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Typology of Camel Breeding in the Wilaya of El-Oued: Feeding Practices Characterization

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ABSTRACT

Background: Dromedary farming is crucial in El-Oued's agricultural systems, but challenges such as drought and land expansion are reducing grazing areas and affecting herd management. The research surveyed 102 camel breeders, representing 4592 dromedaries, representing approximately 09% of the total estimated camel herd in this wilaya, regarding herd organization, structure and feeding practices. Three breeder groups were identified: pure pastoral (54.9%), mixed grazing in summer (16.7%) and urban breeders focused on fattening (28.4%).

Methods: This study involved a survey of camel breeders from six (06) municipalities in El-Oued to analyze herd organization, structure and feeding practices. Data collection and analysis were aimed at understanding the functioning of camel herders and their integration into the meat market system.

Result: The results highlighted significant changes in herd management and operation, showing variable integration of camel production into the meat market system influenced by forage supply variability in Saharan grazing lands. Feeding practices revealed integration with locally produced forage resources, frequent supplementation during grazing and the use of highly energetic concentrated feed as the primary ration for fattening young camels. This study provides valuable insights into camel farming practices in El-Oued, shedding light on the challenges and adaptations of this essential agricultural sector.

Key words: Breeding, Dromedary, Feeding practices, Typology.

INTRODUCTION

Dromedaries are of particular importance in the Saharan regions, as they are the main players in environments where other livestock farming alternatives are uncertain and costly (Narjisse, 1989). Dromedary farming is traditionally associated with extensive transhumant systems in arid and semiarid areas. The camel is renowned for its ability to survive the harsh environment of the desert (Singh *et al.*, 2023). It is content with the food offered by its desert environment, making efficient use of the "poor fodder of the desert' (Faye *et al.*, 2017; Slimani *et al.*, 2013), which is mainly based on rangelands dependent on low and irregular rainfall. Current farming systems can be optimized by identifying development opportunities and considering significant changes in the organization of mobility in response to recent socio-ecological and political changes that could offer development prospects for camel farming (Amsidder *et al.*, 2021; Faye *et al.*, 2015). The change in the herd mobility regime has led to a change in animal feeding practices (Faye, 2016; Traoré *et al.*, 2014), with the emergence of a new trend towards more intensive farming systems, such as fattening camels in peri-urban oasis areas for slaughter (Faye and Konuspayeva, 2011). This evolution is part of the agricultural dynamics of the Saharan regions (Hadeid *et al.*, 2021), promoting the emergence of a genuine market pastoral economy. Furthermore, the growth in the number of livestock in hyper-arid areas can be explained on the one hand, by the development of the dairy and meat sectors, in response to high demand from the local population and by policies that subsidize livestock feed on the other (Laameche *et al.*, 2013). Despite these general trends, rangelands remain an important food resource for livestock (Bencherif, 2013; Neffati *et al.*, 2020) .

According to the Ministry of Agriculture and Rural Development (MARD, 2021), the camel population in Algeria is estimated at 448,546 head, mainly concentrated in three breeding areas (South-East, South-West and Extreme South) and spread over 17 wilayas, with 83% located in 08 Saharan wilayas. Algerian camel meat production ranks 17th in the world, with 5962 tons produced in 2018 compared to

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3900 tons in 2000, representing an increase of 34.58% in less than two decades (FAO, 2020). However, the milk production remained marginal. Despite this substantial growth, camel herbivore biomass is undervalued within institutional and commercial frameworks, unlike that of other herbivores (Demlie *et al.*, 2023).

Since 2000, Algerian authorities, under the National Agricultural Development Program (NADP), have introduced incentive subsidies to stimulate camel breeders' activity, even encouraging young investors, notably with the birth premium instituted by the Ministry of Agriculture (Bedda, 2014).

Many authors have published typologies of camel farming systems in North Africa, notably in Algeria by (Ben Semaoune *et al.*, 2019; Harek *et al.*, 2022), Tunisia by (Salmi *et al.*, 2016), Morocco by (Kamili *et al.*, 2020; Michel *et al.*, 1997) and Mauritania by (Biya *et al.*, 2021).

The objective of this study was to develop a comprehensive typology of camel breeding systems in the Wilaya of El-Oued. This typology is based on herd management and structural, nutritional and health variables, aiming to understand the evolution of the structure and breeding practices, taking into account the socioeconomic transformations of the indigenous inhabitants due to sedentarization and changes in dietary habits. Furthermore, the region's dynamic agricultural activity has become remarkable and has a negative impact on grazing areas.

MATERIALS AND METHODS

Presentation of the study area

The wilaya of El-Oued is located in southeastern Algeria, 600 km from the capital Algiers. The latest administrative division in 2020 covers an area of 35,752 km^2 and has an estimated population of 716,905 inhabitants as of the end of 2021, with an average population density of 20 inhabitants/km^2 and a population growth rate of 3.50% (BPMD, 2021). It is bordered to the north by the wilayas of Tebessa, Khenchela and Biskra; to the west by the wilayas of El M'ghair and Touggourt; to the south by the wilaya of Ouargla; and to the east by Tunisia, with a border strip of 260 km (Fig 1). Its borders extend further if one considers the nomads' grazing areas, which stretch north of the Nememcha Mountains (foothills of the Aures) and south of the Libyan border. This region is characterized by dunes that sometimes reach heights of 100 m, with an average height of 80 m.

Historically, this region has been a refuge for populations seeking security and these populations have organized into a pastoral society that exploits grazing lands and lives off herds (Côte, 2006). Similar to other Saharan regions in Algeria, this region has been characterized by tribal organization. The study area covers a vast agricultural area of over 1,047,900 ha, of which 784,660 ha are reserved for grazing (DAS, 2022). These grazing lands represent 22% of the total wilaya area, with a camel stocking rate of 0.07 head per hectare.

Legally, the status of grazing lands is that of state property (domain status), organized by customary rules and often used collectively. The absence of arched lands, as found in steppe areas, distinguishes the grazing lands of El-Oued. There are four (04) types of grazing land based on the soil type (CF, 2019):

(i) Sandy soil-grazing lands (erg) containing dune ridges and other types of sandy areas, predominantly with *Aristida pungens*.
(ii) Reg grazing lands: large flat areas with loamy or gravelly soil, dominated by *Limoniastrium gyunianum* and *Cornulaca monocantha*.
(iii) Saline soil grazing lands, mainly composed of wet soils called sabkha, are characterized by the presence of two species: *Tamarix aphylla* and *Zygophylum album*.
(iv) Riverbeds, divided into sandy-bottomed and rocky-bottomed riverbeds, dominated by *Retama rćtam*.

The wilaya of El-Oued have experienced significant agricultural development due to the expansion of areas

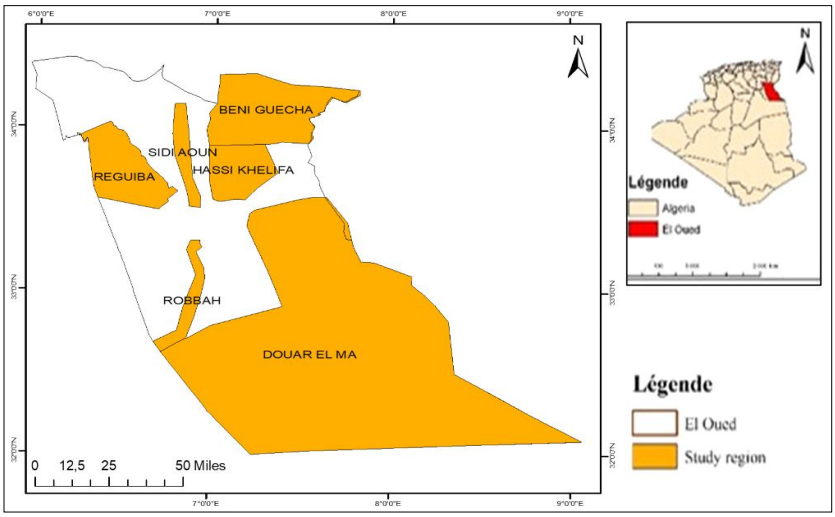


Fig 1: Geographic location of the study area and areas covered by the survey.

dedicated to vegetable crops, especially with the emergence of locally designed potatoes under mini-pivots (Ould Rebai *et al.*, 2017). The cultivated area increased from 18,630.41 hectares in 2000 to 86,153.66 hectares in 2022. However, climatic data for the wilaya have shown severe drought accompanied by a significant increase in the annual maximum temperature, with a temporal slope of 0.04°C per year and a significant decrease in annual precipitation, with a temporal slope of -0.07 mm per year (Boudalia *et al.*, 2023). These agro-climatic changes are considered threatening factors for grazing lands, including camel grazing lands, which are distinguished by their vastness.

The choice of the wilaya of El-Oued was not arbitrary; three main reasons guided our selection of the study area. First, it hosts one of the largest live-camel markets nationwide. Additionally, the camel population positions the wilaya of El-Oued at the forefront of Northern Sahara. It represents 12% of the total camel population in Algeria.

Sampling and surveys

The survey guide was subjected to a field test with 15 breeders, with a minimum herd of 18 camels for each breeder, to adjust the questions based on the respondents' answers, particularly those that were not clearly understood. Subsequently, the guidelines were revised for effective surveys. The questionnaire included a variety of questions addressing the three pillars of the breeding system, namely humans, animals and resources, with a focus on the three main parameters of studying a breeding system: structure, functioning and evolution. The collected data covered the breeding method, socioeconomic characteristics of the breeder (age, level of education, tribe group), herd structure (male, female and young camel), herd composition (presence of other herbivore species), guarding mode, use of grazing lands, degree of feeding intensification, watering, health interventions and agricultural exploitation (type of crops, especially fodder, land tenure status of agricultural land). The survey lasted six months (May 2023-October 2023).

Considering the regional factors proved essential to integrating a diversity of contexts, thus reflecting a variety of livestock farming systems. The study was conducted in six (06) municipalities of the Wilaya of El-Oued: Ben Guecha, Douar Elma, Hassi Khelifa, Reguiba, Robbah and Sidi Aoun. This selection was based on the regional distribution of camel herds, spatial distribution of agricultural land and geographical distribution of municipalities. This approach allowed us to consider the different realities and specificities of the breeding systems present in Wilaya.

The 102 camel breeders included in this study were randomly selected from various areas. The studied herds included 4592 dromedaries, which represented approximately 09% of the total estimated camel herds in this wilaya (Table 1). This sampling method enabled the collection of information on camel breeding systems in the region, with a focus on a population of breeders and herds representative of the study area.

Data analysis

The statistical strategy involved developing synthetic qualitative variables by combining quantitative data, such as the number of different species and dromedaries of different gender and age categories, with other qualitative variables related to breeding methods, grazing methods, food supplementation (concentrated and forage feeds), water sources, roaming practices, movement on grazing lands and veterinary visits. The statistical analysis of the structural variables followed three steps.

(i) Evaluating the degree of specialization while considering the mixture of species within the herd.
(ii) The size of the camel herd was transformed to ensure balanced modalities.
(iii) Developing types reflecting the relative importance of camels within herds, based on the calculation of the percentage of livestock units (LU) for dromedary and female camels, as well as for other animal species.

The conversion of animal numbers into Livestock Units (LU) was performed based on the consumption of coarse feed (grass, forage, *etc.*). The LU coefficient was defined as follows: 1 for cattle and bulls, 0.3 for young cattle, 0.15 for ewes and rams, 0.05 for lambs, 0.17 for goats and bucks, 0.09 for kids and finally 1.1 for dromedary and female camels (Jacquier, 2008). Finally, variables were consolidated to exclude infrequent modalities or even deleted if there was no variability.

We established a list of 13 active variables, to which an additional variable (municipality) was added. The details of this variable, as well as the number of modalities, are listed in Table 2. Descriptive statistics were generated using Microsoft Excel 2021 spreadsheet software, whereas hypothesis testing and factorial analysis were performed using R Core Team 2023 software (version 4.3.2). The Factoshiny Library in RStudio software was used to perform Multiple Correspondence Analysis (MCA) followed by Hierarchical Clustering Analysis (HCA).

RESULTS AND DISCUSSION

Socioeconomic characteristics of surveyed breeders

During study, information collected on tribes indicated a predominance of the Rebaia tribe, with percentages of 63%

Table 1: Distribution of breeders approached.

Municipalities	Number of camels registered	Number of camels surveyed	Percentage (%)
Ben Guecha	11582	2065	17.8%
Douar Elma	5772	1010	17.5%
Hassi Khelifa	2092	277	13.2%
Reguiba	2464	166	6.7%
Robbah	9312	461	5.0%
Sidi Aoun	1835	613	33.4%
Total	33060	4592	13.9%

Table 2: Variables retained for multivariate analysis and their modalities.

Variables	Modalities	Modalities code	Modalities percentage (%)
Lifestyle	Nomadic	LS1	9.80%
	Semi-nomadic	LS2	50.00%
	Sedentary	LS3	40.20%
Farming practice	Yes	PAL1	38.20%
	No	PAL2	61.80%
Degree of specialization	Camel	SP1	26.50%
	Camel and small ruminants	SP2	52.90%
	Camel and goat	SP3	10.80%
	Camel and small ruminants and cattle	SP4	9.80%
Ration LU camel	12-41%	RACAM1	21.60%
	47-68%	RACAM2	29.40%
	71-93%	RACAM3	22.50%
	100%	RACAM4	26.50%
Camel herd size	Less than 20 heads	CAM1	26.50%
	Between 20 and 50 head	CAM2	41.20%
	Between 50 and 100 head	CAM3	17.60%
	More than 100 heads	CAM4	14.70%
Natural Grazing Mod	Annual	NGM1	54.90%
	Mixed	NGM2	16.70%
	Never	NGM3	28.40%
Roaming Practice	Yes	PRW1	43.10%
	No	PRW2	56.90%
Movements	Long-distance (more than 50 Km)	DPL1	42.20%
	Short-distance (less than 30 Km)	DPL2	28.40%
	In stable	DPL3	29.40%
Concentrated Feed Use	Regular Supplement	UCF1	28.40%
	Occasional supplement	UCF2	43.10%
	As a basic ration	UCF3	28.40%
Type of concentrated feeds	Wheat bran	TCF1	30.40%
	Wheat bran and barley	TCF2	27.50%
	Wheat bran and olive pomace	TCF3	13.70%
	Wheat, barley, corn and soybean bran	TCF4	28.40%
Forage supplementation mode	Grazing	MFS1	16.70%
	Distributed	MFS2	28.40%
	No practiced	MFS3	54.90%
Source of drinking water	Pastoral Wells	SEA1	54.90%
	Pastoral wells and agricultural boreholes	SEA2	16.70%
	Agricultural boreholes	SEA3	25.50%
	Potable water	SEA4	2.90%
Veterinary visit	As needed	VISV1	29.40%
	Rarely	VISV2	70.60%
Municipality	Ben Guecha		30.40%
	Douar Elma		27.50%
	Hassi Khelifa		10.80%
	Reguiba		5.90%
	Robbah		15.70%
	Sidi Aoun		9.80%

Abbreviations: LU = Livestock unit.

and 32% for the Messaaba tribe and 2.5% for each of the Aachache and Oulad Saoud tribes. Regarding the lifestyles of the respondents, we observed the coexistence of three distinct lifestyles: sedentary (40.2%), semi-nomadic (50%) and nomadic (9.8%).

Across the entire sample, a significant proportion of owners (68%) considered breeding both as an activity and a primary source of income, while 32% engaged in activities other than breeding, notably in agriculture, commerce and public service. The age of the breeders ranged from 29 to 80 years, with an average of 50.14±13.13 years. However, there was no significant link between the age categories of owners and types of breeding (non-significant Chi^2).

Furthermore, the data collected indicated that herd guarding varies depending on the type of breeding. In pastoral farming, over 58% of shepherd breeders take care of their herds, especially nomads and semi-nomads, while entrusting to other herds to ensure their income. Conversely, sedentary camel breeders (42%) entrusted their herds to shepherds. As for the peri-urban type aimed at fattening, 88% of herds were looked after by family labor and 12% were permanent employees. This distribution of responsibility for herd guarding reflects the different breeding practices and specific needs for each type of breeding.

However, some data were not included in the multivariate analysis owing to the large number of variables involved.

Herd characteristics

The herd was dominated by sheep (57.5%). Camels accounted for 22.2% of herds, followed by goats (19.6%). There were only a few cattle (Table 3).

The size of the surveyed camel herds varied between 02 and 186 heads, with an average size of 45.02±37.78 heads, indicating considerable variability. Of the total surveyed population, dominated by females (74%) responsible for both the internal growth of the herds and camels accounted for only (22.7%) of the total, while male breeders held a negligible share in the herd, accounting for only (3.2%) (Table 4).

Typology of livestock farming

Multiple correspondence analysis

Multiple correspondence analysis (MCA) was conducted using the variables listed in Table 2, contributing 64.23% %to the total inertia of the first three axes. The description of opposition on the factorial axes of individuals is as follows:

The first axis accounts for 35.48% of the total inertia and is characterized by the opposition (to the right of the graph). Sedentary breeders (LS3) are found, keeping their herds in stables (DPL3), distributing feed in fodder (MFS2) or concentrated (TCF4) form as a basic ration (UCF3) and not practicing natural grazing (NGM3). Water was also used as a drinking source (SEA3). However, these breeders have smaller camel herds (CAM1) and camel ratios constitute the smallest part of the herd in LU (RACAM1). Additionally, they resort to medications prescribed by veterinarians during their visits (VISV1).

The second factorial axis represents 20.25% of the total inertia and opposes breeders who move over medium distances (DPL2) and use a dual source of drinking water (SEA2). These breeders distribute concentrated feed (TCF2) as regular supplements (UCF1); however, forage supplementation is of type (MFS1). Moreover, they practiced natural grazing (NGM2) without wandering. They had a camel ratio (RACAM2) with a degree of specialization (SP2). These breeders were particularly concentrated in the municipality of Ben Guecha.

The third factor represents 08.50% of the total inertia and is structured around the opposition (to the right of the graph): breeders with camel herds of size (CAM2) have a degree of specialization (SP2) and a camel UGB ratio (RACAM3). They distribute concentrated feed (TCF3) and are mostly from the municipality of Douar Elma.

Hierarchical clustering analysis (HCA)

The analysis was complemented by Hierarchical Clustering Analysis (HCA) based on the results of the MCA. The results are presented in the form of a dendrogram

Table 3: Size of the surveyed camel herds.

	Camels	Cattle	Goats	Sheep
Total	4592	159	4045	11878
Percentage (%)	22.2	0.8	19.6	57.5
Mean ± Standard deviation	45.02±37.78	1.56±05.68	39.66±45.18	116.45±165.57
Max	186	35	240	736
Min	2	0	0	0

Table 4: Size of the surveyed camel herds.

	Female camels	Male dromedaries	Young camels
Total	3399	148	1045
Percentage (%)	74.0%	3.2%	22.8%
Mean ± Standard deviation	43.57±35.92	1.85±1.56	15.14±13.07
Max	180	08	80
Min	01	01	01

(Fig 3), providing a visualization of the progressive grouping of the data and allowing the identification of homogeneous groups. Three distinct groups have emerged from this typology. The main characteristics of each group are presented in (Fig 2), highlighting the following points:

Group 1, composed of "Purely Pastoral Breeders," includes 56 breeders, representing 54.9% of the total number surveyed. These traditional farms were owned by nomads and semi-nomads, accounting for 18% and 77% of the group, respectively. Some guard herds belonging to sedentary individuals. These breeders live in tents and move with their herds in difficult weather conditions. In this group, breeders specialize in pure camel breeding. They have a high ratio of camel Livestock Units (LU), with an average of 55.01±41.27 heads in their camel herd. Preferring to preserve breeding females (85.4%), they are distinguished by long-distance movements exceeding 50 km without controlling their herds, commonly known as "h'mil" or wandering. Their movements throughout the year aim to find distant pastures, with daily routes covered by camel herds during herding (between 10 and 15 km), varying according to the rainy season and the condition of the pastures. Feeding relies exclusively on pastoral resources, imposed by insufficient natural vegetation. For breeders practicing wandering (78.6%), food supplements are distributed only during the winter season, whereas those who do not practice wandering (21.4%) can distribute food supplements throughout the year. Food supplementation mainly consists of pure wheat bran and barley grain, which are subsidized by the state and sometimes olive cake. The daily quantity of concentrated feed distributed varies between 1 kg and 2 kg, depending on the quality of the feed and the category of animals, focusing particularly on breeding males during mating and females at calving. According to the information provided by this group of breeders, pastoral wells were the main source of drinking

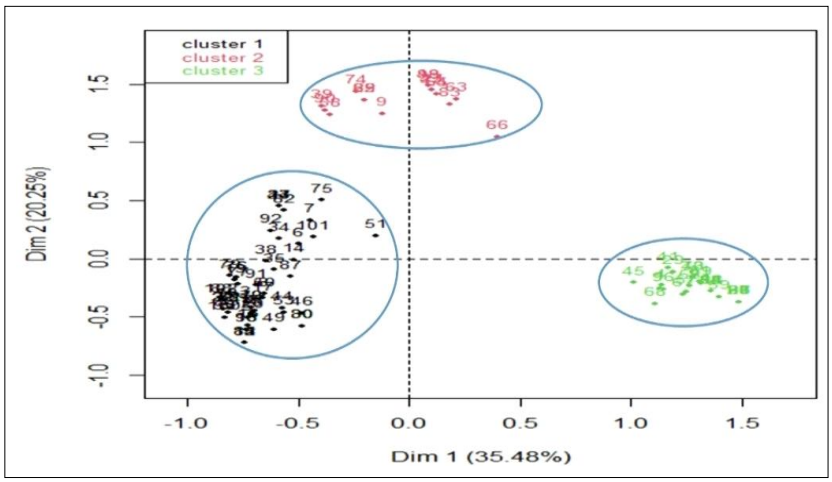


Fig 2: Graphical representation of the three identified typological groups.

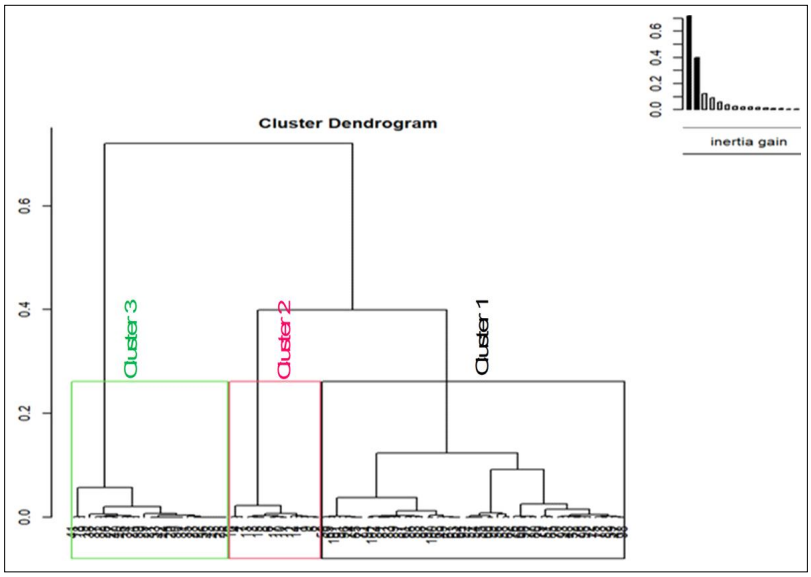


Fig 3: Hierarchical tree of classification of surveyed camel breeders.

water for animals. These wells were either traditionally made by breeders or by the state as part of preserving pastoral wealth and equipping it with solar energy. Finally, the majority of these camel breeders came from the border strip of El-Oued Province, especially from Douar Elma and Ben Guecha.

Group 2, named "Pastoralists practicing mixed grazing in Summer" consisted of 17 breeders, representing 16.7% of the total surveyed. Of these, 53% were sedentary and 47% were semi-nomadic (Table 5). These breeders have mixed herds, mainly sheep, with an average of 53.88±32.4 heads of dromedaries, including 41.58±31.14 adult camels. Shepherds control dromedaries throughout the year, with movements over short distances of less than 30 km. Although their herding was itinerant, they avoided wandering animals. However, the expansion of cultivated land at the expense of pastures has limited the mobility of herds, reducing the contribution of grazing to forage crops and purchased concentrates. Breeders in this group were mainly farmers (52.9%) with cereal crops, such as wheat and barley. The others (47.1%) were landless breeders who leased wheat stubble to feed their herds in the summer. Supplementation was regular and intended for all categories of animals, including wheat bran and barley. The dromedaries of this group were watered by pasture wells or agricultural wells, depending on the availability of the pasture. During summer, breeders often leave their animals near agricultural wells. These camel breeders are mainly located in the northern areas of the study region, particularly in the Ben Guecha municipality.

Group 3, entitled "Urban fattening farmers" consisted of 29 breeders, representing 28.4% of the surveyed camel farmers. They are mainly located in peri-urban areas, where the livestock market is close and most of them are exclusively dedicated to fattening. Their herds are mixed, including sheep, camels and goats (51.7%), but sometimes there are cattle (34.5%) and rarely camels only (3.4%) (Table 5). Dromedaries accounted for 13% of the surveyed population, consisting exclusively of young camels (83.4%) under two years of age. These herds are generally small, with an average of 20.51±18.25. Unlike other groups, these breeders kept their dromedaries in enclosures and did not practice grazing. Feeding is exclusively based on concentrated feed, such as bran, barley, maize and soybeans, accounting for 30%, 20%, 40% and 10%, respectively. Consequently, this feed ratio became more energetic. It is worth mentioning that some mineral and vitamin supplements were added. Feeds were mixed by breeders or purchased as industrial feeds, with a distributed quantity ranging from 3 to 4 kg per day. The fattening period for young camels does not exceed five months and varies depending on the quality of the feed and age of the animal. Drinking is ensured by agricultural wells and sometimes potable water, depending on water quality. In this group, dromedaries are generally vaccinated against digestive diseases. It should be noted that the operating costs of this type of farming are particularly high compared to other groups due to initial expenses, such as animal and feed purchases.

The present study distinguished three types of camel farming systems by considering all descriptive criteria (lifestyle, structural parameters of herds, interspecific diversity, use of grazing lands, degree of mobility, herding practices, level of feeding intensification and health monitoring) (Table 3). The typology resulting from the automatic classification appears to be linked to interregional variability in camel husbandry systems, as indicated by the positioning of municipalities (additional variables), as reported by Kamili *et al.* (2020). The typology results indicate that camel farming in this region is practiced in pastoral systems where camel herders are often nomadic or semi-nomadic, even despite the sedentarization of some herders and they are adapted to arid conditions.

Furthermore, our study shows a relationship between the geographical location of the surveyed municipalities and the typological distribution of surveyed livestock farmers. This trend can be explained by several interdependent socioeconomic and agroecological factors. On one hand, purely pastoral herders are mainly located in the border area of the Wilaya of El-Oued, covering two-thirds of the Wilaya of El-Oued's surface area (DAS, 2022). On the other hand, livestock farmers practicing mixed grazing in the summer season are mainly located in the municipality of Ben Guecha, where the reduction in grazing lands is compensated by the extension of irrigated cereal crops. This practice favors the use of additional pastures in the summer after harvest. Moreover, in municipalities located in the El-Oued region, there is a trend toward camel intensification through camel fattening because of the increasing demand and higher consumption of camel meat in the southern regions (Sadoud *et al.*, 2019).

The dromedary husbandry and breeding are mainly in the hands of semi-nomads, who are more stable than nomads (Adamou and Bairi, 2009), with the latter lifestyle declining because of the demanding nature of the activity, as reported by (Bedda *et al.*, 2019). Therefore, semi-nomads are perceived as having a form of stability linked to their lifestyles and pastoral activities. Additionally, herding remains the main resource related to camel husbandry among local herders (Adamou, 2008). However, herding costs have increased due to rising shepherd wages, a trend also observed in other Maghreb countries, such as Tunisia (Salmi *et al.*, 2016). In contrast, the dromedary represents the family heritage of local pastoral society, combining savings and production opportunities. Therefore, the multifunctional nature of camel husbandry in camel breeders in the El-Oued region is linked to income improvement. This was made possible through ancestral activities, such as pasture exploitation through wood collection, as well as theexploitation of camel by-products through dung collection and valorizing camel hair.

In this context, the practice of wandering, known as “hmil” was the most common system (Bedda *et al.*, 2015). According to our observations, this activity is declining over time due to the reduction of grazing areas, faced with several constraints, such as conflicts between camel herders and farmers, especially in areas near agricultural perimeters, especially in the Ben Guecha municipality, where fees are applied to local camel herders amountingto 5000 DA per camel. Additionally, barbed wires along the Algerian-Tunisian borders, as well as road accidents, are contributing factors.

Table 5: Characteristics of the three types of camel farming systems.

Variables	Modalities	Group 1 (56)	Group 2 (17)	Group 3 (29)
Lifestyle	Nomadic	17.90%	0%	0%
	Semi-nomadic	76.80%	47.10%	0%
	Sedentary	5.40%	52.90%	100%
Farming practice	Yes	1.80%	52.90%	100%
	No	98.20%	47.10%	0%
Degree of specialization	Camel	46.40%	17.60%	3.40%
	Camel and small ruminants	39.30%	82.40%	51.70%
	Camel and goat	14.30%	0.00%	10.30%
	Camel and small ruminants and cattle	0%	0.00%	34.50%
Ration LU camel	12-41%	7.10%	11.80%	55.20%
	47-68%	16.10%	64.70%	27.60%
	71-93%	30.40%	5.90%	13.80%
	100%	46.40%	17.60%	3.40%
Camel herd size	Less than 20 heads	14.30%	5.90%	62.10%
	Between 20 and 50 head	44.60%	41.20%	31.00%
	Between 50 and 100 head	21.40%	29.40%	6.90%
	More than 100 heads	19.60%	23.50%	0%
Natural grazing mode	Annual	100%	0%	0%
	Mixed	0%	100%	0%
	Never	0%	0%	100%
Roaming Practice	Yes	78.60%	0%	0%
	No	21.40%	100%	100%
Movements	Long distance (more than 50 Km)	76.80%	0%	0.00%
	Short distance (less than 30 Km)	23.20%	100%	0.00%
	In stable	0.00%	0%	100%
Use of concentrated feeds	Regular Supplement	21.40%	100%	0.00%
	Occasional supplement	78.60%	0%	0.00%
	As a basic ration	0.00%	0%	100%
Type of concentrated feeds	Wheat bran	55.40%	0%	0.00%
	Wheat bran and barley	19.60%	100%	0.00%
	Wheat bran and olive pomace	25.00%	0%	0.00%
	Wheat, barley, corn and soybean bran	0%	0%	100%
Forage supplementation mode	Grazing	0%	100%	0.00%
	Distributed	0%	0%	100%
	No practiced	100%	0%	0.00%
Source of drinking water	Pastoral Wells	100%	0%	0.00%
	Pastoral wells and agricultural boreholes	0%	100%	0.00%
	Agricultural boreholes	0%	0%	89.70%
	Potable water	0%	0%	10.30%
Veterinary visit	As needed	0%	0%	100%
	Rarely	100%	100%	0.00%
Municipality	Ben Guecha	37.50%	58.80%	0.00%
	Douar Elma	48.20%	0.00%	3.40%
	Hassi Khelifa	3.60%	0.00%	31.00%
	Reguiba	1.80%	17.60%	6.90%
	Robbah	3.60%	11.80%	41.40%
	Sidi Aoun	5.40%	11.80%	17.20%

Farmers who practiced mixed grazing in the summer explained that they prioritized available pastures first. When these are insufficient to meet the daily needs of camels, they take advantage of their herds' presence in pastures near agricultural areas, where travel distances are reduced, thus ensuring year-round herd surveillance. Consequently, these herders have two options: they are either agro-herders cultivating cereals, allowing them to feed their camels by grazing the remains of the harvest throughout the summer, or they are landless herders practicing cereal land rental in the summer season, preferring to stay near agricultural areas where forage sources are available. These findings agree with those of Benidir *et al.* (2020). Conversely, all these herders, regardless of their method of access to forage pastures, practice supplementing available concentrated feeds annually to ensure daily rationing of their animals. Similar findings were also reported by Molefi *et al.* (2017). In this context, what is noticeable in this study region is the anarchic settlement of farmers on the best pastures, which hinders the mobility of camel herders and leads to conflict with these farmers.

Regarding herders who settle in peri-urban areas and practice male camel fattening, camels can be purchased directly, as dealers, or on the livestock market. Moreover, the origin of camels purchased for fattening comes from either locally originating Sahraoui camels or from outside the Wilaya of El-Oued, which are mainly of the Targui breed, originating from the southern wilayas of Algeria (Tamanrasset and Illizi), or of the Chaambi breed from western Algeria, such as the wilaya of Bechar. Furthermore, the Targui breed is preferred by herders, as it seems to fatten more quickly than the Sahraoui breed, as indicated by Babelhadj *et al.* (2017); Benyoucef and Bouzegag, (2006). Additionally, feed for animals is entirely purchased, which increases production costs. This type of camel production is highly vulnerable and its profitability is uncertain and dependent on feed prices and meat markets. It is characterized by annual fluctuations, as indicated by Djenane, (2023).

On the other hand, almost all interviewed herders were meat producers, aligning their activities according to their production strategies. Furthermore, despite the dominance of females (74%) in camel herds, camel milk remains for self-consumption and its consumption is modest compared with that of other domestic species (Chouia and Gori, 2021). The weakest links reside in collection, packaging and health control processes (Faye, 2016).

At the health level, the most common diseases, such as trypanosomiasis (Dhebab), scabies (Jerab) and camel diarrhea (Jedal), have notable effects on reproductive performance. For example, the mortality rate of juveniles was very high, with an average of 35%. In our investigation, we noted a significant prevalence of trypanosomiasis in camels at Chott Dhiba in the Sidi Aoun municipality, where wastewater discharge occurs. This location is considered the best camel pasture in the wilaya. Currently, there is a lack of health coverage and traditional treatment remains the most common, with no preventive treatment. Overall, there is a lack of specialized veterinarians in camel pathology research.

CONCLUSION

According to the results of the present study, the typology of camel production systems revealed three groups of herders. This classification has allowed hypotheses to be made about risk factors, such as changes in lifestyle, including sedentarization, as well as access to new sources of food, such as cultivated feeds or the purchase of concentrated feeds. The new trend of intensifying camel farming is a response to the increasing demand of local consumers for animal-origin products. However, this system is becoming increasingly dependent on the supply of concentrated feeds, making it vulnerable to fluctuations in prices in the international market for concentrated raw materials. This dependency highlights the challenges faced by fattening herders in this region.

Camel farming in this wilaya has faced several constraints, such as the degradation of grazing land productivity due to successive droughts, resulting in a spatiotemporal reduction in herd mobility. Furthermore, the reduction in pasture areas due to the expansion of cultivated lands has led to conflicts between farmers and camel herders. Given the vastness of camel pastures, preserving them, which is vital for maintaining extensive husbandry, is essential for ensuring the sustainability of this activity. However, research on camel farming feeding practices is essential to assess their feasibility and to integrate them into sustainable development processes.

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Author's contributions

Adeldjabbar CHOUIA's contribution includes the design of the survey, data collection, statistical analysis and drafting of the first version. All authors involved in the interpretation of the results and critical revision of the manuscript and they approved the manuscript in its current form.

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