including as production animals for milk and meat, pack animals, saddle animals, racing animals, etc. During festive ceremonies, men with their richly adorned mounts (camels) give demonstrations at parades. The camel is also used to draw water from deep wells in pastoral areas. A study carried out in the Biltine region of Chad reveals that 40% of the exploitation of the camel herd in the area is linked to socio-cultural practices, with 18% attributed to zakat (a form of almsgiving), 13% to dowries and 9% to donations to newborns (Abiola & Laporte, 1998). Among the *Ouled Rachid Arabs* (a tribe found in central Chad), a newborn male child receives a few heads of camels from his parents during his baptism (on the 7th day after his birth), on the day of his circumcision, and for his marriage. This donation already represents a small heritance for him. This custom is discriminatory as a newborn female child is only entitled to a female camel offered by her future husband as a wedding gift (Mahamat Ahmat, 2008).

In most camel pastoral societies in Chad, the marriage dowry is paid in the form of a number of dromedary heads.

Economic aspects

Camel herding is an important part of Chad's economy. It remains an essential component of both capital and savings (Martin et al., 1996b), and contributes to the country's economy through the export of live animals, the sale of milk and meat, job creation, and of course meeting household food needs (Vounba,2010).

It is difficult to assess camel milk production in Chad due to the mobility of breeders and the irregularity of milking. Camel milk is not widely marketed, particularly in pastoral areas. Although the milk is still primarily used for home consumption, the potential sale of milk represents more than 6.3 billion CFA francs per year (Abiola & Laporte, 1998).

Dromedary meat production is marketed entirely within the country. There are no taboos surrounding this meat. Dromedary meat production generates an annual flow of 2.714 billion CFA francs (Abiola & Laporte, 1998).

Live animals are marketed both within and outside the country. The domestic camel trade in Chad generates jobs since it involves several intermediaries. Outside of Chad, the animals are mainly sent to neighbouring countries such as Nigeria, Cameroon, and Egypt via Sudan (Mbaïogaou, 1998). In recent years, however, exports have slowed due to political instability and security problems.

Nutritional aspects

Camel milk remains the most important source of nutrition for pastoralists in many African and Asian countries (Doutoum et al., 2000 ; Faye et al., 2022). Camel milk consumption in Chad is estimated at 2 kg/capita/year (FAOSTAT, 2020). camel meat is a valuable source of protein and other nutrients. It contains less fat and cholesterol than ruminants' meat (Abrhaley & Leta, 2018). Consumption of camel meat in

Chad is estimated at 0.46 kg/inhabitant/year (FAOSTAT, 2020).

The breeds of camels utilized in Chad

Some research has been conducted in Chad to differentiate between camel breeds. One study investigated the genetics of the dromedary population in the Abéché and Biltine areas, located in eastern Chad. It showed that the allelic frequencies made it possible to distinguish the dromedaries sampled near Abéché from those of Biltine, despite the geographical proximity of the two sites, and that it was probable that all of the individuals belonged to the same genotype (Ganda, 1991). A morpho-biometric study conducted in the region of Bahr El Gazal, in the centre-west of Chad, found significant genetic variability within the dromedary population, with the height at the withers and body length identified as the most variable parameters. This analysis showed that the population was made up of three phenotypes. The first two types were closer to each other while the third type was further apart (Djomtchaigue et al., 2015). Martin et al. (1996b) described three "breeds" of camels distinguished by their ethnic and geographical characteristics, namely the Manga, Arab and Tibesti "breeds" (Figure 1). However, genetic differentiation could not be confirmed due to the lack of precise and representative data.

Figure 1. Camel breeds present in Chad (Martin et al., 1996b)

The dromedary of Tibesti (or Gorane, or Kanem, or Ajjer)

The *Tibesti* dromedary comes from Tibesti, a region in the north of Chad. It was probably introduced by the Toubou pastoralists from Borkou and Tibesti. It is a mountain animal, about 1.75 to 1.85 metres tall at the withers, with a solid and stocky appearance, and is used as a saddle and pack animal. It has a very hairy coat with coarse hair that varies in colour from grey to dark. It is mainly present in Kanem.

The Manga dromedary (or Mahamid)

The Manga breed is native to Aïr and is found in Nigerian Borno and to the north of Lake Chad, which is in the western part of the country. This animal is of medium build and is found on the plain. It is about 1.85 to 2 metres tall at the withers and has a live weight of 550 kilos. It has a stocky, muscular build and is not very rustic. It has a fawn to red coloured coat, with hair that is quite long and slightly wavy. It is used as a pack animal and for meat, particularly in Nigerian Borno and north of Lake Chad.

Arab Dromedary (Bahr-EI-Arab or Zebedi)

The Arab breed takes its name from a group of Chadian herders, the Arabs. It is both a mountain and plain animal. It is large, with a very long neck and short hair except at the top of the hump and on the shoulders. Its weight varies between 450 and 500 kg and its coat

colour is dappled black or sand grey. It is used as a pack animal. It is found in the Arab enclave zone of the Lake Chad basin.

A growing herd

Chad has made two censuses of its livestock. The first, conducted in 1976, recorded a camel population of 533,734 heads. In the years that followed, the size of the camel herd was estimated by applying a multiplying factor, corresponding to a fixed annual growth rate of 3%. The second census was not carried out until 2015, 39 years after the first. It recorded 6,413,521 heads, indicating remarkable growth between 1976 and 2015. The camel population had increased by a factor of 12.02 (Koussou et al., 2013). Today, to estimate the camel population, a multiplication factor corresponding to a fixed growth rate of 6.58% has been put in place to extrapolate the census numbers. However, this method of estimating livestock is based on an unverified assumption.

The national camel population has increased sharply (Figure 2). This is explained by the increased use of camels at the expense of other species that are more sensitive to the periods of drought experienced by the country since the 1960s. If we compare Chad to other countries in the world (Figure 3), the growth of the herd appears particularly high with nearly 9,000,000 head, or 26.27% of the total camel population in the top 10 camel herding countries in 2020, far ahead of Somalia with 21.85% (FAOSTAT, 2020).

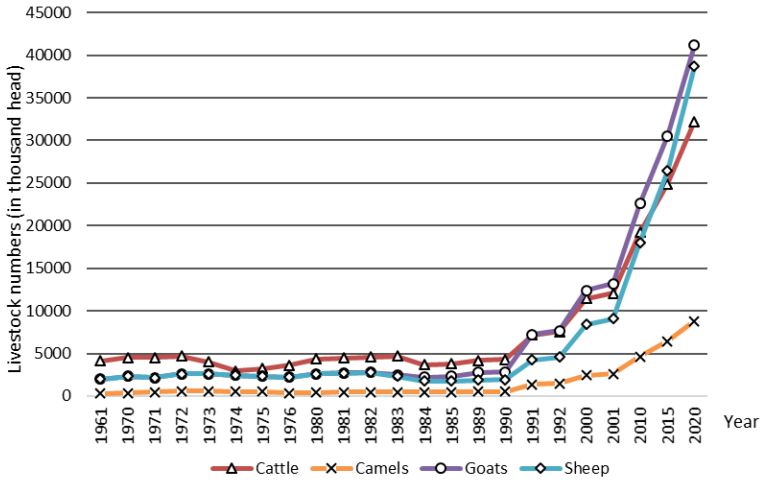

Figure 2. Evolution of livestock numbers in Chad (FAOSTAT, 2020)

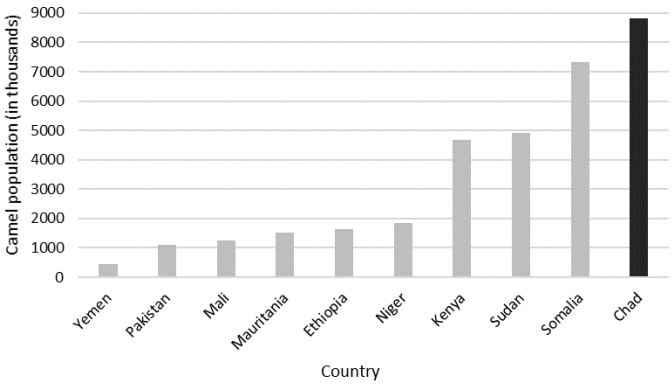

Figure 3. Number of camels from the top 10 countries in the world (FAOSTAT, 2020).

Distribution of camels in Chad

The distribution of camels by region shows that most of the population is concentrated in the regions of Borkou and Ennedi-Ouest, followed by the regions of Batha, Wadi-Fira, Ennedi-Est and Kanem (Figure 4).

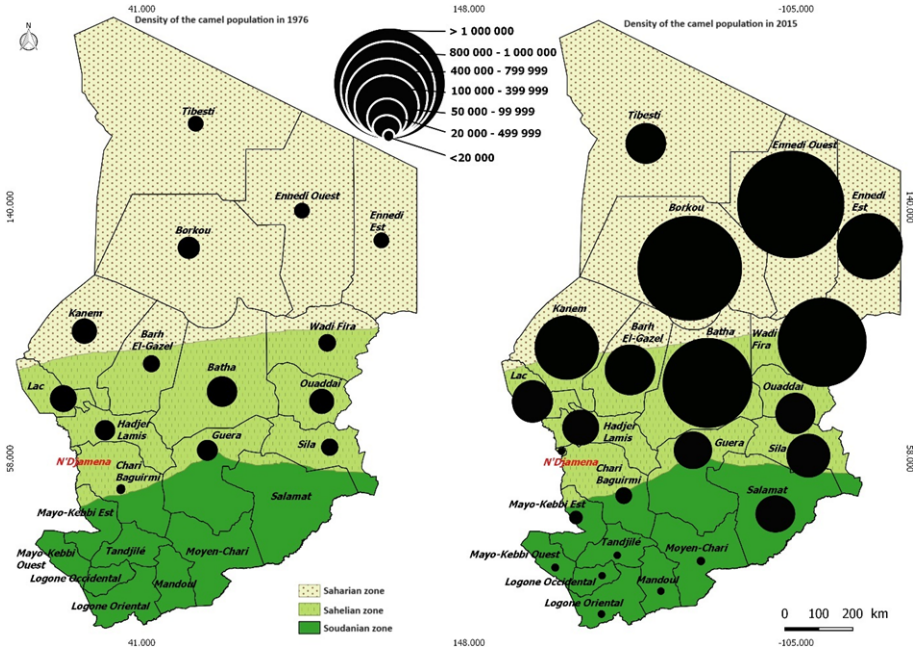

Figure 4. Growth of camel population density by region from 1976 to 2015

Figure 5 shows that most of the camel population is distributed in the Sahelian and Saharan zones. The share of the Sahelian zone decreased from 79.3% in 1976 to 47.5% in 2015. However, the Saharan zone has experienced remarkable growth, increasing from 20.7% in 1976 to 50.3% in 2015. This is because many traders and officials from the Saharan zone began to capitalize on camel breeding. It has been noted that a single person can possess hundreds or even thousands of camels. In the Sudanian zone, the growth rate of the camel population increased from 0 to 2.2% in 2015. This is logical, since dromedaries cannot go too far south due to the humidity, which causes an increase in the number of biting insects. In recent years, however, drought has caused a gradual movement of dromedaries towards the southern zone in search of pastoral resources, despite the presence of biting insects. Such "movement" of camel herds towards the Sudanese zone also has been observed in other Sahelian countries (Faye et al., 2012).

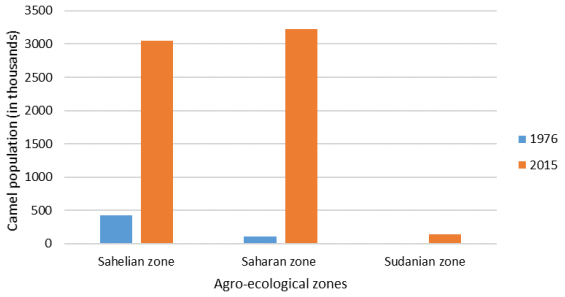

Figure 5. Population distribution according to agro-ecological zones

Camel herding has been expanding in Sahelian countries for the past four decades. It is happening on a significant scale due to recurring droughts and high demand for milk and meat from the local population, as well as the arrival of new owners (officials and traders) who invest in dromedary breeding. In contrast, the irregular evolution of the numbers in the Sudanese zone could be linked to the effects of droughts and the movement south of the isohyets. According to Faye et al. (2013), the Sahelian climate is characterized by pronounced drought and advancing desertification. The climate changes favouring desertification also have favoured the expansion of the camel area throughout the Sahelian countries. In Niger, for example, we have observed a significant increase in the number of camels in traditionally agricultural areas such as Tahoua, Maradi, and Zinder. In Chad, camel herds have reached the border with the Central African Republic. In Kenya, camels are now found in many areas of the country, including those inhabited by the Maasai people, who are traditionally cattle herders. In Mali, the southern and northern areas of the Mopti region are new camel herding zones.

Modes of camel herding

In Chad, camel herding is associated with populations in arid and semi-arid areas. It is implemented in a nomadic or transhumance mode by populations belonging mainly to the Arab and Gorane ethnic groups, and to a lesser extent to the Zaghawa ethnic group. The spatial mobility of herds and families appears to be a strategy for limiting the effects of ecological risks (drought, lack of pasture) and pathological risks (epidemics) (Lhoste, 2007). In recent years, we have observed the development of a semi-intensive milk production system around the city of N'Djamena.

Transhumance

Transhumance is defined by Brémaud (1955) as "*a set of seasonal movements of pendulum rhythm and cyclical character, involving the entire pastoral mass which carries it out within customary pastures*". It is a common practice among pastoralists to optimize the use of pastures and water resources that are distributed in space and time (Mirkena et al., 2018). In Chad, the pastoral camel societies most involved in long-distance transhumance are mainly the Arabs. They are distributed in three transhumance zones (Figure 8).

In eastern Chad, transhumance is practiced by the Arabs Khozam, Ouled Malik and Ouled Rachid. Transhumant herds travel from Ennedi-Ouest in the north and head south, passing through Wadi-Fira, with some groups settling down around Abéché (Ouaddaï), others in the Sila area, and the last ones continuing to Bahr Azoum (Salamat).

In central Chad, there are four routes. The route that goes from Ouadi Haddad or even Ouadi Rimé to the north of Batha separates into two. Some groups take the route which descends towards Fitri in the south of Batha while others continue to the Chari-Baguirmi area; this route is taken by the Ouled Rachid, Khozam, Ouled Himet and Ouled Malik. The second route starts from Ouadi Djedid in the north of Batha and goes down to Melfi in the south of Guéra where some groups settle while others head towards Salamat or Moyen Chari. This route is taken by the Misserié and the Ouled Rachid. The third route goes from Bahr El Gazel in the north and goes down to Fitri to the south of Batha. It is used by the Arabs Ouled Malik, who settle around Lake Fitri, and by the Gorane Kreda, who camp in the N'Djamena Bilala area.

In Western Chad, there is a route which is used mainly by the Ouled Rachid. It goes from North Kanem (Mao, Michémiré) via Hadjer Lamis before splitting into two, one descending towards the Chari-Baguirmi zone and then continuing towards the Sudanian zone (Mayo kebbi, Tandjilé, Logone Occidental, Logone Oriental, Mandoul, Moyen Chari), the second descending towards the Lake Chad area.

In this migration, camels are the last to go south in search of water and pasture, and the first to go north in the Saharan zone because they are restricted by the risk of trypanosomiasis in the Sudanian zone (Doutoum et al., 2000).

Nomadism

Bernus and Centlivres-Demont (1982) define nomadism as the exploitation of natural rangelands with variable forage resources dispersed in complementary areas. It involves the mobility of families and herds, which is made possible by the use of transportable dwellings. This method of herding is governed by the need to find pastoral resources that can meet the nutritional needs of the animals. The main characteristic of this system is mobility, flexibility, and dispersion. This type of behaviour is demonstrated by Gorane and Zaghawa camel drivers.

The Gorane camel herders of Borkou, Ennedi and Tibesti move independently from one watering point to another, depending on the availability of fodder offered by seasonal pastures. In the rainy season, they exploit temporary ponds and *gueltas*. In the dry season, their movement is limited to the boundaries of the Tibesti and Ennedi massifs and, to a lesser extent, around the eastern heights of Kapka and the oases of Faya, Zouar, Bardaï, Fada, and the Lakes of Ounianga, where they exploit wells or permanent ponds (PPT, 2016).

The Gorane Kreda camel drivers of Bahr-EI-Ghazal move around the bed of the old effluent of a lake which in Gorane is called "*Soro*", and they stay on the ponds of the "*Soro*" to the north of Moussoro during the rainy season. After November, they disperse to sandy plateaus with numerous wells where they stay until April (Mbaïogaou, 1998).

The Zaghawa camel herders move within the province of Ennedi-Est and Wadi-Fira up to the Sudanese border. During the rainy season, they exploit the areas of Nohi, Itou, Mourdi and Bao. During the dry season, some disperse into the areas of Ouadi Hawar and Kariari, while others go into the areas of Gréda, Tiné, and Koulbous in the Wadi-Fira up to the Sudanese border.

Peri-urban breeding

Camel herding has been undergoing rapid change for several decades. There has been a significant increase in dairy production systems in the peri-urban area of N'Djamena. This change is characterized by a specialization of the herd, moving from a multi-use function to a more or less single function, in this case milk production for the urban market. This implies a "peri-urbanization" of breeding systems (Faye, 2018). This trend towards peri-urbanization is based on the sedentarization of dairy camel herds. It is also characterized by the use of feed inputs. The management of the animals alternates between grazing during the day and feeding them supplements in camp in the evening. This mode of operation is practiced mainly by the Ouled Rachid Arabs. They settle within a radius of 15 to 80 km around the city of N'Djamena, mainly with their animals in production, to supply individuals and dairies.

Dominant pathologies

The productivity of camel herding is limited by the health of the animals. According to a study carried out in eastern Chad, camels are essentially susceptible to trypanosomiasis, gastrointestinal parasites, pyogenic infections, respiratory diseases, mange, baby camel diarrhoea, symptomatic anthrax, etc. (Doutoum et al., 2000). Other studies carried out in the main dromedary regions of Chad, such as Kanem, Batha, Ouaddaï and Ennedi, have highlighted the presence of trypanosomiasis. The main regions affected are Kanem, Batha and especially Ouaddaï. The dromedaries which make long journeys, particularly towards the south, are the most affected (10 to 30% of the animals), and the nomads located in the north of Kanem are much less affected (0.12%) (Gruvel & Balis, 1965). Trypanosomiasis, called in Arabic "*Djoufar*", is the cause of significant direct (mortality and abortion) and indirect

(lactation decrease, weight loss, inability to transport) losses (MEPA, 2016; Djomtchaigue et al., 2015). Furthermore, another study carried out in Biltine confirmed the presence of trypanosomiasis but found that it is often associated with digestive strongyloidiasis (Ganda & Buron, 1992). Serological studies carried out in particular in Niger and Chad also have shown the probable role of Pl3 (Parainfluenza virus type 3) and pasteurellosis (*Pasteurella multocida* type A and E), whose seroprevalence could reach 93% during the rainy season (Bonnet, 1996). Trypanosomiasis and camel diarrhoea cause significant losses among dromedaries, and the treatments used seem insufficient to overcome these health problems (Faye, 2010). There are several reasons for this, including: (i) difficulty to access certain drugs (availability on the market, prohibitive prices); (ii) non-compliant use of products (for example, deworming not adapted to parasitic cycles); and (iii) presence on the market of fraudulent and ineffective medicines.

Camel milk production

In pastoral areas, due to the distance of herders from consumption areas, camel milk is mainly intended for self-consumption and as an offering for guests (Farah et al., 2004; Faye, 2020). However, urbanization, population growth, and changes in dietary behaviour have led to a demand for animal products. This has accelerated the commercialization of a product that traditionally had been given away. Camel milk production data is essentially obtained from surveys rather than monitoring. Camel milk production remains quite difficult to measure precisely due to the mobility of herders. The frequency of milking varies depending on the herder. Some milk once a day, others more than twice a day. In Chad, observations in the field show an average production of 2,280 litres for a lactation period of 12 months (Ganda & Buron, 1992). This amount is similar to the 2,080 litres observed in the pastoral zone of the Somali Regional State in Ethiopia (Kebede et al., 2015). In Mali, average milk production was 1,395 ± 306 kg in Niono, compared to 380.9 ± 144.3 kg in Sotuba (Ouologuem, Mohomoudou, Nialibouly, et al., 2020). In Saudi Arabia, the milk production of camels in intensive breeding schemes is 1,970 ± 790 kg for a lactation period of 12 months (Musaad et al., 2013). In contrast, a well-fed camel in Pakistan can produce up to 15 to 20 litres of milk per day. The lactation period lasts 270 to 540 days, and total milk production ranges from 1,300 to 4,200 litres (Faraz et al., 2013). Overall, milk production varies depending on genetics, environmental conditions and feed management (Musaad et al., 2013). In most cases, the duration of lactation is on average 365 days, but it can last longer if the feed conditions are good and if the herder wants to continue milking (Keskes et al., 2013).

The milking technique remains very artisanal (Figure 6). It consists of tying the two teats with a cloth to prevent baby camels from consuming the milk. Dairies in N'Djamena have recently begun producing pasteurized milk, a minor technological development. In pastoral areas, the only possible modification is that of fermented milk, which consists of providing an acidified product called "*garass*" stored in leather bags.

Figure 6: Milking practice by a woman in the peri-urban area of N'Djamena.

The national volume of camel milk produced is 32,640 tonnes, the equivalent to 8.24% of the total national milk production in the country (FAOSTAT, 2020). This amount is probably underestimated and may not provide an accurate picture of the situation. Compared to other domestic ruminants, camel milk production occupies a minimal place. It is a little closer to that of sheep (11.56%), but far behind cows and goats, which represent 50.63% and 29.56%, respectively (Figure 7).

Despite having a camel herd that represents 22.82% of the world's camel population, Chad only ranks 9th in milk production among the top 10 camel herding countries in the world (Table 1). Its milk production represents only 1.04% of the estimated world's camel milk production (FAOSTAT, 2020). It is far from producing the quantity that could be expected, especially when compared to the Kingdom of Saudi Arabia, which manages to produce 135,926 tonnes per annum with a camel herd of only 500,000 heads (FAOSTAT, 2020)

Table 1. Comparison of the camel population and milk production (in tonnes) of the top 10 camel herding countries in 2020 (FAOSTAT, 2020)

Country	Camel population	Camel population (%)	Milk production	Milk production (%)
Saudi Arabia	500,000	2	135,926	4
United Arab Emirates	513,092	2	58,176	2
Ethiopia	1,637,223	5	243,429	8
Kenya	4,669,739	14	1,124,527	37
Mali	1,265,915	4	270,995	9
Mauritania	1,509,640	5	26,330	1
Niger	1,858,796	6	112,002	4
Somalia	7,337,450	22	968,615	32
Sudan	4,918,109	15	63,016	2
Chad	8,821,223	27	32,640	1

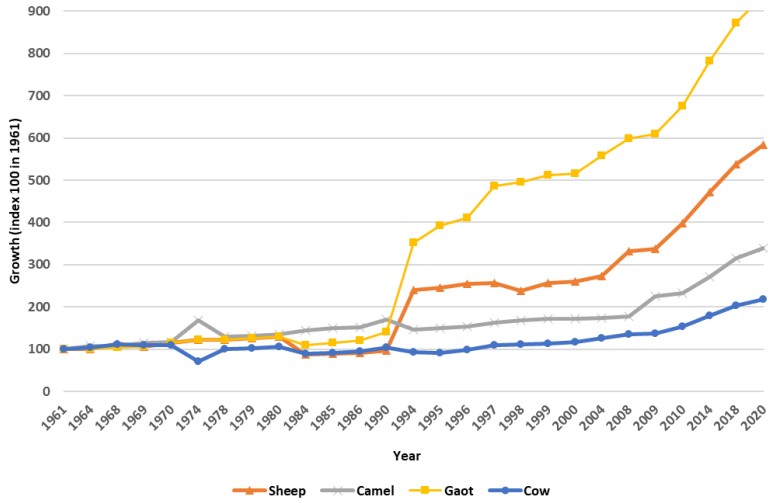

Figure 7. Evolution of milk production in Chad from 1961 to 2020

The emergence of camel dairy sectors in the peri-urban areas of N'Djamena

The Ouled Rachid tribe, who camp near N'Djamena every dry season to sell camel milk, consider this product to be a strategic commodity. They sell the milk through four types of outlets (Mahamat Ahmat et al., 2023):

Roadside sales

This involves women farmers who live close to the tarmac roads leading to the city of N'Djamena. They display their milk by the asphalt roadside and sell it directly to consumers or to transport collectors at a price of 1,000 FCFA per 1.5 litre bottle, or 667 FCFA/litre.

Sales to collectors

This takes place at camp level. There are female collectors, who are herders from the same camp as the sellers or from a neighbouring camp. Collectors are transporters who come from the town, usually on motorbikes, to buy milk on behalf of dairies or food shops. The milk is sold at the camp for 500 FCFA per 1.5 litre bottle, i.e., 333 FCFA/litre.

Sale in town with collection

This combines the sale of milk produced by the household with milk collected from women in the neighbourhood. These women milk collectors use public transport to get to town. They sell the milk either directly to consumers door-to-door, or to dairies or food shops. The selling price is 667 FCFA/litre.

Sales in town without collection

This concerns women farmers who only sell milk produced within the household. They also use public transport. Milk is sold in town either directly to consumers door-to-door, or to dairies or food shops. The price is the same, whatever the customer: 667 FCFA/litre.

The booming camel meat sector

In pastoral societies, the consumption of camel meat is often less culturally important than that of milk. The main reason is that a camel is less easily slaughtered than a sheep or goat (Adamou & Faye, 2007). The slaughter of a camel is limited to ceremonial events which bring together a large number of participants (Faye, 2009). However, due to demographic growth and rapid urbanization, there has been a strong increase in dromedary meat consumption (Figure 8). Consumption went from 180 tonnes

in 1961 to 7,494 tonnes in 2020, a growth of 97.65% (FAOSTAT, 2020). It is widely consumed in the northern and central areas of Chad.

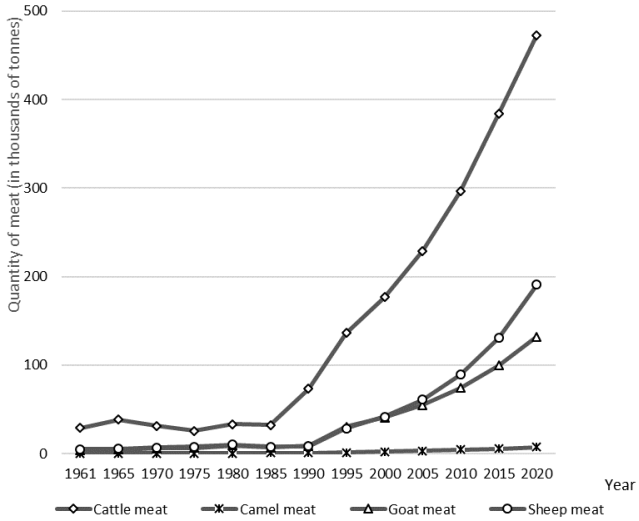

Figure 8. Growth of camel meat consumption in Chad (FAOSTAT, 2020)

In Chad, camels were traditionally slaughtered between February and July, with a peak in May. This is a critical period when only dromedaries are in very good condition due to their ability to make use of scarce feed resources. Today, however, the demand for meat products has become more important. Data on controlled camel slaughters have indeed shown a certain growth. The annual production of camel meat at the Farcha Refrigerated Slaughterhouse in N'Djamena increased from 1,890 tonnes in 2000 to 2,359 tonnes in 2018 (MEPA, 2018). It is mainly adult camels that are slaughtered. The carcass yield ranges between 45 to 55%. Dromedary meat can be processed in several ways: (i) *kilichi* is a meat made from thin slices dried in the sun, coated with a sauce then grilled, which can be kept for several months (Mbaïogaou, 1998); (ii) *Charmout* is a dried meat produced in the traditional way in Chad and represents the only ancient form of meat preservation. It is deboned and cut into strips approximately 1 cm wide, threaded on string and placed to dry in the sun; and (iii) grilled meat in specialized restaurants especially in the capital N'Djamena. Today, the Chadian population are showing enthusiasm for the consumption of this grilled meat, which due in part to its therapeutic or medicinal value (Koussou & Mahamat Ahmat, 2012).

Dromedary export is slowing down

Chad traditionally exports dromedaries to Libya and Egypt via Sudan and Nigeria. However, it is difficult to know the exact figures due to poor statistics and the difficulties of controlling commercial movements of animals. Dromedary exports from Chad to neighbouring countries take place through three main routes (Koussou, 2014): (i) the export route to Libya; (ii) the export route to Egypt; and (iii) the export route to Nigeria. The export route to Libya is the most important because it represents nearly 85% of all exports. Animals are transported by truck or on foot along this route to Koufra or Sebha from the north and east of Chad, which are the main camel herding areas in the country. This is also where the major livestock markets are located (Abéché, Arada, Biltine, Fada, Faya, Bardaï).

Some of the livestock transported to Libya are re-exported to Egypt. From the eastern markets, dromedaries are exported to Egypt via Sudan (Vigneau, 1998). Dromedary exports to Nigeria are carried out from the N'Gueli border post near N'Djamena. Around 44,000 dromedaries were exported in 2013 (Koussou, 2014). Nowadays, dromedary exports to Libya and Egypt are considerably hampered by the political unrest in Libya and Sudan.

Demographic and zootechnical parameters

Herd size

According to a survey carried out in three regions in Chad, the average size of a camel herd was 48 head (from 10 to 155 head). It was on average 14 head (from 14 to 15 head) among the Arabs in the Batha region, 63 head (from 10 to 155 head) among the Goranes in the Ennedi-Ouest region and 50 head (from 13 to 119 head) among the Arabs in the Wadi-Fira region (MEPA, 2016). In the Kidal region of Mali, among the Tuareg, the average herd size was 75.7 head (from 10 to 266 head) (Ouologuem, Mohomoudou, N'Diaye, et al., 2020). On the other hand, according to another study carried out in five regions of Mali, the average size of a dromedary herd was 27 head (Ba et al., 2022). In Ethiopia, in the Somali Regional State, the average herd size was 34.5 head (from 16 to 66 head) (Kebede et al., 2015). In Mauritania, the average size of a dromedary herd was on average 95 head (from 4 to 460 head) (Biya et al., 2021).

Mortality rate

The mortality of baby camels is the main factor behind declines in productivity. It is a formidable scourge in camel herds. In Chad, in the Ennedi-Ouest zone, Wadi-Fira and Batha, the mortality rate in 2016 among young animals was 20.6% compared to 26.5% among adults (PREPAS, 2016). On the other hand, in the same area, in 2020, it was 8.2% among young animals and 7% among adults (MEPA, 2016). In Mali, the mortality rate among young animals was 14.4% compared to 8.4% for the entire herd (Ouologuem, Moussa, Dolo, et al., 2020).

Parturition rate

According to a survey carried out in the central, eastern and northern zones, the parturition rate among subadults was zero. Meanwhile, among adults aged over 4 years, it was 29.6% in Batha, 30.4% in Wadi-Fira and 58.5% in Ennedi-Ouest (MEPA, 2016). On the other hand, in Morocco, the parturition rate among subadult females was 58.4%, while among adult females it was 9.5% (Julien et al., 2021). Furthermore, according to another study carried out in Mali, the parturition rate on station was 77.5% (Ouologuem, Moussa, Dolo, et al., 2020).

Exploitation rate

The exploitation rate of camels observed in the central, eastern and northern zones of Chad is 6% (Koussou et al., 2021). It is almost similar to that obtained in the Biltine area, with an average of 7.98 ± 2.06% (Ganda & Buron, 1992). The exploitation rate of adult males is higher than that of subadults at 23.3% and 12.5%, respectively (Koussou et al., 2021). In Morocco, the exploitation rate concerns subadults much more than adults (Julien et al., 2021). These results indicate that in Chad, adult animals are much more likely to be exported and consumed for meat.

Reproductive performance

Age at first mating

Female camels are characterized by a late sexual maturity. However, in the Biltine pastoral zone in Chad, the average age at first mating is 2.5 years (Brahim, 2012). This is lower than that noted in the Kanem region, where camel drivers declare that the age at first mating is between 3 and 4 years (Mbaïogaou, 1998). In Mali, 65% of breeders report that the age at first mating is 3 years, while 20% report 4 years (Ouologuem, Moussa, Dolo, et al., 2020). In males, full puberty begins around age

4 or 5 years. However, their first mating rarely occurs before 5 or 6 years of age (Faye et al., 2022). Improving the reproduction of the species necessarily involves controlling their diet and management practices.

Age at first parturition

Age at first parturition is a good indicator of sexual precocity. In Chad, according to a survey carried out in the Biltine pastoral zone in the Wadi-Fira region, the age at first parturition is on average 3.6 years (Brahim, 2012). This is lower than the age at first parturition recorded in other areas of the country such as Kanem, where 95.54% of breeders affirm that the first parturition occurs at the age of 5 to 6 years, and 4.46% state 7 years. On the other hand, in Mali, in the district of Ansongo, the age at first parturition was on average 5.9 years (Traoré et al., 2014). In Algeria, in the region of El Oued, the age of first parturition is 4.3 years (Gherissi et al., 2020). In Kenya, large differences were observed between the herd managed in an experimental station and the herd managed in a traditional environment, with age at first parturition respectively 3.2 and 4.8 years (Karimi & Kimenye, 1990). Concerning the size of the litter in this species, it is rare to see twin births (Mbaïogaou, 1998).

Interval between parturitions

The interval between parturitions is the period between two successive parturitions. It is one of the main indicators of reproductive performance. In Chad, according to a survey carried out in the Kanem region, 68.75% of breeders consider the interval to be 2 years, 20.83% place it at 3 years, compared to only 10.42% of breeders for whom this interval can be 18 months (Mbaïogaou, 1998). In Algeria, in the El Oued region, the interval between two parturitions is 1.9 years (Gherissi et al., 2020).

Conclusion and recommendations

Considering the developments observed over the past three or four decades, the camel population in Chad has experienced spectacular demographic growth. This growth has been driven not only by factors of degradation and the disappearance of natural resources, but also by the demand for more protein and changes in dietary behaviour of the population. Pastoral societies began to take an interest in herding camels due to their adaptive capacity to make use of scarce resources and their significant contribution to the livelihoods of pastoral populations marginalized by successive droughts. Despite the demographic, nutritional, and socio-economic importance of camel herding, it plays an insufficient role in the country's development, and there have been very few innovations in the sector. The only notable change has been the integration of milk and meat into the supply chain of N'Djamena. The camel has often been neglected from a research-action standpoint at the national level. However, this species could contribute hugely to the livelihoods of pastoral households, and therefore to the food security of the Chadian population. This role can only be truly strengthened if a research-action programme addressing the following themes is put in place:

- Examine the contribution of camel herding to the overall livestock economy both on a household and national level,
- Improve the zootechnical performance of camels,
- Support and promote camel products,
- Evaluate the impact of climate change on the dynamics of camel herding,
- Evaluate emerging diseases in camels in the face of climate change.

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