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Ecological consciousness and pastoral practices in the steppes of M'sila, Algeria: shepherds' perceptions. Consciência ecológica e práticas pastorais nas estepes de M'Sila, Argélia: percepções dos pastores.

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Abstract

This study examines the ecological awareness of shepherds in M'Sila, Algeria's steppes, an area facing significant environmental challenges. Through semi-structured interviews, the research analyzes 50 randomly selected shepherds' understanding of grazing patterns, environmental changes, and sustainable practices across 10 communes. Findings reveal a complex interplay between traditional knowledge and modern concerns. Shepherds demonstrated awareness of declining plant species, particularly (*Stipa tenacissima* L.) and (*Artemisia herba-alba* Asso), and predominantly practiced random grazing. Drought was identified as principal cause of forage plant scarcity. The study highlights the need for multi-faceted approaches to plant protection and livestock raising, emphasizing the urgency of implementing large-scale sustainable management measures, enhancing training programs, and promoting resilient pastoral practices.
Keywords: Herders. Grazing. Fodder. Rangelands. Sustainability.

Resumo

Este estudo examina a consciência ecológica dos pastores em M'Sila, as estepes da Argélia, uma área que enfrenta desafios ambientais significativos. Através de entrevistas semi-estruturadas, a pesquisa analisa a compreensão de 50 pastores selecionados aleatoriamente sobre padrões de pastoreio, mudanças ambientais e práticas sustentáveis em 10 municípios. Os resultados revelam uma interação complexa entre o conhecimento tradicional e as preocupações modernas. Os pastores demonstraram consciência das espécies vegetais em declínio, particularmente (*Stipa tenacissima* L.) e (*Artemisia herba-alba* Asso) e praticaram predominantemente pastoreio aleatório. A seca foi identificada como a principal causa da escassez de plantas para alimentação animal. O estudo destaca a necessidade de abordagens multifacetadas para a protecção das plantas e a criação de gado, enfatizando a urgência da implementação de medidas de gestão sustentável em larga escala, o reforço de programas de formação e a promoção de práticas pastorais resilientes.
Palavras-chave: Pastores. Pastejo. Forragem. Pastagens. Sustentabilidade.

Introduction

The steppes of Northern Africa cover an area of around 630,000 km2, stretching between the Atlantic Ocean and the Red Sea. The yearly precipitation in this region varies from 100 to 400 mm (AÏDOUD et al., 2006). Moreover, in Algeria steppes cover 32 million hectares, making them vulnerable to desertification. The country has 12 million hectares of arid and semi-arid rangelands in the pre-Saharan area. Steppe rangelands cover 20 million hectares, or 8.37% of the nation's surface. The steppes have 15 million hectares of proper steppe throughout many wilayas and 5 million hectares of cultivated land, scrubland, woods, and barren land (BENCHERIF, 2011).

In particular, steppe rangelands are divided into four types: gramineous (e.g., *Stipa tenacissima, Lygeum spartum*), arbustive (e.g., *Artemisia herba-alba, Hammada scoparia*), crassulescent (halophytic saline-adapted salsolaceae), and coastal succulent (fleshy glycophytes) (HOUÉROU, 1995a; HOUÉROU, 1995b). Neverthelss, since 1970´s the vegetation cover in the Algerian steppes, has experienced a noticeable regress (AÏDOUD et al., 2006).

Algeria is known for its steppe rangelands, which are rapidly being degraded because of human and livestock pressures. Such degradation is manifested by the loss of vegetation and species useful for pastoralism, exerting a negative impact on productivity in these systems; this results in increased poverty among traditional livestock-keeping communities (BOUSSAADA et al., 2022).

As a case in point, the M'Sila region has a pastoral potential of over 1 million hectares of rangelands and a sheep herd of 1.35 million heads, making it one of the areas with high potential for sheep meat production at the national level. Despite this, an analysis of the pastoral potential revealed that only 17.6 percent of the pastures in M'Sila province were properly developed, whereas 64.5% of these lands are very degraded; this situation was largely attributed to overgrazing (SENOUSSI et al., 2014).

Furthermore, shepherds often own their herds without having a clear vision of forage resources and rangeland management principles. Even so, the region hosts a diversity of sheep farming systems, with pastoralists and agro-pastoralists adopting various feeding strategies and resilience measures to cope with the challenges of feed scarcity and environmental changes (SENOUSSI et al., 2014). Given these concerns, numerous studies have been carried out in these areas, particularly on overgrazing. For instance, Marion (1958) in Bakhti (2001) focused on the issues of novel breeding practices, overgrazing, pastoral load, and their impact on steppe degradation. Other major studies in chronological order are Hadbaoui et al. (2019); Hadbaoui et al. (2020); Boukerker et al. (2021); and Boukerker et al. (2022). These papers jointly reflect the ongoing research and concern over these topics.

Consequently, overgrazing has significantly contributed to the degradation of these steppe rangelands, as evidenced by reduced plant cover and the virtual extinction of some species as a result, both pastoral production development and rural poverty reduction have deteriorated (BOUSSAADA et al., 2022).

Notably, this region has a long-standing pastoral tradition, where livestock activities continue to be a primary source of income for many locals. Despite its potential, the region faces challenges, with 73% of rangelands suffering severe degradation due to animal overgrazing, as reported by the High Commission for Steppe Development (HCDS) in 2010 (BOUSSAADA; YEROU, 2022).

Studies on the ecological awareness of pastoralists or nomadic shepherds are scarce. For instance, Tir et al. (2020) and Djamila et al. (2023) examined the understanding of desertification among the local inhabitants of M'Sila. However, a significant research gap remains regarding

pastoralists' awareness of overgrazing, their knowledge of fodder plants, and their perspectives on vegetation cover.

In this context, this study aims to assess the ecological consciousness of shepherds in the Algerian steppes of M'Sila by examining their perceptions and knowledge of changes in the environment and grazing patterns.

Material and methods

The M'sila region is situated in the northeastern part of Algeria, within the dry bioclimatic zone characterised by a cold winter, as indicated by Emberger's rainfall quotient (Q2 = 15.62). September has the most rainfall, with an average precipitation of 25.6 mm, whereas July has the least rainfall, with an average precipitation of 3.75 mm. January exhibits the lowest temperatures, with an average minimum of 8.41 °C, while July experiences the highest temperatures, with an average maximum of 31.11 °C (ADJABI et al., 2019). This vast steppe ecosystem, spanning 18,175 km² (latitude 35.400 N; longitude 4.300 E), was chosen for its significant pastoral and agropastoral potential. The pastoral area covers 1.8 million hectares, with 1 million hectares dedicated to rangelands, indicating a substantial capacity for local sheep meat production (HADBAOUI et al., 2020).

This study, conducted in the steppes of M'sila, Algeria, from October 31, 2023, to May 18, 2024, involved 50 randomly chosen shepherds in 10 communes and 15 locations (Figure 1). Semi-directed interviews were conducted to gather qualitative data on pasture practices, plant knowledge, environmental perceptions, and the adoption of sustainable practices. Shepherds' plant identifications, offered in vernacular names, were verified with scientific nomenclature using taxonomic references (OZENDA, 1977; QUEZEL; SANTA, 1963). This data was analysed using Excel Stat 2019 software.
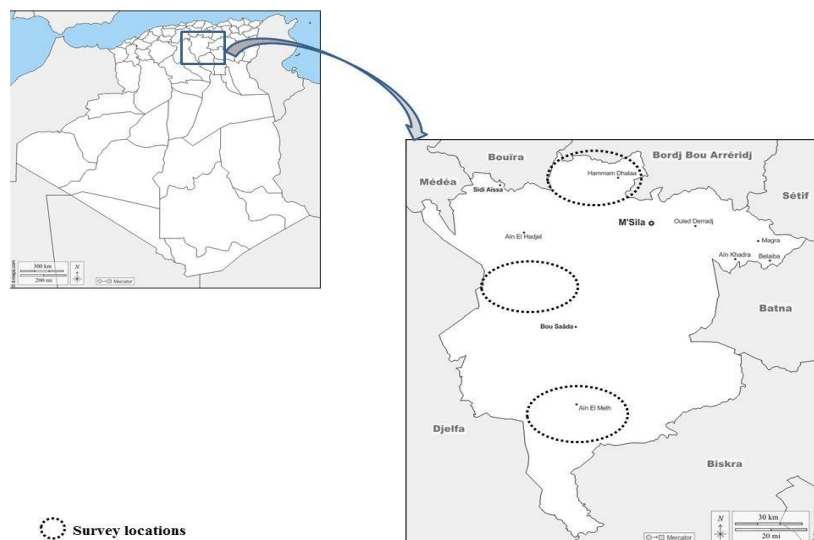

Figure 1 - Geographical location of survey sites. Adapted from https://d-maps.com/ (2024).

M'sila province exhibits a varied agricultural terrain, with rangelands encompassing 59% of its total land area. Based on the data from HCDS in 2016, *Stipa tenacissima* covers an area of 398,200 hectares, while degraded steppes cover 341,700 hectares, making them the most prevalent vegetation groups (Figure 2.a). The main agricultural production in M'sila is comprised of cereals (47%) and fodder crops (33%), which play a crucial role in the farming activities of the region (Figure 2.b). Livestock production plays a vital role in M'sila's economy, with recent statistics

(DSA, 2023) showing 1,403,678 heads of sheep, 215,619 goats, 30,802 cattle, and 1,465 camels in the region (Figure 2.c). Nevertheless, sheep producers are encountering significant challenges, such as drought and a shortage of feed, which are worsened by price speculation. The current methods have proven inadequate in effectively meeting the needs of shepherds and their animals.

An examination of cultivated fodder surfaces showed a considerable dependency on oats and barley (52% of total surfaces), with a low proportion of protein-rich crops like alfalfa (16%) and sorghum (2%). The absence of variety in the sheep population's diet, along with the possibility of low productivity, indicates a probable shortage of forage units (FU) for the sizable population of 1,351,762 sheep. The fodder shortage and increasing strain on cultivated lands underscore the need to rely on pastures for additional animal feeding.

Feeding on grasslands offers a varied and organic source of nourishment, enhancing the nutritional value of the sheep's meal and decreasing reliance on cultivated commodities. This overview emphasises the importance of combining traditional shepherd knowledge with sustainable rangeland management practices to promote a balanced and environmentally conscious use of M'sila's steppes.
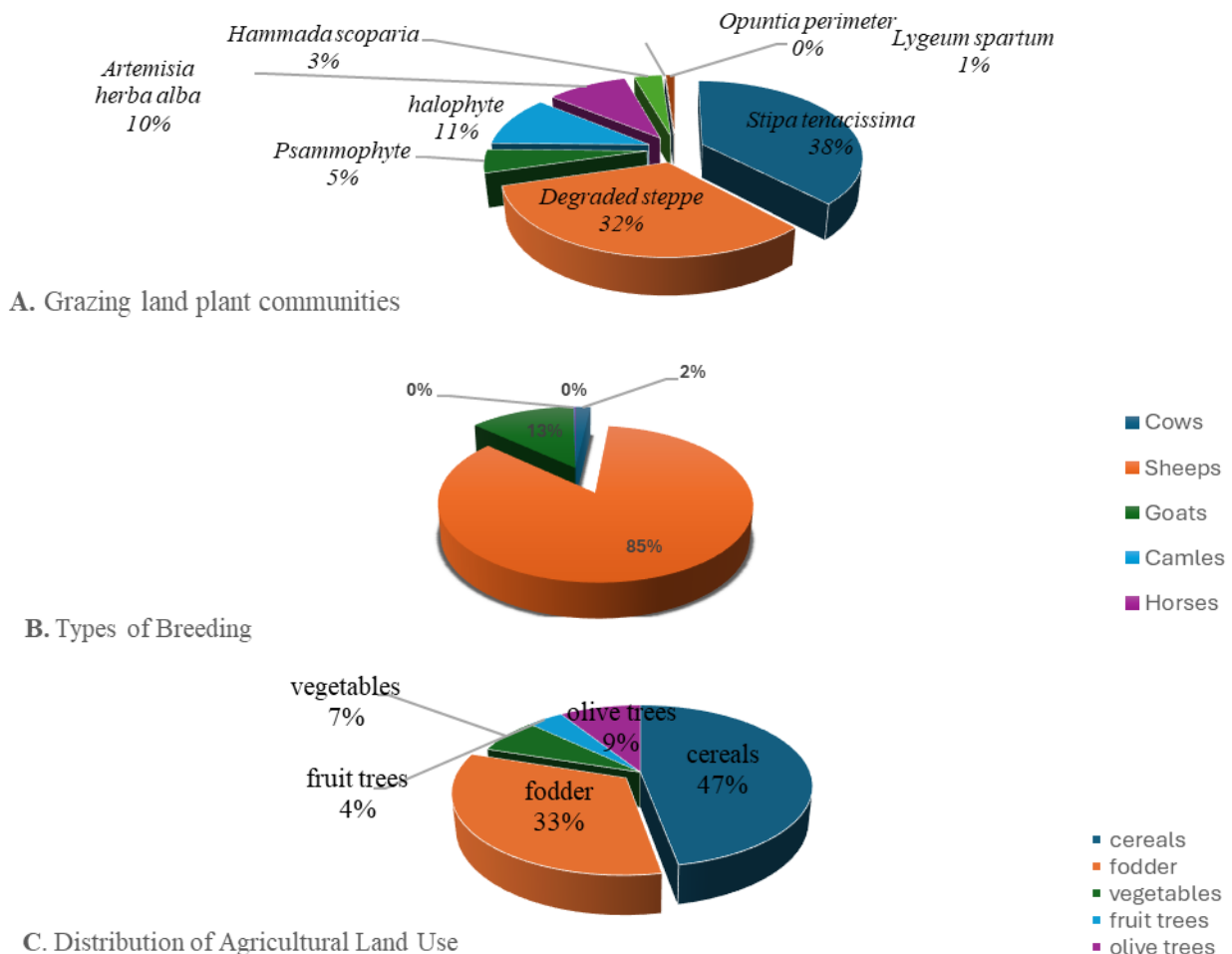

Figure 2 - Distribution of agricultural and pastoral resources in the region.

Results and discussion

Demographic and experience profile of shepherds

The age distribution of shepherds suggests a largely middle-aged workforce (30–59 years, n = 26), essential for economic productivity and stability in pastoral operations. In the Ain Ben

Khelile region of Nâama, Western Algeria, Khalil et al. (2023) found the same age dominance among sheep breeders.

The low number of young shepherds (under 30; n = 6) implies a decrease in youth participation, possibly due to urban migration or other professions. This problem is also found in Europe; for example, there are fears surrounding the participation of younger people in agriculture and its effect on the profitability of the business in the long term (EUROPEAN COMMISSION, n.d.).

Conversely, the considerable elder population (60 and beyond, n = 18) underscores the need for sustainable practices and succession planning. Addressing these demographics is crucial for developing youth participation and helping the ageing population preserve the stability of pastoral institutions (Figure 3).
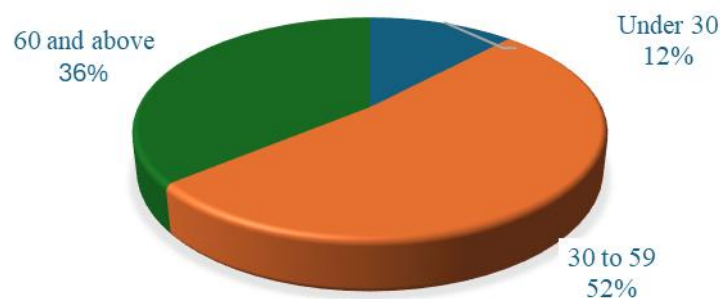

Figure 3 - Age of shepherds.

The region's shepherds comprise 49 men (98%) and one woman (2%). It is possibly due to the cultural customs of the region, where women are not encouraged to work outside the family (BOUDJELAL et al., 2013). In comparison, neighboring Tunisia shows a different scenario. Women actively participate in numerous agricultural operations in both irrigated and rain-fed areas, including weeding, hoeing, feeding, and watering animals (ALDOSARI, 2018).

The distribution of educational backgrounds is as follows: illiterate 56% (n = 28), elementary 26% (n = 13), secondary 14% (n = 7), and university 4% (n = 2). This distribution shows 82% of shepherds have primary education or less, demonstrating traditional knowledge transfer. Similar studies (BECHCHARI et al., 2005; KHALIL et al., 2023; HADBAOUI, 2013) show that the majority of steppe breeders in Algeria are old and illiterate. The gender gap and educational diversity reflect the shepherding culture.

Based on these demographic insights, an assessment of shepherd's professional experience reveals complementary trends. Notably, there is a significant influx of less experienced persons (18 under 20 years), underscoring the need for focused training initiatives. The middle-tier group (15 with 20–39 years of experience) represents essential mentorship and production experience. The 40-year-old and above group (14) highlights the benefits of highly experienced pastoralists, but it reflects an aging workforce (Figure 4).
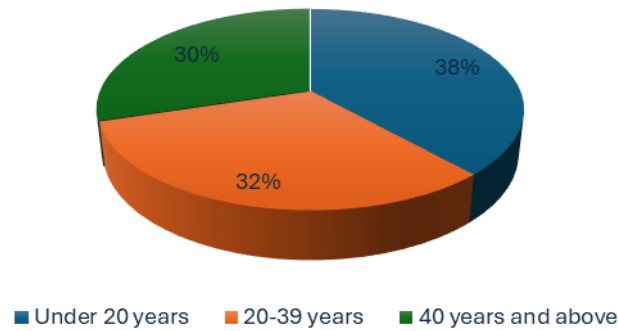
Figure 4 - Professional experience age of shepherds.

According to Fernandez-Gimenez (2000); McAllister et al. (2006); Thomas and Twyman (2004), pastoralists acquire a substantial amount of local ecological knowledge (LEK) about fodder resources from their herding experiences.

Transmission of knowledge and learning

The study shows that 78% of respondents support their children through education and practical knowledge transmission, especially in pasture management. This knowledge is crucial for maintaining traditional agricultural practices and social cohesion in rural areas. Bira and Hewlett (2023) found that children acquire the majority of pastoral skills and knowledge during their early years, predominantly through learning from their parents, a process known as vertical transmission. Thus, 75% of pastoralists have limited interaction with agricultural administration, veterinarians, and academics. A quarter engage in varied interactions with university students, doctors, veterinary services, and occasionally with agricultural and forestry services, which facilitate knowledge acquisition, technical assistance, and long-term pastoral area viability.

Pasture quality assessment criteria

According to the respondents, pasture quality assessment criteria include vegetation abundance and diversity (32%), water availability (14%), and soil characteristics (12%) as primary considerations. Other concerns comprise climate conditions, cattle behaviour patterns, and the temporal dynamics of pasture growth (Table 1).

Table 1 - Pasture quality criteria according to shepherds.

Criteria	Percentage	Example Indicators
Vegetation abundance and diversity	32%	Vegetation cover, Grass diversity, Greenness
Water availability	14%	Water sources, Soil moisture
Soil characteristics	12%	Soil type, Light red soil
Climatic factors	6%	Moderate climate, Sunlight exposure
Livestock behavior and preferences	6%	Herd health, Grazing preferences
Temporal dynamics	6%	After rain, After grazing
Other factors	24%	Absence of stones, Specific species (e.g., *Trifolium repens*)

Preferred forage species

      The survey of sheepherders revealed *33* forage plant species (Figure 5 and 6; Table 2), with *Stipa tenacissima* and *Artemisia herba-alba* being the most preferred. These plants are known for their hardiness in arid environments, but in terms of nutritional content, Boufennara et al. (2012) indicated that *Artemisia herba-alba* is more nutritious than *Stipa tenacissima*, which is a low-quality feed best used in emergencies. Other notable mentions include *Trifolium repens* and *Anabasis articulata*. Other less-cited but potentially beneficial fodder species include *Silybum marianum* and *Triticum durum*, *Globularia alypum*, and *Stipa capensis*. Eight other species earned two mentions. The survey also identified 12 other plants, highlighting the varied range of forage alternatives adapted to different agroecological situations and livestock nutritional needs.

Figure 5 - Sheep grazing in desertified steppe (A: on *Thymellea microphylla,* B: *on Origanum glandulosum Desf,* C: *Artemisia herba-alba & Eruca vesicaria*).

Figure 6 - Fodder plant preferences spectrum.

The examination of animal feed data in Table 2 reveals a marked preference for the use of leaves, which are present in 73.7% of entries, either alone (36.8%) or with stems (36.8%). We observe that 20% of cases consume the entire plant with grains, while only 5% consume dry stems. This distribution highlights a feeding strategy in sheep that favours the most nutrient-rich parts of plants while exploiting the available biomass in a varied manner.

Table 2 - Inventory and utilisation of excellent fodder plants in the region based to shepherds.

Number	Scientific name	Botanical family	Part used as fodder	Repetitions
1	Stipa tenacissima	Poaceae	Leaves	23
2	Artemisia herba-alba	Asteraceae	Leaves, stems	20
3	Atriplex hortensis L	Amaranthaceae	Leaves, stems	10
4	Trifolium repens	Fabaceae	Leaves, stems	7
5	Anabasis articulata	Amaranthaceae	-	6
6	Lathyrus sylvestris	Fabaceae	-	6
7	Hordeum vulgare	Poaceae	Whole plant, grains	5
8	Dichapetalum cymosum	Dichapetalaceae	-	4
9	Silybum marianum	Asteraceae	Leaves	4
10	Triticum durum	Poaceae	Whole plant, grains	4
11	Globularia Alypum	Plantaginaceae	-	3
12	Stipa capensis	Poaceae	Leaves	3
13	Avena sativa	Poaceae	Whole plant, grains	2
14	Bromus rigidus	Poaceae	Leaves, stems	2
15	Juniperus phoenicea	Cupressaceae	-	2
16	Lavandula stoechas	Lamiaceae	-	2
17	Medicago littoralis L	Fabaceae	Leaves, stems	2
18	Neurada procumbens L	Neuradaceae	-	2
19	Peganum harmala	Nitrariaceae	-	2
20	Pistacia Lentiscus L	Anacardiaceae	-	2
21	Zea mays L	Poaceae	Whole plant, grains	2
22	Aegilops geniculata	Poaceae	Leaves	1
23	Anabasis oropediorum	Amaranthaceae	-	1
24	Anacyclus pyrethrum	Asteraceae	-	1
25	Aristida Pungens Desf.	Poaceae	Leaves	1
26	Stubble	-	Dry stems	1
27	Cynodon dactylon	Poaceae	Leaves, stems	1
28	Eruca vesicaria	Brassicaceae	Leaves	1
29	Medicago sativa	Fabaceae	Leaves, stems	1
30	Onopordum macracanthum Schousb	Asteraceae	-	1
31	Rosmarinus officinalis L	Lamiaceae	-	1
32	Stipa barbata Desf.	Poaceae	Leaves	1
33	Zilla spinosa (L.)	Brassicaceae	-	1

The results reveal that certain plant families dominate shepherds' forage preferences (Figure 7). Poaceae (Gramineae) is the most diverse family, with 10 species, including *Stipa tenacissima*. Asteraceae (Compositae) follows with five species, including *Artemisia herba-alba*. Fabaceae (Leguminosae) has four species, including *Trifolium repens*, and Amaranthaceae has 3 salt-tolerant plants. Lamiaceae and Zygophyllaceae have two species each, indicating a broad spectrum of plant types.
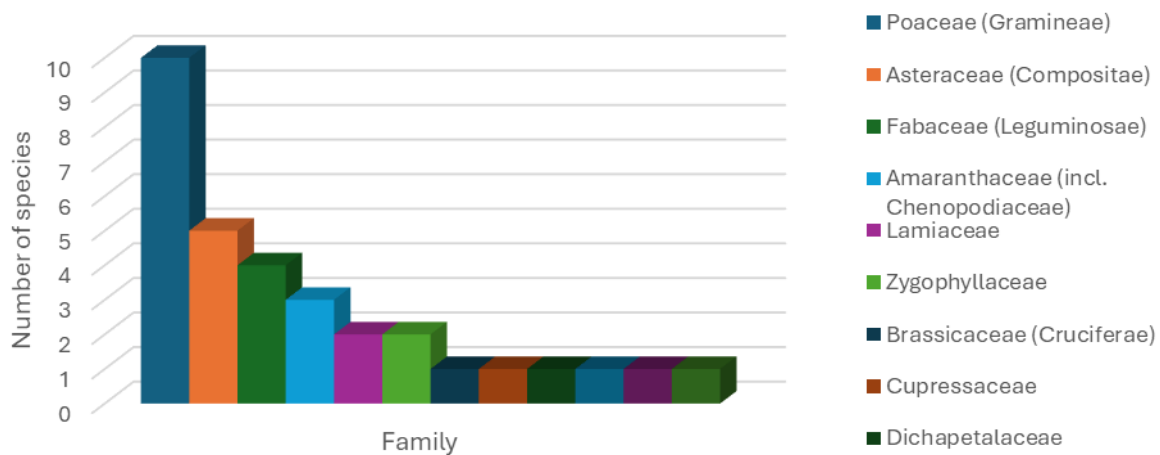
Figure 7 - Fodder plant preferences for Sheep based on botanical family.

The sheepherders identified 32 grazing-friendly fodder plants (Table 3). Xerophytes (50%) dominate, indicating dry to semi-arid conditions in this research area's flora. Psammophytes and halophytes, 12% of species, confirm an arid habitat.

Table 3 - Eco- and biomorphological spectrum of fodder plant preferences in the region based on shepherds.

Ecological groups	No.	%	Life forms	No.	%	Functional groups	No.	%
Xerophyte	16	50%	Therophyte	12	38%	Shrubs	10	31%
Mesophyte	10	32%	Hemicryptophyte	9	28%	Annual grasses	7	22%
Psammophyte	2	6%	Chamaephyte	7	25%	Legumes	4	13%
Xerophyte/Halophyte	2	6%	Phanerophyte	2	6%	Perennial grasses	4	13%
Halophyte	1	3%	Geophyte	1	3%	Non-grass perennial herbs	3	09%
Psammophyte/Halophyte	1	3%				Non-grass annual herbs	3	09%
						Trees	1	3%
Total	32	100%		32	100%		32	100%

Following the decline of *Stipa tenacissima*, therophytes have grown prominent. These annual plants, generating many seeds, rapidly dominated the available space. This therophytization shows environmental degradation (AIDOUD-LOUNIS, 1997; BARBERO et al., 1990; GHENNOU, 2014; KHOUANE et al., 2018). In addition, Aidoud (1983), highlighted that the very low proportion of geophytes is related to a climate that favours the development of short-cycle species. Shrubs dominate at 31% in functional group analysis, suggesting drought-resistant vegetation. Annual grasses (22%) and legumes (13%) can improve soil nitrogen and be grazed. The variety of perennial grasses, non-grass plants, and trees reveals a diverse ecology with many niches. Flora analysis informs conservation and sustainable land use planning by revealing the ecosystem's traits and possibilities.

Based to Raunkiaer (1934) biological forms, the list is largely composed of therophytes (12), and hemicryptophytes (09) demonstrating a great adaptability to life in severe and varied environments, with lower numbers of chamaephytes 8), phanerophytes (2), geophytes (1), and highlighting different survival methods.

According to Boukerker et al. (2022), the abundance of therophytes in Mediterranean and arid zones is a response to water scarcity, resulting in short-lived annual species outcompeting woody plants, and the low percentage of phanerophytes indicates a concerning ecological situation.

Grazing practices and management strategies

The examination of sheep stocks across 50 breeders showed high variability, with a total of 2905 sheep, a mean of 88.03 ± 76.25, a minimum of 10, and a maximum of 300, showing a concentration of low stocks and a positive skew in the distribution. Shepherds make management decisions and contribute significantly to the overall running of farms (LIANOU; FTHENAKIS, 2021). Our survey data reveals seasonal grazing habits. Summer herders prefer the hours of 07:00–09:00 and 16:00–20:00. According to Khalil et al. (2023), during the summer, the herds are taken out twice daily: once in the early morning and again the late in the afternoon. Whereas in winter, herders prefer the hours of 10:00–13:00. Respondents emphasise the importance of fodder supply and plant diversity in their grazing decisions, particularly in times of resource scarcity. The majority of surveyed herders (50%) use random grazing, 30% follow no precise restrictions, and 20% use rotational grazing. The evaluation also stresses the use of traditional methods, such as stick guidance and the "zniga" approach, to optimise rangeland usage and pasture sustainability.

According to Yerou and Benabdeli (2013), all steppe vegetation formations are used as grazing pastures for livestock. This is because more and more livestock husbandry is becoming sedentary and based on mixed systems (semi-sedentary, semi-transhumant, and nomadic).

Table 4 shows the distribution of sheepherders by transhumance practice, with 37 not participating, 10 going outside of provinces, and 3 staying in provinces but moving to neighbouring areas. On the other hand, shorter and more targeted forms of transhumance, as reported by BOURBOUZE (2006), replaced the decline of traditional nomadism.

Table 4 - Transhumance sheepherder distribution.

Transhumance Practice	Number of Herders
No transhumance	37
Yes	13
Outside the province (Bouira, Bordj Bouareridj, Setif, Khemiss Laadhaoura, high plateaus in summer)	10
Inside the province (neighboring areas such as Temsa, Maadher, Bousaada)	3

The examination of pastoral land management techniques reveals that the majority of answers (41.5%) focus on minimising overgrazing and environmental protection, stressing the need to protect pastoral ecosystems and endangered plant species. Furthermore, 31.7% of the responses highlight sustainable management approaches such as pasture rotation and spatial and seasonal organisation, which aims to reduce overgrazing and boost production. Furthermore, 26.8% of the ideas stress the growth of fodder crops to boost animal food supply, especially during times of scarcity, suggesting a realization of their benefits for pastoral systems' resilience.

Rangeland protection and conservation measures

The survey of sheepherders demonstrates diverse approaches to rangeland protection and conservation. A minority of respondents (06%) indicate the presence of protected spaces and trees inside their grazing fields. A relatively large fraction (29%) indicates that the High Commissariat

for the Development of the Steppe (HCDS) protects their rangelands (Figure 8). However, the majority of herders (65%) claim the absence of specialised protective measures for their grazing pastures. These findings show a large vacuum in official rangeland conservation efforts, with approximately two-thirds of the examined regions without specific protection policies. Bourbouze (2006) reported that the state's actions, often ill-timed but rarely successful (creation of pastoral cooperatives, establishment of pastoral zones, vegetation restoration), It is especially necessary to monitor pasture quality in semi-arid regions (LUGASSI et al., 2014).
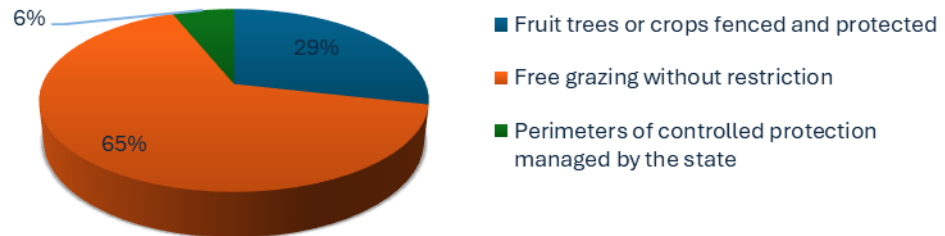
Figure 8 - Distribution of protected grazing areas.

Environmental challenges and perceptions

95% of respondents argue that some plants have become rarer in the steppe over the past few years, whereas 5% do not believe there has been any decrease in plant richness.

According to the respondents, the quantitative analysis of reported declining species in this region reveals *Stipa tenacissima* (21.8%) and *Artemisia herba-alba* (20%) as the most frequently cited (Figure 9). Consistent with these findings, Belala et al. (2018) also demonstrated that since 1960, in the North African steppe, desertification has degraded traditional pastures. This has made steppes unsuitable for livestock. The first prevalent species, *Artemisia herba-alba*, *Stipa tenacissima*, and *Lygeum spartum*, decreased and were gradually replaced by other species. Followed by *Anabasis* articulata (9.1%). *Dichapetalum cymosum*, *Trifolium repens* (7.3% each), and *Globularia Alypum* (5.5%); *Santolina africana*, *Marrubium vulgare*, *Oxalis corniculata*, and *Rosmarinus officinalis* each account for 3.6% of mentions, while the remaining 18 species represent 1.8% each. Notably, the Asteraceae and Poaceae families are the most at risk, with perennial herbs and shrubs being the main plant types that are declining. This shows how different plant species are affected by environmental stresses like overgrazing and random grazing in these ecosystems and how important it is to have targeted conservation strategies to protect biodiversity and ecological integrity in steppe habitats.
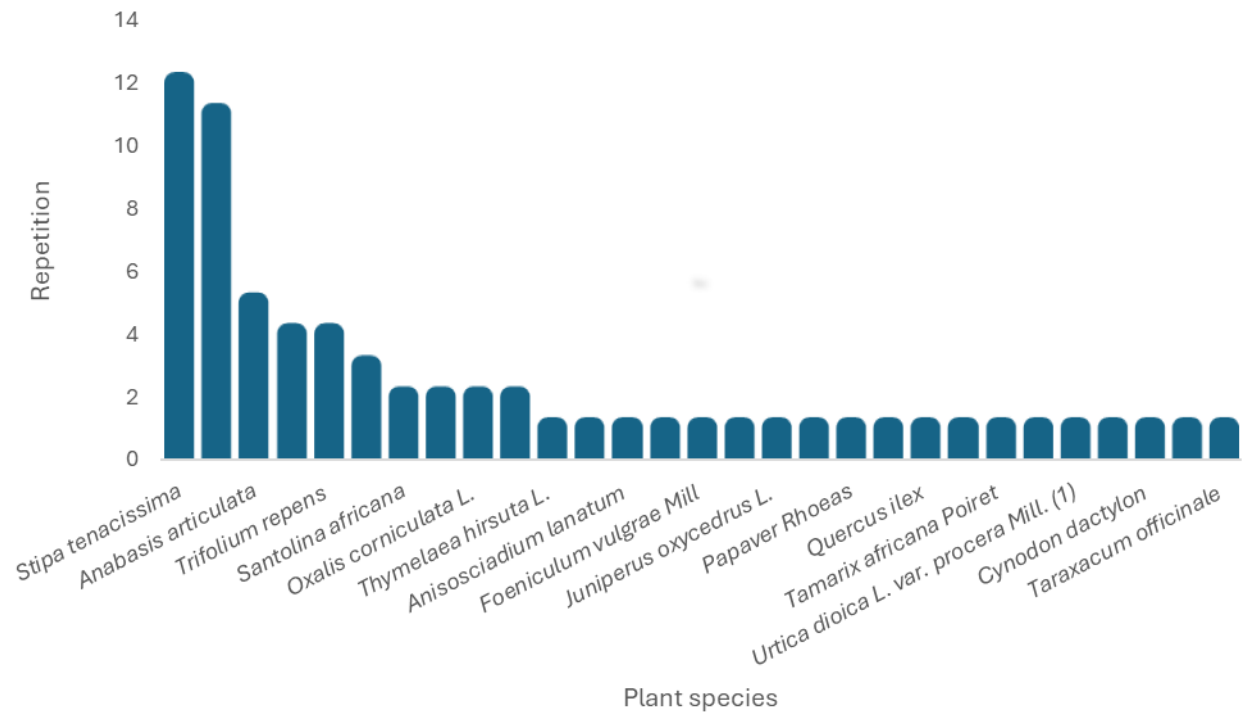
Figure 9 - Declining plant species in the region according to the shepherds.

Causes of forage plant scarcity

The investigation found that environmental variables, particularly dryness (11 mentions), are the most frequently mentioned reasons for plant shortages, significantly decreasing plant growth and survival. Changes in vegetation cover (04 mentions) were the most prominent ecological phenomenon, altering plant communities. Agricultural practices such as overgrazing (three mentions) deplete soil nutrients, inhibiting plant development. Areas with no reported plant shortages (07 mentions) are likely to benefit from effective management. Other causes (06 mentions), including stagnation and invasive species, also contribute to plant shortages. Non-responses (04 mentions) suggest a lack of detailed explanations for plant shortages (Table 5).

Table 5 - Main causes of fodder plant scarcity.

Category	Response	Number of repetitions
Environmental factors	Drought	11
	Decreased rainfall	2
Ecological processes	Change in vegetation cover	4
	Sand encroachment	3
Agricultural practices and land management	Soil depletion / Overgrazing / Lack of fallow	3
	No land protection	3
No scarcity	No scarcity	7
Other responses	Various other responses	6
No response	No response	4

Numerous authors emphasize that the primary factors contributing to the extinction of certain species include excessive land clearance, cultivation practices, overexploitation of alfa grass, intensified overgrazing due to expanding ovine populations, loss of pastoral rangelands, and

increasing demographic pressure (POUGET, 1980). These determinants are aggravated by edaphic fragility (ACHOUR-KADI HANIFI; LOISEL, 1997), vulnerability of vegetative cover, particularly perennial graminoids FRUTOS et al., 2015), aridity (GARCÍA-FAYOS; GASQUE, 2002; NOY-MEIR, 1973), and an irregular climatic regime characterised by prolonged periods of drought (HIRCHE et al., 2011; SLIMANI et al., 2010). Thus, the progressive domination of species with less ecological value disturbs the ecosystem's ecological and socioeconomic balance, ultimately leading to desertification, the final stage of ecosystem deterioration (KHOUANE et al., 2018).

These findings underline the necessity for coordinated management solutions to address these different causes.

Rethinking the pastoral future

With 84.1% of respondents stating important concerns, including big reductions in pastoral systems, the disappearance of vital steppe flora, and considerable land degradation, the poll results reveal a generally gloomy perspective on pastoral land management. Dependency on rainfall aggravates vulnerability to climatic fluctuations even more. By contrast, 15.9% of respondents say there are no significant changes, implying some localities maintain stability. This disparity highlights the immediate necessity of customised treatments to solve the fundamental problems and increase the resilience of pastoral ecosystems.

Survey results reveal a need for a multi-faceted approach to balance local plant protection with pastoral activity. Adaptive grazing management options are prevalent (30%), followed by fodder crop development (25%). Overgrazing restriction (20%) and land conservation measures (15%) are key methods. Institutional and policy support account for 10% of responses. A comprehensive plan incorporating adaptive management and conservation measures, supported by regulatory frameworks, is needed to sustain pastoral systems. Crucially, as emphasised by Roeleveld and Broek (1996), selecting motivated and educated farmers is precondition for success. These farmers may lead others, producing a ripple effect of positive change. Decision-makers should consider this element while adopting novel approaches (YEROU et al., 2019).

The age issue poses a significant demographic challenge in the pastoral sector, as older individuals are increasingly retiring, while younger individuals are inclined to avoid this career due to its demanding nature and their choice for urban living. The increasing tendency of youngsters migrating to cities for educational purposes and their subsequent incorporation into urban life is causing worries regarding the continuity of the herding profession and the succession of the present generation of herders.

Management strategies and recommendations

The management and conservation of pastoral systems in semi-arid environments require an integrated approach that addresses their complex challenges. Key strategies include adaptive grazing management through rotational practices, which allow vegetation recovery and biodiversity preservation, and the development of drought-resistant fodder crops to enhance resilience and reduce dependency on natural vegetation.

Incorporating traditional ecological knowledge (TEK) alongside scientific monitoring can improve understanding of ecosystem processes, informing conservation policies. Additionally, establishing protected areas can safeguard biodiversity hotspots and provide baselines for future research.

Participatory rangeland management is essential to ensure stakeholder involvement and long-term sustainability. Policies should recognize the multifunctionality of pastoral systems, supporting both environmental services and cultural heritage. Exploring alternative livelihoods can reduce reliance on pastoralism and ease ecological pressures.

Future research should focus on long-term ecological monitoring, innovative restoration techniques, and understanding the impacts of changing pastoral practices on ecosystem functions. A holistic, adaptive, and collaborative approach is key to balancing ecological conservation with the socio-economic needs of pastoral communities.

Conclusion

This research aimed to evaluate the ecological awareness of shepherds in the M'Sila steppes, uncovering significant insights into the intricate relationships between pastoral activities and environmental dynamics. Our study indicates that shepherds' views of ecological changes are closely linked to their traditional knowledge and current environmental issues.

The results indicate a substantial discord between existing grazing methods and ecosystem sustainability. Non-rotational grazing (50%) and restricted protected rangelands (36%) significantly contribute to biodiversity loss, notably impacting crucial species such as *Stipa tenacissima* and *Artemisia herba-alba*. The predominant pessimism among respondents (84.1%) on the future of pastoral systems highlights the precarious condition of these socio-ecological environments.

By examining shepherds' ecological awareness, we uncovered the pivotal role of traditional ecological knowledge in understanding and potentially mitigating environmental degradation. The research indicates that adaptive management techniques should integrate scientific knowledge with local methodologies to enhance ecosystem resilience against climate change and increasing environmental pressures.

Our study contributes a nuanced understanding of pastoral systems in semi-arid regions, highlighting the need for collaborative, context-specific conservation strategies.

The findings revealed extend beyond the M'Sila steppes, giving significant views on human-ecosystem interactions in vulnerable natural environments globally.

This paper advocates for integrated management practices that respect traditional knowledge while using scientifically informed conservation methods. The route ahead demands a comprehensive strategy that combines ecological preservation with the socio-economic requirements of pastoral communities.

Conflicts of interest

The author declares no conflicts of interest regarding the work presented here.

Author' contribution

Ahmed Saad – original idea, field survey, original writing, data collection and analysis.

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