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# Lambing Interval Costs In Pelifolk Sheep Under Extensive And Semi-Intensive Conditions In Jalisco, Mexico

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**ABSTRACT**
The aim was to determine the economic losses that are generated by prolonged Lambing Interval (LI) in two production systems of sheep of the Pelifolk breed were analyzed under extensive (Eps) and semi-intensive (Sps) conditions. The LI was calculated, and economic variables such as the Benefit-Cost Ratio (B/C), profitability, and the break-even point (Bp) were analyzed. The study included records from January to December 2019. The LI was 343.04 days and 301.85 days for Eps and Sps, respectively. The B/C ratio was $ 0.80 for Eps and $ 0.95 for Sps. We found that each day that the LI lags from the ideal time, the cost for the producer is of $ 0.18 per animal in Sps and $ 1.24 per animal in Eps, which correspond to the costs of feeding and handling the sheep. Therefore, negative profitability values of -19% (Eps) and -4.36% (Sps) were found, with a Bp of 3,600 and 3,177 kg of meat for production in Eps and Sps, respectively. Economically, significant differences were found in the two systems evaluated, which were related to the prolonged LI derived from the high costs of feeding and handling in each system.

**Keywords:** Productive development; Ovis aries; agribusiness; livestock business; zootechnical parameters; productivity.

## Introduction

Mexico is a country that produces and imports sheep meat; however, it is listed with 63 other countries as not having a real competitive advantage in exports (Ramírez-López et al., 2020). The sheep population in Mexico went from 6.1 million to 8.6 million heads from 1970 to 2014, showing an increase of 2.5 million and corresponding to an average annual growth rate of 0.77% (Bobadilla-Soto et al., 2017), with approximately 53,000 sheep production units (Orona et al., 2014). Nevertheless, only 50% of the sheep meat that is consumed is produced, and it is therefore necessary for sheep farming to be more competitive, since the producer obtains only $2/kg, while intermediaries obtain $3/kg (Mondragón-Ancelmo et al., 2018). However, it should be noted that the price of sheep meat is 40% higher than that of other domestic species (Morales-Morales et al., 2004).

The most common breeds in Mexico are those with meat aptitudes such as Suffolk, Hampshire, Rambouillet, and Dorset (Herrera-Haro et al., 2019). The second most important group is made up of 23% of hair breeds. The Pelifolk breed is considered to have a dual-purpose (hair and meat) and is characterized by its precociousness, since the first parturition occurs at around 12 months, and exhibits a birth weight between 2.8 to 3.5 kg and a weaning weight of approximately 20 kg. A correlation between live weight and fertility has been found in different sheep breeds (McHugh et al., 2019). There are other important factors in sheep production, such as sex, type of parturition, herd, and region (Aguirre et al., 2016); the latter can be related to the influence of the environment on the survival of sheep lambs (Van de Kerk et al., 2020).

One problem that occurs in sheep farms is individuals with low body condition due to insufficient feeding, which generates very prolonged Lambing Intervals (LI), where the lack of organization and inadequate management practices contribute to the problem and impact profitability. Furthermore, factors such as low production and productivity, low reproductive rates, and poor animal and sanitary management are determining factors in sheep production systems (Pérez-Hernández et al., 2011). The objective of the present study was to compare the cost of LI in two production systems: extensive (with feeding based on grazing and silage) and semi-intensive (with mixed feeding, including grazing and balanced feeding).

## Methods

An economic-productive diagnosis was carried out in two farms, where zootechnical and administrative records from January to December 2019 were analyzed. The study sites were located in the state of Jalisco, Mexico. The extensive production system (Eps) is located in the town of Santa Fe, in the municipality of Zapotlanejo, at a latitude of 20.525556 and a longitude of -103.083333; while the semi-intensive production system (Sps) is located in Cajititlán, in the municipality of Tlajomulco de Zúñiga, at a latitude of 20.430000 and a longitude of -103.309444, as shown in Fig. 1.

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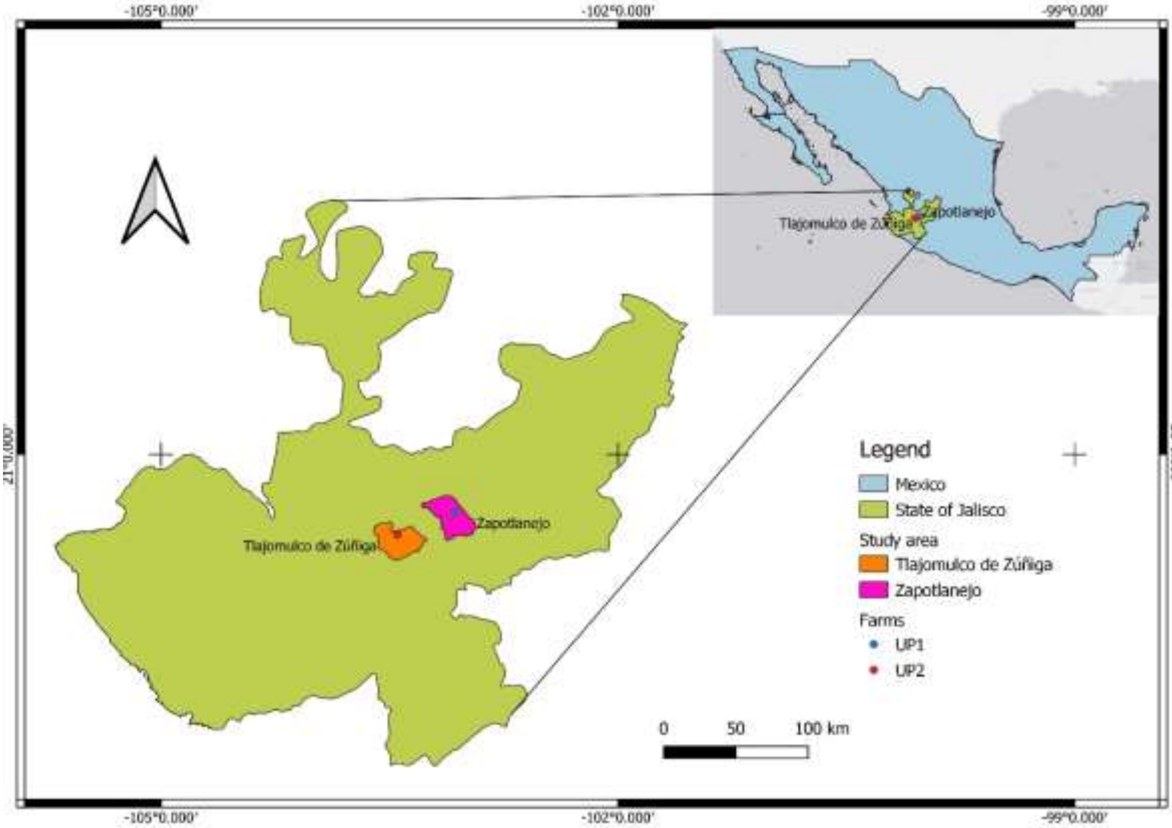
**Fig. 1.** Study area




The municipality of Zapotlanejo exhibits a semi-dry climate, with dry winter and spring, and without a well-defined winter thermal change. The mean annual temperature is of 19.8 °C, with a maximum of 29.3 °C and a minimum of 10.8 °C. The rainy season occurs in June, with an average rainfall of 945.3 mm; the average number of days with frost per year is only 2.6. Cajititlán has a predominating cloudy climate, with temperature ranging between 5 and 31 °C, which can very rarely reach 1 °C or more than 34 °C. The hot season (30 °C) lasts 2 months. The rainy season lasts 3.8 months and the driest season extends to 8.2 months (INEGI, 2005).

Description of the management of the production systems: The production units have different characteristics in terms of feed and infrastructure (Fig. 2); however, they are similar in many management aspects such as breeding at 45 days, the use of creep feeding after birth, weaning, and sanitation. Eps is based on grazing and supplementation with corn silage and concentrate mixed manually. The sheep go out to graze at 10 AM and are locked up at 5 PM. When the sheep are penned, each one is provided with 0.5 kg of concentrate and 1 kg of silage. Grazing occurs in areas where agave has been planted, and therefore some agave plants left after the "Jima" (harvesting process of the agave pineapples) are present, as well as native grasses and some shrubs. The dry season generally compromises the feed in this production system. On the other hand, Sps is based on grazing and offers 1 kg of feed concentrate from a commercial brand. Grazing occurs in an area of 1 hectare divided into 10 sections by an electric fence. When confined, the sheep are provided with feed, and they remain in each section for about 10 days. The sheep are not provided with corn silage as in Eps. The amount of green forage in this farm is remarkable and generates a greater production of biomass, having an impact on the body condition of the sheep.

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**Fig. 2.** Grazing area in A) the extensive production system (Eps), and B) the semi-intensive production system (Sps).

**Methodology**
The present study was approved by the Technical Council of the Faculty of Agricultural Production Systems Engineering of the Universidad Veracruzana, as part of a graduate project. Interviews, measurements, and other data were obtained after receiving the authorization of the producers.

Financial calculation: In both farms, the economic variables were analyzed according to the following formulas:

$$PII = \frac{\text{Number of days between two consecutive births}}{Total\ number\ of\ sheep\ in\ the\ herd}$$

$$\text{Workforce} = \frac{Labor\ Pay}{\text{Number of sheep}}$$

$$\text{Sheep depreciation} = \frac{Vi - Vr}{Vu}$$

Where: Initial value (Vi), Recovery value (Vr), Years of useful life (Vu)

$$\text{Depreciation of motorized equipment} = \frac{Vi - Vr}{Vu}$$

Where: Initial value (Vi), Recovery value (Vr) = 5%, Years of useful life (Vu) = 10 years

$$\text{Depreciation of non} - \text{motorized equipment} = \frac{Vi - Vr}{Vu}$$

Where: Initial value (Vi), Recovery value (Vr) = 7%, Years of useful life (Vu) = 5 years

$$\text{Depreciation of facilities} = \frac{Vi - Vr}{Vu}$$

Where: Initial value (Vi), Recovery value (Vr) = 7%, Years of useful life (Vu) = 15 years

$$\text{Cost of water} = \frac{\text{Payment for water consumption}}{\text{Number of sheep in the herd}}$$

$$\text{Electricity payment} = \frac{\text{Electricity payment}}{\text{Number of sheep in the herd}}$$

$$\text{Sheep feeding cost} = \frac{\text{Feeding cost of grazing sheep}}{\text{Number of sheep in the herd}}$$

$$\text{Ram feeding cost} = \frac{\text{Ram feeding cost in pasture}}{\text{Number of rams in the herd}}$$

$$\text{Health program} = \frac{\text{Cost of vaccination program}}{\text{Number of sheep in the herd}}$$

$$\text{Veterinary service} = \frac{\text{Cost of pregnancy diagnosis}}{\text{Number of sheep in the herd}}$$

$$Total\ costs = Total\ fixed\ costs + Total\ variable\ costs$$

$$IIP\ costs = Sheep\ feeding\ cost + Accumulated\ sheep\ depreciation + (Daily\ healthcare\ cost * IIP) + (\text{Cost of daily veterinary service} * \text{LI})$$

$$Cost - benefit\ ratio = \frac{Income}{Expenses}$$

$$Break - even\ point = \frac{Total\ fixed\ costs}{Product\ selling\ price - Variable\ product\ cost}$$

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**Data Analysis**
A Pearson linear correlation (p> 0.05) was used to evaluate the relationship between the variables of age, number of deliveries, LI, and benefit/cost ratio, using the JASP software (Version 0.13.1). The data are expressed in US dollars ($) with the average exchange rate of August 2024 ($19,30 Mexican pesos) reported by the Bank of Mexico (BANXICO, 2024).

**Results**
The fixed and variable costs comprising the total production cost are shown below, as well as the income generated in 12 months, obtaining thus the profits by subtracting the two concepts (Table 1). The average LI was 343 days for Eps and 301 days for Sps. It is important to note that each day of LI costs the farmer $0.18 and $1.24 to maintain the ewes in Eps and Sps, respectively. The Benefit-Cost ratio of each lamb was positively correlated with the number of lambs (Table 2), indicating that a higher number of lambs results in higher profitability.

**Table 1.** Fixed and variable costs of the production units expressed in US dollars.

| Parameter | Eps | | Sps | |
|---|---|---|---|---|
| | **Cost/ day** | **Number of animals** | **Cost/ day** | **Number of animals** |
| Workforce | $11.49 | 72 | $4.47 | 28 |
| Sheep depreciation | $0.07 | 550 | $0.07 | 550 |
| Depreciation of motorized equipment | $0.06 | 225 | $0.03 | 100 |
| Depreciation of non-motorized equipment | $0.10 | 525 | $0.08 | 420 |
| Depreciation of facilities | $0.88 | 7000 | $1.23 | 9800 |
| Subtotal fixed cost | $12.60 | | $6 | |
| Cost of water / gasoline pump | $0.01 | 170 | $0.00 | 108 |
| Electricity payment | $0.00 | | $0.00 | 0 |
| Sheep feeding cost | $13.05 | 72 | $7.25 | 28 |
| Ram feeding cost | $0.36 | 2 | $0.44 | 1 |
| Health program | $0.85 | 170 | $0.72 | 108 |
| Veterinary service | $2.16 | 170 | $2.16 | 108 |
| *Subtotal variable cost* | $16.43 | | $10.57 | |
| Total production cost = total fixed cost + total variable cost | $29.02 | | $16.45 | |
| Gross income | $23.87 | | $15.71 | |
| Profitability | -19% | | -4.36% | |
| B / C ratio | 0.8 | | 0.95 | |
| Break-even point | 9.86 kg/day | 3600.24 kg/year | 8.70 kg/ day | 3177.27 kg/year |
| Average cost of LI | $0.18 | | $1.24 | |

Source: Own elaboration.

**Table 2.** Pearson's linear correlation between the productive (number of lambs, age, and LI) and economic variables (B/C ratio).

| Variable | | Benefit-cost ratio | Number of lambs | Age | LI |
|---|---|---|---|---|---|
| **Eps** | | | | | |
| Benefit-cost ratio | Pearson's r | — | | | |
| Number of lambs | Pearson's r | 0.664 *** | — | | |
| Age | Pearson's r | -0.021 | 0.696 *** | — | |
| LI | Pearson's r | -0.328 ** | -0.141 | 0.017 | — |
| **Sps** | | | | | |
| Benefit-cost ratio | Pearson's r | — | | | |
| Number of lambs | Pearson's r | 0.877 *** | — | | |
| Age | Pearson's r | 0.398 * | 0.745 *** | — | |
| LI | Pearson's r | -0.416 * | -0.108 | 0.213 | — |

* p < .05, ** p < .01, *** p < .001
Source: Own elaboration

In Eps, according to the LI data, 25 animals were within the acceptable range and 47 animals extended to more than 300 days. This means that 46% and 54%, respectively, of the sheep are not within the acceptable LI range. The graphic representation allows to observe the differences between each type of production system, where the problem arises from a prolonged LI due to various factors. In Eps, the presence of ewes with poor body condition during breeding was notable, since the area where they were allowed to graze was composed of native grass and some shrubs. The body condition of ewes showed values between 2 and 3 in the semi-intensive system and a mean value of 2 in the extensive system, with several animals exhibiting lower scores. The benefit-cost ratio was 0.80 and 0.95 for Eps and Sps, respectively. This indicates that for each peso invested, $0.20 is lost in Eps and $0.05 is lost in Sps.

**Discussions**

Body condition is of utmost importance in sheep production systems (Kenyon et al., 2014). In the present study, we found higher values in Eps (2 to 3) compared to values between 1 and 2 in Sps, which may have a significant effect on LI. Some authors mention that the optimal body condition for sheep is within the range from 2.5 to 3 (Romero, 2015). The higher values in Sps may be due to the higher availability of quality pastures, since increasing the quality and availability of feed tends to improve the productive indicators of body condition, fertility, and reproductive efficiency, as well as of milk production, having direct effects on the economic variables (Udrea, 2018). On the other hand, Eps exhibited poor pasture management, mainly during critical seasons, with low forage quality affecting animal nutrition and leading to low weight gain in developing animals, low fertility in reproductive ewes, shorter lactation curves, and high costs (Sánchez et al., 2014). The poor body condition observed in Eps resulted from insufficient food for the entire herd, which is reflected in the reproductive parameters, causing a very prolonged LI (Rae et al., 2002). A correlation between live weight and fertility has been found in different sheep breeds (McHugh et al., 2019).

The highest costs were found in Eps, which is partly explained using an electric fence in a larger area, while the area in Sps is smaller and therefore results in a lower depreciation cost, as well as a lower maintenance cost, although the facilities are better structured since they have concrete handling pens and a roof. In this regard, the facilities must be designed according to the vital needs of the animals, as well as their physiological stage and zootechnical purpose (Córdova-Izquierdo et al., 2009). In addition, having inadequate facilities generates losses due to external factors that cannot be controlled (Morris, 2017; Van de Kerk et al., 2020), such as in the case of Eps.

The estimated cost of water was higher in Eps, where a gasoline-based motor pump is used, resulting in the higher observed cost. The lower costs in Sps are explained by the availability of electricity, which reduces the operating cost of the pump used to supply water. This cost was estimated based on the location and the domestic rate published by the Federal Electricity Commission, which was $0.0359 for the first 75 kilowatts-hour, corresponding to basic consumption (CFE, 2020). The number of animals managed also affects the cost of water; in Eps, there was a higher number of animals compared to Sps. Water consumption also depends on the physiological stage of the animals, since there are stages that consume more water. A sheep in maintenance consumes 2 to 3.5 L of water/day, a lactating sheep consumes 4 to 7 L/day, a lamb consumes 2 L/day, and a sheep of 45 kg of live weight consumes 3.5 to 4 L of water/day (dos Santos et al., 2019).

The feeding cost was higher in Sps because the feed used is from a well-known commercial brand. Several studies have determined the productive efficiency of sheep and have concluded that the feeding cost is a function of feed consumption and weight gain, where the chemical composition of feeds is of special relevance (Martínez et al., 2002). Sheep in Eps are provided with corn silage, which reduces the feeding cost since silage is a lower-cost feed with respect to commercial balanced feeds that use mostly imported raw materials, and thus corn silage represents a cheaper alternative for the rancher (Garcés et al., 2004). Several studies have shown a significant improvement in the overall profitability of the production company when using corn silage; however, some studies indicate that better results are obtained when using corn stubble combined with 2 and 3% urea (Sánchez et al., 2015). Veterinary service costs were the same in both production units, since the doctor charged a fixed fee per month regardless of the number of animals in each herd. The profits from each production unit were calculated by subtracting the income from the sum of the fixed and variable costs, the result of which was a negative number. This means that neither of the two units is profitable since they do not even cover the production costs. The negative profitability values of Eps and Sps were -19% and -4.36%, respectively.

In addition to the above, microentrepreneurs in the primary sector had to face the challenge of surviving the COVID-19 pandemic, since food costs represent between 70 and 88.9% of total costs, and therefore the search for feeding methods and programs that allow reducing these costs (Vilaboa-Arroniz et al., 2006). This is even more relevant when sales are reduced, and revenues are insufficient to cover fixed costs. This has had an impact due to the prevention measures that emerged from COVID-19. Most of the strategies have a common factor: isolation or social confinement measures to prevent, mitigate or contain the spread of the virus. In this sense, and prioritizing health as an essential good, response actions are generating collateral effects in social and economic conditions due to the forced pause in economic activity (Serna-Gómez et al., 2020).

Another determining factor is the shortage of grains in national crops due to climatic events, as well as the high volatility of the US dollar, which affects the import price of grains. While the price of lamb ranged between 16.8% and 26.9% after the arrival of the pandemic, the goat meat market also suffered a reduction close to 12.5% in prices per kg; however, for some herds, the losses reached up to 40% (Vidaurreta et al., 2020). This causes food costs to increase more than projected, rising production costs. Given that there is a low demand for animals, the number of animals grows, leading to two scenarios: the need for more food and the increase in labor. Finally, some strategies that producers have used are the implementation of fodder pasture and protein banks, since the nutrients they contain contribute to increasing the protein intake in concentrate-based diets, which reduces the feeding cost (González-Castillo et al., 2014). These plants provide an important amount of nutrients to the soils, contributing to their recovery, and increase the yield of contiguous crops, improving their profitability.

**Conclusion**
The cost-benefit ratio of Sps and Eps was 0.80 and 0.95, respectively. The LI was higher in Eps, with 343.04 days, compared to 301.85 days in Sps, which may be associated with inefficient sheep feeding in the extensive system. Each additional day of LI costs the producer $ 0.18 and $ 1.24 to keep the sheep in Eps and Sps, respectively. Finally, it is necessary to increase production to values above the equilibrium point, which is 3,600 and 3,177 kg of meat in Eps and Sps, respectively.

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**References**
1. Aguirre, R. E. L.; Ferraz, J. B. S. and Mattos, E. C. 2016. Influence of non-genetic factors on growth and reproductive traits of sheep Santa Inês in extensive systems. Development 28:7.
2. BANXICO. 2024. Sistema de Información Económica. https://www.banxico.org.mx/
3. Bobadilla-Soto, E. E.; Flores-Padilla, J. P. and Perea-Peña, M. 2017. Comercio exterior del sector ovino mexicano antes y después del Tratado de Libre Comercio con América del Norte. Economía y Sociedad 21:37, 35-49.
4. CFE. 2020. Comisión Federal de Electricidad. https://www.cfe.mx/
5. Córdova-Izquierdo, A.; Ruiz-Lang, C. G.; Saltijeral-Oaxaca, J. A.; Xolalpa-Campos, V.; Cortés-Suárez, S.; Méndez-Mendoza, M.; Huerta-Crispin, R.; Córdova-Jiménez, M. S.; Córdova-Jiménez, C. A. and Guerra-Liera, E. 2009. Importancia del bienestar animal en las unidades de producción animal en México. REDVET. Revista Electrónica de Veterinaria 10:12. https://www.redalyc.org/articulo.oa?id=63617155010
6. dos Santos, F. M.; de Araújo, G. G. L.; de Souza, L. L.; Yamamoto, S. M.; Queiroz, M. A. Á.; Lanna, D. P. D. and de Moraes, S. A. 2019. Impact of water restriction periods on carcass traits and meat quality of feedlot lambs in the Brazilian semi-arid region. Meat Science 156, 196-204. https://doi.org/https://doi.org/10.1016/j.meatsci.2019.05.033
7. Garcés, M. A. M.; Berrio, R. L.; Ruíz, A. S.; Serna, D. L. J. G. and Builes, A. A. F. 2004. Ensilaje como fuente de alimentación para el ganado. Revista Lasallista de Investigación 1:1, 66-71.
8. González-Castillo, J. C.; Hahn von-Hessberg, C. M. and Narváez-Solarte, W. 2014. Características botánicas de Tithonia diversifolia (Asterales: Asteraceae) y su uso en la alimentación animal. Boletín Científico. Centro de Museos 18:2, 45-58.
9. Herrera-Haro, J. G.; Álvarez-Fuentes, G.; Bárcena-Gama, R. and Núñez-Aramburu, J. M. 2019. Caracterización de los rebaños ovinos en el sur de Ciudad de México, México. Acta universitaria 29. https://doi.org/http://doi.org/10.15174/au.2019.2022
10. INEGI. 2005. Guía para la interpretación de cartografía: climatológica. Instituto Nacional de Estadística, Geografía e Informática.
11. Kenyon, P. R.; Maloney, S. K. and Blache, D. 2014. Review of sheep body condition score in relation to production characteristics. New Zealand Journal of Agricultural Research 57:1, 38-64. https://doi.org/10.1080/00288233.2013.857698
12. Martínez, d. A. M.; Bravo, J.; Betancourt, M.; Bracho, I. and Quintana, H. 2002. Influencia de la suplementación proteica sobre el crecimiento de corderos post destete. Zootecnia Tropical 20, 307-318.
13. McHugh, N.; McGovern, F.; Creighton, P.; Pabiou, T.; McDermott, K.; Wall, E. and Berry, D. P. 2019. Mean difference in live-weight per incremental difference in body condition score estimated in multiple sheep breeds and crossbreds. Animal 13:3, 549-553. https://doi.org/https://doi.org/10.1017/S1751731118002148
14. Mondragón-Ancelmo, J.; García-Hernández, P.; Rojas-Sandoval, L. A.; Domínguez-Vara, I. A.; Gómez-Tenorio, G. and Rebollar-Rebollar, S. 2018. Caracterización de consumidores agroindustriales de carne de pequeños rumiantes en el Estado de México. Investigación y Ciencia: de la Universidad Autónoma de Aguascalientes:74, 17-24.

15. Morales-Morales, M.; Martínez-Dávila, J. P.; Torres-Hernández, G. and Pacheco-Velasco, J. E. 2004. Evaluación del potencial para la producción ovina con el enfoque de agroecosistemas en un ejido de Veracruz, México. Revista Mexicana de Ciencias Pecuarias 42:3, 347-359.
16. Morris, S. T. 2017. Overview of sheep production systems. In D. M. Ferguson, C. Lee, and A. Fisher Eds., Advances in Sheep Welfare pp. 19-35. Woodhead Publishing. https://doi.org/https://doi.org/10.1016/B978-0-08-100718-1.00002-9
17. Orona, C. I.; López, M. J. D.; Vázquez, V. C.; Salazar, S. E. and Ramírez, R. M. E. 2014. Análisis microeconómico de una unidad representativa de producción de carne de ovino en el Estado de México bajo un sistema de producción semi intensivo. Revista mexicana de agronegocios 34:1345-2016-104425.
18. Pérez-Hernández, P.; Vilaboa-Arroniz, J.; Chalate-Molina, H.; Candelaria-Martínez, B.; Díaz-Rivera, P. and López-Ortiz, S. 2011. Análisis descriptivo de los sistemas de producción con ovinos en el estado de Veracruz, México. Revista científica 21:4, 327-334.
19. Rae, M. T.; Kyle, C. E.; Miller, D. W.; Hammond, A. J.; Brooks, A. N. and Rhind, S. M. 2002. The effects of undernutrition, in utero, on reproductive function in adult male and female sheep. Animal Reproduction Science 72:1, 63-71. https://doi.org/https://doi.org/10.1016/S0378-4320(02)00068-4
20. Romero, O. 2015. Evaluación de la condición corporal y edad de los ovinos. Herramientas de Manejo Animal. Instituto de Investigaciones Agropecuarias, Ministerio de Agricultura:79.
21. Sánchez, L. A.; Torres, N. E.; Estupiñan, V. K.; Vargas, B. J.; Sánchez, T. J. and Sánchez, V. N. 2015. Valoración nutritiva del rastrojo de Zea mays y Oryza sativa para la alimentación de ovinos en el trópico ecuatoriano. Revista Amazónica Ciencia y Tecnología 4:3, 235-249.
22. Sánchez, T.; Rosalba, M.; Lamela, L. and López, O. 2014. Indicadores productivos de una vaquería comercial en la provincia de Matanzas. Pastos y Forrajes 37:2, 173-181.
23. Serna-Gómez, H. M.; Barrera-Escobar, A. and Castro-Escobar, E. S. 2020. Efectos en el empleo en las micro y pequeñas empresas generados por la emergencia del COVID-19: Caso Colombia. ORMET, Universidad de Manizales., 1-19.
24. Udrea, L. 2018. New Approach for Bio-Economic Integrated Management in Sheep Growth. Annals of Valahia University of Targoviste-Agriculture 12:1, 1-6.
25. Van de Kerk, M.; Arthur, S.; Bertram, M.; Borg, B.; Herriges, J.; Lawler, J.; Mangipane, B.; Lamber, K. C.; Wendling, B. and Prugh, L. 2020. Environmental Influences on Dall's Sheep Survival. The Journal of Wildlife Management 84:6, 1127-1138. https://doi.org/DOI: 10.1002/jwmg.21873
26. Vidaurreta, I.; de la Fe, C.; Orengo, J.; Gómez-Martín, Á. and Benito, B. 2020. Short-Term Economic Impact of COVID-19 on Spanish Small Ruminant Flocks. Animals 10:8, 1357. https://www.mdpi.com/2076-2615/10/8/1357
27. Vilaboa-Arroniz, J.; Díaz-Rivera, P.; Platas-Rosado, D. E.; Ortega-Jiménez, E. and Rodríguez-Chessani, M. A. 2006. Productividad y autonomía en sistemas de producción ovina: Dos propiedades emergentes de los agroecosistemas. Interciencia 31:1, 37-44.