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Research note

Lamb growth and ewe productivity in Pelibuey sheep under tropical conditions

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Abstract:

Preweaning growth of lambs and ewe productivity are vital indicators of sheep production system success. An evaluation was done of the effects of birth season and year, birth type, sex and parturition number on preweaning growth and ewe productivity in Pelibuey sheep in a semi-extensive system in the humid tropics of Mexico. Data were from the production records of 323 ewes over a 7-yr period (2011-2017). Birth weight (BW), weaning weight (WW, at 60 d) and litter weight at weaning (LWW) were evaluated. Other evaluated factors included ewe prolificacy, preweaning mortality and lamb weight per ewe in a 240-d cycle (LW240d). All the factors affected ($P \leq 0.05$) the response variables. Lambs from multiple births had lower ($P<0.05$) BW and WW, but higher ($P<0.05$) LWW, LW240d, and mortality than lambs from single births. Lambs born in the dry season had higher ($P<0.05$) BW and WW, and ewes had higher LWW and LW240d, than in other seasons. Compared to multiparous ewes (≥3 parturition), primiparous ewes had lighter lambs ($P<0.05$) at birth and weaning, as well as lower ($P<0.05$) prolificacy, LWW and LW240d. Birth year affected ($P<0.05$) BW, WW, mortality and productivity characteristics. Preweaning growth performance was best in lambs born from multiparous sheep with a single parturition in the dry season. However, ewe productivity was highest in the dry season in multiparous ewes with two parturitions a year.

Key words: Hair sheep, Birth weight, Preweaning growth, Lambs.

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Preweaning growth in lambs and ewe productivity are critical aspects of sheep production that impact herd profitability. They must be constantly evaluated on sheep ranches since they function as productivity indicators used to adjust existing or incorporate new management, nutritional and genetic improvement strategies[1,2].

Lambs births, their birth weight, weaning weight adjusted to 60 days, parturition interval and preweaning mortality are financially important characteristics used in estimating productivity parameters[3,4,5]. Ewe productivity is a composite characteristic determined by herd fertility, number of lambs per parturition, total litter weight at birth, average weaned lamb weight, total litter weight at weaning and the number of lambs weaned[6]. Each of these parameters can be used as a selection criterion, but combining them into in an appropriate selection index can result in more efficient genetic improvement gains per generation and/or year[3,7,8,9].

Productivity and other financially important characteristics are the result of interaction between genotype and environment. Genetic components include factors such as ewe age, prolificacy, and calving number, while environmental factors include herd nutritional management, birth year, birth season environmental conditions and forage availability[10].

All these genetic and environmental factors significantly impact ewe reproductive performance and productivity, as well as lamb development and growth[10,11].

Establishing management and selection strategies in Pelibuey sheep herds in the humid tropics requires identification of the genetic and environmental factors that influence lamb preweaning growth, and short- and long-term ewe productivity[4]. Further research is needed on the factors associated with lamb growth and Pelibuey ewe productive capacity. These data will inform decision making on management practices and establishment of genetic improvement strategies aimed at conserving Pelibuey sheep in their natural habitat. The present study objective was to evaluate the effects of some environmental factors on lamb preweaning growth and ewe productivity in Pelibuey sheep under a semi-extensive production system in the humid tropics.

The analyzed data is from 7 yr (2011-2017) of production records for Pelibuey sheep (n = 323) in a production unit in the state of Tabasco, Mexico. Regional climate is humid tropical with rains year-round (2,550 mm on average). Based on seasonal variations in climatic variables, three seasons are identified in the region: dry (March to May), rainy (June to October) and northwinds (November to February). Average temperatures are 18 °C minimum and 36 ºC maximum, with an annual average of 27 ºC. Relative humidity fluctuates between 60 and 95 % depending on season[12].

During the study period the production unit had two modules. The first was a 15-ha area designed for breeding which included sheds, mating pens, a grazing area (2 ha *Panicum maximum* grass and 9.5 ha *Cynodon dactylon* grass), and a 3.5 ha field of corn for silage. The second consisted of 5 ha of roofed birthing sheds housing pregnant sheep, for parturition and lamb care.

General animal management during the study period consisted of controlled natural mounting, with continuous breeding at a 25 to 30 ewe to ram ratio. After birth lambs were confined with their mothers for the first few weeks. The ewes were later allowed to graze. Lambs were provided free access to concentrate in creep feeding cages during the 60-d preweaning period. At the end of the postpartum period male lambs were fattened for slaughter or selected as sires, while the best female lambs were set aside as replacements and housed in raised-floor pens. The ewes received commercial dietary supplements to ensure fulfillment of nutritional requirements according to physiological state: breeding (crude protein [CP] = 12%, metabolizable energy [ME] = 2.4 Mcal/kg dry matter [DM]); gestation (CP = 11-12%, ME = 2.4 Mcal/kg DM); and lactation (CP = 12-16%, ME = 2.2.-2.5 Mcal/kg DM). When pasture forage availability was low hay was provided in pens with a commercial concentrate supplement.

Parasites were monitored monthly using the FAMACHA© test. Deworming was done alternately with 2.5% albendazole (Valbazen, Zoetis®) and 12.0% levamisole (Riperocol, Zoetis®), after coprological parasite testing every three months. Animals were vaccinated against clostridiasis and pneumonic pasteurellosis every six months (April and October), and the herd was brucellosis-free.

A database was created using the records of 343 ewes that gave birth between 2011 and 2017, producing 2,335 lambs. The data collected for each ewe was parturition number; season, parturition date, litter size, number of lambs weaned and weaned lambs at 240 d postpartum. The data collected for each offspring included identification number; sex; birth weight (BW); weaning weight (WW); and weight at 240 d postpartum. Calculations were done of prolificity (number offspring born per parous ewe); preweaning mortality rate (percentage offspring mortality during weaning period); litter weight at weaning (LWW); total litter weight adjusted to 60 d; and total litter weight adjusted to 240 d postpartum (LW240d). Productivity adjusted to 240 d[2] was defined as LWW adjusted by ewe parturition interval and multiplied by 240 d (i.e. the optimal time for attaining three gestations in two years under a continuous breeding system).

All results were analyzed with the SAS statistical package[13]. For BW and WW the model included the fixed effects of birth year, birth season, type of birth, sex, birth number, and first-order interactions. This previous model was also used for LWW and LW240d, but without including the effect of sex and interactions. In the case of prolificacy the model included the effects of birth year, birth season, birth number and simple interactions. The interactions were not significant (P>0.05) for any of the study variables. Preweaning mortality was analyzed using Chi-square test.

All the preweaning and productivity traits were affected (P≤0.05) by the studied factors, with the exception of season for prolificity and preweaning mortality. In terms of birth type, lambs that were sole progeny had higher (P<0.05) BW and WW, but lower LWW and LW240d, than lambs born as part of a multiple birth (Table 1). Mortality was highest for lambs in triple births, followed by those in single births. Lambs born in the dry season had higher (P<0.05) BW, WW, LWW and LW240d, but no difference in prolificacy and mortality rates (P>0.05), compared to those born during the rainy and northwinds seasons. Male lambs were heavier (P<0.05) at birth and weaning than female lambs. Sex had no affect (P>0.05) on preweaning mortality rate.

Table 1: Least means squares (±standard error) for the effects of birth type, birth season and lamb sex on preweaning growth and ewe productivity variables in Pelibuey sheep

	BW (kg)	WW (kg)	LWW (kg)	LW240d (kg)	Prol	Mort (%)
Birth type	<0.0001	<0.0001	<0.0001	<0.0001	-	<0.01
Single	3.14±0.03[a]	12.82±0.15[a]	12.92±0.20[a]	11.56±0.39[a]	-	21.34[b]
Doble	2.52±0.02[b]	10.56±0.17[b]	20.76±0.22[b]	19.15±0.43[b]	-	15.07[c]
Triple	2.04±0.05[c]	-	-	-	-	30.17[a]
Birth season	<0.0001	<0.0001	<0.0001	<0.0001	0.36	>0.05
Dry	2.63±0.04[a]	12.45±0.23[a]	18.09±0.31[a]	16.67±0.46[a]	1.61+0.04[a]	22.10[a]
Rainy	2.53±0.03[b]	11.79±0.16[b]	16.84±0.21[b]	15.02±0.76[b]	1.51+0.05[a]	22.10[a]
Northwinds	2.54±0.03[b]	10.82±0.17[c]	15.59±0.22[c]	14.36±0.39[b]	1.56+0.05[a]	22.38[a]
Lamb sex	<0.0001	<0.0001	-	-	-	>0.05
Male	2.64±0.03[a]	12.11±0.16[a]	-	-	-	21.24[a]
Female	2.50±0.03[b]	11.26±0.15[b]	-	-	-	23.14[a]

BW= birth weight; WW= weaning weigh; LWW= litter weaning weight; LW240d= litter weight adjusted to 240 d; Prol= prolificity; Mort= preweaning mortality.

[abc] Different letter superscripts in the same column and within the same effect indicate significant difference (*P*<0.01).

Lambs born to primiparous ewes had the lowest (*P*<0.01) BW, WW, LWW, LW240d and prolificity. Ewe mortality was highest for those with one or six parturitions.

Table 2: Least means squares (±standard error) for the effect of parturition number on preweaning growth and ewe productivity variables in Pelibuey sheep

	BW (kg)	WW (kg)	LWW (kg)	LW240d (kg)	Prol	Mort (%)
Part. No.	<0.0001	<0.0001	<0.0001	<0.001	<0.01	<0.01
1	2.20±0.03[d]	10.82±0.17[d]	15.52±0.22[b]	13.50±0.43[b]	1.39±0.03[c]	24.77[a]
2	2.48±0.03[c]	11.94±0.20[b]	17.02±0.26a	15.42±0.47[a]	1.45±0.04[c]	19.99[b]
3	2.59±0.03[b]	12.15±0.23[ab]	17.43±0.30[a]	15.89±0.50[a]	1.54±0.04[b]	19.79[b]
4	2.65±0.04[a,b]	11.94±0.26[b]	17.18±0.34[a]	15.74±0.55[a]	1.72±0.05[a]	23.08[ab]
5	2.72±0.04[a]	11.92±0.30[b]	16.73±0.39[a]	15.84±0.64[a]	1.62±0.05[a]	20.15[b]
6	2.72±0.05[a]	12.52±0.37[a]	17.32±0.47[a]	15.58±0.76[a]	1.50±0.05[bc]	26.58[a]
≥7	2.61±0.05[a,b]	11.40±0.32[c]	16.69±0.45[a]	15.50±0.88[a]	1.60±0.06[ab]	20.99[b]

BW= birth weight; WW= weaning weight adjusted to 60 d; LWW= litter weaning weight; LW240d= litter weight adjusted to 240 days; Prol= prolificity; Mort= preweaning mortality.

[a,b,c,d] Different letter superscripts in the same column indicate significant difference (*P*<0.01).

The improved BW and WW of lambs from single births did not result in better productivity since multiple-birth ewes exhibited higher LWW and LW240d. Similar results on lamb preweaning growth and ewe productivity in Pelibuey sheep have been reported previously in sub-humid[2] and arid tropical climates[1]. Lower BW and preweaning growth in offspring from multiple births may be due to delayed fetal scheduling of growth in the prenatal period[14]. Another possible cause is undernourishment in response to insufficient breast milk production to adequately nourish two or more lambs[15]. Limited space in the uterus in pregnancies with multiple products can also be reflected in low BW[1,15]. Although lambs born in multiple births exhibit less growth and a higher preweaning mortality rate, litter size at weaning per ewe is larger, which increases the overall weight of lambs weaned per ewe.

The effect of sex on BW and WW in Pelibuey and Pelibuey cross lambs has been reported previously[15,16,17]. This occurs because during the prenatal to postnatal stages male lambs secrete testosterone, a steroidal hormone important in growth due to its anabolic effects and stimulation of growth hormone[18].

Birth season and year also influenced lamb growth and ewe productivity, which is to be expected due to climatic variations, as well as year-to-year differences in forage availability and quality in extensive and semi-extensive systems[19]. Years and seasons with more rainfall and more thermoneutral temperatures for sheep tend to result in better lamb growth due to greater forage availability [16,20]. Preweaning mortality consequently decreases while weaned lamb weight per parous ewe increases during the most favorable season. This explains why lamb growth and ewe productivity varied between years, which coincides with previous studies in tropical regions of Mexico[11,17,21].

The improved lamb growth and ewe productivity observed in Pelibuey sheep during the dry season in the present study partially coincides with a previous study from the same region in which preweaning growth in Pelibuey lambs was best in the dry and rainy seasons[17]. Another study found ewe productivity at weaning to increase during the dry and northwinds seasons[21]. These discrepancies in results may be due to inter-study variations in facilities, management practices, and feed regime.

Lambs born from multiparous ewes exhibited higher BW and WW than lambs born from primiparous ewes, which was reflected in better productivity levels for multiparous ewes. An ewe's number of parturitions is financially important because it influences the efficiency of her productive life and lamb growth. For example, in Pelibuey[21,22] and Blackbelly[23] sheep BW, WW, prolificity and ewe productivity at weaning improve after the second parturition. The fact that primiparous ewes produce lambs with light weights and lower preweaning growth capacity may be due to inadequate nutrient allocation during gestation to support fetus development and growth; prenatal lambs require large amounts of nutrients for proper development[24]. There is also evidence suggesting that the uterus of primiparous ewes is smaller and less flexible than in multiparous ewes, with the consequent lack of uterine space limiting fetal growth capacity and offspring birth weight[24].

Preweaning mortality rate in the present study was generally higher than reported for Black Belly[3] and Katahdin[25] lambs, but comparable to mortality rates found for Pelibuey x Katahdin lambs[5]. The high preweaning mortality rates in sheep production systems in the humid tropics of Mexico deserves serious attention since they negatively impact herd productivity. It is a complex issue involving multiple factors such as lamb survival, ewe maternal capacity, pre- and postpartum sanitary management practices, milk production, and climate, among others[26,27,28]. The present mortality results suggest that climate, maternal capacity and herd management practices may have been vital to increasing lamb survival rates.

Under the semi-extensive conditions in a humid tropical climate studied here lamb preweaning growth and ewe productivity in Pelibuey sheep were affected by environmental and breed-intrinsic factors. Single-birth lambs grew faster than multiple-birth lambs but resulted in less productivity per ewe at weaning and in 240-d cycles. Lamb preweaning growth and ewe productivity were highest in the dry season and in multiparous ewes.

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