



Integration of Pastoral Fencing Areas in Sheep Feed Management Systems in the Algerian Steppe: Case of Tiaret Region

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Received: September 18, 2023 Accepted: October 16, 2023

Abstract: The aim of this novel study is to examine the incorporation of pastoral fencing areas as a forage resource in the management of sheep herds in the Algerian steppe areas. In the quest to reduce feed costs during specific periods, several sheep breeders in the Algerian steppe have resorted to rent pastoral fencing lands. The research methodology employed consists of interviews with fencing area renters and floristic surveys conducted prior to the opening period of the pastoral fencing. Fencing areas of M'Kimen and Saouas in Tiaret region were selected for this study due to its agro-pastoral potential. The findings of the study reveal that the problem of animal overstocking on rangelands is present even in rangelands controlled by fencing. In spite of the measures taken to control the fenced areas, the rangelands meet only a fraction of the feed requirements for the flocks, specifically 25% for M'Kimen and 38.4% for Saouas. The results of this investigation contribute to the scientific understanding of enhancing the management mechanisms of pastoral fencing lands and the overall development of sheep breeding programs in the steppe.

Key words: Forage, management, rangeland, regeneration, steppe rangelands.

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Guest Editors

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Citation

Hadbaoui, I., Khaouani, B., Berrabah, D.E., Safi, R. and Zemour, H. 2023. Integration of pastoral fencing areas in sheep feed management systems in the Algerian steppe: Case of Tiaret region. *Annals of Arid Zone* 62(4): 341-350.
<https://doi.org/10.59512/aaz.2023.62.4.9>
<https://epubs.icar.org.in/index.php/AAZ/article/view/123925>

The Algerian steppe is a vast area covering 20 million ha, including 13 million ha of rangelands, used for extensive livestock breeding and episodic cereal cultivation without irrigation (Aïdoud *et al.*, 2006). However, the decline in the natural rangelands of the steppe has led to a significant reduction in their surface area and pastoral productivity (Abbas, 2004). At the same time, Algeria's sheep herd has grown strongly, rising from 5 million heads since the independence in 1962 to more than 30 million in 2020 (Ministry of Agriculture and Rural Development MADR, 2019). Sixty two per cent of which (18.6 million heads) remain in steppe area. To protect rangelands against degradation, fencing is a passive technique applied to certain areas of steppe rangeland. This technique makes it possible to temporarily protect an area from human activity and/or access by domestic animals,

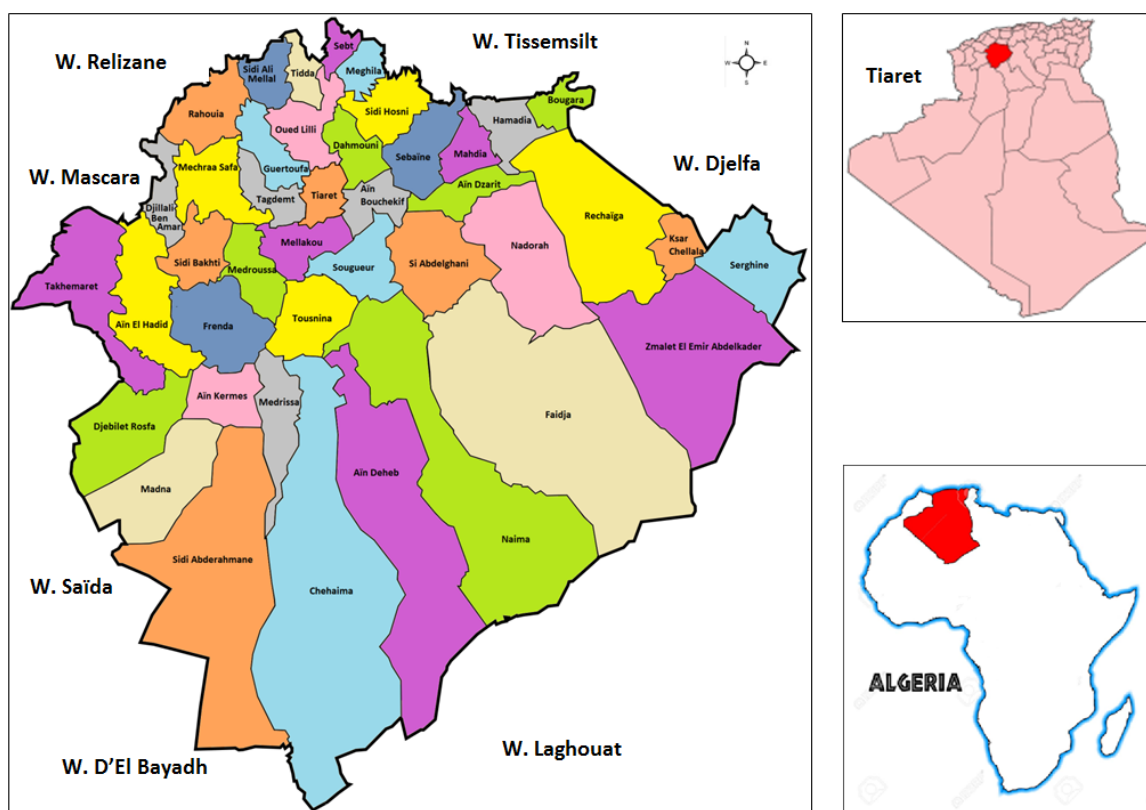


Fig. 1. Tiaret region location [Source: HCDS, 2019 (adapted)].

thereby restoring the pre-existing vegetation and preventing soil degradation in arid and semi-arid zones (Bourbouze, 1997; Ferchichi and Abdelkebir, 2003; Amghar *et al.*, 2016). According to Le Houérou (1995), fencing is a natural method of protecting a territory or plot of land from human activity and domestic animals' access (temporary ban on grazing). This technique has been known for centuries and was practised by our ancestors, as illustrated by the "Agdal" system in North Africa and the "Hema" system in the Middle East and Arabia (Khalid *et al.*, 2015). Defencing has also been widely applied throughout the world, particularly in the arid areas of Australia, the United States and dry tropical Africa (Grouzis, 1988). This technique is an effective grazing management strategy for restoring vegetation and preventing land degradation in arid and semi-arid areas. Faced with the scarcity of fodder resources in rangelands and the socio-economic disruption of livestock feed markets, renting of plots of fencing land has become a fodder alternative for some period of the year for livestock breeders in the steppe. This study was carried out as part of a research

project by the Scientific and Technical Research Centre on Arid Regions (CRSTRA) in Algeria during the 2017-2018 period. The aim of the project is to develop a decision-support tool for the sustainable management of pastoral areas in the steppe, in particular pastoral fencing lands. The region of Tiaret is chosen to carry out the study. Tiaret region is one of the most potential regions in terms of sheep breeding, ranking second position with 2.39 million sheep heads in 2019, just after Djelfa (3.45 million heads) (MADR, 2019). This study analyses the integration of pastoral fencing land as a fodder resource in the management of livestock flocks. The results of this study are intended to improve the mechanisms for managing the fencing land as well as any development programme for sheep breeding in the steppe environment.

Materials and Methods

Study site

Tiaret region in north-west Algeria was chosen for the study (Latitude, 35°22'42.56"N; Longitude, 1°19'32.48"E) (Fig. 1) because of its



Fig. 2. Location of PFAs for the study. [Source: Image adapted from GoogleEarth (2023)]

agro-pastoral potential, which is determined by its geographical and climatic diversity. The favorable soil and climate conditions in the steppe areas of Tiaret, particularly the rainfall regime (295 mm in 2017 and 607 mm in 2018), which favored the biological recovery of vegetation, have encouraged the preservation of rangelands through fencing. Tiaret region boasts the largest expanse of preserved rangeland through fencing, encompassing 245,522 ha (Habib, 2012).

The M'kimen ($34^{\circ}38'3.62''\text{N}$; $1^{\circ}52'7.60''\text{E}$) and Saouas ($34^{\circ}35'15.18''\text{N}$; $1^{\circ}1'38.18''\text{E}$) pastoral fencing areas (PFA) were chosen for this study because of the pastoral importance and biodiversity of vegetation with Alfa facies (*Stipa Tenacissima*) present in these two areas (Fig. 2). This choice was also motivated by geographical diversity, which enabled comparisons to be made on several levels (ecological, technical and sociological). The M'Kimen pastoral fencing area is located in the south-east of Tiaret in the commune pastoral of Naïma. It covered an area of 35000 ha, providing an important pastoral reserve for livestock breeders during the rental grazing season. Similarly, Saouas fencing area is located

in the south-western part of Tiaret, in the commune of Sidi Abderrahmane, surrounded on three sides (east, south and west) by the lake of Chott El Chergui. This fencing area, which covers 10000 ha, is also an important pastoral reserve for livestock breeders.

Sampling and data collection

The methodology comprised two components: (i) interviews with renters during the rental period to gather insights about their usage of fenced areas, and (ii) floristic surveys. Information about the origins of renter breeders and their motivation for renting, practices for using rangelands, the nature and organization of flocks, and feeding practices of the flocks during the rental period was collected through interviews. We conducted interviews with a random sample of renter breeders.

In the M'Kimen PFA during the spring 2017 rental season (mid-March to mid-May), we selected a sample of 25 breeders from a total of 96 renter breeders. However, it is revealed that one of the surveyed breeders was not a renter, but benefits from peripheral land after an early departure of some renters. Consequently, this breeder's data is not accounted for in the

diverse statistical computations related to feed ration. In the Saouas PFA during the spring 2018 rental season (mid-April to mid-June), we selected a sample of 38 breeders from a total of 96 renters. The difference in the period during which the interviews were conducted is explained by the fact that some PFAs were not let out for some seasons due to the absence of a minimum occupancy rate for renters required by law. This rate is set at 70% of the total surface area of the PFA, and as some areas are very large, they did not always get this rate and were therefore not leased. The interview method allowed a rapid and realistic approach towards the breeding systems (Lhoste, 2001).

Floristic surveys of the fenced areas before opening them for rent, was carried out to assess biological diversity and ecosystem health. In the present study, only the values of pastoral productivity are used in the calculations for estimating the average rangelands forage supply during the rental period. For the floristic surveys, numerous field inspections were conducted for the most representative areas in each PFA. To facilitate the sampling, PFA was divided into homogeneous vegetation stations, 12 stations for M'Kimen PFA and 19 stations for the Saouas PFA.

The data obtained were used to calculate different parameters like feed requirement and feed intake of the flock etc. The feed requirements of flocks were estimated using the conversion coefficients proposed by Moskal (1983). These coefficients are adapted to the zootechnical characteristics of Algerian livestock. In addition, a supplement of around 20% was added to cover the expenses due to distances covered by the animals during the grazing period (CIRAD, 2002). Flocks requirements are adjusted by division to match the rental period (2 months). The rangelands feed intake for each flock is estimated by multiplying the average forage productivity (fodder unit FU) found using floristic surveys by the area rented (hectare). In addition, the feed intake of the concentrates fed was assessed using the reference feed values available in the literature (Table 1). For this, each feed quantity used was multiplied by the corresponding feed value. Previous estimates made it possible to establish a feed balance for the rental period and assess whether the animals' requirements were being met or not. It was also possible

Table 1. Reference fodder values for concentrates feeds

Type of feed	Feed Value (FU kg ⁻¹ crude material)
Grain barley	0.94
Wheat bran	0.74
Soft wheat	1.05
Maize	1.09

Source: (INRA, 2018).

to determine the extent of the diet deficit. Another data processing consisted of analysing the seasonal movements of flocks during the year, thus enabling trajectories of animal movements to be established. This approach makes it possible to understand the position of fencing areas in flock movements.

Results and Discussion

Users' identification and using lands ways

Regarding the M'Kimen pastoral fencing area (PFA), the majority of renters originate from the Djelfa department, located approximately 200 km away, accounting for 60% of the surveyed renters. Following closely were breeders from Tiaret, situated around 50 km away, comprising 28% of the surveyed renters. Additionally, breeders from the Laghouat department, which is approximately 180 km away, represent 12% of the surveyed renters. In the case of the Saouas PFA, renters primarily come from the surrounding areas within the same Tiaret department, which is about 50 km away, making up 94.7% of the sample. It is worth noting that there is a breeder in the M'Kimen PFA who is not a renter but utilizes the grazing area after some renters have left early.

The rented plots both in both M'Kimen and Saouas showed heterogeneity. In the case of M'Kimen, the area of rented plots varied from 50 to 2000 ha while in Saouas, it ranged from 20 to 200 ha. Methods used to exploit the fenced area were single use or co-location (several breeders exploit the same area rented by one of them) in M'Kimen PFA, and single use or co-use (several breeders collectively exploit all the areas rented by all of them) in Saouas. The flocks introduced were mainly sheep, with a few goats or some heads of local cattle.

Description of flocks' feed composition

During the PFA renting period of two months, the feed diet was consisted of two types of feed: rangelands and concentrated

Table 2. Pastoral productivity of stations

M'Kimen stations	Pastoral productivity FU ha ⁻¹ two months ⁻¹	Saouas stations	Pastoral productivity FU ha ⁻¹ two months ⁻¹
1	50.3	1	68.2
2	44.2	2	47.1
3	46.5	3	64.5
4	63.8	4	72.4
5	93.7	5	52.1
6	51.5	6	75.1
7	45.1	7	62.5
8	41.8	8	77.6
9	38.1	9	65.4
10	48.4	10	55.0
11	67.6	11	81.7
12	64.2	12	47.9
		13	72.8
		14	63.6
		15	64.0
		16	44.1
		17	68.2
		18	63.2
		19	72.9
Average	54.6	Average	64.1

feeds. As the animal stocking rate administered often exceeds the pastoral capacity of the rented land, renter breeders are obliged to supplement with concentrated feed to meet the requirements of their flocks. Almost all renters supplement their flocks during the lease period; 95.8% in M'Kimen and 92.1% in Saouas. The duration, quantity, and types of feed utilized for supplementation however varied amongst breeders. The duration of supplementation varies from 20 to 60 days according to the rate of depletion of the rented rangeland. Barley, wheat bran, soft wheat, and maize are commonly used by breeders in varying proportions as concentrated feed. The amount of concentrates provided ranged from 0.3 to

1.5 kg head⁻¹ day⁻¹ by renters in M'Kimen and from 0.25 to 1.2 5 kg head⁻¹ day⁻¹ in Saouas.

The floristic surveys indicated that the average pastoral productivity of the fencing rangelands during the rent periods is around 54.6 FU ha⁻¹ two months⁻¹ for M'Kimen and 64.1 FU ha⁻¹ two months⁻¹ for Saouas (Table 2) (i.e. 273 FU ha⁻¹ year⁻¹ at M'Kimen and 320 FU ha⁻¹ year⁻¹ at Saouas). While pastoral productivity may vary across different locations, average values were utilized for calculating feed diet for practical reasons.

Description of the feed balance sheets

The feed balances were initially calculated on an individual basis for each surveyed

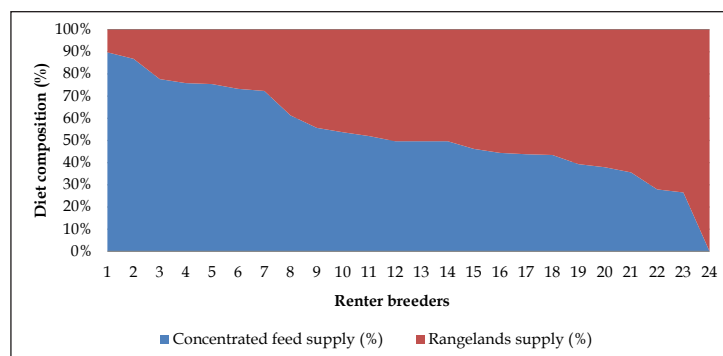


Fig. 3. Diet composition for M'Kimen surveyed breeders.

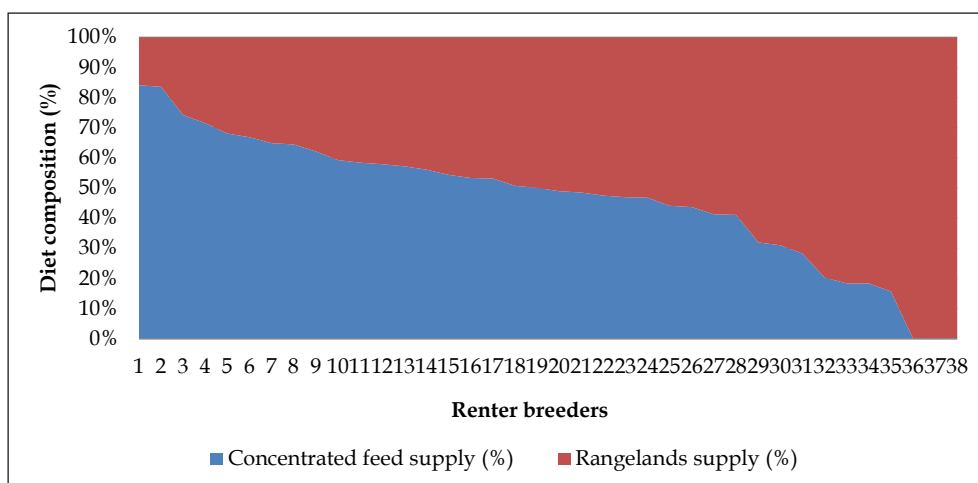


Fig. 4. Diet composition for Saouas surveyed breeders.

breeder, and subsequently, an overall balance for altogether surveyed breeders was computed of each PFA. The individual balances revealed variations in the contribution of the two types of feed sources (rangeland and concentrates feed) among breeders. Feed composition for each surveyed breeder in M'Kimen and Saouas PFAs is shown in Figs. 3 and 4. The proportion of rangeland in the diet in M'Kimen ranged from 10 to 73%, whereas in Saouas it varied from 16 to 100%. The fraction of concentrated feed ranged from 27 to 90% among M'Kimen renters, and from 0 to 84% among those in Saouas.

Overall feed balance in PFA rent period

Overall feed balances were conducted for altogether surveyed renters within each fencing area to assess the global meeting of the flocks' feed requirements. The results of these balances are depicted in Fig. 5 and 6. It is crucial to highlight that in both fencing areas, there exists

an imbalance in the feed composition, with a diet deficit around 20.3% for M'Kimen and 17.9% for Saouas.

Despite the control exerted over the fenced areas, rangelands provided only a part of the flocks' feed requirements, i.e. 25% in M'Kimen and 38.4% in Saouas. Consequently, concentrated feed played a crucial role in meeting the animals' nutritional needs, constituting the majority of their requirements, namely 54.7% in M'Kimen and 43.7% in Saouas renters.

Description of flocks' movements

Three types of breeders can be identified by classifying them according to the movements of their flocks during the year viz. (i) Sedentary breeders who use the feed sources available in the neighborhood of their places of origin, so they choose to rent out the fenced lands near their place for exploitation (ii) Semi-sedentary transhumant breeders move their



Fig. 5. Feed balance of M'Kimen renters.

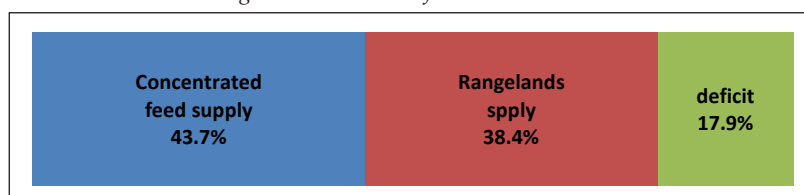


Fig. 6. Feed balance of Saouas renters.

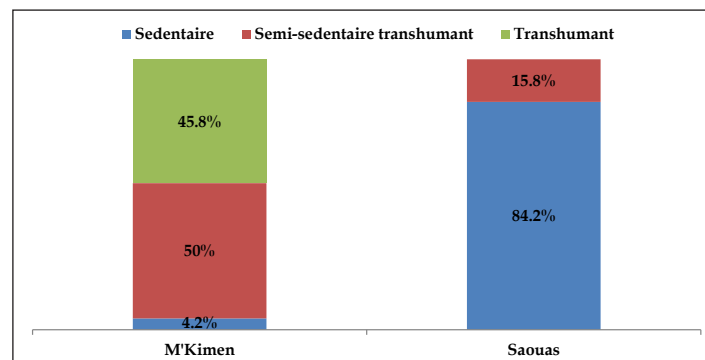


Fig. 7. Summary of breeder types according to flocks' mobility.

flocks between several areas (pre-Saharan rangelands, steppe, PFAs and tellian cereal production areas), however the frequency of their movement and destination changed each year depending on the fodder abundance sought and (iii) Transhumant breeders move their flocks with the same frequency between different destinations (pre-Saharan rangelands, steppe, PFAs and tellian cereal production areas). An overview of the distribution of surveyed breeders based on the movements of their flocks is given in Fig. 7. In M'Kimen, half of the breeders were semi-sedentary transhumant, whereas in Saouas, this category represented only 15.8% of breeders. The majority of breeders in Saouas were sedentary, representing 84.2% of the cases, while in the PFA of M'Kimen, this category accounted for only 4.2% of the breeders. Transhumant breeders are present only in the PFA of M'Kimen and represent 45.8% of surveyed.

Flocks movement trajectories

The results show that breeders adopt different flock movement trajectories. The

visual representations of the trajectories taken by breeders in the two fenced areas are presented in Fig. 8 and 9. In all, six trajectories were identified; the first one being used by sedentary breeders, while the others are used by semi-sedentary transhumant breeders and transhumant breeders. The common aspect among all these trajectories is that they all include a step of renting out the PFA during the spring.

Each destination area provides breeders with specific types of feed source: (i) Tellian cereal production areas provide in summer, post-harvest stubble and damaged cereals where yields remain weak, and fallow land in autumn and winter (ii) Pastoral Fencing areas provide better quality pasture than uncontrolled rangelands (iii) Steppe areas offer pastures to be exploited after the rainy seasons, particularly in autumn, as well as some stubble and damaged cereals in summer (iv) Pre-Saharan areas provide favorable grazing for use in autumn and winter after the rainy season.

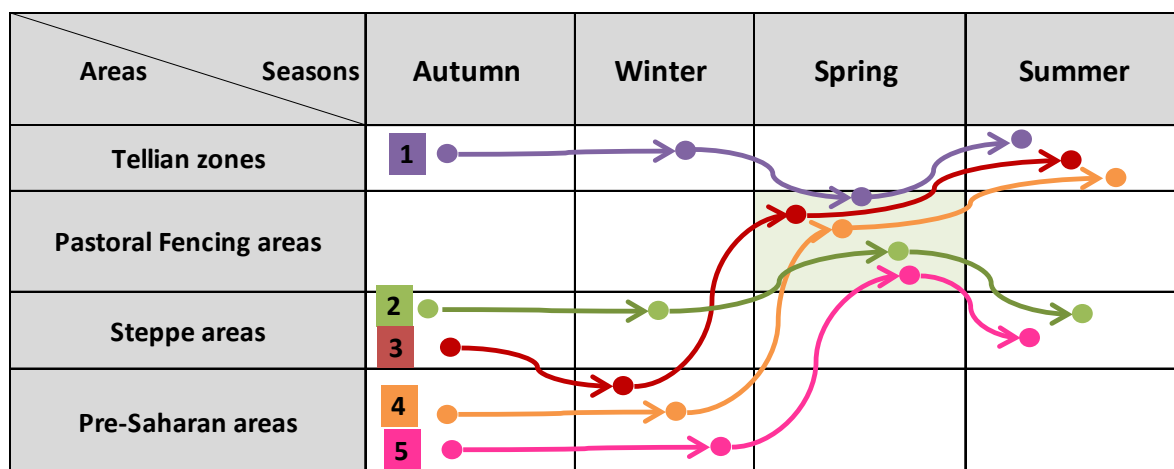


Fig. 8. Trajectories taken by M'Kimen renters.

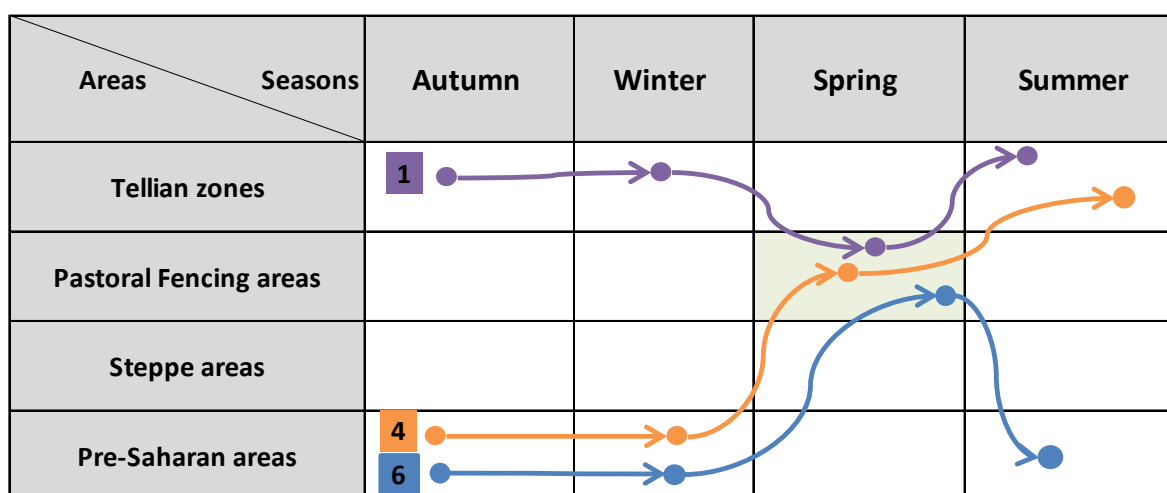


Fig. 9. Diagram of trajectories taken by Saouas renters.

The results indicated notable distinctions between the two fenced areas with respect to origin of renters, grazing land use practices, and the types of breeders who rented the land. These differences can be attributed to the geographical position of each PFA. M'Kimen, being situated on the transhumance ways of the Ouled Naïl tribe (a group of transhumant breeders from Djelfa region), exhibits a significant presence of semi-sedentary transhumant and transhumant breeders (Fig. 7). On the other hand, Saouas is located in an isolated region bordering by Chott El Chergui lake, which limits the possibility of being crossed by transhumant breeders. As a result, sedentary breeders prevail in this PFA. These findings underscore the significance of geographical location when breeders choose PFAs to rent. Gaci *et al.* (2021) reported also that sheep breeders from Djelfa, on their way to the Tellian stubble fields in summer, make stopovers in the PFAs of the Tiaret region.

In a study conducted on the Maamora PFA located in the Saïda department of western Algeria, which is close to our PFAs, Yerou *et al.* (2022) reported pastoral productivity at about 302.5 FU ha⁻¹ year⁻¹ during the spring of 2019. This value was close to the productivity recorded in our study area. However, despite supplementation with concentrated feed, the feed balances of the flocks in the fenced areas were negative. This situation reflected the breeding methods employed, which animal overstocking rate the rangelands, including those within the controlled areas. Consequently, the management systems employed for fencing and the breeding methods used don't facilitate an adequate regeneration of rangeland vegetation.

Furthermore, it is important to note that, within the fencing areas, a significant portion of the animal's nutrient intake is derived from supplementary feed rather than from the rangelands itself. This discovery adds scientific support to the findings of numerous studies that have criticized the extensive reliance on concentrated feed in sheep breeding within the Algerian steppe. In fact, the use of concentrated feed has become the prevailing solution for satisfying the nutritional requirements of flocks, as highlighted in studies by Mouhous (2007); Senoussi *et al.* (2014); Yabrir *et al.* (2015).

The PFAs play a significant role within sheep breeding systems, as they serve as "crossroads" when breeders from several breeding systems meet during the rental period. However, it is crucial to acknowledge that animal overstocking rate on grazing areas can result in the overexploitation of natural resources and a decline in the quality of grazing fodder. It is therefore important to implement sustainable management of fencing rangelands in order to preserve biodiversity and natural resources. Salemkour *et al.* (2016), mention the positive effect of stocking rate control on controlled rangelands in the Algerian steppe.

While the study has limitations in terms of its temporal and spatial scope, its findings offer valuable insights for enhancing the management of steppe rangelands, particularly those under control. Implementing appropriate stocking rate control measures within fenced areas can improve the pastoral efficiency of rangelands, thereby contributing to more sustainable management of these pastoral regions.

However, fencing technique alone cannot serve as the sole solution for achieving sustainable. Therefore, it is imperative to explore alternative forage options to compensate for the limited availability of feed in the steppe. Senoussi *et al.* (2014) emphasize that actions aimed at rehabilitating rangelands, such as fencing, can effectively restore vegetation cover for fodder purposes. However, it is crucial to accompany these actions with initiatives that consider the needs and practices of local populations and their traditional methods of organization. This holistic approach is essential for achieving long-term sustainability in the management of both livestock and the natural environment.

Conclusion

The results demonstrate the potential of pastoral fencing as a sustainable approach to preserve and utilize rangelands effectively. Furthermore, the study highlights the importance of improving sheep breeding practices in the steppe environment. By integrating the use of fencing with other complementary measures, such as rotational grazing and forage diversification, breeders can optimize the utilization of available resources while minimizing the negative impacts on the ecosystem. This calls for the development of training programs and knowledge-sharing initiatives to equip breeders with the necessary skills and information to implement sustainable practices. However, it is crucial to recognize that pastoral fencing alone isn't a comprehensive solution to all the challenges faced in steppe pastoral systems. It should be seen as one component of a broader integrated approach to grazing management. Continued research and monitoring are essential to refine and improve fencing techniques, assess their long-term impacts on vegetation dynamics and biodiversity, and identify potential socio-economic implications for local communities.

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