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Original

Behaviour of the population structure and performance indicators in sheep production systems in Colombia

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ABSTRACT

Objective. The behavior of the population structure, indicators of reproduction and production in sheep were determined. **Materials and methods.** 104 sheep farms were monitored, in 7 regions of Colombia, corresponding to a population of 7708 animals, distributed in: Inventory, Infants, Growth 1, Development, Completion and Adults. It was applied descriptive statistics and simple ANOVA and with covariance. **Results.** The mean Inventory per farm is 74.1±79 heads; category Infants corresponds to 8.7% of the population, Growth1 15.3%, Development 12%, Completion 20.8% and Adults 43.3%. The Age of Conception in Corderas was 15.7±5.5 months; Age at First Delivery of 20.7±5.5 months; the Birth Interval Concepción was 160.3±65.4 days, the Interval Between Births was 310.3±65.4 days. The Birth Weight of males was 4.2±4 kg and females 3.4±1.2 kg, without significant differences (p>0.05); Weaning Weight, adjusted at 90 days (3 months) in males was 16.8±6.4 kg and females 16.3±5.6 kg, without significant differences (p>0.05); the weight at 12 months for males was 34.9±13.7 kg and females 33.4±10.7 kg, without significant differences (p>0.05). **Discussion.** Different sizes of farms are evident; the onset of reproductive activity is late, with Interval Between Births that maintain a not very dynamic reproductive rhythm. The productive variables are within the range. **Conclusions.** The indicators obtained represent referential information on the population structure and productive behavior of sheep production systems in the seven monitored regions of Colombia.

Keywords: Populations; biological indicators; reproduction; animal production; weaning (*Source: DeCS, CAB*).

RESUMEN

Objetivo. Se determinó el comportamiento de la estructura poblacional, indicadores de reproducción y producción en ovinos. **Materiales y Métodos.** Fueron monitoreadas 104 granjas ovinas, en 7 regiones de Colombia, correspondiente a una población de 7708 animales, distribuidos

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en: Inventario, Lactantes, Crecimiento 1, Desarrollo, Finalización y Adultos. Se aplicó estadística descriptiva y ANOVA simple y con covarianza. **Resultados.** La media de Inventario por granja es de 74.1±79 cabezas; la categoría Lactantes corresponde al 8.7% de la población, Crecimiento 1 15.3%, Desarrollo 12%, Finalización 20.8% y Adultos 43.3%. La Edad de Concepción en Corderas fue de 15.7±5.5 meses; la Edad al Primer Parto de 20.7±5.5 meses; el Intervalo Parto Concepción fue 160.3±65.4 días, el Intervalo Entre Partos fue de 310.3±65.4 días. El Peso al Nacimiento de los machos fue de 4.2±4 kg y hembras 3.4±1.2 kg, sin diferencias significativas (p>0.05); el Peso al Destete, ajustado a los 90 días (3 meses) en machos fue 16.8±6.4 kg y hembras 16.3±5.6 kg, sin diferencias significativas (p>0.05); el peso a los 12 meses para machos fue de 34.9±13.7 kg y hembras 33.4±10.7 kg, sin diferencia significativas (p>0.05). **Discusión.** Se evidencian diferentes tamaños de las granjas; el inicio de la actividad reproductiva es tardío, con Intervalo Entre Partos que mantienen un ritmo reproductivo poco dinámico. Las variables productivas están dentro del rango **Conclusiones.** Los indicadores obtenidos representan información referencial sobre la estructura poblacional y comportamiento productivo de sistemas de producción ovina en las siete regiones de Colombia monitoreadas.

Palabras clave: Poblaciones; indicadores biológicos; reproducción; producción animal; destete (*Fuentes: DeCS, CAB*).

INTRODUCTION

Sheep are organisms that create alternatives for development, productivity and competitiveness when they are established as a production system (1); they are mostly organised in small and medium size producers. Management in small systems occurs in most cases with little information on the performance conditions of the animals (2); they are worked by hand with low levels of production, so the final product, and the growth and productivity of the farm are not clear or standardised(3,4,5), nor is the importance of evidencing the events that occur on the farm through records, which facilitate the analysis of information, construction of performance indicators and the proposal of measures to improve productivity, viability and competitiveness in comparative terms (3,6,7). All of the above leads to a lack of information regarding indicators or data that allow reaffirming the opportunities presented by small ruminants. These advantages, such as rapid growth, a shorter age at first service, prolificacy, adaptation to varied climates, are what make these animals attractive for a better development of the sector and the country; more equitable and inclusive with small producers (8,6). In this case, the deficiencies can be overcome under associative schemes and productive chains, which promote growth, organisation, product safety, quality aspects, all of this, of course, linked to the analysis of information as part of an adequate administration and with projection (9).

The objective of this paper was first to know the behaviour of the population structure by categories that are part of the production system, identifying them by their ages: lactation, growth and completion (growing females) and reproductive physiological condition: adults (parturient females), breeding males and the relationships between them; and, secondly, to identify the behaviour of reproductive and productive indicators based on monitoring for a period of five years in 104 sheep farms.

MATERIALS AND METHODS

Location and target population. The research project was carried out in seven regions of Colombia, located in the departments of Córdoba, Sucre, Antioquia, Boyacá, Cundinamarca, Santander, and Valle del Cauca, in 104 sheep farms, where the minimum base population for each of them had to be greater than 20 adult females of the ovine species, taking wool-type and hair-type animals for the study.

Information system. Once the process of selecting the producers to participate in the monitoring programme (visits with a frequency between 45-60 days) was completed, the information system was set up. In each farm, the animals were identified through a plastic device placed in the ear (flap or earmuff), determining sex, classification of the breed typology, estimation of age by evaluating the dental structure or chronometry (10, 11), and physiological state (empty, pregnant).

Population, reproductive and productive indicators. Table 1 shows the indicators that were evaluated within three categories: population, reproduction, and production. The first being those that assess the behaviour of the population dynamics at the level of females and males, the reproductive ones, which show the reproductive performance and some productive indicators for assessing weighing and monitoring of the growth of the animals.

Statistical model. The Stata 11.2® package was used, and descriptive statistics analysis was conducted, which includes measures of central tendency (mean and median), measures of dispersion (standard deviation), and ANOVA. Normality, homoscedasticity (which refers to the characteristic of a linear regression model that implies that the variance of the errors is constant over time) and independence of the data were evaluated to determine the statistical model to follow.

Model

$$Y(ij)=\mu+\alpha(i)+\beta(i)+...+\alpha(i)\beta(i)...+e(ij)$$

Where:

Y(ij)	Dependant indicator
μ	General average of each indicator
α, β	Treatment effect
e (ij)	Experimental error

The work was carried out within the framework of the project "Development and Implementation of a Technology Management System to Improve the Competitiveness of the Sheep-Goat Chain (SIGETEC)", with funding from the Ministry of Agriculture and Rural Development, where the National University of Colombia – Bogotá Campus, La Salle University, the Colombian Corporation for Agricultural Research (CORPOICA, now AGROSAVIA) and the National Association of Goat and Sheep Farmers of Colombia (ANCO) participated.

Table 1. Estimated population, reproductive and productive indicators and their determination

Type / Indicator	Comprising
Population	
Lactating (L)	Females or males in calf of 1 - 4 months of age.
Growth 1 (C1)	Females or males weaned from 4 - 8 months, when puberty begins.
Development (D)	Females or males in the stage of puberty, suitable for reproduction, aged between 8 - 12 months.
Completion (F)	Includes breeding ewe lambs ranging from 12 months to first calving and feeder males ranging from 12 months to slaughter.
Replacement Females (HR)	Sum of all the females of categories L, C1, D and F.
Adults (A)	Including Adult Females (HA), those females that have already given birth or more, and the Breeding Males (MR) of the farm.
Replacement Females to Adult Females Ratio (R HR:HA)	Growing females divided by adult females.
Total Stock (INV)	Total number of animals on the farm.
Breeding Female Stock (HV)	Inventory of females in Completion plus the Adult Females.
Breeding Female/Male Ratio (R HV:MR)	Total females ready for reproduction divided by the number of reproducers.
Ratio of Breeding Males to Breeding Female Stock (R MR/HV)	Proportion of Breeding Males over the stock of total Breeding Females.
Female Growth Rate per month (RHCm)	Ratio in the animal stock of females and their physiological stage.
Reproduction	
Lamb Age of Conception (ECC)	Age in which the female becomes pregnant for the first time.
First Calving Age (EPP)	Age at which the female has her first calving.
Birth-Conception Interval (IPC)	Days that elapse from birth to conception.
Interval Between Births (IEP)	Time that elapses from one birth to the next birth, in days.
Production	
Birth Weight (PN)	
Weaning Weight (P3M)	Adjusted to 90 days or 3 months.
Weight at 8 months (P8M)	
Weight at 12 months (P12M)	
Weight at 24 months (P24M)	
Daily weight gain (GDP)	Calculated for different time intervals.
Harmonic Replenishment Rate (TAR)	The indicators obtained from the HA, EPP and IEP inventory were used, with which an average discard age of 6 years could be estimated. A baseline mortality of 2% in adults and 5% in young people was considered, with a perspective of a desired IEP of 240 days.

RESULTS

Population indicators. For the population structure, the stock of each farm incorporated into the information system was considered, defining animal categories, classified by age and physiological reproductive status.

With the monitoring performed, the data of the studied population were obtained, corresponding to 7708 animals, of which the total HR, which includes females L, females in C1, females in D and females in F, was 2710 animals; the total of males L, males in C1, males in D and males in F was 1666 animals; the total of HA was 3154 animals, which, in addition to the females in F, adds up to a total stock of HV of 4497, and the total MR was 178 animals.

Lactating animals. The category of animals in the lactation stage is shown in table 2, where females and males from 0 to 4 months of age are listed. 104 farms were evaluated, of which 60 were lactating animals, representing 57.6% of the total. In the remaining 42.3%, no lactating animals were found.

Table 2. Male and female lactating animals by farm.

Category	n(G)	n(A)	%	Mean	Median	Sta Dev
Lactating						
Females	54	347	4.5%	6.4	3.5	9
Males	53	325	4.2%	6.1	3.0	8
Total stock	60	672	8.7%	11.2	6.5	16

n(G)= Number of farms, n(A)= Number of animals, %=Total population percentage.

On the 60 farms with lactating animals, 54 were females and 53 males. Category L corresponds to 8.7% of the total stock of a farm, structured by 4.2% lactating males and 4.5% lactating females; the total mean per farm was 11.2±16 animals. So, the total stock for category L was very dispersed regarding females and males.

Growth 1, Development and Completion. Taking the 104 farms monitored for all categories as a starting point, 84 were found with animals in stage C1, representing 80.7%; 19.3% correspond to farms without animals in C1. Regarding category D, it was observed that in 85 farms there was the presence of animals, equivalent to 81.7% of the total; in 18.2% no animals were found at this stage. Likewise, for category F, 100 had animals in F, corresponding to 96.1% of the farms, 3.9% did not have animals in this category (Table 3).

Table 3. Animals in Growth stage 1, Development and Completion, females and males per farm.

Category	n(G)	n(A)	%	Mean	Median	Sta Dev
Growth 1						
Female growth 1	80	620	8.0%	7.8	5	9
Male growth 1	74	561	7.3%	7.6	5	8
Total stock growth 1	84	1181	15.3%	14.1	9	17
Desarrollo						
Female development	62	400	5.2%	6.5	4	9
Male development	80	522	6.8%	6.5	4	8
Total stock development	85	922	12.0%	10.9	6	14
Completion						
Suitable age females	98	1343	17.4%	13.7%	7	20
Fattening males	47	258	3.3%	5.5%	2	12
Total stock completion	100	1601	20.8%	16.0%	8	26

n(G)= Number of farms, n(A)= Number of animals, %=Total population percentage

As for category C1, of the 84 farms, equivalent to 80.7%, the distribution of females and males was 74 with males, 80 with females and with both sexes 84 farms; category C1 corresponds to 15.3% of the total stock of a farm, consisting of 8% with females and 7.3% with males. The average total stock of animals per farm in category C1 was 14.1±17. In stage D, 85 farms were observed, 62 of which had females, 80 males and 85 males or females; 12% of the total stock of a farm is found in this category, made up of 6.8% males and 5.2% females. The average number of animals in D per farm was 10.9±14 animals. On the other hand, on F, in 98 farms out of 100 that were observed, females were found, in 47 males and in 100 males or females. This stage F involves 20.8% of the total inventory of a farm, made up of 3.3% males and 17.4% females. The total average of animals in the category per farm was 16±26 animals. A high dispersion is observed in relation to the number of average animals for each category in which the animals were grouped.

Adult stock. The following table shows the results of the adult animal stock. 104 farms were evaluated, of which 100% had the presence of adult animals, both female and male.

Table 4. Adult animals present on farms, breeders and females.

Category	n (G)	n (A)	%	Mean	Median	Sta Dev
Adults						
Females	102	3154	40.9%	30.9%	20	31
Breeding	81	178	2.3%	2.2%	1	2
Total stock adult	104	3332	43.2%	32.0%	21	32

n(G)= Number of farms, n(A)= Number of animals, %=Total population percentage

Of the total farms analysed, females were found in 102, males in 81 and males or females in 104; this stock includes HA and MR; 43.2% of the animals in the total inventory of a farm are in this category, consisting of 40.9% HA and 2.3% MR. The average total number of animals per farm was 32±32 animals.

Ratio of Growing Females per month HCm and ratio of Growing Females / Adult Females – R HC: HA. The following figure (figure 1) shows the percentage distribution of the females in their different categories. The L stage showed an average of 6.4 animals/farm, which represent 4.5% of the figure. In C1, 7.8 animals/farm were found, accounting for 8%; In D, the average was 6.5 animals, which appear at 5.2%; In F, on average, there were 13.7 animals/farm, which concerns 17.4%; lastly, adult females, with an average of 30.9 animals per farm, were the majority, being equal to 40.9% of the animal stock per farm.

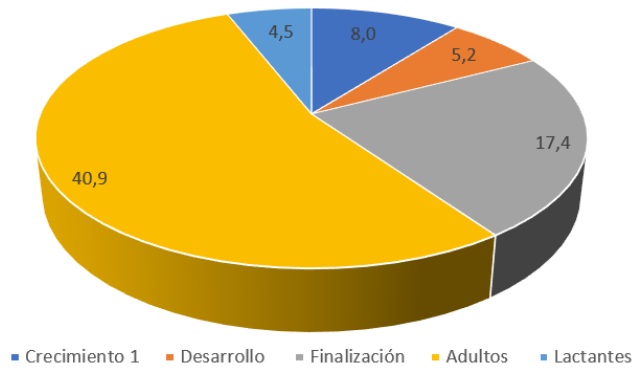

Figure 1. Proportional ration for each category from the Growing Females.

The desired population dynamics or composition estimates took into account the behaviour of the indicators obtained: Average HA stock - 30.3 animals/farm, EPP - average 20 months, IEP - average 310 days, based on which a discarding age of 6 years was estimated. With this parameterisation and assuming a mortality of 5% in young people and 2% in adults, an ARR of 23% was obtained. Hence, when generating the RHCM, there should be a constant in the HC stock: 2 females in Lactating, 2 females in C1, 2 females in D, and 5 females in F. When comparing it with the current stock found, we observe that in every category there is a surplus of animals that may be indicating that all females are being retained, which can be explained if an increase in the size of the herd or females to sell is being sought, generating an overload in the productive system if its permanence is prolonged and there is no adequate management of grasslands.

Of the 104 farms observed, the R HC/HA parameter had an average of 0.73±0.47, a median of 0.72, which indicates that for each HA there are 0.73 HC. Previously, we mentioned that, if what is expected is that a female is productive for about 6 years, and that at 20 months she has her first calving, females could be productive for about 4.3 years, this allowed determining that the annual replacement would be 23% to keep the stock stable. The 23% TAR allows calculating an additional indicator, taking the TAR to RHCm and multiplied by the age at first calving, and estimating the amount of HC (replacement ewe lambs) at 0.38, that is 38 HC for every 100 HA. Due to the fact that the average of this ratio for the animals under study was 0.73, it is confirmed that the number of females is high and exceeds the needs of the system. These females are generally used for future replacements, sale, larger stock, or inventory, but if they are not controlled, they lead to significant cost overruns that affect the performance indicators of the system.

Breeding Female/Breeding Male Ratio. As seen in table 5, on the farms, the HV parameter (HA plus F) has a mean of 58.3±47%.

The R HV/MR is 25:1, which corresponds to a ratio of 3.8% males in the herd for mating (MR – 178 / HA – 3154 + L – 1343).

Table 5. Ratio between growing and adult females with breeding males.

Category	n(G)	n(A)	Mean	Median	Sta Dev
HC/Adult	104		0.7	0.72	0.47
Total Breeding Females	103	4.497	58.3	29	47
Breeding Female/ Male	80		25.3	20	17

n(G)= number of farms, n(A)= number of animals

Reproduction indicators. Hereunder are some indicators related to reproductive aspects of ewe lambs for 90 farms observed (n=1422). The first is the ewe lamb conception age (ECC), an average of 15.7±5.5 months and a median of 15 months was reported; the age at first calving (EPP) was 20.7±5.5 months with a median of 20 months. As for adult females, 85 of the 104 farms evaluated (n=2949) had an average calving to conception interval (CPI) of 160.3±65.4 days, with a median of 153 days. As for the calving interval (IEP), this average was 310.3±65.4 days, with a median of 303 days (Table 6).

Table 6. Reproduction indicators: ECC, EPP, IPC and IEP evaluated on farms.

Indicator	n(G)	n(A)	Mean	Median	Sta Dev
ECC	90	1422	15.7	15	5.5
EPP	90	1422	20.7	20	5.5
IPC	85	2949	160.3	153	65.4
IEP	85	2949	310.3	303	65.4

n(G)= number of farms, n(A)= number of animals

On the other hand, it was found that the females monitored at the age of 36 months had an average adult weight of 43.8 kg (table 7), which would allow estimating said females are in a state of weight above the recommended one, which it is about 70% (adult weight), in other words, about 30.7 kg (more or less); the females reach such weight at about 11 months of age, and this also depends on factors such as genetics (Figure 2; Table 7).

Production indicators. In this section, the weights of females and males at different ages are analysed. The mean PN of the males was 4.2±4 kg (n=519) greater than the weight of the females, which was 3.4±1.2 kg (n=557) (p>0.05), finding no difference in the PN variable between sexes Table 7.

Birth weights are observed up to month 40, expressed in kg for females and males present in the monitored production systems. The average adjusted weaning weight at 90 days - P3M was 16.6±6 kg, with the weaning weight of the males being 16.8±6 kg, surpassing the females who had 16.3±5.6 kg. No significant differences were found between sexes (p>0.05).

Significant differences were found from month 16, males being heavier and with a greater deviation compared to females of the same age.

With the data taken from the weights of the animals, a growth curve by sex was created, observing that the PN for females began with a PN of 3.5 kg, inclined with a maximum growth slope close to 9 months of age with a weight of 30.2 kg, evidencing an GDP of 0.098 kg/day, over 9 to 16 months the growth observed is lower, starting from 30.2 kg up to 36 kg, with GDP rates of 0.027 kg/day. In the 16 to 26 months stage, growth slows down even more, starting from 36 kg to 39.8 kg, the GDP rate for this moment was 0.012 kg/day. Thus, at 36 months, the maximum weight was obtained with a value of 43.8 kg. Regarding the males, the weight at birth was 4.4 kg. Following the growth curve at 10 months of age, weights around 31.5 kg were obtained with GDP of 0.090 kg/day, and at 20 months weights over 50 kg with GDP of 0.061 kg/day, showing a variability in weights with ups and downs perhaps related to reproductive activity (Figure 2).

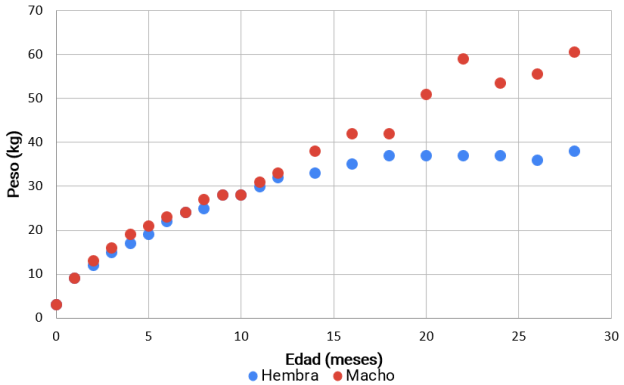

Figure 2. Male and female sheep growth curve.

Table 7. Male and female sheep weight at birth and in months (kg)

	Female					Male				
Age	**n (G)**	**n (A)**	**Half**	**Median**	**Sta. Dev.**	**n (G)**	**n (A)**	**Half**	**Median**	**Sta. Dev.**
BW	87	557	3.4[a]	3.0	1.2	85	519	4.2[a]	3.0	4.0
1	82	525	9.1[a]	9.0	3.2	81	494	9.3[a]	9.0	3.8
2	83	531	12.6[a]	12.0	4.4	82	500	13.2[a]	13.0	4.8
3	85	544	16.3[a]	15.0	5.6	85	519	16.8[a]	16.0	6.4
4	84	538	18.3[a]	17.0	5.6	83	506	20.2[a]	19.0	7.9
5	85	544	21.2[a]	19.0	7.6	79	600	22.3[a]	21.0	7.9
6	80	512	23.7[a]	22.0	8.5	78	593	24.4[a]	23.0	9.2
7	78	499	25.7[a]	24.0	9.3	78	593	27.2[a]	24.0	11.2
8	78	499	26.9[a]	25.0	9.3	70	532	29.0[a]	27.0	11.2
9	81	632	30.2[a]	28.0	11.6	71	462	31.1[a]	28.0	13.5
10	82	640	29.6[a]	28.0	9.9	67	436	31.6[a]	28.0	12.4
11	84	655	32.1[a]	30.0	12.0	65	423	34.4[a]	31.5	12.9
12	84	655	33.4[a]	32.0	10.7	58	377	34.9[a]	33.0	13.7
14	83	540	34.6[a]	33.0	10.8	50	165	38.9[a]	38.0	16.4
16	83	540	36.0[b]	35.0	10.9	48	158	42.3[a]	42.0	14.6
18	84	546	38.2[b]	37.0	12.1	40	132	46.3[a]	42.0	14.2
20	83	540	38.8[b]	37.0	10.7	38	125	50.0[a]	51.0	15.5
22	79	2441	39.1[b]	37.0	11.8	34	75	56.9[a]	59.0	17.4
24	82	2534	39.7[b]	37.0	11.2	35	77	55.9[a]	53.5	20.1
26	80	2472	39.8[b]	36.0	11.4	29	64	55.5[a]	55.5	19.3
28	84	2596	41.2[b]	38.0	12.5	31	68	62.0[a]	60.5	18.7
30	76	2348	42.6[b]	39.0	13.2	17	37	55.5[a]	49.5	19.0
32	77	2379	42.5[b]	38.5	12.3	24	53	58.6[a]	54.0	18.2
34	80	2472	43.3[b]	39.5	14.2	17	37	64.9[a]	63.0	20.5
36	79	2441	43.8[b]	41.0	13.1	25	55	65.5[a]	66.0	22.1
38	78	2410	43.6[b]	40.0	14.2	24	53	74.0[a]	70.5	26.4
40	73	2256	43.1[b]	41.0	13.1	23	51	70.4[a]	65.0	25.9

Age= months, n(G)= number of farms, n(A)= number of animals, Mean=expressed in Kg. Means with different literals in columns indicate difference ($p<0.05$)

DISCUSSION

Population indicators. The average values of animals per farm were 74.1±79 with a median of 47 animals. Herd size was similar to data reported from Costa Rica, with a median number of animals of 50 (12), being higher than that found for Mexico, where authors record an average of 21 to 40 animals per herd (13). Regarding the total stock of animals, (14) the research concludes that a better distribution of animals, and therefore, good performance, are associated with the degree of intensification of the production system. This is related to the fact that sheep production, the object of this study, is an activity by small agricultural producers (15), for which several things must still be organised, especially regarding the dynamics. In this sense (6), it is mentioned that, associated with a small number of animals in inventory, producers with a low technological level are assumed, for which it is proposed that, when there are more animals, the systems tend to have a higher technological level and a high degree of specialisation, which is not necessarily always the case.

In reference to adult animals, the average value found, which was 32, is comparable with stratum I categorised by (14); where an average number of bellies of 23 ± 9 animals was observed for hair sheep, these farms being less susceptible to variation in the number of animals.

Breeding Females/Reproductive Males Ratio. The R HV/MR is 25:1, which is within normal parameters (16, 17).

Reproduction indicators. When high ECC are present, this has the effect of greater EPP, shortening the productive lifespan, which results in a lower number of births, as well as fewer offspring produced in the life of the female (18), which it is associated with the management system, feeding, breed typology, body development, the weight of the lamb, the availability of breeding males, time of year, amongst others (19).

As for the weight and age at conception, it was mentioned that the ewe is fit to reproduce at over 11 months; Therefore, conception is sought after 12 months of age, so it is estimated at 17 months to have calved females (EPP). As reported by some authors, the EPP, in hair sheep, has been found at values of 17.5 months (20), 15.9±2.8 months (21), even reporting higher values than those shown here, with EPP of 23.7±0.4 months (22).

There is a relationship between the IPC and IEP indicators, generating the IPC an impact by shortening the productive time of the female, which caused a lower number of births, and therefore, of offspring bred during the productive life of the females. All of this is also related to the availability of food at the time of delivery: if there is little forage, the animal does not have energy reserves to restart its ovarian cycle (21). Moreover, errors in detecting heat interfere with insemination or mounts, breed type, seasonality, which cause low reproductive efficiencies (23). The IEP has been reported in 259.2 days (24), 351.82±1.12 days (22).

Production Indicators. Birth weights were 4.2 for males and 3.4 for females, which conforms with that reported by (25, 26), who also found no significant differences. Regarding the weight at weaning, there were no significant differences, which is a case similar to that reported for heavy sheep (27).

The indicator of daily weight gain was higher in the lactation stage compared to other stages, which is related to the ability of small animals to be major transformers of milk in kilograms of meat (28). This gain, with the passage of age, is influenced by the quality of the food, the health status of the offspring, etc.

The significant differences found from month 16 are based on the fact that, within the study, varied animals are found in terms of whether there were wool and hair, modifying a little the breed phenotype, diversity of forage supply, affected by the particular conditions of the environment and the technological level of the producer, which evidently generates an effect on the reported weights (29).

In figure 2, some reports on the PN were presented. Some authors for hair type sheep (to a large extent) obtained weights of 2.6±0.07 kg, where the difference is associated with the factor of the breed typology (29), finding that wool-type animals, of the merino breed, obtained birth weights of 4.83 kg (30), in animals of early breeds the PN was 4.8±1 kg (31) and in wool-type sheep, the PN was 4.1±0.1 kg. (32).

In addition, in relation to birth weight, females with Dorper * Blackbelly crossings were found with weights of 2.8±0.08 kg, Dorper * Pelibuey with 2.9±0.08 kg, Kathadin * Blackbelly with 2.7±0.09 kg, Katahdin * Pelibuey with 2.9± 0.07 kg, Pelibuey * Blackbelly with 2.7±0.08 kg, Pelibuey 2.6±0.07 kg (29) and in merino animals 4.3 kg, evidently higher than those of this study (30), as for premature breeds, weights of 4.5±1 kg (31). Within the behaviour of the variables of a production system, the variable birth weight has a great impact on the survival of the lambs and on growth during the lactation stage. All of this is subject to factors intrinsically associated with the genetics of the parents, the mother, mainly age, food availability, supplementation especially in the last three months of gestation, type of delivery, time of year, sex of the offspring and handling in nutritional and health terms (30).

In conclusions from this study, it is worth noting that, to a large extent, the producers are small with an average stock of 74.1 animals/farm. The population dynamics of the herds oscillates between 4.5% of females in L, 8.0% of females in C1, 5.2% females in D, and 17.4% females in F, leading to an R HC:HA of 0.73, which implies more females in the herd than what might be needed based on population dynamics, as well as an accelerated or uncontrolled herd growth.

The ECC, EPP, IPC and IEP reproductive indicators of the sheep in the monitored production systems have a lower performance than that reported by other authors.

The PN, P3M, P8M, P12M; P24M productivity indicators are within the regular parameters reported for the species, finding a higher weight

for males compared to females, with significant differences being found in some stages of development ($p<0.05$).

Conflict of Interests

The authors declare that they have no conflict of interest. The funders had no role in the design of the study, nor in the collection, analysis or interpretation of data, nor in the writing of the manuscript or in the decision to publish the results.

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