



Characterization and Dynamics of Sheep Farming Systems in the Arid Steppe of Eastern Algeria

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OPEN ACCESS

Received: June 22, 2025 Accepted: July 14, 2025

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Citation

Douh, M., Karkour, L., Chekchaki, S., Rahal, O. and Cherif, I. 2025. Characterization and Dynamics of Sheep Farming Systems in the Arid Steppe of Eastern Algeria. *Annals of Arid Zone* 64(4): 643-656

<https://doi.org/10.56093/aaz.v64i4.168104>

<https://epubs.icar.org.in/index.php/AAZ/article/view/168104>

Abstract: Sheep farming is a vital component of rural livelihoods in Algeria's arid regions, especially in the Tebessa area. This study examines the spatial distribution and economic characteristics of sheep production farms in these dry lands, with a focus on management strategies, resource utilization, and socio-economic and environmental challenges. A survey of 161 agro-pastoralists revealed diverse farming systems as influenced by traditional practices and harsh climatic conditions. Two primary flock management models and varied feeding strategies, integrating pasture and crop residues, were identified. While direct grazing supports satisfactory economic performance, larger farms face constraints related to feed supply and input costs. About 70% of farms follow traditional practices, while 30% are transitioning toward semi-intensive systems, encompassing both changes in genetic selection and feed management. The results underscore both the resilience and vulnerability of sheep farming in arid zones, emphasizing the need for improved feed resources, support for semi-intensive transitions, and policies that address socio-economic and climate-related challenges to ensure sustainable development.

Key words: Sheep farming, socio-economic challenges, management strategies, resource utilization.

The livestock sector is essential for the economies of developing countries, particularly for meat production and income generation. In the Mediterranean region, sheep farming is vital for local diets and rural economies (Kanoun *et al.*, 2017; Rebai *et al.*, 2023). In Algeria, sheep production has a significant impact on GDP and rural income, enhancing food security and mitigating economic and environmental fluctuations. However, the sector faces challenges related to climate change and extreme weather conditions, making risk management essential for livestock farmers (Nurk and

Table 1. Sample by number of farmers in the areas considered

No	Designations	Survey area	Total in Tebessa District	%
001	Bioclimatic zones	Arid and semi-arid	2	50.00
002	Situation	Central	1	50.00
003	Number of municipalities	11	28	39.29
004	Area vocation model (number)	Steppe; Meadow-steppe (2)	4	50.00
005	Total Area (ha)	804 924	1387800	58.00
006	Number of livestock herds	652073	1161202	56.16
007	Total breeders (Number)	2172	4775	45.49
008	Sample studied (Number)	161	355	45.35

1- The designation of Zone C: represents the intervention experiences in region for the study.

2- Inferior arid: represents two climate patterns, namely (thermo-Mediterranean (short dry season) and thermo-Mediterranean (long dry season: Arid, and semi-arid).

Nurmet, 2023). Sheep farming relies on resilient grazing practices from traditional pastoralism, allowing herders to adapt to seasonal changes and manage resources efficiently (Dumont and Bernués, 2014). This practice contributes to biodiversity and semi-natural vegetation. However, in Algeria, inappropriate grazing leads to land degradation and increased social vulnerability due to climate change (Douh *et al.*, 2018). Moreover, evolving agricultural policies, favoring market-oriented approaches, degrade key pastures and forage resources, while land tenure issues persist (Douh *et al.*, 2024; Sraïri *et al.*, 2017). This study aims to analyze sheep farming in eastern Algeria, focusing on practices, economic performance, and dynamics to guide future national research and development policies.

The growth of sheep farming in drylands is strongly influenced by rapid increase in population and consequent increases the demand for livestock products. However, livestock development programs often prioritize foreign breeds over adapted local breeds, such as Ouled Djellal, Rembi, Hamra, Berbere D'men, and Sidaou, which are threatened by socio-economic factors (Yabrir *et al.*, 2015; Yousfi *et al.*, 2017). Sustainable livestock farming depends on the improvement and conservation of these indigenous Algerian breeds. Traditionally, sheep farming in Algeria relies on natural rangelands, which offer limited forage due to high climate variability. Despite this challenge, grazing remains a viable strategy, and thus it is crucial to either adapt or mitigate climate risks, especially droughts. Analysing livestock production within the framework of cultural systems enhances our understanding of how production practices

and management structures influence habitat utilization. Farm typologies provide insights into household production and consumption decisions, including crop and livestock system choices. In arid and semi-arid regions, sheep farming is developing with extensive practices adapted to harsh climates (Brossier *et al.*, 1990; Ben Salem and Smith, 2008; Hicher *et al.*, 2020). Stakeholder engagement in research is essential to address the challenges of diminishing grazing land due to population pressure. Given their traditional significance and key role in agriculture, Algerian sheep breeds require protection to preserve biodiversity, enhance climate resilience, and support rural livelihoods in challenging environments.

Materials and Methods

General design of the study and presentation

A survey conducted among 161 breeders in the central area of the Tebessa department characterized sheep farms during the 2022-2023 agricultural seasons. Zootechnical performances (producing females, pregnant females, births, economic losses due to mortality) were monitored for one year, from November 2022 to October 2023, through two phases (pre-survey and actual survey), in order to create a Bas du formulaire diagram survey and actual survey), in order to create a diagram of the existence of the herds. The study area, located in the arid Algerian steppe, covers 804924 ha spread over eleven municipalities (Table. 1; Fig. 1), with an altitude of 600 to 1200 m and low and irregular rainfall (150 to 250 mm) mainly in winter. This research is the first of many studies to comprehensively examine the adaptations and evolution of livestock systems over a five-

year period (2020-2025) in relation to climate impacts. The survey covered eleven micro-zones representing 58% of the total area of the province, or approximately 1387800 ha, and aims to improve understanding of agricultural practices in this central region of Tebessa.

Sampling and data collection and statistical analysis

For the survey, farmers were required to own a minimum of 50 sheep and be located in Zone C of Tebessa, Algeria (Fig. 1). This zone comprises eleven micro-zones and is characterized by two climatic models: the thermo-Mediterranean with a short dry season and the thermo-Mediterranean with a long dry season. The climate in this region is predominantly arid to semi-arid, featuring hot and dry summers with maximum temperatures reaching 35°C in July, and harsh cold winters with minimum temperatures around 1.7°C in January. The area receives approximately 27 mm of precipitation during the winter months (Dekak *et al.*, 2018).

Out of total 2172 breeders (Table 1) 161 were randomly selected. Data was collected through face-to-face interviews on aspects such as infrastructure, economic activities, and management practices. Economic and technical

indicators were analyzed to develop a typology of sheep farming systems, with statistical analyses using Statistica version 2016. Ten quantitative parameters related to area, fallow land, and cereal cultivation were identified to characterize farms and monitor flock dynamics, including annual variations in flock numbers and zootechnical performance.

Results and Discussion

Socio-economic characteristics

The socio-economic profile of the 161 sheep farmers showed that over 98% of farms were managed by men, with permanent settlements increasing to 52% between 2010 and 2021 (Youcefi *et al.*, 2023). The farmers belonged to eight tribal groups, mainly Ouled and Abid N'mamcha, representing 25 to 50% of the population (Table 2; Fig. 2). The age of the farmers ranged from 20 to 80 years, with an average of 48.21 years. Regarding education, 10.56% had no formal education 55% had completed primary school, 33% secondary school, and 2% had a university degree. The economic motivations for sheep farming are mainly profit-oriented, with 70.10% of households directly managing their farms. The number of sheep per farm ranged from 50 to 450 heads. Many livestock farmers were also engaged in other economic activities,

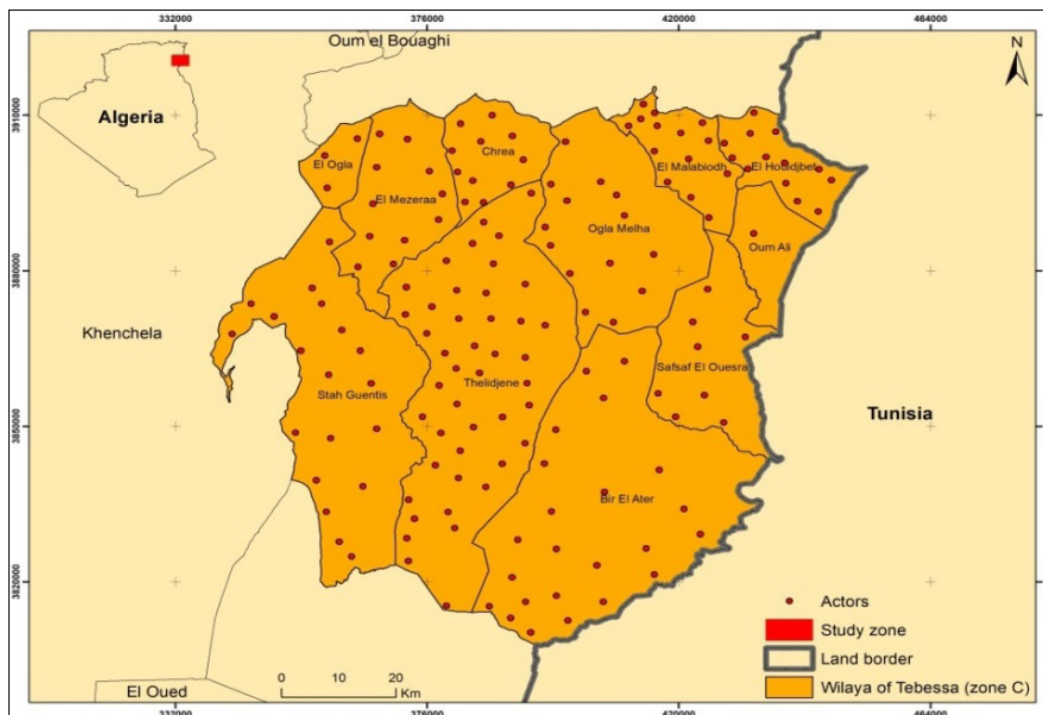


Fig. 1. Localization sheep breeders of the study sites in Tebessa.

Table 2. Presentation of land distribution using box plots (Sup) for the region

Parameters	Area	Fallow land
Number of observations	161	161
Minimum	2.0000	0.0000
Maximum	45.0000	23.0000
1 st Quartile	7.0000	0.0000
Median	10.0000	1.0000
3 rd Quartile	15.0000	3.0000
Mean	12.2329	2.1969
Variance (n-1)	67.1063	15.1607
Standard deviation (n-1)	8.1918	3.8937
Coefficient of variation	0.6676	1.7668

and 21.12% combine livestock farming with agriculture. Sheep farming is often a secondary activity, supplemented by food crops, mainly dry cereals and fodder crops. Investments in livestock farming are financed by personal resources, due to the strict lending conditions of Algerian banks. Access to livestock markets depends on individual needs, with 20% of livestock farmers having direct contact with traders. However, unfavorable market trends, such as increasing feed costs, have impacted financial margins.

Land transition dynamics

Analysis of agricultural land areas showed that more than 68% of agro-pastoralists own land with an area of less than or equal to 10 ha, with an absolute dominance of the class between 0 to 10 ha (57%), followed by the class of 10 to 15 ha (25%), with areas over 15 ha having a rate of (18%). In total, 67% of the land owned by the agro-pastoralists surveyed does not have legal titles. These lands are known as Arch or communal lands, which belong to the municipality and are considered collective property of the Algerian state. Traditionally used by tribes for agriculture, these lands are officially inalienable but are often used without legal authorization. Only 33% of the respondents have legally owned land-15% as individual properties and 18% as group concessions.

The first year of cultivation served as a reference to determine the dynamics of agricultural transition of pastoral lands, of all legal types, by agro-pastoralists. Examining this dynamic shows that about 91% of the land held

Table 3. Socioeconomic characteristics of sheep breeders in the study areas

Parameters	Categories	Number	(%)
Breeder's age	[20-40]	47	29.19
	[40-60]	77	47.83
	[60-80]	37	22.98
Tribal distribution	Frachich (FR)	04	2.48
	N'guernia (NG)	09	5.59
	Nmamcha (NM)	85	52.80
	Ouled Abid (OA)	40	24.84
	Ouled Derradj (OD)	08	4.97
	Ouled Melloul (OM)	03	1.86
Degree of education	Ouled Yahia (OY)	09	5.59
	Ouled Nail (ON)	03	1.86
	Illiterate	17	10.56
	Primary	88	54.66
	Secondary	53	32.92
Management system	University	3	1.86
	Sedentary	25	15.53
Financial source	Semi transhumant	136	84.47
	Livestock	30	18.63
	Livestock and agriculture	34	21.12
Size sheep flock (no. of heads)	Livestock and others	97	60.25
	<100	5	3.11
	101-200	80	49.69
	201-300	73	45.34
Batch Separation	>300	3	1.86
	Yes	122	75.78
Percentage Female	No	39	24.22
	≤50%	111	68.94
	50-60%	48	29.81
Racial composition of flocks	≥60%	2	1.24
	Sheep exclusive	45	27.95
	Sheep associated with goat	27	16.77
	Sheep associated with cattle	11	6.83
Stalling	Sheep associated with goat and cattle	78	48.45
	Classic sheepfold (Zriba)	97	60.25
	Semi-covered sheep	41	25.47
Cultivation method adopted	Covered barn	23	14.29
	Dry cultivation	132	81.988
	Irrigated cultivation	29	18.012

prices (530.10 to 795.14 € t⁻¹) strongly impacting farmers' profitability. Average profitability is 6.29 € kg⁻¹ for a 50 kg sheep (approximately 331.42 € carcass⁻¹), but can drop to 3.31 € kg⁻¹ (172 €) under unfavorable conditions, where drought is prevalent.

The min and max values define the range of data for each variable across 161 observations (studied farms), potentially revealing precise data on acronyms (quantitative measures assumed to be areas or counts). CF: Min (0 ha) for zeros; max (30 ha) as the extreme, explaining the widest range; FP: Min (0 ha) dominant; max (4 ha) reinforces the skewing in a sparse distribution; DP: Min (0 ha) for almost all data; max (2 ha) as the rare outlier (extreme CV); FC: Min (0 ha) frequent; max (3 ha) contributes to the dispersion, and MG: Min (0 ha) predominant; max (2 ha) for isolated cases (high relative variability). The set of studied variables presents a strongly contrasted statistical structure between a main variable, CF, and a group of secondary variables (FP, DP, FC and MG). Cereal crops stand out as the only variable showing an extended distribution, real dispersion, and moderate relative variability. Its median =7 ha, lower than the mean=8.54 ha (Table 4), reveals a slight positive asymmetry, probably due to a few high values. This variable thus appears as a central measure, continuous or of abundant counting. In contrast to the values presented by: FP Fruit Plantation; DP: Date Palm (*Phoenix dactylifera*); FC: Forage crops, and MG: Market Gardening: These crops practiced by these farms in the study region (Tebessa) share the same dynamic, involving: (Distributions very concentrated on zero; Rare and sporadic events; extremely low means; Strong positive asymmetries; Very high coefficients of variation). These variables therefore seem to reflect occasional occurrences or states activated only in a minority of cases. They likely play a secondary role in the studied phenomenon, in contrast to CF which carries the largest share of useful variability, justifying the massive exploitation of agricultural land by cereals, with the cereal-livestock association presenting a dominant criterion. This situation suggests a data structure where a main indicator (CF=30 ha) coexists with occasional indicators (FP, and MG) of (4 and 2 ha), possibly dependent or explanatory of specific phenomena. In conclusion, the dataset combines

a robust dominant variable and several very weakly active satellite variables, which orients future analyses towards differentiated approaches according to the type of variable (continuous analysis vs. rarity or count analysis). These results reflect an agricultural sector dominated by cereal Farming, with a high degree of specialization and very little diversification into fruit orchards, fodder crops FC, market gardening MG, and date palms, which represent only a small minority of cultivated land (Fruit orchards: 0.43 ha; Date palms: 0.03 ha; Fodder crops: 0.53 ha; and Market gardening: 0.096 ha).

Inter-herd production management

Inter-herd production management is evolving towards agro-pastoralism, a strategic response to climatic and economic challenges, aimed at securing stable and economical food resources. However, socio-economic and ecological crises have intensified within agro-pastoral activities. Historically, resource management in agro-pastoral systems was governed by customary institutions, where land use rights were shaped more by environmental conditions than by formal legal or social ownership frameworks (Bouderbala, 1999). Today, over 90% of agro-pastoralists continue to practice extensive, year-round grazing on natural rangelands, reflecting a persistent dependence on open access to forage resources (Krätli and Schareika, 2010). During seasonal returns to traditional enclosures known as *Zriba*, livestock diets are typically supplemented with concentrated feeds such as barley and bran to mitigate recurrent fodder shortages (FAO, 2021). Water provision strategies reveal adaptive responses to local hydrological variability, with herders relying predominantly on fountains (45%), wells (25%), and boreholes (20%). Livestock housing also illustrates a range of adaptive practices: approximately 60.25% of herds are kept in conventional sheepfolds, 25.47% in semi-open shelters, and 14.29% in covered barns. These infrastructural choices highlight diversified strategies employed by pastoral households to cope with climatic constraints, resource availability, and varying levels of financial capacity (Gertel and Breuer, 2007).

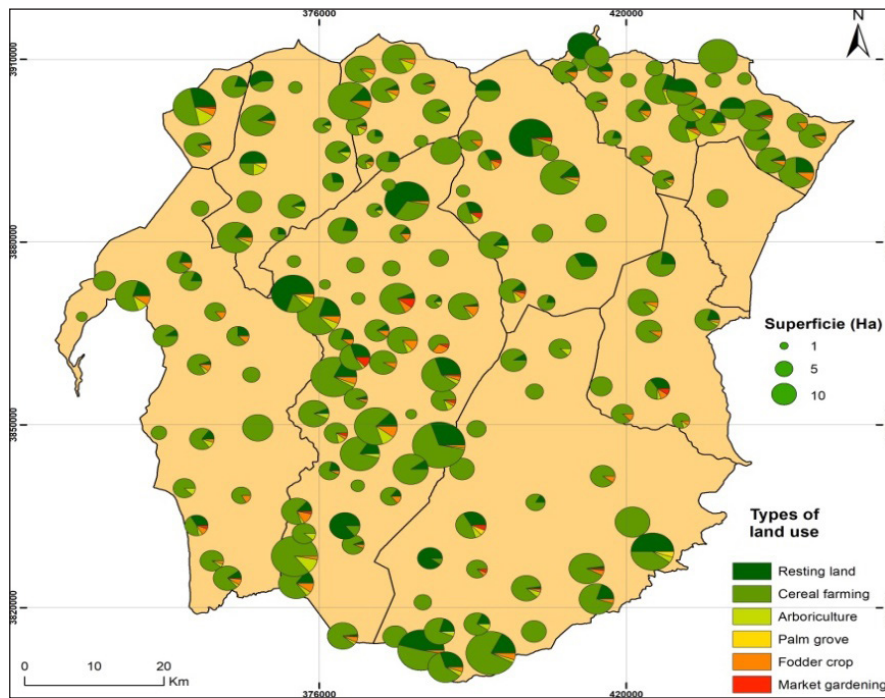


Fig. 3. Land use of livestock in the study area.

Inter-herd breeding and improvement

The majority of agro-pastoralists (90%) prioritized selection of males to ensure a good skeletal profile, while only 10% focus on females. Animals are mainly sourced from existing farms (60%), with the remaining 40% purchased from neighbouring farmers. Unselected males, usually lambs aged 6-12 months, are sold during favorable market periods. With 98% of matings being free-breeding, the main selection objectives include improving adult weight (87.9%), growth rate (83.3%) and robustness (54.5%). Selection criteria include adult size (68.2%) and conformation (39.4%), with visual assessments for growth and weight. Poultry farmers face challenges such as forage shortages (33.3%) and parasitic diseases (23.3%). To improve productivity, effective management practices are needed, including rigorous hygiene, vaccinations and balanced feeding. More than 80% of farmers assess the weight of their sheep visually, while 18.3% use scales. Selection criteria for fattening are based on physical traits, in line with Notter's (2000) recommendations for the Sahel region.

Typology and multiple correspondence analyses

A multiple correspondence analysis (MCA) was performed on nine variables, allowing

the identification of three key factors (F1 and F2: 73.21% of the total variability). Axis 1 distinguishes two groups: the first is associated with high zootechnical performance, encompassing variables such as mortality rate, herd size and births recorded. This group is linked to a low level of education and extensive farms. On the other hand, the second group, characterized by large herds and a higher level of education, shows less intensification. Axis 2 relates intensification indicators, such as agricultural area and supplementation strategies, with the education of the actors. This analysis reveals positive correlations with concentrated feeding throughout the year. The Statistical analyses, such as PCA and MCA, are vital for studying North African agricultural, pastoral, and social dynamics, revealing nuanced typologies. They distinguished Moroccan dairy farm profiles by intensification and education levels (Sraïri *et al.*, 2017) and compared traditional versus modern dairy systems in Algeria (Kadi *et al.*, 2018). They also highlighted technical efficiency variations in Tunisian farms and identified farm types in Morocco's irrigated zones (Alary *et al.*, 2016). Tunisian farmers' water constraint adaptation strategies were explored (Elloumi *et al.*, 2011), and researchers' informational behaviours showed diverse profiles in scientific information

Table 5. Correlation matrix (Pearson (*n*))

Variables	Area	RL	CF	SF	YSRE	EF	TDA	BL	MR
Area (A)	1								
Resting lands (RL)	0.628	1							
Cereals farming (CF)	0.822	0.144	1						
Sheep flock Herds (SF)	0.430	0.244	0.425	1					
Young sheep (Ram; Ewes)	0.299	0.240	0.271	0.599	1				
Existing Female (EF)	0.388	0.221	0.381	0.952	0.437	1			
All dead alive (TDA)	0.455	0.251	0.436	0.914	0.395	0.835	1		
Births (BL)	0.371	0.172	0.379	0.891	0.327	0.801	0.960	1	
Total mortality (TMR)	0.485	0.350	0.406	0.602	0.409	0.585	0.697	0.468	1

The values in bold are different from 0 at a significance level $\alpha=0.05$

(A): Area; (RS): Rest Surface, (CF): Cereal Farming, NL: SF: Sheep flocks (Herds); (YSRE): Young sheep (Ram; Ewes) (EF): Existing Female; (TDA): Total dead alive; (LB): Lamb births; (TMR): Total Mortality.

access and use (Gdoura, 2018). These studies illuminate the complexity of North African socio-economic and environmental systems, offering valuable insights for research and public policy, especially in Algeria.

The correlation results presented in Table 5 and illustrated in Fig. 3 reveal several important relationships among the variables. Resting lands (RS) show a strong positive correlation with cereal area (CF), suggesting that larger areas of resting lands tend to support increased cereal output, while their moderate correlation with livestock (SF) indicates a weaker but still meaningful association. Cereal production is also positively linked to both resting lands and existing female livestock (EF), implying that areas with higher cereal production may provide favorable conditions for maintaining female animals. Livestock numbers exhibit a very strong relationship with existing females, along with moderate correlations with total mortality (TDA) and births (BL), highlighting connections with reproductive performance. The ram and ewe (Male sheep/Female sheep) areas (R,E) display moderate correlations, particularly with livestock and existing females, indicating that these zones contribute to supporting animal populations. Existing females show exceptionally strong correlations with births and notable links to mortality, emphasizing their central role in herd productivity and health outcomes. Births are strongly tied to the number of existing females and moderately related to mortality, while total mortality correlates with both existing females and births, pointing to ongoing management challenges. Overall, Table 5

underscores the strong interdependence among these variables, especially the key influence of existing female livestock on reproductive success and mortality patterns. The findings align with studies in Algeria and North Africa, which show that improving sheep productivity relies on increasing breeding females and reducing mortality, particularly among lambs. Research indicates that maintaining an optimal ram-to-ewe ratio (1:25-30) and ensuring good body condition ($BCS \geq 3$) enhances fertility and prolificacy in the Ouled Djellal breed (Benyounes *et al.*, 2013). The use of Deman rams further increases fecundity while keeping mortality low (Madani *et al.*, 2017), and lamb mortality often linked to nutrition and inadequate health care (Chikhi and Bouchemal, 2017) can be reduced through better management. Additionally, the male effect supports oestrus synchronization and fertility, while agro-pastoral systems with supplementation and irrigated forage help maintain body condition and reduce neonatal losses (Chikhi, 2004).

Classification of farms by farming system

The boxplot of axes F1 and F2 presents 73.21% of the total variance in the data from the studied agricultural farms (Fig. 4), offering an effective dimensional reduction. F1 (57.03%) embodies the dominant factor of "size and agro-pastoral integration," grouping agricultural lands and sheep farming (correlated land and sheep variables). F2 (16.20%): presents the factor of "land-productivity contrast," distinguishing farms oriented toward extensive land use (e.g., more agricultural and fallow surfaces, associated with cereal farming); it highlights a secondary factor of "land-productivity contrast,"

Table 6. Correlations between variables and factors

Designations	F1 (57.03%)	F2 (16.20%)
Agricultural area	0.673	0.702
Lands at rest	0.415	0.605
Cereal farming	0.613	0.471
Sheep herd	0.941	-0.292
Young sheep (Ram and Ewes)	0.573	-0.005
Females existing	0.878	-0.301
Total dead and alive	0.929	-0.257
Births	0.853	-0.355
Total mortality	0.746	0.096

opposing soil extension to the reproductive intensity of the herd. The strong loadings on F1 signal probable multi-collinearity (correlations) between sheep variables and lands, reflecting agro-pastoral interdependence. For F2, the opposite loadings underline agricultural trade-offs (Extensivity Vs intensivity). Overall, F1 (57.03%) appears to represent a factor strongly associated with positive agricultural outcomes (Table 5), including larger sheep herds, existing females, births, and total livestock counts. Conversely, F2 (16.20%) shows negative correlations with critical livestock variables, suggesting it may represent a contrasting or less productive agricultural scenario. This analysis highlights the differing influences of the factors on agricultural productivity and livestock management. The analysis of the treatment components revealed two distinct central groups according to Lambert coordinates: sedentary livestock farming (-3.024; 0.311), representing approximately 16% of the participants (25 agro-pastoralists), and semi-transhumant livestock farming (0.556; -0.057), representing approximately 84% (136 actors) (Table. 2; Fig. 4 and 5). These results confirm the hypotheses of Belhouadjeb and Chehat (2023), Daoudi *et al.* (2015), and Adaouri *et al.* (2023).

Hierarchical classification and description of clusters

The distribution of livestock farmers according to the “lifestyle” criterion and the quantitative variables of the farm show a classification differentiating sedentary and semi-transhumant systems. Semi-transhumant livestock farmers, representing approximately 64% of the sample, are mainly located

outside large cities and manage larger flocks of sheep. The semi-transhumant system involves occasional movement of herds, due to limited local fodder resources. Factor analysis identified two main types of livestock behaviour, explaining 53.68% of the variance: Category 1: Fixed sedentary livestock farming (25 farms, 15.53%), characterized by small farms (average 7.51 ha) integrating crops and livestock. Category 2: Large-scale semi-transhumant livestock farming (136 farms, 84.47%), characterised by occasional movement of herds and adaptation to environmental conditions. These results highlight a trend towards sedentarisation that impacts herd mobility, resource use and territorial changes, as noted by Yabtir *et al.* (2015).

Constraints in sheep farming within the steppe zone

Analysis of sheep farming systems in the Tebessa region revealed significant variability in herd management practices, influenced by various constraints. The analysis of sheep farming in Tébessa revealed significant variability between flocks ($p < 0.05$) in terms of management practices, herd size relative to agricultural land ($p = 0.0001$), flock dynamics, and zootechnical performance ($p = 0.0001$), as well as the presence and manifestation of productive females. This structural and technical heterogeneity justifies tailored recommendations for each system. A hierarchical cluster analysis identified two distinct groups of farmers, explaining 73.21% of the total variance (Fig. 4; Table 6). Group 1: The sedentary group, comprising 25 farmers (16% of the total), includes tribes such as Ouled Deradj, Frachich and Ouled Yahia. This group practice a traditional, purely extensive livestock system, with herds fixed in the same locality, displaying positive coefficients on the F1 axis. Group 2: The semi-transhumant group, comprising 136 farmers (84% of the total), mainly includes the N'mamcha and Ouled Abid tribes (Table 3). This group uses supplementary feeding during part of the dry season and presents distinct characteristics on the F2 axis. These results highlight the varied strategies adopted by herders in the Tebessa region to address environmental and management challenges. These results highlight the diverse strategies adopted by livestock farmers in the Tebessa region (Algeria) to address environmental

and management challenges (Bencherif, 2019; Nedjraoui and Bédrani, 2020; Haddouche and Ariouat, 2022; Bensmira *et al.*, 2023). These strategies include adaptations to climatic constraints and innovative management practices, supported by several relevant studies.

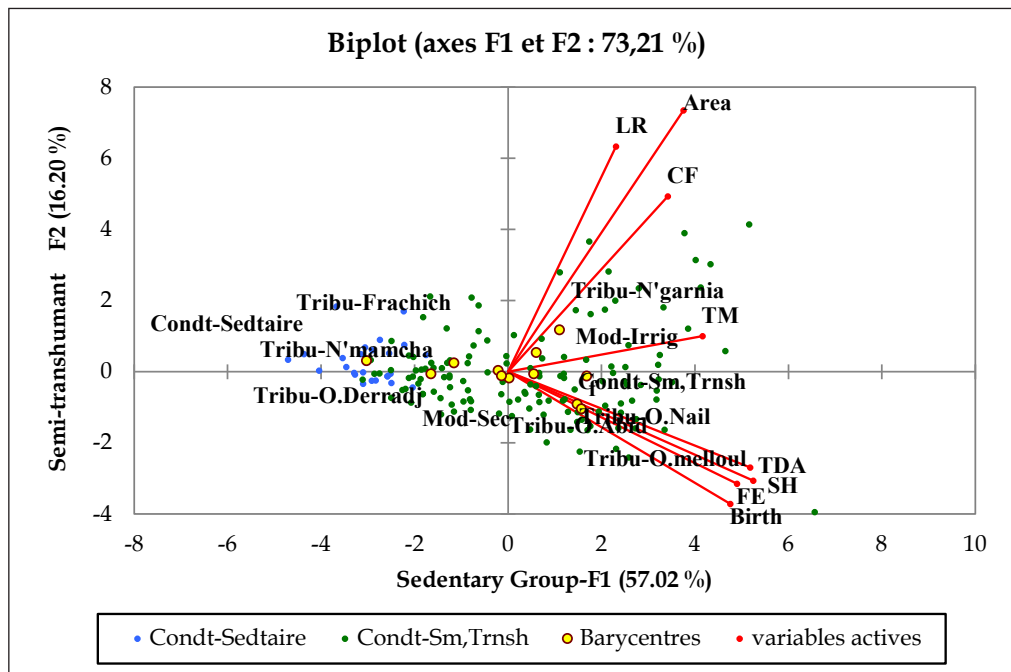
Land use and educational influence on sheep farming practices

The land-use map provides an initial descriptive analysis of land occupation, as noted by Hirche *et al.* (2015). The analysis reveals notable spatial variability in tribal land occupation. The N'mamcha, Ouled Abid, and Ngarnia tribes have occupation rates of 37%, 32%, and 16%, respectively, while the other four tribes account for only 15% (Fig. 5). This distribution highlights the predominance of semi-transhumant herders, with varying proportions across sites. The analysis of practices shows that tribal groups often share similar methods. Regarding the level of education of herders, a significant disparity is observed: 10.56% have no formal training, 54.66% have a primary level, and 32.92% have a secondary level. This disparity may reflect the Algerian

government's efforts to address educational needs in rural areas. Thus, sheep farming in the study region appears to be divided into two sectors: one characterized by modern practices and the other by traditional methods. Farmers with lower levels of education are mostly engaged in traditional (extensive) practices and manage larger flocks, while those with higher or intermediate levels of education are more likely to adopt semi-extensive practices with medium-sized flocks.

Sheep farming objectives and profitability and factors affecting sheep farming

Several key factors contribute to the challenges of sheep farming in the region. First, management issues, such as insufficient staffing and inadequate feed supply, are significant. In addition, the practice of retaining sheep beyond the age of optimum profitability, in the hope of selling them later, results in unproductive feed costs. The price gap between farm gate and consumer price is relatively narrow, ranging from 1.2 to 1.9 times the farm gate price, while production costs range from 5 to 8 times this price. Limited consumer purchasing power



N'garnia Tribe: Family group belonging to the Negrine tribe; Mod-Irrig: Irrigated agricultural system; Mellout Tribe: Family group belonging to the Ouled Melloul tribe; Abid Tribe: Family group belonging to the Ouled Abid tribe; Ouled Derradj : Family group belonging to the Ouled Derradj tribe; Area: Agricultural area; LR: Lands at rest; CF: Cereal farming; SH: Sheep herd; FE: Females Existing; TDA: Total dead and alive; Births; TM: Total Mortality; Condt-Sedtaire: Sedentary livestock farming management; Condt-Sm, Transh: Semi-sedentary livestock farming management.

Fig. 4. Graphic representation of modalities on axis 1 and 2 (see Table. 1 for signification).

constrain, spending on animal product placing down word pressure on prices. Disease and mortality rates further reduce profitability, discouraging self-investment and access to credit. It is important to note that current profitability assessments often overlook the multi functional role of sheep, including their monetary and non-monetary benefits. Valuing these broader contributions could improve the assessment of the economic viability of sheep farming, thus explaining the persistence of this activity in the region. The feeding system and free grazing practices observed are consistent with those of other similar regions. The main difference between livestock groups lies in the supplementation strategy, which varies according to the spatial distribution during the dry season, often focused on risk management, while quasi-annual supplementation aims to maximize production. The prevalence of self-medication among livestock farmers (52.5%) and the absence of impact of distance to basic infrastructure on farming operations are also notable.

Conclusion

This study examines the impact of livestock systems on steppe territories, highlighting that sedentarization (Settlement of sheep herders on private land to develop and expand cereal cultivation), has fragmented land and limited access to pastures. The average sheep population per household comprises 5% rams, 13.3% ewes and 1.7% lambs. About 36.7% of sheep are fattened for profit, while 43.3% are kept for production. The production system is mainly semi-intensive (80%), with sheep grazing and receiving supplementary feed. Recommendations to improve reproductive performance include optimizing local breeds and improving veterinary and feeding services. Support from governmental and non-governmental organizations is needed to move towards more intensive systems. Agricultural practices in these areas face considerable uncertainties. Pastoralism in Tebessa (Algeria), faces desertification, water scarcity, rangeland degradation, and socio-economic constraints such as limited market access and land conflicts. Despite the

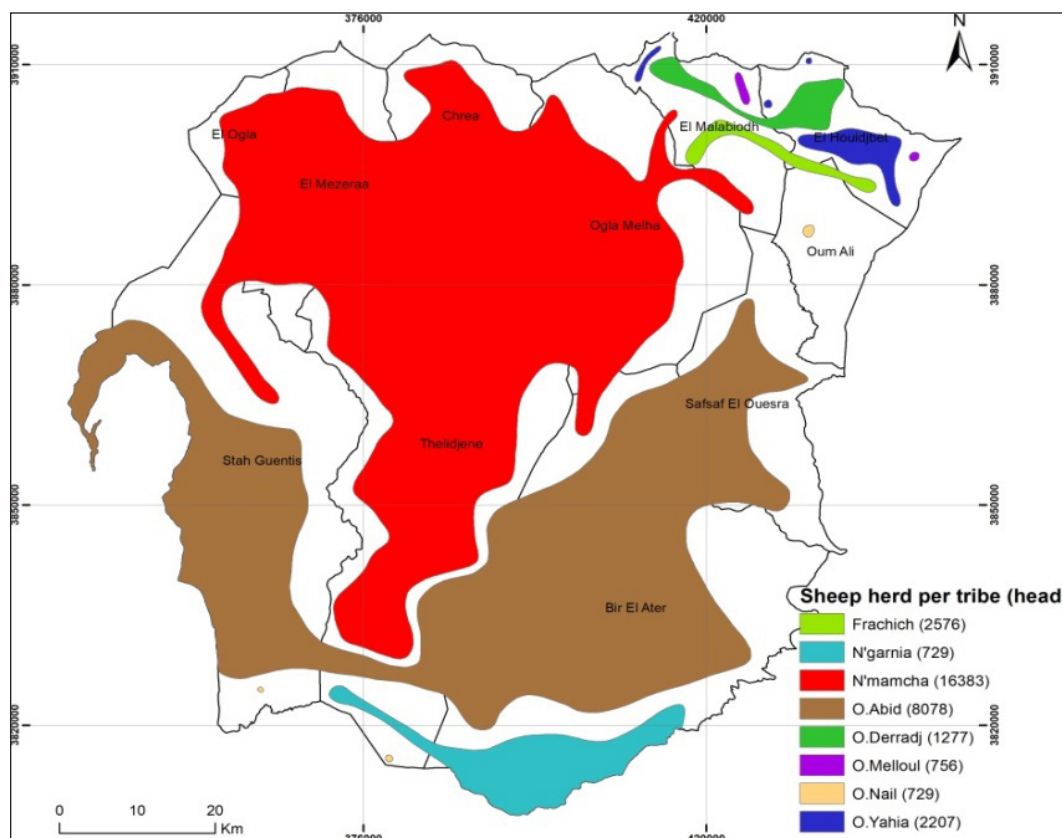


Fig. 5. Spatial occupancy of sheep by tribal allocation.

resilience of herders, who combine traditional knowledge with modern practices, political and institutional support is crucial to ensure the sustainability of these livestock systems. For sustainable development, securing access to resources, reforming land management, funding agro-ecological practices, involving local communities, and establishing regional collaborations are essential. These measures would enhance resilience to climate and socio-economic changes while preserving the region's cultural and ecological dynamics. Our proposed solutions based on this observation are based on four pillars: Investing in renewable energy (solar, wind); Promoting resilient crops and efficient irrigation techniques; Encourage participatory governance and collaboration, and raise community awareness to ensure the sustainability of initiatives,

Acknowledgements

The author would like to thank all the sheep breeders, and Organizations such as the Agricultural Technical Services (ATS), the Directorate of Forests (DG), and the High Commission for the Development of the Steppe (HCDS), in the Tebessa region for the help and support provided for the completion of this work.

Conflict of Interest

The authors have declared no conflict of interest.

References

- Adaouri, M., Lebied, M., Mefti Korteb, H., Merkoune, C., Guenzet, S. and Sebbag, L. 2023. Évaluation des performances de reproduction et de productivité chez la race Rembi dans la région de Médéa (Algérie). *Rech Agro* 21(1): 63-75. <https://asjp.cerist.dz/en/article/217555>
- Alary, V., Messad, S. and Tizaoui, H. 2016. Typologie des exploitations agricoles dans les zones irriguées au Maroc : une analyse des dynamiques et des contraintes. *Revue d'Études en Agriculture et Environnement* 97(3): 345-367.
- Belhouadjeb, F.A. and Chehat, F. 2023. Coût de production et la compétitivité de la viande ovine algérienne : cas de l'agneau de Djelfa les cahiers du CREAD n°104.
- Ben Salem, H. and Smith, T. 2008. Feeding strategies to increase small ruminant production in dry environments. *Small Rum Res* 77 : 174-194. Doi: 10.1016/j.smallrumres.2008.03.008
- Bencherif, S. 2019. Stratégies pastorales traditionnelles et modernes dans les hauts plateaux algériens. *Peuples Nomades* 6(4): 15-29.
- Bensmira, A., Zenati, N. and Bouras, D. 2023. Stratégies d'adaptation des éleveurs au changement climatique dans la région de Tébessa, Algérie. *Revue des environnements arides* 15(2): 45-60. <https://doi.org/10.4000/com.12259>
- Benyounes, A., Madani, T. and Aggad, H. 2013. Zootechnical parameters of Ouled Djellal ewes in semi-arid areas of Algeria. *Livestock Research for Rural Development* 25(11). Lien : <https://www.lrrd.org/lrrd25/11/beny25199.htm>
- Bouderbala, N. 1999. Les systèmes de propriété foncière au Maghreb. Le cas du Maroc. Montpellier: CIHEAM. *Cahiers Options Médit* 36 : 47-66. <http://om.ciheam.org/article.php?IDPDF=CI020475>
- Chikhi, A. 2004. Contribution à l'étude des systèmes d'élevage ovin en zones steppiques. *Revue d'élevage et de médecine vétérinaire des pays tropicaux*, CIRAD. Lien : <https://revues.cirad.fr/index.php/REMT/article/view/36801>
- Chikhi, A. and Bouchemal, M. 2017. Influence de l'alimentation sur la mortalité des agneaux en zone semi-aride. *Livestock Research for Rural Development* 29(11). Lien : <https://www.lrrd.org/lrrd29/11/mada29206.html>
- Daoudi, A., Colin, J.P., Derderi, A. and Ouendeno, M.L. 2015. Mise en valeur agricole et accès à la propriété foncière en steppe et Sahara. *Cahiers du Pôle Foncier* 13/201: 34. https://horizon.documentation.ird.fr/exl-doc/pleins_textes/divers16-06/010067476.pdf
- Dekak, A., Rabah., A.B., Chabi, B., Taha Menasria, C. and Yacine Benhizia, B. 2018. Phenotypic characterization of rhizobia nodulating legumes *Genista microcephala* and *Argyrolobium uniflorum* growing under arid conditions. *Journal of Advanced Research* 14: 35-42. Doi: 10.1016/j.jare.2018.06.001
- Douh, M., Aissaoui, C., Hicher, A. and Abdelmajid, S. 2018. Lambing and mortality rate in Ouled-Djellal sheeps in Tebessa region-Algeria. *Iraqi Journal of Veterinary Sciences* 32(2): 273-279. https://www.vetmedmosul.com/article_153863_282c37f.pdf. Doi: 10.33899/IJVS.2019.153863.
- Douh, M., Rebai, N., Gouasmia, Y., Rebai, S. and Aissaoui, C. 2024. Productive performance of Ouled Djellal Ewes in arid and semi-arid zones of Eastern Algeria. *AAZ*. 63 (1): 1-8 Doi. [org/10.59512/aaz.2023.63.1.1](https://doi.org/10.59512/aaz.2023.63.1.1).
- Dumont, B. and Bernués, A. 2014. Agroecology for producing goods and services in sustainable animal farming systems. *Animal* 8: 1201-1203. *The Animal Consortium* Doi:10.1017/S1751731114001554

- Elloumi, M., Selmi, S. and Jeder, H. 2011. Stratégies d'adaptation des agriculteurs tunisiens face aux contraintes hydriques: une analyse par les approches statistiques multi variées. *Cahiers Agricultures* 20(4): 289-297.
- FAO 2021. Pastoralisme dans les zones arides d'Afrique : Renforcer la résilience aux chocs environnementaux et économiques. Organisation des Nations Unies pour l'alimentation et l'agriculture, Rapport technique, Rome, 102 p. Doi : 10.4060/cb1234fr.
- Gdoura, W. 2018. Comportements informationnels des chercheurs nord-africains : une analyse des profils d'accès et d'utilisation de l'information scientifique. *Revue des Sciences de l'Information et de la Communication* 14(2): 123-145.
- Gertel, J. and Breuer, I. 2007. *Pastoral Morocco: Globalizing Scapes of Mobility and Insecurity*. Springer. <https://www.researchgate.net/publication/288964785>
- Hadbaoui, I., Senoussi, A. and Huguenin J. 2020. Les modalités d'alimentation des troupeaux ovins en steppe algérienne, région de M'Sila: pratiques et tendances. *Cahiers Agricultures* 29: 28 [httpsdoi.org/10.1051/cagri/2020027](https://doi.org/10.1051/cagri/2020027). Doi: 10.1051/cagri/2020027
- Haddouche, I. and Ariouat, M. 2022. Dynamiques socio-économiques et environnementales du pastoralisme à Tébessa, Algérie. *Revue africaine des sciences des parcours et des fourrages* 8(3): 77-92.
- Hicher, A., Bairi, A., Huguenin, J., Meziani, M. and Douh, M. 2020. Prevalence rate of caseous lymphadenitis (CLA) in sheep slaughtered in an abattoir in Biskra, Algeria. Doi: 10.13140/Rg.2.2.30910.92480. URL: <https://www.researchgate.net/publication/341781604>
- Hirche, A., Salamani, M., Boughani, M., et al. 2015. Guide technique écologie pour la collecte, L'analyse des données et le calcul des indicateurs écologiques suivant l'approche harmonisée. Roselt/Dnse/Oss/; Oss, Tunis: 159p. ISBN: 978-9973-856-9-3. <https://www.researchgate.net/publication/304014804>
- Kadi, S.A., Yakhlef, H. and Belhadia, M. 2018. Systèmes laitiers traditionnels et modernes en Algérie : une analyse comparative des dynamiques de production. *Livestock Research for Rural Development*, 30(5), Article 89. <https://www.researchgate.net/publication/280716487>
- Kambashi, B., Boudry, C., Picron, P and Bindelle, J. 2014. Forage plants as an alternative feed resource for sustainable pig production in the tropics: A review. *Animal* 8: 1298-1311. Doi : 10.1017/S1751731114000561
- Kanoun, M., Huguenin, J., Yakhlef, H., Meguellati-Kanoun, A., Julien, L., Benidir, M., Taugourdeau, S. and Et Bellahrache, A. 2017. Diversités des stratégies d'adaptation des agropasteurs ovins face aux situations d'incertitude en territoires steppiques : cas de la région d'El Guedid. *Revue des BioRessources* Vol 7 - 2 . <https://agritrop.cirad.fr/586926/1>
- Kassam, A., Friedrich, T., Shaxson, F. and Pretty, J. 2010. The spread of conservation agriculture: justification, sustainability and uptake. *International Journal of Agricultural Sustainability* 9(1): 102-110. <https://www.researchgate.net/publication/232861957>
- Krätli, S. and Schareika, N. 2010. Living off uncertainty: The intelligent animal production of dryland pastoralists. *European Journal of Development Research* 22(5): 605-622. Doi: 10.1057/ejdr.2010.41
- Madani, T., Mouffok, C., et al. 2017. Effect of the D'man ram on reproductive performance of Ouled Djellal ewes. *Livestock Research for Rural Development* 29(11). Lien: <https://www.lrrd.org/lrrd29/11/mada29206.html>
- Nedjraoui, D. and Bédrani, S. 2020. Pastoralisme et défis environnementaux dans les steppes algériennes: Études de cas des régions orientales. *Revue des sciences agronomiques* 12(1): 23-38. Doi : <https://doi.org/10.19182/remvt.31879>
- Notter, D. 2000. Effects of ewe age and season of lambing on prolificacy in US Targhee, Suffolk and Polypay sheep. Virginia Polytechnic Institute and State Univ Blacksburg, VA 24061-0306. *Small Rum Resea* 38: 1-7. Doi : 10.1016/s0921-4488(00)00144-9
- Nurk, K. and Nurmet M. 2023. Mise En Place De Mesures D'adaptation Liées Au Changement Climatique Dans Les Entreprises Agricoles. *Agraarteadus* 34(1):31-38. [https://dx.Doi.org/10.15159/jas.23.06](https://dx.doi.org/10.15159/jas.23.06) .
- Rebai, N., Rahmani, A., Chacha, F., Douh, M., Ahmed Laloui, H., Cherb, N., Derdour, M., et Abbas, K. 2023. Effets de régimes contenant différentes proportions de féverole (*Vicia faba* var. minor) sur les performances d'engraissement, les caractéristiques des carcasses et la qualité de la viande d'agneaux mâles de race O.Djellal. *LRRD* 35 (5) 2023. <https://www.researchgate.net/publication/370489278>
- Sraïri, M.T., M'ghar, F.A., Benidir, M. and Bengoumi, M. 2017. Analyse typologique de la diversité et des performances de l'élevage oasien. *Cahier Agricultures* 26(1): Doi:10.1051/cagri/2017002
- Yabrir, B., Laoun, A., Chenouf, N.S. and Mati, A. 2015. Caractéristiques des élevages ovins de la steppe centrale de l'Algérie en relation avec l'aridité du milieu: Djelfa. *LRRD* 27. (10). <http://www.lrrd.cipav.org.co/lrrd27/10/yabr27207.html>
- Youcefi, AT., Marouf A. 2023. Impact des politiques foncières sur la typologie d'élevage et la dynamique des parcours steppiques dans la région de Naâma (Ouest algérien). *Med. Vet. Pays*

Trop 76 (2023)/ Doi: <https://doi.org/10.19182/remvt.37014>.

Yousfi, M., Chachoua, I. and Bougouffa, N. 2017.
Contribution des parcours à l'alimentation des

petits ruminants en steppe et dans la wilaya de Djelfa, Algérie. *LRRD* · <https://www.researchgate.net/publication/317099120>