

Preferences for sheep traits among male keepers in El Oued, Algeria: socio-cultural and breeding insights

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Abstract: Identifying farmer trait preferences is fundamental to designing participatory breeding programs adapted to local agroecological constraints, yet such data remain scarce for Algeria's arid zones. This study investigated sheep trait preferences and their socioeconomic determinants among male sheep keepers in El Oued Province, southeastern Algeria. A mixed-method approach combining structured questionnaires and qualitative interviews was applied to 200 randomly selected male sheep keepers registered in the 2023 national sheep census, covering eight municipalities across the province. Multivariate analysis of variance (MANOVA) and chi-square tests were used to assess the influence of age, education, experience, and occupation on trait prioritization. For rams, breed identity (27%), body conformation (12.5%), and apparent health status (12%) emerged as the most valued selection criteria. For ewes, breed (22%), drought tolerance (16%), and udder size (10%) were ranked highest, reflecting the paramount importance of environmental adaptability and reproductive functionality under arid conditions. Locally adapted breeds, particularly Ouled Djellal, were strongly favored. A significant three-way interaction among education, experience, and occupation (Pillai's Trace = 0.070, $p = 0.009$) indicated that farmers with higher education, greater experience, and full-time breeding status prioritized long-term resilience traits, while less experienced or less educated keepers favored readily observable morphological attributes. Farmer age and education level were independently associated with drought tolerance preference in ewes ($p = 0.036$ and $p = 0.004$, respectively). These findings provide a socio-ecological evidence base to support the design of context-specific, participatory breeding programs targeting genetic resilience and sustainable livestock production in North African drylands.

Keywords: Breeding programs, Livelihoods, Sheep Keepers, Trait selection, Productivity.

1. Introduction

Sheep production is vital to Algeria's agricultural economy, particularly in arid and semi-arid regions such as El Oued, where livestock farming is the primary source of income for rural families. Environmental constraints, drought, fodder scarcity, and climatic fluctuations threaten the sustainability and productivity of this important sector. Under such difficult conditions, genetic improvement and well-planned selection are essential tools to strengthen herd resilience and performance (Berihulay et al., 2019; Siad et al., 2022).

In Algeria, sheep breeding accounts for a major share of animal production, with the national flock estimated at around 28–31 million heads, the majority of which are located in steppe and semi-arid regions (FAO, 2017; Laoun et al., 2026; Meziane et al., 2024). The sector supports the livelihood of a significant portion of the rural population and holds important economic and cultural value (Laoun et al., 2026). Production is primarily oriented toward red meat, supplying a substantial share of domestic consumption, though the country is increasingly dependent on imports due to rising demand and production shortfalls (Meziane et al., 2024; Mouffok et al., 2026). However, rising prices, rural migration, and recurrent droughts have made this sector less profitable and less accessible, increasing dependence on imported meat (Hadbaoui et al., 2023; Meziane et al., 2024). Beyond meat, sheep contribute significantly to rural livelihoods by providing manure, supporting mixed farming, and helping families diversify their income (Meziane et al., 2024).

Understanding sheep keepers' preferences for certain traits is therefore crucial for developing suitable, sustainable breeding programs adapted to local environments. Many studies across African countries have shown that farmer preferences vary by production system, cultural background, and ecological conditions. For example, Ethiopian farmers prefer large body size, good mothering ability, and litter size, while in Nigeria, disease resistance is the top priority (Duguma et al., 2011; Gizaw et al., 2010; Hemacha et al., 2022a; Welay et al., 2022; Yakubu et al., 2020). Despite these valuable findings, information about trait preferences in Algeria's arid regions, especially El Oued, remains very limited.

This study fills this gap by identifying, for the first time, the preferred traits of sheep keepers in the El Oued region of southeastern Algeria, with attention to differences in selection criteria between males and females. Using quantitative questionnaires and qualitative interviews, this research analyses decision-making processes and the factors influencing farmers' breeding choices. The results are expected to provide policymakers, agricultural extension services, and development programs with practical insights to inform the design of more sustainable and participatory breeding strategies. The novelty lies in integrating environmental, social, and genetic dimensions to better understand how traditional knowledge can inform breeding strategies adapted to arid, harsh conditions.

2. Materials and Methods

2.1. Description of the Study Area

This investigation was conducted in the El Oued region of Southeast Algeria from June 2023 to January 2024. The state is located at 33°22'16.823" north latitude and 65°52'6.866" east longitude.

2.2. Sampling Procedure

Sheep keepers were selected from the study area (El Oued) based on sheep production and farmers' willingness to participate in this research. A total of 200 male sheep keepers were randomly sampled in the study area, covering 08 municipalities: El Oued, Debila, Guemar, Hassi Khelifa, Mih Ouensa, Ourmes, Robbah, and Taleb Larbi (Figure 1). This sampling ensured representative coverage of the region's main sheep-producing zones, reflecting variations in management practices, flock sizes, and environmental conditions.

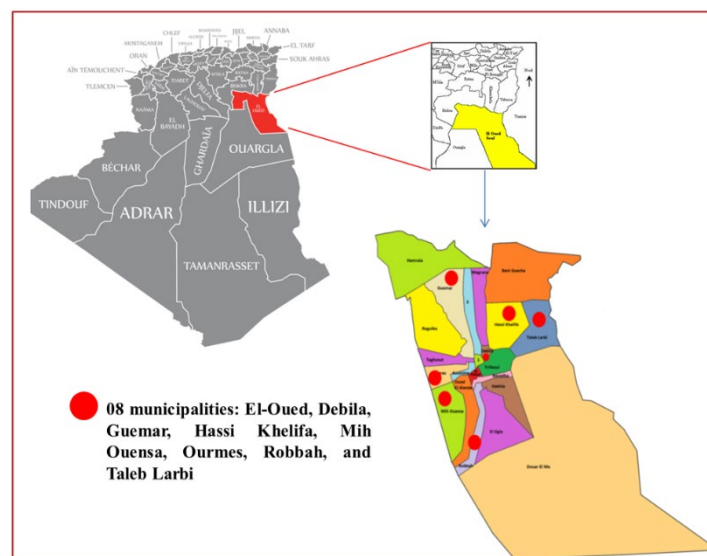


Figure 1 – Map of the study area of El Oued, southeastern Algeria.

2.3. Data Collection Procedure

Before the main survey, the semi-structured questionnaire was pre-tested with 10 sheep keepers to ensure clarity, relevance, and adaptation of the questions to local conditions, as recommended by Dossa et al. (2015). The pre-test data were not included in the final analysis and were used solely to refine the questionnaire. The finalized questionnaire combined open-ended and closed-ended questions to obtain comprehensive data on several aspects: (a) the socioeconomic characteristics of sheep keepers, (b) flock size, and (c) specific trait preferences for male and female sheep. For the main study, sheep keepers were randomly selected from those registered in the government's 2023 national sheep numbering campaign across eight municipalities in El Oued (El Oued, Debila, Guemar, Hassi Khalifa, Mih Ouensa, Ourmes, Robbah, and Taleb Larbi), ensuring that only officially recognized farmers were included. Each selected participant managed a flock ranging from fewer than 20 to more than 100 animals, with categories defined as <20, 20–50, 50–100, and >100. All respondents operated under grazing-based systems typical of the region. Data collection involved in-person interviews and field observations to obtain detailed information on trait preferences. The questionnaire structure allowed sheep keepers to elaborate on their preferences and farming practices, while also including multiple-choice options to ensure data consistency and comparability across responses.

Statistical Analysis

A multivariate analysis of variance (MANOVA) was conducted to examine the effects of age, education, experience, and occupation on trait preferences among sheep keepers. The analysis was performed using IBM SPSS Statistics version 25.0. Pillai's trace was chosen as the primary multivariate test statistic because of its robustness to violations of assumptions, such as unequal sample sizes and heterogeneity of covariance matrices (Olson, 1976; Tabachnick & Fidell, 2019). The significance level was set at $\alpha = .05$. Partial eta squared (η^2) was used as a measure of the effect size to quantify the proportion of variance in the dependent variables explained by each independent variable or interaction. To further explore specific associations between individual socioeconomic variables and particular trait preferences, chi-square tests of independence were performed. When significant relationships were identified, Cramér's V was calculated to assess the strength of the associations. In addition, data visualization techniques, such as heatmaps and pie charts, were used to illustrate the relationships among the studied parameters and the distribution of trait preferences among respondents. These graphical representations were generated using R (version 4.4.2), enabling effective visual exploration of correlations and frequency patterns within the dataset.

3. Results

3.1. 3.1 Socio-economic characteristics

The socio-economic characteristics of respondents are presented in Table 1. The sample comprised exclusively male participants with heterogeneous educational backgrounds, ranging from primary education or less to university level, with basic schooling representing the predominant category. Age distribution spanned young to older adulthood, with the majority exceeding 25 years of age and middle-aged participants (36–45 years) forming the largest demographic cohort. Sheep breeding was the primary occupation for most respondents, while others engaged in it alongside civil service, trading, or other professional occupations. Years of experience demonstrated marked variability, encompassing novice practitioners with limited tenure to highly skilled breeders with extensive careers exceeding two decades.

Parameters	Category	No. Of respondents	Percentage (%)
Sex	Male	200	100%
	Female	0	0%
Age	Younger than 25	22	11.0
	From 26 to 35	27	13.5
	From 36 to 45	58	29.0
	From 46 to 55	50	25.0
	55 or older	43	21.5
Education level	Primary school or less	77	38.5
	Middle school	47	23.5
	Secondary school	53	26.5
	University	23	11.5
Occupation	Breeder	142	71.0
	Civil job	13	06.5
	Free occupation	28	14.0
	Trading	17	08.5
Experience years	Less than 5 years	32	16.0
	From 5 to 10 years	25	12.5
	From 10 to 15 years	44	22.0
	From 15 to 20 years	46	21.5
	More than 20 years	56	28.0

Table 1 – Socio-economic characterization of sheep keepers in El Oued, Algeria.

Figure 2 illustrates the cross-tabulation between educational attainment and occupational status among respondents. The data reveal a distinct pattern in which participation in sheep breeding as a primary occupation predominates among individuals with lower educational levels, with progressively diminishing engagement among those with higher academic qualifications. This distribution suggests that sheep farming in the region operates predominantly as a traditional vocation transmitted through inherited practical knowledge rather than through formal educational channels. Conversely, higher educational attainment appears to be correlated with occupational diversification, as university-educated respondents demonstrate a greater propensity for civil service or self-employment. The relative paucity of representation in commercial and professional categories across all educational strata indicates that livestock production remains a dominant economic activity, particularly among less formally educated cohorts. Collectively, these findings demonstrate an inverse association between educational level and direct involvement in sheep husbandry, underscoring education's role as a determinant of professional trajectory and economic diversification within this agrarian context.

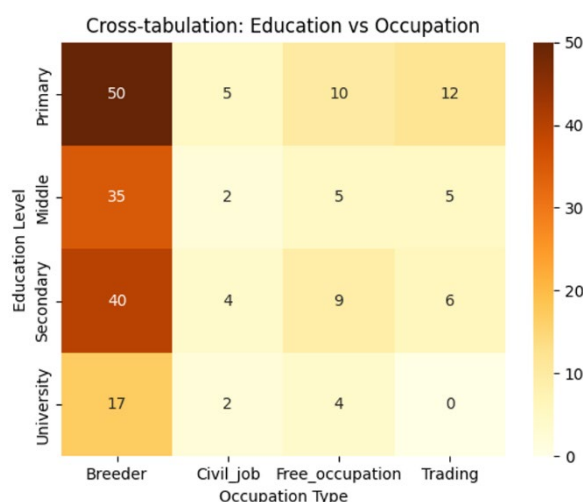


Figure 2 – Heatmap shows the relationship between education level and occupation type among male sheep keepers in El Oued, Algeria.

3.2. Characterization of Studied Farms

The farms studied were distributed throughout the El Oued region under homogeneous breeding conditions and comparable resource availability and infrastructure. All producers employed traditional grazing systems adapted to the arid climate, utilizing sparse vegetation surrounding oases and desert peripheries to sustain their herds. Geographic distribution exhibited spatial concentration within specific localities, particularly Robbah and Taleb Larbi, establishing these areas as principal centers of ovine production activity (Table 2). Flock demographics were predominantly small- to medium-sized operations, with most breeders maintaining moderate-sized herds, while large-scale enterprises remained notably scarce. The principal mechanism for flock establishment involved integrated strategies that combined hereditary transfer with market acquisition, reflecting a mixed approach to livestock procurement.

Parameters	Category	No. Of respondents	Percentage (%)
Location	El Oued	11	5.5
	Debila	06	3.0
	Guemar	19	9.5
	Hassi Khalifa	15	7.5
	Mih Ouensa	24	12.0
	Ourmes	19	9.5
	Robbah	57	28.5
	Taleb Larbi	49	24.5
Flock size	Less than 20 heads	77	38.5
	From 20 to 50	82	41.0
	From 50 to 100	28	14.5
	More than 100	13	6.50
Source of the herd	Inherited	21	10.5
	Purchase from the market	33	16.5
	Both	146	73.0

Table 2 – Characterization of studied farms of sheep keeper in El Oued, Algeria.

Figure 3A illustrates the spatial distribution of the surveyed sheep keepers across the eight municipalities of the El Oued region, showing both the number of respondents and their corresponding percentages for each site. Consistent with the data presented in Table 2, the figure clearly shows a concentration of sheep keepers in Robbah (28.5%) and Taleb Larbi (24.5%), confirming these two municipalities as the main centers of sheep production in the region. Moderate representation is observed in Mih Ouensa (12%), Guemar (9.5%), and Ourmes (9.5%), while El Oued (5.5%) and Debila (3%) record the lowest proportions of breeders. This spatial pattern underscores the unequal distribution of livestock activity across the study area, reflecting differences in rangeland availability, water resources, and grazing opportunities. Overall, the results indicate that sheep farming is primarily concentrated in the southern and border zones, where pastoralism remains a dominant livelihood, and traditional management practices continue to play a crucial role in sustaining rural economies.

Figure 3B presents the distribution of sheep keepers by flock size, highlighting the predominance of small- to medium-scale herds in the study area. The data, consistent with Table 2, show that the majority of respondents manage flocks containing 20 to 50

heads (41%), followed closely by those with fewer than 20 heads (38.5%). These two categories together account for nearly four-fifths of the total sample, reflecting the dominance of smallholder production systems in El Oued. By contrast, medium-sized flocks of 50 to 100 heads represent 14.5%, while only 6.5% of sheep keepers own herds exceeding 100 animals. This structure indicates that extensive large-scale breeding remains limited and that sheep farming in the region is primarily a family-based, traditional activity relying on modest herd sizes adapted to the arid environment and local resource constraints.

Figure 3C illustrates the main sources of herd acquisition among sheep keepers in the El Oued region. The results reveal that the majority of respondents (73%) acquired their herds through a combination of inheritance and market purchases, reflecting a mixed strategy that balances family continuity with market-based expansion. A smaller proportion, 16.5%, rely exclusively on purchasing animals from local markets, while only 10.5% reported that their herds were entirely inherited. These findings, in line with Table 2, indicate that most breeders maintain their flocks through both generational transfer and periodic renewal via market exchanges. This practice enhances herd diversity and resilience within the region's traditional livestock systems.

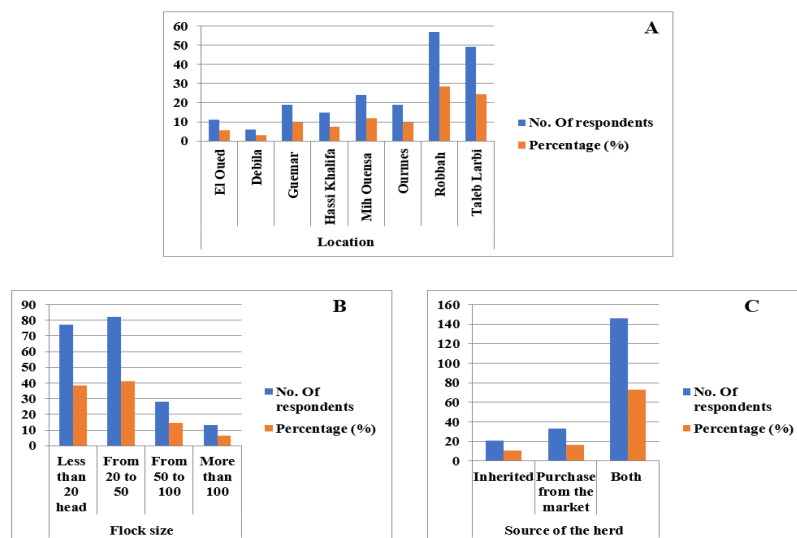


Figure 3 – Socioeconomic characteristics of male sheep keepers in El Oued, Algeria: (A) Spatial distribution of surveyed sheep keepers across the eight municipalities of El Oued, showing the number of respondents and their corresponding percentages per location. (B) Distribution of respondents according to flock size, highlighting the predominance of small and medium flocks (less than 50 heads). (C) Sources of herd acquisition indicate that most flocks originate from both inheritance and market purchases.

3.3. Selection of male and female sheep breeds

Selection criteria for breeding rams are illustrated in Figure 4. Breed identity emerged as the predominant consideration among respondents, substantially outweighing all other attributes. In particular, the Ouled Djellal breed was consistently cited as the preferred choice, reflecting its recognized adaptation to arid environments and its suitability for meat production systems in southern Algeria. Physical conformation and robustness constituted secondary priorities, with structural characteristics and apparent health status ranking prominently in the decision-making hierarchy. Reproductive and behavioral traits, including temperament and testicular size, represented intermediate preferences. In contrast, aesthetic features such as coat color and horn morphology, along with production-related attributes like growth rate and disease resistance, received comparatively modest emphasis. Notably, chronological age was accorded minimal priority compared with morphological and genetic qualities, suggesting that phenotypic superiority and breed integrity supersede youth in ram selection criteria in this production context.

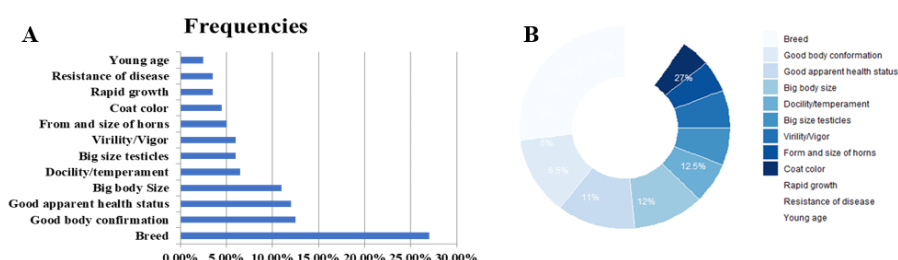


Figure 4 – Male selection traits preferred by male sheep keepers in El Oued, Algeria.

The breed selection criteria are illustrated in Figure 5. Breed identity constituted the foremost priority among respondents, substantially outweighing other considerations. In particular, the Ouled Djellal breed was predominantly preferred, reflecting its well-established adaptation to arid conditions and its suitability for extensive production systems in southern Algeria. Environmental adaptation emerged as a prominent secondary factor, with drought tolerance ranking highly in the selection hierarchy, reflecting the ecological constraints of the arid production environment. Udder morphology and apparent health status were significant intermediate priorities, underscoring the importance of reproductive function and vitality in the female stock. Physical conformation and temperament ranked relatively high in importance, while structural attributes such as body size and disease resistance, along with aesthetic characteristics including coat color, occupied lower positions in the preference ranking. Production-oriented traits such as growth rate and feeding efficiency, alongside chronological age, received comparatively modest emphasis, indicating that genetic integrity, adaptive capacity, and reproductive soundness supersede accelerated development or ease of management in ewe selection within this pastoral context.

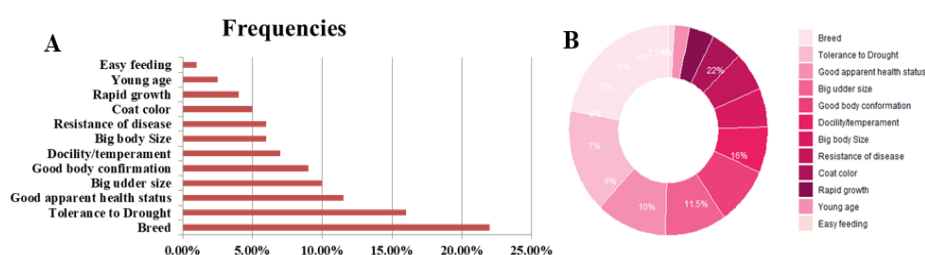


Figure 5 – Female selection traits preferred by sheep keepers in El Oued, Algeria.

3.4. Effect of socio-economic characterization on trait preferences

Multivariate analysis revealed a significant three-way interaction between education, experience, and occupation (Pillai's Trace = 0.070, $F(2, 128) = 4.833$, $p = .009$, partial $\eta^2 = .070$). No other main effects or interactions were significant (all $p > .05$). This suggests that the combined effects of education, experience, and occupation significantly influenced trait preferences among sheep keepers (Table 3).

Effect	Value	F	Sig.	Partial Eta Squared
Intercept	.648	117.760 ^b	.000	.648
Main effect				
Age	.038	.631	.751	.019
Education	.029	.642	.696	.015
Experience	.049	.814	.591	.025
Occupation	.053	1.182	.316	.027
Two-way effect				
Age / Education	.122	1.401	.165	.061
Age / Experience	.120	1.369	.181	.060
Age / Occupation	.084	1.419	.189	.042
Education / Experience	.128	.980	.484	.064
Education / Occupation	.058	.637	.810	.029
Experience / Occupation	.065	1.075	.381	.032
Three-way effect				
Age / Education / Experience	.052	1.722	.145	.026
Age / Education / Occupation	.000	. ^b	.	.
Age / Experience / Occupation	.000	. ^b	.	.
Education / Experience / Occupation	.070	4.833 ^b	.009	.070

Table 3 – Effect of socio-economic characterization on trait preferences in El Oued, Algeria.

3.5. Socioeconomic Determinants of Trait Preferences

Chi-square analysis revealed two statistically significant associations between farmer characteristics and trait preferences (Table 4). Farmer age significantly influenced the selection of drought tolerance in ewes ($\chi^2(4)=10.26$, $p=0.036$, Cramer's $V=0.227$). Post-hoc analysis of standardized residuals indicated that farmers aged 56 or older selected drought tolerance significantly less frequently than expected (2.3% vs. 16.0% overall; standardized residual = -2.24). Conversely, the youngest farmers (<25 years) showed the

highest preference for drought tolerance (27.3%), though this did not exceed the critical threshold for statistical significance in residual analysis (standardized residual = +1.32). The effect size was small to medium.

Education level showed a significant association with drought-tolerance preference ($\chi^2(3)=13.37$, $p=0.004$, Cramer's $V=0.259$). Farmers with secondary education exhibited significantly higher selection rates for drought tolerance than expected (30.2% vs. 16.0% overall; standardized residual = +2.58). In contrast, farmers with only primary education showed significantly lower selection rates (7.8%; standardized residual = -1.80). University-educated farmers demonstrated intermediate preferences (21.7%). This represents a medium effect size.

No significant associations were detected between socioeconomic variables and male trait preferences, nor between experience/occupation and female trait preferences. However, marginal associations were observed between education and preferences for good body confirmation ($p=0.087$) and udder size ($p=0.090$) in females.

Trait (Selection Type)	Predictor	χ^2	df	p-value	Cramer's V	Effect Size
Female: Drought Tolerance	Age	10.26	4	0.036*	0.227	Small-Medium
Female: Drought Tolerance	Education	13.37	3	0.004**	0.259	Medium
Female: Drought Tolerance	Experience	4.17	4	0.383	0.144	Small-Medium
Female: Drought Tolerance	Occupation	4.61	3	0.203	0.152	Small-Medium
Female: Good Body Confirmation	Education	6.56	3	0.087	0.181	Small
Female: Big Udder Size	Education	6.48	3	0.090	0.180	Small
Male: Good Apparent Health Status	Experience	7.71	4	0.103	0.196	Small
Female: Breed	Age	7.39	4	0.117	0.192	Small

* $p < 0.05$, ** $p < 0.01$ (chi-square test of independence)

Table 4 – Effect of socio-economic characterization on trait preferences in El Oued, Algeria.

4. Discussion

The dominance of male interviewees in the present study aligns with findings from Laoubi et al. (2011) in the Laghouat region (94.3%) and from Kadi et al. (2014) in the Kabyle mountainous area of Algeria (86.2%). This gender disparity is likely due to the traditional and cultural structure of society, where men are typically the primary decision-makers in livestock management and are less likely to allow women to participate in interviews. This cultural dynamic may limit women's perspectives and experiences in shaping breeding practices and trait preferences, despite their potential contributions to household livestock management. The exclusive male composition of the sample constitutes a methodological limitation of this study. Future research should employ gender-responsive sampling strategies to capture women's trait preferences and decision-making roles, particularly given documented evidence that women manage substantial proportions of small-ruminant herds in North African agropastoral systems (Gizaw et al., 2010). The proportion of illiterate individuals in this study (44.34%) was lower than that reported by Ouchene-Khelifi et al. (2021) among goat farmers across various Algerian regions. However, the relatively low literacy level in El Oued can be attributed to the remoteness of schools and limited access to educational infrastructure, particularly in livestock-breeding areas. This lack of education may hinder sheep keepers' ability to adopt advanced breeding practices, record pedigrees, and monitor animal performance. Educated sheep keepers are more likely to prioritize traits that enhance productivity and resilience, such as growth rate and disease resistance. In contrast, less-educated keepers may rely more on traditional knowledge and prioritize visible traits such as body size or coat color (Gizaw et al., 2010).

The low percentage of breeders under 30 years old (11%) indicates a lack of interest among young people in sheep farming. This trend may be driven by the pursuit of professions with faster, easier revenue streams, such as business or trading. The aging population of sheep keepers raises concerns about the future sustainability of sheep farming in the studied region, as younger generations may not continue traditional practices. This finding aligns with observations by Meziane et al. (2024) in the Batna region of Eastern Algeria, where the younger population views sheep farming as less profitable than other career options due to its physical demands and economic challenges. A similar trend was reported by Amare et al. (2021) in pastoral areas in Ethiopia, where young people are increasingly moving away from livestock farming due to economic and social factors. This demographic trend underscores an urgent need for targeted policy interventions, including youth-oriented incentive schemes, vocational training in modern animal husbandry, and access to microcredit, to attract younger entrants and ensure the intergenerational transfer of indigenous breeding knowledge before it is irretrievably lost.

The majority of respondents (71%) were full-time breeders, reflecting the central role of sheep farming in their livelihoods. This aligns with findings from Meziane et al. (2024) in Batna, Algeria, where only a small proportion (10%) of the surveyed sheep keepers pursued other professions such as teaching or commerce. Similar results from Yakubu et al. (2020) in Nigeria showed that full-time breeders prioritized traits such as growth rate and meat quality to maximize economic returns. However, the study also found that cultural and religious significance influenced trait preferences regardless of occupation, suggesting that occupation status may not heavily influence specific preferences. For example, in the studied region, the high demand for sheep meat during religious festivals may drive preferences for traits such as body size and health status, regardless of the sheep keepers' primary occupation.

Experience also plays a critical role in shaping trait preferences. In the study region, 28% of respondents had more than 20 years of experience, while 16% had less than 5 years of experience. Experienced sheep keepers are more likely to prioritize traits that ensure long-term flock productivity and resilience, such as drought tolerance and health status. This is consistent with findings from Amare et al. (2021), who reported that experienced sheep keepers in Afar, Ethiopia, prioritized fast growth and trekking ability to

cope with arid conditions. In contrast, less experienced sheep keepers may focus on short-term gains, such as rapid growth or market value.

The geographical distribution of respondents shows that Robbah and Taleb Larbi are the most prominent areas for sheep farming in El Oued wilaya. This concentration is likely driven by improved access to oasis resources, groundwater, and crop residues for supplementary feeding, proximity to local markets, and long-standing farming traditions in these districts. The predominance of small- to medium-sized flocks (fewer than 50 sheep) aligns with recent findings from arid and steppe regions of Algeria, where smallholder systems prevail due to limited capital, feed resources, and infrastructure constraints (Faradji et al., 2022; Meziane et al., 2024; Ouali et al., 2023). Such modest flock sizes are typical in resource-scarce arid environments, limiting many keepers' ability to expand operations. However, the presence of a small percentage of respondents with flocks exceeding 100 sheep indicates that some breeders are gradually scaling up, often linked to improved access to resources, market integration, or supplementary income sources. Most respondents (73%) acquired their herds through a combination of inheritance and market purchases. This mixed strategy reflects the interplay between traditional practices and modern market dynamics in flock building. Inheritance remains a cornerstone in many Algerian pastoral and agropastoral systems, ensuring the continuity of family-owned livestock, the preservation of locally adapted breeds, and the transmission of indigenous knowledge across generations (Amare et al., 2021; Bencherif et al., 2021; Meziane et al., 2024). Market purchases, on the other hand, enable keepers to introduce new genetic material, potentially enhancing traits such as growth rate, disease resistance, and reproductive performance. This dual approach demonstrates the adaptive capacity of sheep keepers in the El Oued region, allowing them to balance cultural continuity with innovation amid environmental and economic pressures.

The survey results indicate that breed, good body conformation, and large body size were the most important criteria for selecting male sheep (rams) in the El Oued region. Among the breeds mentioned by respondents, the Ouled Djellal breed was predominantly preferred, reflecting its well-known adaptation to arid conditions and desirable productivity traits. These findings both support and contrast with previous studies on sheep breeding preferences in various African regions, where physical appearance and reproductive potential are often highly valued. However, the relative importance of specific traits varies by production system and environment. In the present study, the top-ranked trait, "breed," reflects the value placed on locally adapted types that ensure survival and productivity under arid conditions. This aligns with broader patterns in smallholder systems, where observable physical traits linked to market value and flock expansion are prioritized.

For instance, Abebe et al. (2020) reported that body size and coat color were among the primary criteria for ram selection in the northwest highlands of Ethiopia, with body size receiving the highest index. Similarly, in southern Ethiopia, Hemacha et al. (2022) found that farmers placed strong emphasis on body size and conformation when selecting breeding rams. These preferences are consistent with the current study's focus on good body conformation and large body size, suggesting that sheep keepers in arid environments such as El Oued are commonly selected for strong structural features that are assumed to improve breeding success, meat yield, and overall flock resilience. The importance attributed to "good apparent health status" (12%) further underscores the need for robust animals that can thrive in challenging conditions. This finding aligns with Yakubu et al. (2020) in Nigeria, who identified disease resistance and overall health as top breeding priorities among sheep farmers. Additionally, the emphasis on "big size testicles" (6%) highlights attention to reproductive capacity, echoing results from pastoral systems where traits related to fertility and growth potential receive notable consideration (Amare et al., 2021; Meziane et al., 2024). Overall, these preferences illustrate how sheep keepers in the El Oued region balance adaptation to harsh arid environments with economic and productive goals, while revealing both commonalities and contextual differences with other African smallholder systems.

In the present study, the relatively low importance given to docility/temperament (6.5%) contrasts with broader research on sheep behavior, which shows that temperament traits can be consistently selected for and may influence ease of handling and welfare (Beausoleil et al., 2012). This difference could stem from differing livestock management systems or cultural perspectives, in which physical and health-related traits are prioritized over behavioral traits in harsh, arid environments such as El Oued. In such contexts, observable attributes linked to survival, productivity, and market value often take precedence over temperament. Similarly, rapid growth (3.5%) and disease resistance (3.5%) received lower rankings compared to breed, body conformation, and size. This pattern differs from several Ethiopian studies, where smallholder farmers frequently prioritize growth rate and survival traits to cope with environmental stresses (Abebe et al., 2020; Hemacha et al., 2022b). The lower emphasis in El Oued may reflect that these traits are implicitly assumed within preferred local breeds or are less immediately visible to keepers under traditional extensive systems, where short-term observable physical features dominate decision-making. The minimal preference for young age (2.5%) further indicates that sheep keepers place greater weight on physical and genetic attributes than on age at selection. This aligns with findings from Duguma et al. (2011), who reported that preferences centered more on physical and reproductive characteristics. In contrast to studies in Ethiopia and Botswana, where coat color was sometimes ranked highly for cultural or market reasons (Bolowe et al., 2022), this trait received little emphasis in the current study. This variation likely reflects the unique environmental pressures and functional priorities in the arid El Oued region, where adaptation and productivity traits outweigh aesthetic ones.

Finally, horn shape and size (5%) were considered of low importance, consistent with research showing that such secondary morphological traits rank below body size, conformation, and health in ram selection (Abebe et al., 2020; Hemacha et al., 2022b). Overall, these results highlight how breeding preferences in the study area are shaped by the demanding arid conditions, favoring traits that support flock resilience and economic returns.

The results from the studied region highlight the importance of genetic quality, adaptability to harsh environmental conditions, health, and milk production potential in the selection of female sheep (ewes). The strong prioritization of breed attributes in our study aligns with findings from Abebe et al. (2020), who reported that smallholder sheep keepers in the northwest highlands of Ethiopia placed a high emphasis on genetic and physical traits, such as body size and coat color, when selecting breeding ewes. However, body size received greater prominence in Ethiopian highlands, suggesting regional differences in the breeding objectives shaped by local environmental and production challenges. In the arid context of El Oued, keepers appear to prioritize the breed's overall adaptability to drought and resource scarcity over individual morphological traits. The high value placed on drought tolerance (16%) is consistent with the recognized importance of adaptive traits in smallholder systems facing environmental stress. Similar emphasis on resilience-related traits (such as trekking ability and survival under harsh conditions) has been documented in pastoral areas (Amare et al., 2021; Meziane et al., 2024). This underscores the critical need for breeding programs in arid zones like El Oued to target traits that enhance long-term survival and productivity amid recurrent drought and fodder scarcity.

The preference for “good apparent health status” (11.5%) and “big udder size” (10%) reflects a clear focus on animal robustness and milk production potential, both essential for lamb survival and overall flock productivity. This finding corresponds with studies in Nigeria, where disease resistance and health were ranked among the top breeding priorities (Yakubu et al., 2020), and with research in Ethiopian pastoral systems, where milk yield and mothering ability were highly valued (Amare et al., 2021). The moderate emphasis on “good body conformation” (9%) and “docility/temperament” (7%) is consistent with Hemacha et al. (2022), who identified body size and mothering ability as key criteria for ewe selection in southern Ethiopia. However, the relatively low importance of temperament in our study contrasts with research showing that behavioral traits can be reliably selected for and may improve handling and welfare (Beausoleil et al., 2012). This discrepancy likely arises from differences in extensive management practices and cultural attitudes toward animal behavior in arid versus other production systems. Notably, the emphasis on udder morphology in the present study is particularly relevant under arid conditions where colostrum availability and early lamb nutrition are critical determinants of neonatal survival during heat stress and feed scarcity; this suggests that participatory breeding indices for the El Oued region should formally incorporate udder conformation as a quantifiable selection criterion. Overall, these preferences illustrate how sheep keepers in the El Oued region adapt selection criteria to the specific demands of arid environments, balancing genetic quality, resilience, and productive traits.

For the design of sustainable genetic improvement programs, a thorough understanding of existing reproductive performance, community trait preferences, and the relative importance of different production constraints is essential (Baker & Gray, 2004). Education also plays a pivotal role, as it influences household income, adoption of improved technologies, demographic patterns, health outcomes, and the overall socio-economic status of livestock-keeping communities (Meziane et al., 2024; Tabachnick & Fidell, 2021). The present study's statistical results further demonstrate the combined influence of education, experience, and occupation on trait preferences. Although the main effects of these socio-demographic factors were not statistically significant, their three-way interaction was significant ($p = 0.009$, partial $\eta^2 = 0.070$). This indicates that sheep keepers with higher education levels, extensive practical experience, and full-time involvement in breeding tend to prioritize traits associated with long-term flock productivity and resilience (e.g., Adaptability and health). In contrast, less educated or less experienced keepers often focus on more immediately visible traits such as body size or coat color, which align with traditional knowledge and short-term economic returns. These findings highlight the need to account for the complex interplay between education, experience, and occupation when developing participatory breeding programs, ensuring that interventions are tailored to the diverse priorities and capacities of sheep keepers in arid regions such as El Oued.

The findings from the present study reveal both similarities and differences in sheep trait preferences compared to other African regions. For male sheep (rams), the strong emphasis on breed and physical traits such as body size and conformation aligns with studies in Ethiopia and Botswana, reflecting a widespread preference for traits that enhance reproductive performance, meat yield, and economic value (Abebe et al., 2020; Bolowe et al., 2022). However, the lower priority assigned to coat color in El Oued highlights the influence of regional environmental challenges and cultural practices, where functional adaptation often outweighs aesthetic traits.

For female sheep (ewes), the high value placed on drought tolerance and udder size (linked to milk production potential) contrasts with the greater emphasis on body size and twinning ability observed in many Ethiopian highland and pastoral systems (Abebe et al., 2020; Amare et al., 2021; Hemacha et al., 2022b). These differences underscore the importance of developing context-specific breeding objectives tailored to local agro-ecological conditions.

The observed generational difference in drought tolerance preference is consistent with findings reported in similar arid and semi-arid production systems. For instance, Meziane et al. (2024) highlighted that younger sheep farmers in eastern Algeria exhibit greater sensitivity to climate-related constraints and are more inclined toward adaptive management practices. In contrast, older farmers tend to rely on traditional, visually assessable traits. Comparable patterns have also been documented in Ethiopian pastoral systems, where younger and more educated farmers place higher importance on resilience-related traits such as trekking ability and survival under environmental stress (Amare et al., 2021; Hemacha et al., 2022). Furthermore, the significant influence of education observed in the present study aligns with Abebe et al. (2020), who demonstrated that higher education levels are associated with increased consideration of functional and adaptive traits in livestock selection. However, the pronounced effect at the secondary education level in this study suggests a context-specific dynamic in arid regions such as El Oued, where this level of education may provide sufficient awareness of climate challenges without distancing farmers from practical livestock engagement.

These findings reveal two key dynamics shaping trait preferences in the El Oued region. First, there is a clear generational shift toward greater awareness and valuation of climate resilience among younger farmers. Second, education emerges as a critical driver of adaptive decision-making, with secondary schooling playing a particularly influential role. In contrast, older and less-educated farmers continue to prioritize readily observable traits such as breed, body size, and conformation, likely reflecting reliance on accumulated experiential knowledge and immediate productivity needs in a resource-constrained environment.

Several limitations of the present study should be acknowledged. First, the exclusively male sample restricts the generalizability of findings. It omits the perspectives of women sheep keepers, whose trait preferences and household decision-making roles may differ substantially in this agropastoral context. Second, the cross-sectional design captures preferences at a single point in time and cannot account for temporal shifts in breeding objectives driven by interannual climate variability or changing market conditions. Third, self-reported trait rankings obtained through questionnaire surveys may be subject to social desirability bias, particularly for culturally prestigious traits such as breed identity. Fourth, the study was confined to eight municipalities within El Oued Province, limiting direct extrapolation to other arid zones of Algeria. Future research should adopt gender-inclusive and longitudinal designs and employ conjoint-based discrete choice experiments to derive the relative economic weights of preferred traits—an essential step toward constructing formal breeding objective indexes applicable to the Ouled Djellal and other locally adapted breeds in North African drylands.

Overall, while certain traits such as reproductive performance, health, and body conformation remain universally important across smallholder systems, others are strongly influenced by local environmental pressures, market demands, and farmer priorities; therefore, breeding and extension programs in arid regions like El Oued should prioritize resilience traits (e.g., drought tolerance and adaptability) alongside productivity, while incorporating farmers' economic, cultural, and traditional knowledge and remaining sensitive to socioeconomic differences, particularly age and education to tailor communication and interventions that enhance the adoption of resilience-oriented selection criteria and ultimately support long-term genetic resilience and sustainability livestock production under increasing climate variability. Practically, this implies that national breeding programs and extension services in Algeria should move beyond top-down genetic improvement schemes and instead co-design community breeding programs that anchor selection indexes on the trait priorities documented here, breed identity and drought tolerance for both sexes, udder conformation for ewes, and body conformation for rams progressively incorporating objective performance recording as farmer literacy and infrastructure improve. Sustained investment in participatory genetic resource management, coupled with genomic characterization of locally adapted breeds such as Ouled Djellal, will be essential to safeguarding the productive and adaptive capital of Algerian sheep populations under accelerating climate change.

5. Conclusion

In conclusion, this study provides valuable insights into the socioeconomic characteristics and breeding preferences of sheep keepers in El Oued Province, Algeria. The community is predominantly male, with many keepers over 36 and substantial experience in the sector. Preferred traits such as breed, body conformation, health status, and drought tolerance reflect a strategic emphasis on sustainability and adaptation to the region's harsh environmental conditions. The prioritization of resilience-related traits in both male and female sheep underscores the importance of long-term viability over short-term productivity. Interestingly, the relatively low focus on rapid growth and early maturity indicates that sheep keepers prioritize herd stability and genetic integrity over immediate commercial returns. The emphasis on breed quality, virility, and docility demonstrates a practical understanding of the need for manageable, productive, and robust flocks in resource-limited environments.

Furthermore, the predominance of herds obtained through both inheritance and market acquisition reveals the coexistence of traditional knowledge and economic adaptation, contributing to the preservation of genetic diversity. Collectively, these findings highlight the deep-rooted adaptive strategies employed by local breeders to sustain sheep production under arid and semi-arid conditions. Looking forward, integrating traditional selection practices with modern breeding programs, farmer education, and genetic improvement initiatives will be crucial for enhancing productivity, sustainability, and resilience. Future research should focus on genomic characterization of local breeds and the development of tailored breeding strategies to ensure the long-term sustainability of sheep farming in El Oued and comparable dryland regions.

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