A Pesquisa nos Diferentes Campos da Medicina Veterinária 3

Alécio Matos Pereira
Sara Silva Reis
Wesklen Marcelo Rocha Pereira
(Organizadores)

Atena Editora
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APRESENTAÇÃO

O livro abrange temas relevantes relacionados a saúde animal, parasitologia, comportamento animal e produção de forragens. E estão divididos em volume II e volume III somando 52 capítulos. Nestes foram descritos relato de caso, experimentos e revisões. Que contém informações importantes para o entendimento do leitor, proporcionando uma visão clara e completa de todo conteúdo a ser abordado. No volume II e III, estão descritos assuntos como o comportamento, cognição e aprendizagem em cães, avaliação de carrapaticidas químicos, produção de forragem, coccidiose aviária, diagnóstico de tumores de pele em animais domésticos entre outros.

Os estudantes dos cursos das agrárias têm a sua disposição uma literatura cientifica ampla e aprofundada sobre os assuntos de maior vigência na atualidade. É um livro que aborda as mais diversas áreas da Medicina Veterinária e da produção animal, tornando os seus capítulos indispensáveis para uma atualização dos profissionais da área.

Nas últimas décadas houve grande aumento no número de grupos de pesquisa e publicações sobre comportamento, cognição e bem-estar de cães. Trazendo o foco nos novos conhecimentos gerados, nas dificuldades de compreensão desse conhecimento e as iniciativas que parecem poder suplantar as dificuldades.

Com tudo, a diversidade de assuntos abordados nos volumes II e III apresentam capítulos com pesquisas, relatos, objetivos e resultados, desenvolvidos por diversos pesquisadores, professores, profissionais e estudantes. Como uma maneira de expandir a pesquisa cientifica como uma fonte importante para auxiliar na atualização de todos que buscam uma fonte segura e atualizadas sobre a ciência animal.

Alécio Matos Pereira
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SUMÁRIO

CAPÍTULO 25

USE OF ENVIRONMENTAL AND GENETIC DESCRIPTORS TO INTEGRATE HERDS OF SHEEP

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ABSTRACT: Assuming that each region and/or country represents a unique productive environment, it is important to define that there are diverse productive environments that may exist within a country or even in the same region. The objective of the study was to identify and group sheep herds in the municipality of Temoaya, State of Mexico, Mexico, to allow better planning and distribution of resources (subsidies) aimed at increasing the productivity of the different processes in the sheep herds. The study examined 23 sheep herds using an applied integral quiz (64 descriptors of environmental and genetic type), which was initially subjected to a discriminant statistical analysis, then a multivariate statistical analysis, resulting in the establishment of 15 principal components (PC), that explained 94.25% of the differences between the herds. The variables that constituted the PC presented significant correlations among them ($P < 0.05$). Finally, clusters were analyzed, integrating the 23 herds into 5 groups or clusters (CL) with similar environments. The clusters allowed the identification of diverse productive products of the sheep sector in each region. The use of this methodology is a reliable tool for the structural solutions that currently limit the good sustainable development of sheep production.
KEYWORDS: Sheep, environmental descriptors, main components, cluster, sustainable.

RESUMO: Assumindo que cada região e / ou país representa um ambiente produtivo único, é importante definir que existem diversos ambientes produtivos que podem existir dentro de um país ou mesmo na mesma região. O objetivo do estudo foi identificar e agrupar os rebanhos ovinos no município de Temoaya, Estado do México, México, para permitir um melhor planejamento e distribuição dos recursos (subsídios) destinados a aumentar a produtividade dos diferentes

processos nos rebanhos ovinos. O estudo examinou 23 rebanhos ovinos por meio de questionário integral aplicado (64 descritores de tipo ambiental e genético), o qual foi inicialmente submetido a uma análise estatística discriminante, em seguida a uma análise estatística multivariada, resultando no estabelecimento de 15 componentes principais (CP), que explicou 94,25% das diferenças entre os rebanhos. As variáveis que constituíram o CP apresentaram correlações significativas entre si (P <0,05). Por fim, foram analisados os clusters, integrando os 23 rebanhos em 5 grupos ou clusters (CL) com ambientes semelhantes. Os clusters permitiram a identificação de diversos produtos produtivos do setor ovino em cada região. A utilização desta metodologia é uma ferramenta confiável para as soluções estruturais que atualmente limitam o bom desenvolvimento sustentável da produção ovina.
PALAVRAS-CHAVE: Ovinos, descritores ambientais, componentes principais, cluster, sustentável.

1 | INTRODUCTION

Due to its geographic and climatological conditions, the Mexican highlands region has been identified as the area with the greatest ability to graze sheep to produce meat and wool (SAGARPA 2016). In the context of the State of Mexico, the importance of sheep activity is known, and in particular in the municipality of Temoaya as an annual primary activity – with 1,084 and 546 tons of live livestock and meat, respectively, representing around 1% at the national level (SAGARPA 2016) – but there is no reliable information that describes or characterizes in a specific way the production systems, such as the genetic resources involved, inputs used in food, integral management of the herd, type of reproductive management, preventive health measures, and so on. The programs that promote sheep farming in the State of Mexico are mainly provided by the governmental sector, which generally globalizes the systems of production. Under these circumstances, the development of sheep breeding in the region could be encouraged with a clear direction of resources, producing productive and sustainable projects that potentiate the aspects of genetic improvement, reproduction, feeding, sanitary management and improvements in the productive environment, with greater precision according to the resources and the production objectives of this municipality, which is in line with the Sustainable Animal Diets promoted by the FAO (Makkar and Ankers 2015) .

Considering that each region and/or country represents a unique productive environment, it is important to define that there are several productive environments that may exist within a country or even in the same region (Fikse et al. 2003). Clusters of herds with similar management conditions and production systems have been used to identify production levels among groups of herds (Fikse et al. 2003; Vasconcelos et al. 2006).

The cluster is a grouping procedure that may be attractive for defining herds under similar environmental conditions (Weigel and Rekaya 2000), which have been recently integrated using climate, management and productive variables (environmental descriptors), allowing the identification with greater clarity of environmental levels (Osorio-Avalos et al. 2015), making the characterization of the production systems of a region and/or country more reliable.

The objective of the present study was to develop a descriptive analysis of variables on aspects of genetic improvement, reproduction, feeding, sanitary management and facilities, among others, of the sheep herds prevalent in the municipality of Temoaya, defining the integration of herds based on the cluster methodology.

2 | MATERIAL AND METHODS

2.1 Information of the population

The study was carried out with information from 23 herds in the municipality of Temoaya, State of Mexico, which was obtained from a poll given to owners and/or managers of the herds.

2.2 Survey and environmental descriptors

The application of the survey (Rivas et al. 2014) consisted of 92 questions that corresponded to nine general indicators with a number of particular variables: herd data, herd composition, health management, commercialization, breed type, equipment, feeding, mating and reproduction, as well as the characteristics of genetic resources.

2.3 Statistical analysis

The information of the variables (previously standardized) of the herds was integrated in a database. A first discriminate statistical analysis was applied to all the variables (Proc Stepdisc SAS 9.2 2007) in order to select those variables that allowed a better discrimination of the descriptors for the differentiation of the herd grouping. These variables (environmental and genetic descriptors) were analyzed using the principal components method (Proc Princomp SAS 9.2 2007) in order to reduce the size of quantitative variables and to specify the classification factors (Pardo et al. 1999; Macedo et al. 2003, Paz et al. 2003). Cluster analysis was performed using the Proc Cluster procedure (SAS 9.2 2007, Weigel and Rekaya 2000) to order herds in homogeneous groups according to the estimated correlation distances of their environmental variables and genetic characteristics.

3 | RESULTS AND DISCUSSION

3.1 Discriminant Analysis and Principal Components (PC)

A total of 92 variables were found; the discriminant analysis indicated that 28 variables were not selected because there were no differences between them (P> 0.05), so they were discarded. The 64 environmental descriptors were used for the analysis of principal components (PC), resulting in the establishment of 15 PCs which explained 94.25% of the differences among production units (Complement 1). This percentage was higher than those found in other studies (78.3%) with dairy cows (Weigel and Rekaya 2000; Zwald et al. 2003), possibly due to the differences between species and the difference in the number of environmental descriptors considered in both studies. Thus it was also higher than another study in Merino sheep herds in Spain (Osorio et al. 2015), which found an explanation of 78.3% of the total variance, using 20 environmental descriptors (which were integrated in 7 factors). The difference of 16% with respect to this study is probably due to the fact that a greater number of descriptors was considered (64 vs. 20 indicators), explained by more variability among herds.

3.2 Association of variables

The analysis of principal components (PC) in which eigenvalues were greater than the unit explained a very high percentage of variability (94.25%); the first 15 CPs that were integrated in 64 variables (Complement 1) were selected, which were considered for the grouping analysis (cluster, CL) that followed. The variables that contributed mainly to the explanation of the variance (18.5%) among herds were the total amount of sheep and the characteristics in the herd composition (adult males and females, fattening lambs and rearing lambs). The percentage of pregnant sheep, lamb mortality, replacement animals and the average age of rearing females were closely linked to the production systems.

Osorio-Avalos et al. (2015), in a study with Merino sheep herds in Spain, found that only the variables such as size of herd, feeding area, days of feeding, and animal load contributed to 29.9% of the differences among herds. Neser et al. (2008) studied the contribution of variables related to the production systems in meat production characteristics in beef cattle in South Africa, finding that they were the best option to define groups of herds under similar conditions.

In this study, the productive data (environmental descriptors) contributed 9.8%, similar to Osorio-Avalos et al. (2015), because birth weight at 30 and 75 days of age (weaning) in Merino sheep accounted for 9.7% of the total variance. Winding et al. (2005) found in dairy cows that the milk yield production (% of fat, protein and amount of milk produced), contributed 10.3%. Also, when a study was carried

out analyzing the productive characteristics in dairy cows in different countries, they founded that 64.3% of the total variance corresponded to these variables (Vasconcelos et al. 2006). These differences in the total contribution may be due to the large differences that exist between production systems in different countries.

3.3 Cluster analysis (clusters, CL)

The cluster analysis procedure resulted in a hierarchical dendogram resulting from the application of the variables described above, showing the composition of 5 clusters (groups) with similar environments. Groups are shown in Figure 1 formed by the close values of variance between them, also differentiated by their values of the distance of the variance between the herds, derived from the descriptors used in this study. According to the general characteristics presented, the formed groups were described as: CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_intensive systems.

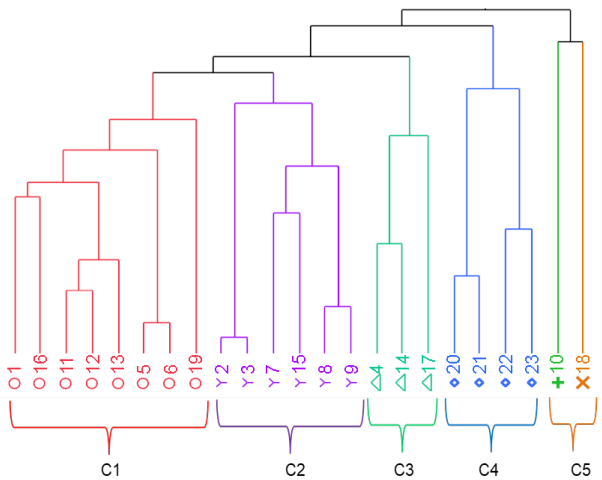

Figure 1. Integral hierarchical dendogram of the 23 sheep herds according to the environmental descriptors in the municipality of Temoaya, State of Mexico. C1_ backyard, C2_backyard-extensive, C3_semiextensive, C4_extensive, C5_intensive.

3.4 Description of clusters due to similarities in their environmental circumstances

The production systems have been characterized by analyzing their structure, reproductive variables, feeding strategies, animal health and marketing, among others (Vázquez et al. 2009; Valerio et al. 2010). Table 1 presents the general characteristics that characterized the integration of the five clusters. Important

differences between them are given below.

3.5 Data of the farmer and the herd

The farmer's experience in sheep breeding is important and continuously used as a variable since it is related to a better understanding of the production process. It is also directly related to the case of accepting new technologies and improving system productivity (Vázquez et al. 2009; Rivas et al. 2014).

Cluster integration indicates that older farmers show greater experience in sheep management, but show almost no academic studies and the lowest inventory of animals (24%, CL1 and CL2). In relation to the young farmers (with the exception of CL4), CL 3 and 5 showed less experience in the activity, while CL5 found farmers with professional academic information (Table 2). Rivas et al. (2014) mentions that the years of experience of farmers in Spain was 15.6 years, which is very similar to Borroto et al. (2011) in Cuba (17 years), while Galaviz et al. (2011) in Mexico found the experience for Sheep Production Systems (SPS) at around 48 years on average; the differences are due to the fact that there are areas where sheep breeding is an emergent activity.

Concept	CL1	CL2	CL3	CL4	CL5
(Number) and % herd	(8) 34.8	(6) 26.1	(3) 13.0	(4) 17.4	(2) 8.7
System Production	Backyard	Backyard and extensive	Semi-extensive	Extensive	Intensive
Owner's education level	100 % does not have	68% does not have	Primary and high school	100% Primary and high school	Bachelor's degree
Animal inventory	≤15	Average around 25	Average around 48	50 to 199	≥200
Sheep production activity	Primary	Secondary	Secondary	Primary	Primary and secondary
Origin of the herd	Family	Acquired/ inherited	Acquired	Acquired	Acquired
Government subsidy	Does not have	Does not have	Yes	Yes	Yes
Job generation	Self-employment	Self-employment	Yes	Yes	Yes
Herd genotype	Local	Grade Suffolk	Suffolk, Dorper and Pelibuey	Suffolk, Hampshire and Dorper	Suffolk and Hampshire
Identification of the herd	Does not have	Does not have	Deficient	Complete	Complete
Fence	Does not have	Does not have	Yes	Does not have	Yes
Available drinking wáter	Spring	Rivers	Spring	Rivers	Potable

Herd inventory	Decrease	Maintain	Maintain	To increase	To increase
Sanitary management	Little	Little	Regular	Regular	Good
Type of forage pasturage	Not performed	Pasturage ocrop residues	Pasturage of crop residues	Pasturage and crop residues	Rotational pasture and feed lot
Land for pasturage	Ejidal	Ejidal	Communal	Tree Forest	Private property
Hectares for pasture	2-00	1-00	3-00	4-00	2-00
Displacement to feed (km)	4	1	3	8	0.5
Birth control	Does not have	Does not have	Yes	Does not have	Yes
Type of parturition (predominant)	Single	Single	Single and twin	Single and twin	Single and twin
Origin of rams and sheep replacements	Own herd	Own herd	Females of the own herd and rams of other herds and breeder market	Females of the own herd and rams of other herds and breeder market	Other herds
Cause of animal removal	Sale according to needs	Sale according to needs	Sale at barbacoyeros	Commercialization	Commercialization
Commercialization of animals	Own herd	Own herd	Own herd and/ or market of animals	Market of animals	Market of animals
Way of marketing with a barbacoyero	Package	Package	kg	Kg	kg
Use of wool	Hand craft	Payment of shear	No data	No data	Sale
Interest in the organization of producers (sheep association)	No	No	Yes	Yes	Yes

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 1. Description of the main characteristics of the herds in five groups according to the cluster analysis (CL).

The number of sheep that make up the flock has frequently been used as a variable in characterizations that analyze the relationship between the productive system and the social context (Valerio et al., 2010; Rivas et al. 2014). CL4 resulted in the highest number of animals (Table 3), while CL 1, 2, 3 and 5 had an average range between 13 to 31 animals. Borroto et al. (2011) mention that in Cuba, sheep herds are characterized as having 30 sheep on average, which is similar to this study, as well as Nuncio et al. (2001) in Tabasco, Mexico, with herds between 20-40 sheep,

while Vázquez et al. (2009) in the highlands in Mexico found that the average size of the herds was around 60 sheep. It is indisputable as some authors mention that the variable number of sheep should be used as a criterion for grouping herds (Pérez et al., 2011).

Cluster	Herd		Animals		Farmer's age (years)			Experience (years)	Level of education (%)			
	No.	%	No.	%	Average	Maximum	Minimum		None	Basic	Highschool	Bachelor 's
CL1	8	34.8	28	18	51	71	32	25	**88**	0	12	0
CL2	6	26.1	13	6	55	77	23	23	68	16	16	0
CL3	3	13.0	25	6	35	50	24	5	0	33	33	33
CL4	4	17.4	**202**	65	39	50	20	28	0	**100**	0	0
CL5	2	8.7	31	5	36	42	30	6	0	0	0	**100**
Total	23	100	299	100	43	58	25.8	17	31.2	29.9	12.3	26.7

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 2. Cluster description according to the data of the farmer and herd composition.

3.6 Data on the production unit and herd composition

According to their origin, sheep herds that were acquired (CL 3, 4 and 5) are considered as a primary activity, presenting a tendency to increase the sheep inventory, obtain governmental subsidies (including technical assistance) and generate employment. Plata et al. (2016) mention that employment is necessary for the functioning of family-type herds (generating self-employment), as presented in CL 1 and 2, which show a tendency to decrease their inventory (even to disappear), ignoring the existence of government subsidies including technical assistance (Table 3). To our knowledge there are no preliminary studies that have examined these variables.

50% of the herds in this study receive technical assistance. Pérez et al. (2011) mention that in the state of Veracruz, Mexico, 60% of the herds lack technical assistance, with 37% of the farmers having private animal science engineers or veterinarians as assistants – supplying antibiotics, anthelmintics and vaccines.

3.7 Sanitary management in herds

Sanitary practices differ according to the type of herd. In this study, deworming and vaccination are activities performed to a lesser extent, as well as the use of vitamins and minerals. Pérez et al. (2011) mention that the common sanitary practices are the administration of anthelmintic, vaccines and vitamins, which relates to our

study, in which almost 66% of the herds apply anthelmintic. In the present study the groups in CL 3, 4 and 5 use anthelmintic practices (100%) at least once a year. In some studies it has been emphasized that there are no technical criteria in the frequency of deworming (Cuéllar et al. 2011), while in others (Góngora et al. 2010) it has been found that deworming occurs around every six months (41.7%) or annually (33.8%). The use of vaccines is very poor (only 25% of the herds do, in CL 4 and 5), which corresponds to the results of other authors (Morantes et al. 2008; Valerio et al. 2010; Borroto et al. (2011), highlighting that few producers use immunizations (i.e. pasteurella).

Cluster	Activity (%)		Herd origin (%)			Sheep Tendency (%)			Employed persons (%)	Subsidy %
	Primary	Secondary	Created	Acquired	Family	Decrease	Maintain	Increase		
CL1	100	0	0	0	100	100	0	0	0	0
CL2	0	100	20	30	50	50	33	17	0	0
CL3	0	100	0	100	0	0	100	0	100	100
CL4	100	0	0	100	0	25	25	50	50	50
CL5	50	50	0	100	0	0	0	100	100	100
Total	50	50	4	66	30	35	31.6	33.4	50	50

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 3. Description of the clusters according to the data and composition of the herd.

Farmers comment that the most prevalent diseases are respiratory problems and secondly digestive illnesses (Table 4). These results coincide with Plata et al. (2016) in the Municipality of Toluca, Mexico. However, the prevalence of these disorders was 68% in herds of Tlaxcala (Galaviz et al. 2011) highlighting that digestive cases were more frequent. It is important to mention that in this study there is a poor identification system of the sheep inventory, perhaps because of the cost this entails (i.e. ear tags, tattoos) given the total number of animals with a herd. The irregular practice of cutting the tails of the lambs is performed even in lambs at an older age, which is a reflection of the lack of training and/or technical assistance.

3.8 Marketing in herds

The type of products or by-products for sale has been used in various characterizations to describe the commercial or economic component (Vázquez et al. 2009). The commercialization products of the herds in this study are mainly sheep for meat or for breeding oriented to the production of meat. The sale of fattened lambs takes place on the farm itself and is paid for per “package” (CL 1, 2, 3), or in

CL 4 and 5 per kilogram or per live animal. The final destination of the lambs is for the production of barbecue (76% on average) in all five clusters. Sheep production has been described as an alternative for the family economy and for the self-consumption of the meat (Vázquez et al. 2009, Valerio et al. 2010 and Borroto et al. 2011). Producers of CL 1, 2 and 5 expressed interest in the creation of community fattening, while CL 2 herds lack interest in the creation of civil associations (Table 5). The lack of associations has meant that farm producers are dependent on intermediates and that sheep companies do not grow as in other countries such as Spain or Brazil that create cooperatives or associations, thus providing certain advantages.

Cluster	Management activities in sheep (%)					Tail		Major diseases (%)	
	Deworming	Vaccine	Vitamin-selenium	Minerals	Identification	%	Days %	Respiratory	Digestive
CL1	12	0	0	0	25	25	39	62	38
CL2	17	0	0	0	17	100	40	50	50
CL3	100	0	100	100	33	100	18	100	0
CL4	100	25	50	100	100	100	30	75	25
CL5	100	100	100	100	100	100	15	0	100
Total	65.8	25	50	60	55	85	28.4	57.4	42.6

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 4. Description of the clusters according to the sanitary management of the herds.

The herds that were part of CL 5 considered as income the sale of wool, while in the rest of the herds it represented a loss in production, with a high percentage of producers who discard or burn it, as was found in herds in the municipality of Toluca, Mexico. In Chile and other countries 50% of the income on farms is from the sale of wool, which puts us at an international disadvantage, because in Mexico we import wool from other countries (Plata et al. 2016).

3.9 Composition by breed type (females and males) in the production units

The breeds that are handled in the herds are a variety widely used for their contribution to the description of the productive purpose and the animal component. Vázquez et al. (2009) mention that within the herds generally there are no clear criteria for the selection of breeding stock, or some other aspects of breeding. The herds in this study are based on two breed types of sheep: natives and crossbreed animals (Suffolk and Hampshire); native sheep are present in 15% of the clusters, mainly in CL1. Clusters 1, 3 and 4 have Suffolk animals and CL 3 and 4 also have

Dorper sheep. The pure breed of Suffolk and Hampshire are only in CL 2 and 5.

Cluster	Wool utilization (%)			Lambs sale place (%)		Purchase of lambs (%)		Price	Organization (%)	
	Sale	Craft	Losses	Farm	Market	Barbacoyero	Producer	$	Fattening	Asociation
CL1	0	12	88	100	0	88	12	1000	12	37
CL2	0	0	100	100	0	100	0	1500	16	0
CL3	0	0	100	100	0	67	33	1800	0	100
CL4	25	0	75	0	100	75	25	2500	0	100
CL5	100	0	0	0	100	50	50	2800	100	100
Total	25	2.4	72.6	60	40	76	24	1920	25.6	67.4

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 5. Description of the clusters according to the commercialization of the herd.

The rams present in the herds are based on four racial types: Dorper, Hampshire, Pelibuey and Suffolk, as well as locals (natives) and crossbreed animals (Suffolk and Hampshire). The native sheep present in the semi-arid and temperate regions of the country need to be identified and defined and a census of the different varieties needs to be taken to guide the programs for their conservation and use, within the ecosystems in which they are found (SAGARPA 2017). Native local sheep are a great alternative for this region due to their adaptability, with low food demand, high disease resistance and easy rearing (FAO, 2010). In this study, the native sheep are present in 7% of the clusters, with CL 1 presenting the greatest percentage (> 50%). In all clusters the Suffolk breed type is present, with Suffolk, Hampshire, Dorper and Pelibuey standing out in order of importance (Table 6). These results are similar to Valerio et al. (2010) and Rivas et al. (2014), finding that some herds are composed of improved breeds while others use local breeds (Suffolk, Hampshire, their crosses) and local.

3.10 Installations and equipment in herds

Farm infrastructure has been described by several authors (Borroto et al. 2011; Rivas et al. 2014) as one of the aspects that determine the technological level of the herds. In this study it was found that the use of fences corresponds to 82% of the herds, located in CL 1 and 2. Water available from a spring (37% of herds) was integrated into CL 1 and 3, and natural river water is used by CL 2 and 4. Only CL 5 herds use potable water. The water well is the least used water source on the farms. As for lamb pens, breeding pens, feeders, drinking troughs, food storage

tanks, manure troughs, dunghills and grazing areas, the possession of these facilities progressively decreases from cluster 5 to 1 (Table 7).

Cluster	Maternal breeds (%)					Paternal breeds (%)					
	Local	Hamsphire	Suffolk	Grade Suffolk	Grade Dorper	Local	Suffolk	Hamphire	Pelibuey	Dorper	Grade Suffolk
CL1	75	0	0	25	0	38	38	0	12	0	12
CL2	0	17	83	0	0	0	83	17	0	0	0
CL3	0	0	0	67	33	0	33.3	0	33.3	33.3	0
CL4	0	0	0	75	25	0	50	25	0	25	0
CL5	0	50	50	0	0	0	50	50	0	0	0
Total	15.0	13.4	26.6	33.4	11.6	7.6	50.9	18.4	9.1	11.7	2.4

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 6. Description of the clusters according to composition by breed type in the herds.

3.11 Herd feeding management

The food that is used in the herds is most commonly used to describe the feeding system, because it provides information about several characteristics of the productive unit (Pérez et al. 2011; Rivas et al. 2014). In the five clusters, 90% of the animals are fed based on grazing, which is the most common practice (Plata et al. 2016). The problem is that the production unit use low-quality native pastures (below 7% crude protein) of a very mature age. Non-grazing systems (feedlot) correspond to 50% of the herds located in CL 1, 2 and 4 (Table 8). CL 5 (intensive) uses rotational and rationed grazing, using stabling and feeding on stubble and concentrates. Rivas et al. (2014) comments that this is a production system in which herds are grazed for some hours a day, in grasslands that are generally native, and characterized by the animals returning to their pens to receive food supplementation. The supplementation consists of supplying the herd a mixture of fodder such as agricultural by-products (i.e. straw and stubble) and also sometimes cereals (i.e. maize, sorghum) (Vázquez et al. 2009; Pérez et al. 2011), with or without commercial cereal concentrates.

3.12 Land ownership, surface utilization and herd movement

The type of crop planted by the farmers is used as an indicator of the feeding of the herd. There is a direct relationship between sheep and crops; the former are fed stubble and grazing, from the farmland after harvest (Vazquez et al. 2009; Pérez et al. 2011). The use of land for feeding prevails in the region of the community type (CL 1 and 2) called "*ejido*". While in CL 3 the property is in communal use, CL 4 herds

are in forested areas and CL 5 are privately owned. Each formed cluster showed a different amount of hectares planted with crops for the use of sheep. The sowing of forage maize is used mainly in the herds that comprise CL 1, 2, 3 and 4; while the herds in CL 5 use grass and oats (Table 9).

Cluster	Fences	Water source (%)			
		Spring	Water well	River	Potable water
CL1	63	63	12	2	0
CL2	50	0	0	83	12
CL3	100	100	0	0	0
CL4	100	0	0	100	0
CL5	100	0	0	0	100
Total	82.6	32.6	2.4	37	22.4

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 7. Description of the clusters according to the possession of facilities and equipment of herds.

Cluster	Pasturage (%)	Grazing crop Residues (%)	Concentrate (g)	corn stover (%)	Pasturage (%)			
					Rotation	Conducted	No conducted	Rationed
CL1	100	100	0	75	0	0	100	0
CL2	100	100	0	67	16	50	50	0
CL3	100	100	0	100	33	67	0	0
CL4	100	100	0	100	0	0	100	0
CL5	50	0	400	0	50	0	0	50
Total	90	80		68.4	19.8	23.4	50	10

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 8. Description of the clusters, according to the feed in the herds, considering the variables of pasturage, grazing crop residues and supplementation with concentrate.

In the study of the distance of the animals to the feed source, it was observed that CL 2 and 5 do not have a significant degree of displacement, whereas CL 1, 3 and 4 have to be displaced at distances of at least 2 km. In general, grazing areas are where the herds are driven daily during the rainy season and in the dry season (Vázquez et al. 2009; Góngora et al. 2010; Borroto et al. 2011). 100% of the farmers consider that the breed type of their herd is suitable for the environmental conditions

in relation to the use of the food. Some authors have included in their studies the grazing time, distance traveled and months of grazing (Valerio et al. 2010; Galaviz et al. 2011).

3.13 System and production objectives

Extensive systems have as their main characteristic that all animals are kept in a single herd, there is no defined reproductive control, the ram remains in the herd throughout the year (continuous mating), and deliveries have very wide margins between them and occur throughout the entire year (García et al. 2010). This description was found in the present study: the form of production that prevails is extensive (43.2%) in CL 1, 2 and 4, whereas backyard production is present in CL 1 and 2 (16.8%), while the semi-extensive (CL 3) and intensive (CL 5) systems accounted for 20% (Table 10). In the semi-extensive there is greater control in the reproduction of the herd, with strategies such as well-defined breeding seasons, and the ram can be kept separate from the herd and only be used for breeding. The intensive type is mainly used by producers of finished animals for supply, therefore the animals generally depend on the food provided in the corral; these results match with Pérez et al. (2011), for example, with grazing of sheep, housing of lambs, supplying food supplementation before sale (Pérez et al. 2011), but also presented herds where feeding is based on grazing with periods of housing complementing the feed, with agricultural by-products and concentrates (Rivas et al. 2014).

Cluster	Land use (%)				No. of hectares used for livestock					Sheep activity (kilometers)				
	Communal	Ejidal	Forest	Private property	1	2	3	4	Sowing	0.5	1	3	4	8
CL1	0	100	0	0	0	100	0	0	Corn	0	0	0	100	0
CL2	0	100	0	0	100	0	0	0	Corn	0	100	0	0	0
CL3	100	0	0	0	0	0	100	0	Corn	0	0	100	0	0
CL4	0	0	100	0	0	0	0	100	Corn	0	0	0	0	100
CL5	0	0	0	100	0	100	0	0	Grass and oats	100	0	0	0	0
Total	20	40	20	20	20	40	20	20		20	20	20	20	20

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 9. Description of clusters according to land ownership, utilization of hectares and herd movement.

Within the production objectives, fattening of lambs is carried out in only 10% of the herds, while 90% of them are full cycle. In all herd nocturnal confinement is

carried out, while daytime confinement represented only 19.8% of herds (CL 3 and 5); this system of production is commonly used throughout the world (Valerio et al. 2010; Rivas et al. 2004).

3.14 Breeding, reproduction and replacement

It is fundamental to have a high reproductive efficiency that derives from good reproductive management, as well as from the incorporation of technological practices such as: weaning, controlled stock, flushing, use of the male effect, among others (Cuéllar et al. 2011). In this study, it is possible to observe that single births prevail in the herds, whereas in the herds that make up the CL 3 and 4 there are genotypes with a good rate of twin births. Generally, genotypes that do not present reproductive seasonality (67.6%) predominate, with seasonality (32.4%) representing mainly the herds that include CL 5. Pérez et al. (2011) in Veracruz, when studying the reproductive component, analyzed the period of mating and the time of birth, and found that the highest number of births is concentrated in winter (December-February) and spring (March-May), as was observed in this study.

Cluster	Production system (%)				Production objective (%)		Nocturnal	Daytime
	Extensive	Semi-extensive	Intensive	Backyard	Complete cycle	Fattening	confinement	confinement
CL1	50	0	0	50	100	0	100	0
CL2	66	0	0	34	100	0	100	16
CL3	0	100	0	0	100	0	100	33
CL4	100	0	0	0	100	0	100	0
CL5	0	0	100	0	50	50	100	50
Total	43.2	20	20	16.8	90	10	100	19.8

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 10. Description of the clusters according to the system and production objective of the production units.

It has been determined that the stock strategies in the herds commonly adopt the natural behavior of the sheep (Vázquez et al. 2009). Valerio et al. (2010) mention that in the Dominican Republic the producers use continuous stock throughout the year, while Góngora et al. (2010) found that the producers with a level of intensification used controlled stock and the less technological herds used continuous stock. Morantes et al. (2008) observed that in herds in Venezuela 100% of the production units do not carry out any control over the amounts. In contrast, countries such as Chile, Argentina, Uruguay, New Zealand and Australia carry out controlled births by

introducing the rams 2 to 3 months a year, later withdrawing, allowing the lambs to be collected at 2 months postpartum for sale.

It is proposed to apply genetic improvement in herds through the selection of replacement animals based on productive parameters such as birth weight, weight gain, weaning weight. For this, it is necessary for farmers to manage productive records. In all clusters, the percentage of replacements for both females and males varies between 1% and 3%, with a marked difference for those herds that make up CL 4, which shows a higher replacement rate, of 11% in females. The replacement females are produced on the farm itself (80%, CL5), while 20% (CL 1 and 2) females are purchased on the livestock market. In contrast to our study, producers in the Municipality of Toluca, Mexico keep the lambs as replacements and only 20% select a lamb as a replacement ram, which increases inbreeding within the herds (Plata et al. 2016). It is well known that inbreeding can generally produce a loss of aptitude or vigor, as well as affect productive characters.

Cluster	Reproduction in sheep (%)				Replacements (%)		Replacement females (%)			Replacement males (%)		
	Single	Twin	Seasonal	Not seasonal	Female	Male	Farm	Market	Another farm	Farm	Market	Another farm
CL1	100	0	12	88	3	1	50	50	0	50	38	12
CL2	100	0	50	50	1	1	50	50	0	50	50	0
CL3	67	33	0	100	3	2	100	0	0	0	50	50
CL4	50	50	0	100	11	1	100	0	0	0	0	100
CL5	100	0	100	0	2	1	100	0	0	0	0	100
Total	83.4	16.6	32.4	67.6	4	1.2	80	20	0	20	27.6	52.4

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_ intensive systems

Table 11. Description of the clusters according to the type of breeding, reproduction and replacement females of herds.

With regard to rams, 52.4% are acquired in another herd's breeding stock, 27.6% in the livestock market and 20% are produced within the UP (CL 1 and 2), suggesting a possible consanguinity scenario, such has been studied in another sheep population in the State of Mexico, finding little genetic variability (Camacho 2015). In the Municipality of Toluca (Plata et al. 2016) the producers obtain their replacements (males) within the locality or in nearby localities (50%). The rest of the farmers buy mainly in sheep farms relatively close to the region.

3.15 Selection of animal breeding

In the selection of the animals, it was found that 90% of the animals are chosen within the herd itself; in contrast, of animals that are purchased externally, 80% are selected according to a particular genetic line (Table 12). For productive information, only 10% use this information for the selection of the animals within their own herds (CL 5), while productive data is applied to 20% of animals purchased externally (CL 3 and 5 herds). It has been determined that when animals are selected within the locality or in surrounding localities, producers consider that “animals are healthy”, and when they are selected in livestock markets, the reason for buying there is because “there is higher quality of animals” (Plata et al. 2016).

3.16 Age of animal breeding and cause of elimination

It was found that the age of the sheep is between 18 to 36 months in 56.8% of the herds, while 43.2% did not know the age of the animals (Table 13). The average age of wombs at first calving is 16.6 months, with the highest age being recorded in the herds CL 1 and CL 2. This may be due to the fact that they do not supplement and do not plan the calving period. After more than a year, when at around 10 months of age sheep are already able to receive their first service and become pregnant, in these cases by limiting the management of supplementation, the animals do not reach the desired weight and because of this it takes more time until the sheep are ready to give birth. It has been observed that in countries like South America and in Australia, when supplements are not used, sheep do not reach their ideal weight and give birth between 12 and 16 months of age. It is also known when the lambs are weaned late, then it will be difficult for females to become pregnant before the lambs have reached one year of age. In the case of rams, 20% were younger than 36 months and 80% were older than 3 years of age, represented mostly in CL 1, 2, 3 and 4. The main cause of elimination of male breeders corresponds to their commercialization (81.8%). Only the herds of CL5 refer to eliminating animals for reproductive reasons, representing 10% of the total of the herds. To our knowledge there are no studies that have examined these variables.

Cluster	Sheep selection criteria			
	Own animals (%)		External animals (%)	
	For genetic line	For productive data	For genetic line	For productive data
CL1	100	0	100	0
CL2	100	0	100	0
CL3	100	0	50	50
CL4	100	0	100	0
CL5	50	50	50	50
Total	90	10	80	20

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_intensive systems

Table 12. Description of the clusters according to the selection criteria of the animals used by the sheep farmers.

Cluster	Age of females (%) (months)			Age of males (%) (months)			Cause of elimination in the herd (%)		
	Does not know	18 to 36	To calving	18 to 36	3 to 5 years	Mating	Reproductive	Sale	Substitution
CL1	25	75	18	25	75	18	0	100	0
CL2	16	84	20	0	100	19	0	84	16
CL3	25	75	14	0	100	16	0	75	25
CL4	100	0	14	25	75	17	0	100	0
CL5	50	50	17	50	50	21	50	50	0
Total	43.2	56.8	16.6	20	80	18.2	10	81.8	8.2

CL1_backyard, CL2_backyard-extensive, CL3_semiextensive, CL4_extensive, CL5_intensive systems

Table 13. Description of the clusters according to the age of the animals breeding and cause of their elimination in the herds.

4 | CONCLUSIONS

The generation of information and knowledge about practices implemented in the herds, and ways of improving them, can lead to a rational, sustainable and efficient use of resources. The integration of herds into clusters, according to the environmental descriptors through the methodology used in this study, allowed the productive structures within the sheep sector in different regions and/or countries to be characterized. The knowledge generated in this study will facilitate government agencies in implementing programs more suited to the needs of sheep production units.

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