

Typology and extensive smallholders' farmer-desired traits in the selection of local goats in northern Mexico

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ABSTRACT

Objective: To improve a production system, it is necessary to define the critical points for their attention, being the characterization of the system the first step. In this way, it is necessary to know the characteristics of the producer, his problems, limitations and strengths, in order to generate tools that allow making decisions that adjust to the producer's reality.

Design/methodology/approach: It was characterized the goat producers from northern Mexico. A total of 117 goat farmers were interviewed using a survey composed of 54 items. Qualitative variables were analyzed by descriptive statistics. Principal component, factor, and cluster analysis were performed. Two well-differentiated groups were formed. One group comprises similarities in age, family members, milking animals, grazing time, animal age and weight at sale. The second group considers producers with similarities in schooling, milk production, and experience in the activity, price per liter of milk, and sold animals.

Results: The majority select their animals (94%). The main selection criteria are based on appearance (71%) to select bucks and empirical maternal ability (60%) to select does. The producers share similar characteristics, with a deep knowledge of the activity.

Limitations on study/implications: It is imperative to educate goat producers in northern Mexico on the selection of replacement animals through the utilization of quantifiable records, with the objective of enhancing the productivity of their goat populations.

Findings/conclusions: The system is traditional, with no changes and no technological innovation, and they use very few criteria to select their animals and do not have clear breeding objectives.

Keywords: Small ruminants, socioeconomy, genetic improvement, arid zones.

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INTRODUCTION

Characterizing goat production systems is essential to understanding their role in the livelihoods of low-income households, particularly in arid and semi-arid regions (Torres-



Hernández *et al.*, 2022a). Goats represent a key livestock species due to their adaptability to harsh environments, efficient feed conversion, and relatively low maintenance requirements (Martin *et al.*, 2019). By identifying and classifying production systems extensive, semi-intensive, or intensive researchers and policymakers can design targeted strategies to enhance productivity, sustainability, and profitability (Torres-Hernández *et al.*, 2022a). Moreover, system characterization enables the identification of constraints and opportunities within the value chain, thereby facilitating improved productivity and market access for smallholder farmers (Ali *et al.*, 2020). Ultimately, such insights support the development of policies aimed at fostering rural development, climate change resilience, and sustainable livelihoods (Torres-Hernández *et al.*, 2022). In northern Mexico, goat farming is predominantly practiced under extensive grazing systems in marginal areas, primarily due to their low economic cost. This production method has enabled the Laguna region located between the states of Coahuila and Durango to emerge as the country's leading producer of milk and kid goats (Torres-Hernández *et al.*, 2020). However, several defining features of this production system remain undocumented, hindering its advancement due to the limited understanding of producer profiles an essential component of the value chain (Guilherme *et al.*, 2017; Granados-Rivera *et al.*, 2022). Additionally, it has been observed that improvement programs that overlook the role of producers tend to fail in the short term, having minimal impact at the farm level (Tadesse *et al.*, 2014; Alam-Bhuiyan *et al.*, 2017). Therefore, understanding both the personal characteristics of farmers and the production system itself is critical for the comprehensive development of these systems, as it provides insight into producers' perspectives, capacities, and constraints (Méndez-Cortez *et al.*, 2019). Furthermore, producers vary considerably in their selection of animals for herd formation, influenced primarily by production goals and resource availability. Addressing this variability requires defining production objectives prior to implementing any improvement scheme (Alebel *et al.*, 2020). Thus, understanding producers' preferences is crucial for productivity-focused programs, particularly given that production systems are dynamic and evolve in response to social change and the integration of new, everyday-use technologies (Cevallos-Suarez *et al.*, 2019). The success of such improvement strategies depends heavily on active producer participation and a clear understanding of their self-defined production goals. To achieve this, several methodological approaches have been developed, including choice experiments, trait ranking, and *in vivo* classification (Tadesse *et al.*, 2014; Abebe *et al.*, 2020). In light of the above, the objective of this study was to characterize goat producers in the Comarca Lagunera region, encompassing parts of Durango and Coahuila in northern Mexico, as well as to identify the desirable traits in goat selection. The ultimate aim is to inform the design of genetic improvement programs that are both compatible with local production systems and aligned with producer preferences.

MATERIALS AND METHODS

The study was conducted across the municipalities comprising the Lagunera region, which spans the states of Durango and Coahuila in northern Mexico. This region is geographically situated at 24° North latitude and 102° West longitude, at an elevation of

1,130 meters above sea level. It is characterized by a dry desert climate, with an average annual temperature of 25 °C and mean annual precipitation of 240 mm (García, 2004).

Interviews were conducted with producers from the most prominent localities for milk and kid goat production. In Coahuila, the municipalities of Torreón, Matamoros, Viesca, Francisco I. Madero, and San Pedro de las Colonias were surveyed. In Durango, data collection took place in the municipalities of Gómez Palacio, Lerdo, Tlahualilo, and Mapimí (Figure 1).

The study employed an unrestricted random sampling approach, in which producers were selected based on their availability and willingness to participate, continuing until the target number of interviews was achieved. The preliminary sample size was determined following the methodology described by Méndez-Cortez *et al.* (2019), using the following formula:

$$n = \frac{(p)(q)(N)(z^2)}{E^2(N-1) + z^2 + (p)(q)}$$

Where: N =total population of the study area (1644 producers in the municipalities of the Lagunera region, Coahuila-Durango; SADER, 2021); n =sample size; p =estimated percentage of positive variability (50%); $q=100-p$ (negative variability); E =allowable estimation error or precision (10%); Z =confidence level, Z of tables (1.96).

Replacing Values:

$$n = \frac{(0.50)(0.50)(1644)(1.96^2)}{0.10^2(1644-1) + 1.96^2 + (0.50)(0.50)} = 90.79 \text{ interviews}$$

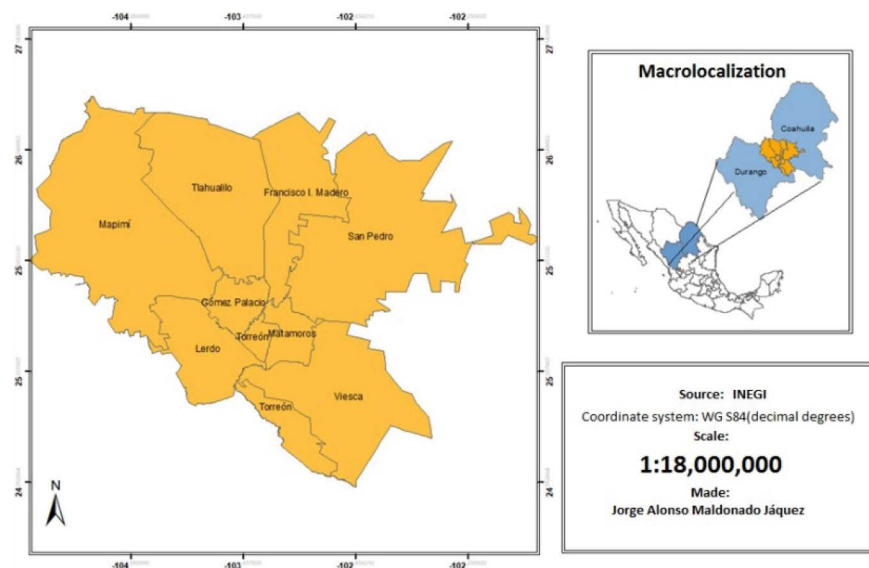


Figure 1. Geographical location of the municipalities visited in the states of Coahuila and Durango, northern Mexico.

A total of 117 goat farmers were surveyed through direct interviews accompanied by on-site visits to production units, conducted between January 2021 and September 2022. A semi-structured questionnaire consisting of 54 items was employed, covering aspects such as the geographic location of the production unit, producer socioeconomic profile, production objectives, and goat selection criteria. Data were recorded using Microsoft Excel 2019, with survey sections organized according to the structure of the questionnaire. An exploratory analysis was performed to identify inconsistencies, errors, and duplicate entries, thereby validating the field-collected data. From the initial set of 54 variables, 40 were selected for analysis 24 variables were used to characterize producers, while 16 were employed to assess goat selection criteria. Qualitative variables were coded, processed, and analyzed to generate both descriptive and inferential statistics. Typology analysis followed the methodological guidelines proposed by Toro-Mujica *et al.* (2012). General producer characteristics were analyzed using multivariate statistical techniques, specifically principal component analysis (PCA), factor analysis (FA), and cluster analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity (χ^2) were calculated to validate the suitability of the dataset for factor analysis. A KMO value between 0.5 and 1.0 was considered indicative of model adequacy (Putra & Ilham, 2019). To enhance interpretability, the factor matrix was subjected to varimax orthogonal rotation. Based on the results from PCA and FA, cluster analysis was performed using the k-means method, and a dendrogram was constructed to identify distinct producer groups. All analyses were conducted using R Studio v.2023.03.0+386. Lastly, producers' selection criteria were evaluated in two stages. The first stage employed descriptive statistics to characterize key reproductive parameters within the herds. In the second stage, the proportions of preferred traits were analyzed using a nonparametric frequency approach through the Kruskal-Wallis test, applying the chi-square statistic (χ^2) to assess the independence of trait categories. This analysis was carried out using the statistical software InfoStat v.2008.

RESULTS AND DISCUSSION

The results indicate that goat farming in this region is managed almost exclusively by men, with production primarily focused on kid goats and fluid milk. However, producers do not have dedicated infrastructure for the milking process. The farmer demographic is characterized by older individuals with limited formal education some of whom are illiterate which prevents them from maintaining productive or financial records for their herds. Nonetheless, they possess extensive practical experience in goat husbandry. Regarding entry into goat farming, a significant portion of producers attribute their involvement to inheritance (47%) and personal interest in goats (39%). For most families, goat farming represents their principal if not sole source of income, as they do not engage in other forms of employment or migrate in search of alternative work. They remain in the sector because it serves as a form of self-employment (Tables 1 and 2). These findings are consistent with those reported by Salinas-González *et al.* (2016) and Ramos-Martínez *et al.* (2020) for goat producers in the same region. This consistency suggests that the producer profile has remained unchanged, even over a relatively short comparison period nearly a decade since the previous studies. Furthermore, this stagnation indicates a lack of technological

Table 1. Absolute (AF) and relative (RF) Frequencies for qualitative traits in local goat producers from Comarca Lagunera in northern Mexico.

Variable	AF	RF	Variable	AF	RF
Gender			Can read and write		
Male	110	0.94	Si	107	0.91
Female	7	0.06	No	10	0.09
Start of the activity			Income contribution from goat farming		
Inheritance	54	0.47	<50%	10	0.10
Interest	45	0.39	>50-<100%	47	0.40
Self-employment	18	0.14	100%	58	0.50
Production objective			Milking area available		
Meat	19	0.16	Si	10	0.09
Meat and milk	98	0.84	No	107	0.91
Works out of their community			Reason for permanence		
Yes	16	0.15	Interest	49	0.42
No	99	0.85	Self-employment	68	0.58
Keep any type of record?					
Yes	14	0.12			
No	103	0.88			

adoption and minimal external intervention in the production system, whether through training, technical assistance, or investment aimed at transforming production practices (Espejo, 2011; Castro *et al.*, 2021). Paradoxically, this limited dependence on external inputs has contributed to the sustainability of the system (Daskiran *et al.*, 2018; Chávez-Espinoza *et al.*, 2022).

On another note, the average age of producers remains around 50 years, suggesting the possible onset of a modest generational transition. This could be beneficial for the continuity of the activity, as highlighted in various studies that identify generational renewal as a critical issue (Escareño-Sánchez *et al.*, 2011; Ramos-Martínez *et al.*, 2020). If generational replacement were not occurring, a notable increase in the average age of producers would be expected which is not the case. Nevertheless, this interpretation should be approached with caution, given that the long-term viability of the activity depends heavily on the active incorporation of younger generations into goat farming (Mena *et al.*, 2014).

As shown in Table 2, livestock inventories are of medium scale; however, the number of lactating animals is notably low, with fewer than half of the goats on each farm being milked. Despite this, milk production exceeds 1,000 g/day, with producers dedicating approximately seven hours to daily grazing in an area where forage quantity and quality fluctuate significantly throughout the year. In certain seasons, available vegetation fails to meet the nutritional requirements of the animals (Selemani *et al.*, 2013; Maldonado-Jáquez *et al.*, 2017). In this context, Ramos-Martínez *et al.* (2020) reported comparable production levels (1.49 kg/goat) to those stated by producers in the present study, but with fewer milking animals, suggesting that current productivity has been maintained with a

Table 2. General characteristics of the local goat producer and the production unit in Comarca Lagunera, from northern Mexico.

Variable	Description	Average	S.E.	C.V.
Y1	age (years)	53.77	1.01	20.28
Y2	schooling level (years)	2.05	0.15	78.62
Y3	family members (No.)	4.50	0.22	53.33
Y4	livestock inventory (No.)	79.54	5.36	72.92
Y5	milking animals (No.)	35.19	2.63	80.90
Y6	milk production (kg)	38.94	3.46	96.22
Y7	experience in the activity (years)	25.95	1.40	59.40
Y8	price per milk litter (MXN\$)	6.97	0.16	24.07
Y9	time dedicated to grazing (hours)	7.34	0.23	33.24
Y10	self-consumption animals (No.)	5.07	0.72	152.32
Y11	sold animals (No)	47.73	4.15	93.60
Y12	age of consumption (days)	30.18	1.24	44.28
Y13	consumption weight (kg)	8.09	0.32	43.16
Y14	age of sale (days)	32.54	0.81	26.72
Y15	sales weight (kg)	8.85	0.22	27.11

S.E. = Standard error; C.V. = Coefficient of variation.

reduced number of lactating goats. This can yield multiple benefits for the production system, including reduced grazing pressure and improved pasture conditions (Pulido *et al.*, 2018). Similarly, Torres-Hernández *et al.* (2020) evaluated 2,200 lactations from 1,500 goats over four years in the same region and found an average production level of 0.940 kg/goat, consistent with the values reported by producers in this study. These findings underscore the importance of farmer involvement in the success of any improvement strategy, as they possess in-depth knowledge of all aspects of the production process (Tadesse *et al.*, 2014; Salinas-González *et al.*, 2016). Nonetheless, despite managing productive herds under extreme environmental conditions, producers receive a low price per liter of milk, often failing to recover their investment. This highlights the urgent need to explore and establish alternative markets that ensure fair compensation and enhance producers' bargaining power (Maldonado-Jáquez *et al.*, 2023a), as has been achieved in other parts of the world where goat-derived products command higher market prices (Miller & Lu, 2019; Farrera-Vázquez *et al.*, 2020). Regarding meat commercialization and consumption, goat farming serves not only as a critical income source but also as a food resource for local populations even though producers themselves consume only about 10% of their total output. This reinforces the notion that goat farming provides food security for vulnerable population segments (Monau *et al.*, 2020). Moreover, the production system in northern Mexico closely resembles those described in northern, central, and southern South America, where consumer preferences favor young animals (Dubeuf *et al.*, 2004). However, despite the existence of a niche market for such products and reported increases in goat prices of up to 20% over the past five years (Maldonado-Jáquez *et al.*, 2023a) farmers retain only around 20% of the final sale value, with the

remaining 80% captured by intermediaries and restaurants (Rebollar-Rebollar *et al.*, 2007). This scenario is far from encouraging, particularly considering that approximately 90% of producers depend almost entirely on this activity for their livelihoods. Therefore, efforts must be directed toward improving profit margins through the identification and development of alternative markets.

The principal component analysis (PCA) was statistically significant according to the Kaiser criterion, with sampling adequacy values exceeding 0.5 (Table 3). Three principal components (PCs) collectively explained 51% of the total variability. All three components exhibited positive loadings. PC1 accounted for 24% of the total variance and grouped producers with similarities in age, household size, and milk prices. PC2 explained 16% of the variance and included variables related to education level, herd size, milk yield, experience in goat farming, price received for milk, and number of animals sold. Similarly, PC3 accounted for 11% of the total variability, capturing producers with comparable levels of age, herd size, number of lactating animals, milk production, farming experience, grazing duration, animals sold, and levels of self-consumption. In this study, the criterion for discrimination was based on similarities between variable groups rather than within-group similarity (Gelasakis *et al.*, 2017). Accordingly, distinct groups emerged, each with clearly defined production objectives. The differences among these groups are mainly in the magnitude of variables such as age, productivity, commercialization, and product consumption. Future research should focus on analyzing these groups to better understand

Table 3. Correlation values of the variables with the three principal components in the typification of local goat producers in Comarca Lagunera, in northern Mexico.

Variable	PC1	PC2	PC3	Communality	KMO
Y1	0.0411	-0.1608	0.5067	0.0673	0.50
Y2	-0.0767	0.2902	-0.4203	0.2205	0.54
Y3	0.0207	-0.2116	-0.1097	0.1074	0.54
Y4	-0.4364	0.0651	0.1972	0.7041	0.73
Y5	-0.0848	-0.1797	0.3249	0.1025	0.50
Y6	-0.4234	0.2411	0.0729	0.7905	0.65
Y7	-0.3605	0.3600	0.0478	0.7798	0.61
Y8	0.0248	0.2401	-0.0934	0.1385	0.50
Y9	-0.0820	-0.2553	0.3637	0.1785	0.50
Y10	-0.3296	-0.0460	0.0455	0.4008	0.80
Y11	-0.4516	0.0854	0.1005	0.7604	0.78
Y12	-0.2388	-0.4440	-0.2137	0.6737	0.50
Y13	-0.2387	-0.4085	-0.3129	0.5873	0.50
Y14	-0.1079	-0.2959	-0.1044	0.2494	0.50
Y15	-0.1982	-0.2075	-0.32599	0.2449	0.50
% Variance	24.29	15.75	10.65		
Cumulative variance	24.29	40.04	50.69		
P-Value	<0.0001				

KMO=Kaiser-Meyer-Olkin score.

their specific constraints and potential, as has been done with producer typologies in other regions of the world (Sow *et al.*, 2021).

Using Euclidean distances derived from the k-means analysis of principal components and factor scores, a dendrogram was constructed to identify the key variables distinguishing groups of producers (Figure 2). One cluster was defined by similarities in producer age, household size, number of lactating animals, grazing time, animals for self-consumption, and both the age and weight at the time of sale. The second cluster comprised producers with comparable levels of education, milk yield, farming experience, milk price received, and number of animals sold and consumed. These results align closely with the previously described distinctions between producer groups (Figure 3), even though the majority of producers were concentrated in a single group. These findings are consistent with other studies (Tade & Melesse, 2023; Reddy *et al.*, 2023), which have documented traditional goat production systems in India and Ethiopia. In those contexts, most producers share similar characteristics: they rely heavily on goat farming as their primary source of income and do not actively pursue new market niches to enhance profitability. This is crucial to develop the activity, given that the knowledge of the market demands will allow orienting

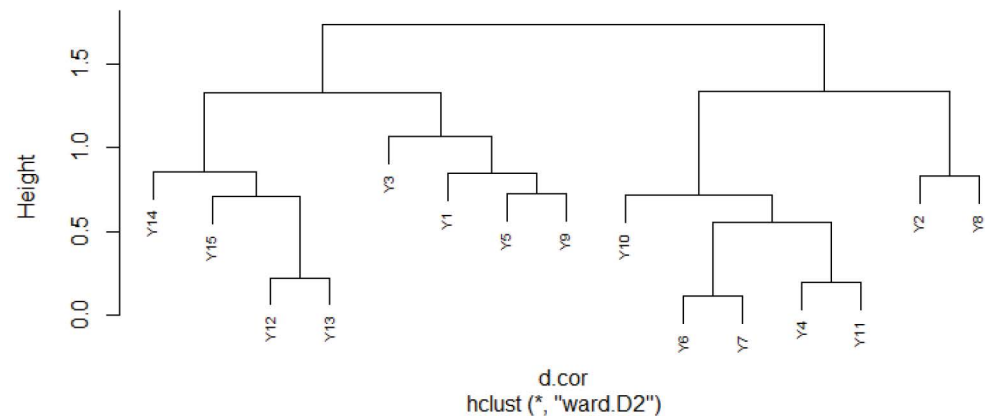


Figure 2. Cluster dendrogram of discriminant variables between groups of local goat producers in Comarca Lagunera, in northern Mexico.

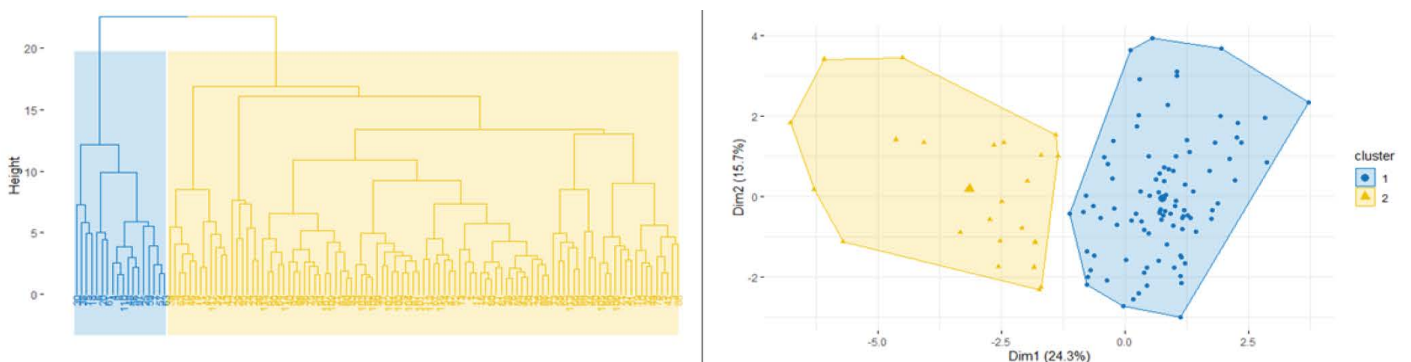


Figure 3. Grouping clusters for local goat producers in Comarca Lagunera in the states of Durango and Coahuila, in northern Mexico.

the efforts of the producer to access new markets and power of negotiation for better prices, which will help them to increase their incomes and consequently, their living standards (Sesay, 2023).

The criteria employed by producers within selection and genetic improvement programs reflect parameters that, in many cases, align with the general characteristics of their production units (Table 4). In this context, the reported figures for production, replacement, and breeding males correspond to average flock sizes. However, the observed female-to-male ratio appears disproportionately high, which may have adverse implications for flock productivity. Previous research has demonstrated that reproductive performance tends to decline when a single male is exposed to groups exceeding 30 females (Zarazaga *et al.*, 2018). Despite this imbalance, reproductive parameters overall fall within the average ranges documented in the literature for this production system. Specifically, based on producers' responses, the reproductive behavior of bucks is consistent with the findings of Mellado *et al.* (2000), who reported that, under extensive mating conditions, male goats copulate approximately nine times per day. Additionally, females typically have their first kidding at around 13 months of age and exhibit high prolificacy, averaging two kids per birth. These observations suggest that producers schedule first matings for females at approximately eight months of age, which is a favorable practice provided that animals have reached sufficient physiological maturity to enter the reproductive phase.

The selection criteria employed by local goat producers are presented in Table 5. Most producers report having some form of selection methodology, typically based on empirical maternal ability meaning without formal production records and physical appearance. These criteria are used to select replacement females under the belief that such animals are more productive and exhibit greater disease resistance. These findings partially align with reports from Ethiopia, where producers select animals with the best growth rates for integration into their herds (Tadesse *et al.*, 2014). Additionally, most producers acquire breeding bucks from external flocks, a practice that contributes to maintaining low inbreeding levels (Luigi-Sierra *et al.*, 2022).

Table 4. Reproductive parameters for the definition of breeding objectives mentioned by local goat producers in Comarca Lagunera, in northern Mexico.

Variable	Mean \pm S.E.	C.V.
Does (No.)	68.79 \pm 4.64	73.08
Bucks (No.)	2.32 \pm 0.15	70.73
Replacements (females; No.)	8.60 \pm 1.28	161.10
Relation male: female	32:1 \pm 1.72	57.58
Number of services by bucks (No.)	5.90 \pm 0.24	43.96
Age at first delivery (months)	13.12 \pm 0.27	22.02
Female productive life (years)	7.74 \pm 0.21	28.49
Prolificacy (kids/ delivery)	1.97 \pm 0.03	15.38

S.E. = Standard error; C.V. = Coefficient of variation.

Table 5. Absolute (AF) and Relative (RF) Frequency of the main selection criterion of local goats used by producers of Comarca Lagunera, in northern Mexico.

Variable	AF	RF	P-Value	Variable	FA	FR	P-Value
Selects their animals				Characteristics a male should have			
Yes	110	0.94	0.0546	Weight	3	0.03	0.1740
No	7	0.06		Growth	11	0.9	
Separates their bucks				Large testicles	20	0.17	
Yes	65	0.56	0.6479	Breed (appearance)	82	0.71	
No	52	0.44		Characteristics a female should have			
Origin of the bucks				Weight	7	0.06	0.1190
Buy	105	0.90	0.6794	Growth	3	0.03	
Lending	10	0.09		Production of the mother	69	0.59	
Own	2	0.02		Birth origin	1	0.01	
Which selection criteria uses				Breed	37	0.32	
Weight	3	0.03	0.0740	Reason for disposal of the animal			
Appearance	44	0.38		Sickness	20	0.17	0.1586
Registration	10	0.09		Age	80	0.68	
Corporal conformation	4	0.03		Economic need	12	0.11	
Maternal ability	57	0.49		Problems at birth	5	0.04	
Why this criterion?							
Grow faster	3	0.03	0.0437				
Get sick less	44	0.38					
By interest	3	0.03					
Produce more	57	0.49					

Furthermore, the selection of males is primarily based on breed phenotype (appearance), with no consideration given to productive traits even when the animals are sourced externally. This approach is problematic, as the breeding male significantly influences herd productivity through the number of offspring sired. Failure to incorporate productive parameters in the selection process increases the risk of poor genetic choices (Pabón-Quevedo & Pulido-Medellín, 2021). Similar practices have been reported among goat producers in Pakistan, where bucks are also purchased from other herds (Ramzan *et al.*, 2020). Conversely, producers in Ethiopia often select bucks directly from their own flocks, citing their proven resilience under harsh conditions including limited water, poor nutrition, and minimal management as reasons for avoiding exotic breeds for crossbreeding (Gebre *et al.*, 2020). This behavior is particularly relevant for conservation programs, as one of the main factors contributing to the extinction of local breeds is indiscriminate crossbreeding with exotic ones. In this regard, the Ethiopian producers' perspective offers a valuable model; conservation efforts could be more effective if coupled with appropriate training to raise awareness about the genetic value of local breeds. Consequently, it is essential to educate goat producers in northern Mexico about the advantages of their native animals and implement strategies to limit the introduction of exotic genetics into local herds (Torres-Hernández *et al.*, 2022b; Maldonado-Jáquez *et al.*, 2023b). With respect to

female selection, producers rely primarily on empirical assessments of does' productivity. While this approach is somewhat logical since selection occurs within the same herd and high-performing individuals are more easily identified it reflects a limited range of criteria. This narrow focus could hinder the identification of truly superior animals. Compared to producers in other regions, where selection parameters are better defined, the lack of emphasis on traits such as efficient forage use, maternal ability, milk production, kid survival, drought resistance, and birth weight may limit genetic progress (Abraham *et al.*, 2018). As such, comprehensive strategies are needed to equip producers with more robust selection tools, enabling them to make informed choices and achieve consistent, cumulative improvements over time. Finally, regarding reproductive and genetic management practices, the data reveal that approximately half of the surveyed producers do not separate bucks from females. Moreover, most cull their does once productivity declines due to age. These findings are consistent with reports by Alva-Pérez *et al.* (2019) for producers in Tamaulipas, Mexico, where similar practices were found to limit productivity due to a lack of reproductive control and suboptimal efficiency.

CONCLUSIONS

Two distinct groups of producers were identified, primarily differing in age, education level, productivity, prices obtained for milk and meat, and the number of animals sold or used for self-consumption. Overall, goat farmers in northern Mexico possess extensive experience in the activity, enabling them to understand and manage local goat production under grazing conditions. However, despite this expertise, the activity remains traditional, constrained by both technological and economic limitations. Moreover, selection practices are rudimentary, lacking defined breeding objectives. These limitations, however, are addressable in the short term, provided that a structured training and monitoring program is implemented. Such a program should include incentives to encourage producer engagement in the design and adoption of comprehensive genetic improvement strategies. In conclusion, there is significant potential to improve extensive goat production systems in northern Mexico. Achieving this will require coordinated efforts among researchers, producers, and government authorities at the municipal, state, and federal levels. The implementation of viable, targeted strategies will be essential to increase the competitiveness of goat farming an activity that remains critical to the livelihoods of rural communities in some of the most marginalized regions of the country.

REFERENCES

- Abebe AS, Alemayehu K, Johansson AM, Gizaw S. 2020. Breeding practices and trait preferences of smallholders' farmers for indigenous sheep in the northwest highlands of Ethiopia: Inputs to design a breeding program. *Plos One*. 15(5): e0233040. <https://doi.org/10.1371/journal.pone.0233040>.
- Abraham H, Gizaw S, Urge M. 2018. Identification of breeding objectives for Begait goat in western Tigray, North Ethiopia. *Tropical Animal Health and Production*. 50: 1887-1892. <https://doi.org/10.1007/s11250-018-1640-5>.
- Alam-Bhuiyan MS, Haque-Bhuiyan AKF, Lee JH, Lee SH. 2017. Community based livestock breeding programs in Bangladesh: Present status and challenges. *Journal of Animal Breeding and Genomics*. 1(2): 77-84. <https://doi.org/10.12972/jabng.20170009>.

- Alebel MG, Wolele BW, Kide HA. 2020. Characterization of goat production system and breeding practices of goat keepers for community-based breeding strategies at Mandura, Metekel zone, Ethiopia. *International Journal of Animal Husbandry and Veterinary Science*. 5(4): 10-21.
- Ali W, Ceyhan A, Ali M, Dilawar S. 2020. The merits of Awassi sheep in terms of milk production and major factors affecting the reproductive traits. *Journal of Agriculture, Food, Environment and Animal Sciences*. 1(1): 50-69.
- Alva-Pérez J, López-Corona LE, Zapata-Campos CC, Vázquez-Villanueva J, Barrios-García HB. 2019. Condiciones productivas y zoonositarias de la producción caprina en el altiplano de Tamaulipas, México. *Interciencia*. 44(3):154-160.
- Castro OE, González MF, Herrera VG, Gómez R. 2021. Valoración agroecológica de los sistemas de producción caprina en ambientes áridos. II Congreso Argentino de Agroecología. Chaco, Argentina. 13 al 15 de octubre de 2021. Pp: 230-234.
- Cevallos-Suarez M, Urdaneta-Ortega F, Jaimes E. 2019. Desarrollo de sistemas de producción agroecológica: Dimensiones e indicadores para su estudio. *Revista de Ciencias Sociales* 25(3):172-185.
- Chávez-Espinoza M, Cantú-Silva I, González-Rodríguez H, Montañez-Valdez OD. 2022. Sistemas de producción de pequeños rumiantes en México y su efecto en la sostenibilidad productiva. *Revista MVZ Córdoba*, 27(1):e2246. <https://doi.org/10.21897/rmvz.2246>.
- Daskiran I, Savas T, Koyuncu M, Koluman N, Keskin M, Esenbuga N, Konyali A, Cemal I, Gül S, Elmaz O, Kosum N, Della G, Bingöl M. 2018. Goat production systems of Turkey: Nomadic to industrial. *Small Ruminant Research*. 163: 15-20. <https://doi.org/10.1016/j.smallrumres.2017.10.001>.
- Dubeuf JP, Morand-Fehr P, Rubino R. 2004. Situation, changes and future of goat industry around the world. *Small Ruminant Research*. 51(2):165-173. <https://doi.org/10.1016/j.smallrumres.2003.08.007>.
- Escareño-Sánchez LM, Wurzinger M, Pastor-López F, Salinas-González H, Sölkner J, Iñiguez L. 2011. La cabra y los sistemas de producción caprina de los pequeños productores de la comarca lagunera, en el norte de México. *Revista Chapingo Serie Ciencias Forestales y del Ambiente*. 17: 235-246. <https://doi.org/10.5154/r.rchscfa.2010.10.087>.
- Espejo U.R. 2011. Sistemas tradicionales y adopción de tecnología en comunidades productoras de caprinos: Diagnostico y estrategias de acción. *Temas Sociales*. 31:157-181.
- Farrera-Vázquez IC, Cervantes-Escoto F, Palacios-Rangel MI, Martínez-González EG, Luna-Olea RA. 2020. Factors influencing financial profit in goat farms in the laguna, Durango, Mexico. *Revista BioCiencias*. 7:e933. <https://doi.org/10.15741/revbio.07.e933>.
- García E. 2004. Modificaciones al Sistema de Clasificación Climática de Köppen. Quinta edición. Instituto de Geografía, Universidad Nacional Autónoma de México, México.
- Gebre KT, Yfter KA, Teweldemedhn TG, Gebreselama T, Gebremariam T. 2020. Participatory definition of trait preferences and breeding practices of goats in Aba'ala, Afar region: as input for designing genetic improvement program. *Tropical Animal Health and Production*. 52: 41-52. <https://doi.org/10.1007/s11250-019-01968-1>.
- Gelasakis AI, Rose G, Giannakou R, Valergakis GE, Theodoridis A, Fortomaris P, Arsenos G. 2017. Typology and characteristics of dairy goat production systems in Greece. *Livestock Science*. 197: 22-29. <http://dx.doi.org/10.1016/j.livsci.2017.01.003>.
- Granados-Rivera LD, Maldonado-Jáquez JA, Bautista-Martínez Y, Garay-Martínez JR, Álvarez-Ojeda MG. 2022. El horario de complementación alimenticia modifica la respuesta productiva de cabras lecheras en pastoreo. *Revista MVZ Córdoba*. 27(1):e2340. <https://doi.org/10.21897/rmvz.2340>.
- Guilherme RF, Lima AMC, Alves JRA, Costa DF, Pinheiro Alves FSF, Azevedo SS, Alves CJ. 2017. Characterization and typology of sheep and goat production systems in the State of Paraíba, a semi-arid region of northeastern Brazil. *Semina: Ciências Agrárias*. 38(4): 2163-2178. <https://doi.org/10.5433/1679-0359.2017v38n4p2163>.
- Luigi-Sierra MG, Fernández A, Martínez A, Guan D, Delgado JV, Fernández-Álvarez J, Landi V, Such FX, Jordana J, Suara M, Amills M. 2022. Genomic patterns of homozygosity and inbreeding depression in Murciano-Granadina goats. *Journal of Animal Science and Biotechnology*. 13:35. <https://doi.org/10.1186/s40104-022-00684-5>.
- Maldonado-Jáquez JA, Granados-Rivera LD, Hernández-Mendo O, Pastor-López FJ, Isidro-Requejo LM, Salinas-González H, Torres-Hernández G. 2017. Uso de un alimento integral como complemento a cabras locales en pastoreo: Respuesta en producción y composición química de la leche. *Nova Scientia*. 9(1):55-75. <https://doi.org/10.21640/ns.v9i18.728>.
- Maldonado-Jáquez JA, Mora-Flores JS, Torres-Hernández G, Granados-Rivera LD, Hernández-Mendo O, Gallegos-Sánchez J. 2023a. Rentabilidad y productividad de la complementación alimenticia continua

- por tipo de parto en caprinos locales en pastoreo. V Congreso Internacional Abanico Veterinario, Agroforestal, Pesquero y Acuícola. Colima, Colima, México. Pp: 46-54.
- Maldonado-Jáquez JA, Torres-Hernández G, Bautista-Martínez Y, Arenas-Báez P, Granados-Rivera LD. 2023b. Effect of coat and skin color variation on longevity, ethnological and functional indices in local goats. *Revista Científica, FCV-LUZ*. 33:e33241. <https://doi.org/10.52973/rcfcv-e33241>.
- Martin GB, Maloney SK, Vercor PE. 2019. "Steps to sustainable Livestock": Focus on mitigation and adaptation to global warming. Proceedings of the 7th Pan Commonwealth Veterinary Conference "The role of veterinarians in addressing the global challenges to the lives of our pets, livestock, wildlife, humans and our environment". Bangalore, India. 3rd-7th march, 2019.
- Mellado M, Cárdenas C, Ruiz F. 2000. Mating behavior of bucks and does in goat operations under range conditions. *Applied Animal Behaviour Science*. 67(1-2): 89-96. [https://doi.org/10.1016/S0168-1591\(99\)00109-4](https://doi.org/10.1016/S0168-1591(99)00109-4)
- Mena Y, Ruiz FA, Gutiérrez R, Vázquez M, Castel JM. 2014. La función de la ganadería en el mantenimiento y aprovechamiento de los montes mediterráneos. *Ambienta*. 108: 52-67.
- Méndez-Cortés V, Mora-Flores JS, García-Salazar JA, Hernández-Mendo O, García-Mata R, García-Sánchez RC. 2019. Tipología de productores de ganado bovino en la zona norte de Veracruz. *Tropical and Subtropical Agroecosystems*. 22:305-314.
- Miller BA, Lu CD. 2019. Current status of global dairy goat production: an overview. *Asian-Australian Journal of Animal Science*. 32(8): 1219-1232. <https://doi.org/10.5713%2Fajas.19.0253>.
- Monau P, Raphaka K, Zvinorova-Chimboza P, Gondwe T. 2020. Sustainable utilization of indigenous goats in Southern Africa. *Diversity*. 12(1):20. <https://doi.org/10.3390/d12010020>.
- Pabón-Quevedo HY, Pulido-Medellín MO. 2021. Circunferencia escrotal como criterio de selección para carneros de reemplazo. *Pensamiento y Acción*. 31:52-73. <https://doi.org/10.19053/01201190.n31.2021.12583>.
- Pulido M, Schnabel S, Lavado-Contador JF, Lozano-Parra J, González F. 2018. The impact of heavy grazing on soil quality and pasture production in rangelands of SW Spain. *Land Degradation and Development*. 29(2): 219-230. <https://doi.org/10.1002/ldr.2501>.
- Putra WPB, Ilham F. 2019. Principal component analysis of body measurements and body indices and their correlation with body weight in Katjang does of Indonesia. *Journal of Dairy and Veterinary Animal Research*. 8(3):124-134. <https://doi.org/10.15406/jdvar.2019.08.00254>.
- Ramos-Martínez J, Salinas-González H, Medina-Elizondo M, Figueroa-Viramontes U, Maldonado-Jáquez JA. 2020. La organización como eje toral para el diseño de esquemas de atención a caprinocultores en el norte de México: Estudio de caso. *Abanico Veterinario*. 10:1-19. <http://dx.doi.org/10.21929/abavet2020.13>.
- Ramzan F, Sajjad Khan M, Ali Bhatti S, Gültas M, Schmitt AO. 2020. Breeding objectives and selection criteria for four strains of Pakistani Beetal goats identified in a participatory approach. *Small Ruminant Research*. 190: 106163. <https://doi.org/10.1016/j.smallrumres.2020.106163>.
- Rebollar-Rebollar S, Hernández-Martínez J, García-Salazar JA, García-Mata R, Torres-Hernández G, Bórquez-Gastélum JL, Mejía-Hernández P. 2007. Canales y márgenes de comercialización de caprinos en Tejupilco y Amatepec, Estado de México. *Agrociencia*. 41(3):363-370.
- Reedy KS, Anitha A, Rao SJ, Sudhakar K. 2023. A study on marketing practices and constraints perceived by goat rearers in Guntur district of Andhra Pradesh. *Indian Journal of Animal Production and Management*. 37(1):1-6.
- SADER- Secretaria de Agricultura y Desarrollo Rural. 2021. Datos abiertos. Padrón de beneficiarios del programa producción para el bienestar en la región lagunera. Revisado el 31 de marzo de 2020 en: <https://www.agricultura.gob.mx/datos-abiertos/sader>
- Salinas-González H, Valle-Moysen ED, De Santiago-Miramontes MA, Veliz-Deras FG, Maldonado-Jáquez JA, Vélez-Monroy LI, Torres-Hernández D, Isidro-Requejo LM, Figueroa-Viramontes U. 2016. Análisis descriptivo de unidades caprinas en el suroeste de la región lagunera, Coahuila, México. *Interciencia*. 41(11):763-768.
- Selemani IS, Eik LO, Holand O, Adnoy T, Mtengeti E, Mushi D. 2013. Variation in quantity and quality of native forages and grazing behavior of cattle and goats in Tanzania. *Livestock Science*. 157(1): 173-183. <https://doi.org/10.1016/j.livsci.2013.08.002>.
- Sesay AR. 2023. Consumer preference for goat meat in Sierra Leone. *Asian Journal of Research and Veterinary Sciences*. 11(1):24-33.
- Sow F, Camara Y, Traore EH, Cabaraux JF, Missouhou A, Antoine-Moussiaux N, Hornick JL, Moula N. 2021. Characterisation of smallholders' goat production systems in the Fatick area, Senegal. *Pastoralism: Research, Policy and Practice*. 11:12. <https://doi.org/10.1186/s13570-021-00195-4>.

- Tade B, Melesse A. 2023. A review on differentiation of goat populations in Ethiopia based on husbandry practices, breeding and morphological traits: The primary step for conservation. *International Journal of Livestock Production*. 14(1):13-21. <https://doi.org/10.5897/IJLP2022.0799>.
- Tadesse D, Urge M, Animut G, Mekasha Y. 2014. Perceptions of households on purpose of keeping, trait preference, and production constraints for selected goat types in Ethiopia. *Tropical Animal Health and Production*. 46: 363-370. <https://doi.org/10.1007/s11250-013-0497-x>.
- Toro-Mujica, P., García, A., Gómez-Castro, A., Perea J, Rodríguez-Estéves V, Angón E, Barba. 2012. Organic dairy sheep farms in South-Central Spain: Typologies according to livestock management and economic variables. *Small Ruminant Research*. 104: 28-36. <https://doi.org/10.1016/j.smallrumres.2011.11.005>.
- Torres-Hernández G, Maldonado-Jáquez JA, Granados-Rivera LD, Salinas-González H, Castillo-Hernández G. 2022b. Status quo of genetic improvement in local goats: a review. *Archives Animal Breeding*. 65:207-221. <https://doi.org/10.5194/aab-65-207-2022>.
- Torres-Hernández G, Maldonado-Jáquez JA, Granados-Rivera LD, Wurzinger M, Cruz-Tamayo AA. 2022a. Creole goats in Latin America and the Caribbean: a priceless resource to ensure the well-being of rural communities. *International Journal of Agricultural Sustainability*. 20(4): 368-380. <https://doi.org/10.1080/14735903.2021.1933361>.
- Torres-Hernández G, Maldonado-Jáquez JA, Salinas-González H, Granados-Rivera LD, Pastor-López FJ, Vaquera-Huerta H, Bautista-Martínez Y. 2020. Influence of milk production records on the estimation of typical and extended curve lactation parameters in local goats under grazing management. *Indian Journal of Animal Sciences*. 90(4): 643-646. <https://doi.org/10.56093/ijans.v90i4.104224>.
- Zarazaga LA, Gatica MC, Gallego-Calvo ML, Guzmán JL. 2018. When using photostimulated buck to induce the male effect in female goats living at Mediterranean latitudes, a male: female ratio of 1:20 is optimum. *Journal of Applied Animal Research*. 46(1):883-887. <https://doi.org/10.1080/09712119.2017.1418669>

