

## Wool quality and daily weight gain in native lambs from the Central Region of Argentina

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**Abstract.** The ovine population of the central Argentine territory is the result of constant introductions of different animal biotypes, which determined the existence of ovine populations with great variability. The main objective of the breeders is to produce a lamb for self-consumption and sale of surpluses, without considering the wool product. The objective of this work was to evaluate the quality of lamb's wool and the evolution of the weight gain of lambs belonging to the native sheep flock of the area under two production systems. Characterization of the productive systems was carried out, seeking to highlight the attributes of weight gain, and wool of native lambs. The characteristics of wool and weight gain lamb were evaluated under two treatments, in either free range conditions or lambs supplemented under confinement. For the analysis of daily weight gain we used a general mixed model. The analysis of the behaviour of the productive systems, although the confinement system was superior in this regard, no significant differences were observed between biotypes of lambs ( $p < 0.05$ ), which coincides with the fact that the variation within an animal biotype is even more important than expected between biotypes. Both treatments can be used according to the particular situation of each productive unit, since in them, the production of a lamb for slaughter is compatible with the production of wool for the textile industry, and the feasibility of marketing lamb wool produced, seeking in its benefits and optimizing the meat product through proper management techniques of the productive system.

**Keywords:** Production conditions, Lamb performance, Average daily gain, Genetic variability.

## Análisis de la calidad de la lana y la ganancia de peso diaria en corderos nativos de la Región Central de Argentina

**Resumen.** La población ovina del territorio central argentino es el resultado de constantes introducciones de diferentes biotipos animales, que determinaron la existencia de poblaciones ovinas con gran variabilidad. El principal objetivo de los ganaderos es producir un cordero para autoconsumo y venta de excedentes, sin considerar el producto lana. Este trabajo tuvo como objetivo evaluar la calidad de la lana de cordero y la evolución de la ganancia de peso de los corderos pertenecientes a los rebaños autóctonos de la zona en dos sistemas de producción. Se realizó la caracterización de sistemas productivos, buscando resaltar los atributos de aumento de peso y lana de corderos nativos. Las características del producto lana y ganancia de peso de cordero se evaluaron bajo dos tratamientos, en condiciones a campo y corderos suplementados en confinamiento. Para el análisis de ganancia diaria de peso utilizamos un modelo general mixto. El análisis del comportamiento de los sistemas productivos, si bien el confinamiento resultó superior al respecto, no se observaron diferencias significativas entre biotipos de corderos ( $p < 0.05$ ), lo que coincide con que la variación dentro de un biotipo animal es aún más importante que la esperada entre biotipos. Ambos tratamientos se pueden utilizar según la situación particular de cada unidad productiva, siendo que en los mismos la producción de un cordero para faena, es compatible con la producción de lana para la industria textil, debiendo evaluar la factibilidad de la comercialización de lana de cordero que se produce, buscando bondades, y optimizando a la vez mediante prácticas adecuadas de manejo del sistema productivo.

**Palabras clave:** Condiciones de producción, Rendimiento del cordero, Ganancia diaria promedio, Variabilidad genética.

## Introduction

The sheep biotype of the central territory of Argentina is the result of the introduction of different animals breed and biotypes, which determined the actual stocking of a sheep population of great variability. La Pampa province is located in the aforementioned area, where both north and east border, has a temperate climate with strong agricultural activities making livestock production a challenge due to its displacement towards less favorable areas. Sheep and cattle production based its nutrition on either pure or consociated, and natural pasture. Rotation with crops stubble is a frequent practice (Inventory of Natural Resources Province of La Pampa, 2004). The ovine stock, in Maracó department, where the study was carried out, was 74 790 sheep and 6,684 rams (SENASA, 2018) being considered as a secondary economic activity (Goizueta et al., 2013; Agüero et al., 2010). The farmers mainly have the flocks for self-consumption and constitute a decapitalized subsystem with low productivity (Mazzola, 2008), they lack objective information in relation to productive alternatives for lamb meat and its compatibility with the wool product (Gómez et al., 2019).

In terms of primary production, in many areas of Argentina, the farmers and employees have lost the sheep rearing culture, adding that they perceive high legal insecurity due to rustling (Bettinotti, 2003). Therefore, they prefer to have small flocks to satisfy their meat needs and sale the surplus of lambs to a local butcher. The types of lambs they produce are small and light, whole, and ready to sell during the spring and autumn seasons. In Argentina the consumption of sheep meat per inhabitant is segmented, there is a sustained demand in small

towns, where exist an influence of farmers culture (De Gea, 2004). In the neighboring country of Uruguay, the main state research organization have carried out different research projects evaluating many aspects of the sheep meat quality and production (Bianchi et al., 2001). They conclude that there is available technology to produce either light or heavy lambs using purebred or dual-purpose races, such as Corriedale, Merino and Romney Marsh mother crossed with meat breeds (Garibotto et al., 1999; Bianchi et al., 2000a, 2000b; Garibotto et al., 2000; Bianchi, 2001).

Lamb wool is soft, and is obtained by shearing it for the first time between six to seven months of age. In this period the wool wick length is about 5 centimeters approximately and require minimal processing. The resulting fibers are smoother, stronger and maintain higher elasticity than older sheep wool (Madeley et al., 1998). To achieve the productive utility of wool from native lambs, it is necessary to know its quality measures.

In 2001 Argentina state, approved a national law supporting and encourage the farmers with the objective of reintroducing and recover the sheep associated activities (InfoLEG 90, 2001). Therefore, it is possible to produce high-quality wool and meat under the present circumstances, but to reach those goals it is necessary to both define and characterize an efficient management system. The objective of this work was to provide tools and information to facilitate and evaluate the production of different biotypes of lambs, meat, and lamb wool, under two production systems, and characterize lamb's wool of the central region of Argentina.

## Material and Methods

The assay was carried out in a classic farm, with agricultural and livestock production activities, in the department of Maracó, La Pampa province, during sixty days in spring.

One hundred and seven lambs were assign to the trial that were individually identified with a common color group ear tag, deworming and vaccinated against clostridial diseases at the beginning of the trial. Twenty-one days after the initial of the trial, the animals received a booster vaccination.

Fifty-four lambs were placed under treatment 1(t1), under extensive system, as most farmers do, lambs raised at the feet of the mother, whereas the other 53 lambs of the second treatment (t2), once weaned, were rearing in confinement conditions.

For the lamb's traditionally managed at the mother's foot, the feeding of the ewes, was carried out under an extensive production system, based on consociated pastures of alfalfa, oats and ray grass. The animal load used on the grazing was four animals per hectare. The ewes were supplement with 400 grams/day of corn, delivered in mobile feeders, which had forty centimeters of linear space per ewe, at 50 centimeters from the ground, on the same allotment where they were staying. Water consumption was ensure trough a water supply within the allotment, which provided clean water suitable for sheep consumption on a permanent basis. A curtain of trees provided shelter to the animals.



For the lambs raised under confinement, the provided conditions were, 1 m<sup>2</sup> and thirty centimeter and linear feeder per lamb hanging at 30 centimeters from the floor. Shelter to inclement weather condition, was located in a corner of the pen (Martinez Gonzalez et al., 2010; Bayer and Petryna, 2012).

The initial mean lamb weight was 19 kg ± 2 kg and 100 days of age ± 10 days. Alfalfa hay was delivered ad libitum, and obtained from rolls that were produced in the same establishment, made over consociated of cultivated grasses. The rolls are housed in the open air. A commercial concentrate for lambs is formulated in a correct relation energy-protein providing 16 % of crude protein, calcium phosphorus and 2 900 Kcal/kg MS of metabolizable energy.

The fattening of the lambs, under confinement, began with a period of 15 days of adaptation to the foodstuff to the following feeding schedule: day 1: Alfalfa hay and unrestricted access to water; days 2 – 4: alfalfa hay + 100 g of commercial concentrate; days 5 – 7: alfalfa hay + 200 g of commercial concentrate; days 8 – 10: alfalfa hay + 300 g of commercial concentrate; days 11 – 15: alfalfa hay + 500 g of commercial concentrate; days 15 and onwards: alfalfa hay and commercial concentrate ad libitum. During the feeding adaptation period, the lambs were monitored to evaluate its behavior, to avoid off food or any grade of ruminal acidosis.

The average of daily weight gain was obtained from weighting the lamb's with a digital balance Balcoppa (Pesamatic S.R.L), on a regular basis every 15 days since the beginning of the trial, as well as the score of the animal according to Russel and Gun (1969).

Lamb wool production was determined by extracting individual fleece samples taken 53 days ± 2 after the start of the trial.

The sampling site was made in the center of flank, through a hand below the dorsal line (Aylan-Parker and McGregor, 2002; Frank, et al., 2006; Hick et al., 2016), between 10 and 30 grams.

The wool was processed in the animal fiber laboratory of the Productive Sustainability Program for Small

Ruminants in Disadvantaged Areas (SUPPRAD) of the Catholic University of Córdoba, where the mean diameter (MD) and length of wick (LW) analyzes were performed. For the samples for determination of productive characters or attributes (quality) of lamb fleece, we used a Clipper Oster ShearMaster for sheep. Once the fleece sample was cut, it was extracted by hand taking the wicks at the base and keeping their structure as unalterable possible. The wicks were placed in polyethylene bags numbered in the order of selection corresponding to the field registers. Finally, they were sent for analysis to the laboratory. A specialized laboratory technician guaranteed this work. The basic protocol for processing all fleece samples consisted first to identify the sample bags with a unique laboratory code and then determined, Mean diameter (MD), with a 500 x microprojector based on the ITW O 80-3 standard, adapted by establishing a minimum number of observations or counts to achieve a desired error (Lamb, 1998; Frank, et al., 2009). The MD is adjusted by ambient humidity level when mounting the sample for the microprojector (Rae and Bruce, 1973) and Length of wick (LW), measured in centimeters with the use of a graduated ruler (Gómez et al. 2017). From mean diameter (MD) determination, we obtained the classify of wick fineness (WF) in super fine, fine, intermediate, coarse and very coarse (Muller, 2000; Gómez, 2017).

#### Statistical analyses of data

For the analysis of daily weight gain, we used a general mixed heterocedastic model given by weighing days per treatment, represented in the following equation:

$$DGW = \mu + \text{day of weight} + \text{systems} + \text{day of weight} \times \text{systems} + \text{biotype} + \epsilon$$

The animal was used as a random effect; the comparison of means represented with a point graph.

To evaluate lamb wool between biotypes and systems we used variance analysis, ANOVA.

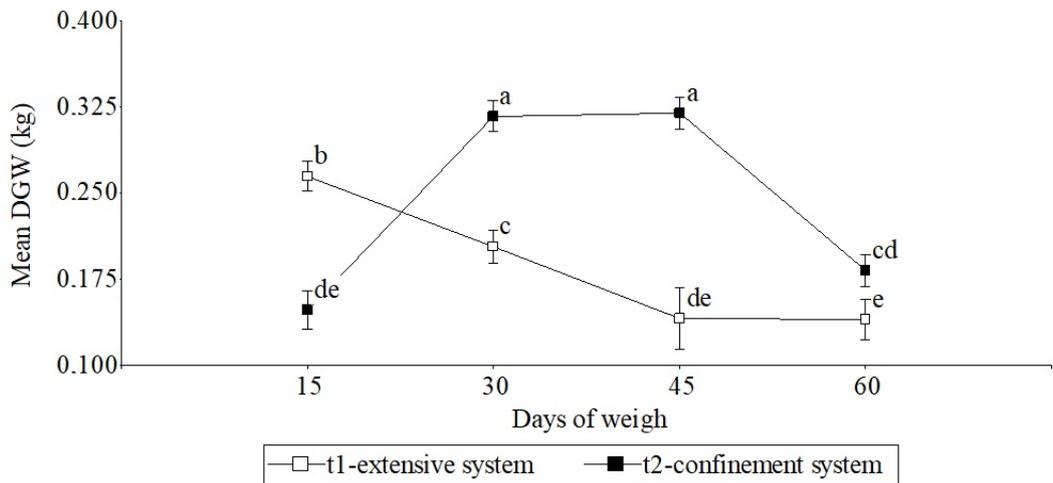
## Results

Average daily weight gain (ADWG).

There was significant variation ( $p < 0.001$ ) between treatments in the ADWG (Figure 1), with the highest increase in t2 relating to t1. It was also observed that the period of the highest ADWG of the lambs was

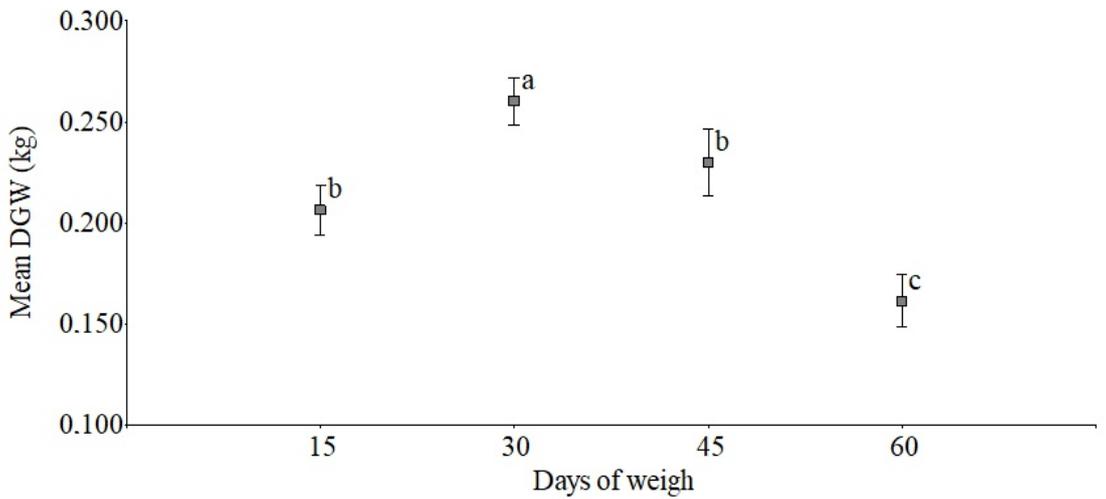
from day 15 to day 30, at the beginning of the trial, and the lowest ADWG was awarded from day 45 to day 60 (Figure 2). There was also register no significant differences among lamb biotypes ( $p < 0.05$ ) on the ADWG (Figure 3).





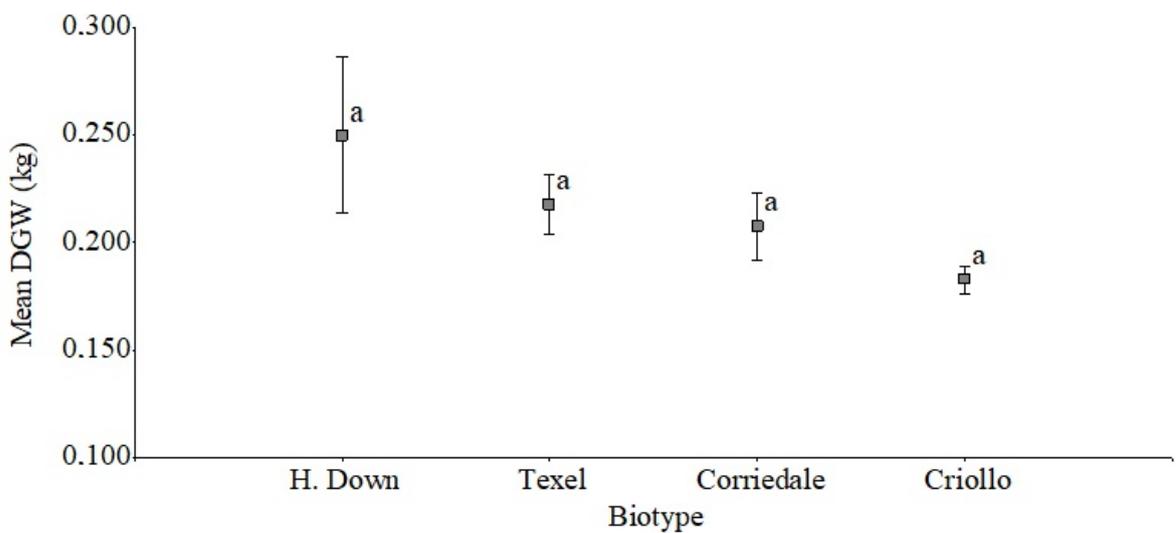
Means with a common letter are not significantly different  $p < 0.05$

Figure 1 Daily gain weight according to days of weight



Means with a common letter are not significantly different  $p < 0.05$

Figure 2 Behaviour of daily weight gains according to treatment days



Means with a common letter are not significantly different  $p < 0.05$

Figure 3 Contrast of daily gain weigh between different biotypes

## Lamb wool quality

The lamb wool quality was evaluated through both mean diameter (MD) and length of wick (LW), (Table

1), where no significant differences were observed between both systems on the aforementioned variables.

Table 1. Wool quality stockings of the racial denominations according to production system.

Treatment	Biotype	Mean diameter (MD) $\pm$ E. E. ( $\mu\text{m}$ )	Length of wick (LW) $\pm$ E. E. (cm)
Field System	H. Down	23.36 $\pm$ 8.41 <sup>A</sup>	6.00 $\pm$ 3.40 <sup>A</sup>
	Texel	28.97 $\pm$ 3.43 <sup>A</sup>	8.86 $\pm$ 1.28 <sup>A</sup>
	Corriedale	36.31 $\pm$ 8.41 <sup>A</sup>	11.67 $\pm$ 1.39 <sup>A</sup>
	Criollo	31.88 $\pm$ 1.49 <sup>A</sup>	10.70 $\pm$ 0.53 <sup>A</sup>
	Total	31.34 $\pm$ 1.46 <sup>A</sup>	10.48 $\pm$ 0.54 <sup>A</sup>
Confinement	H. Down	24.50 $\pm$ 5.95 <sup>A</sup>	5.25 $\pm$ 2.40 <sup>A</sup>
	Texel	24.35 $\pm$ 3.18 <sup>A</sup>	5.36 $\pm$ 1.28 <sup>A</sup>
	Corriedale	22.30 $\pm$ 3.43 <sup>A</sup>	6.00 $\pm$ 1.39 <sup>A</sup>
	Criollo	35.72 $\pm$ 1.51 <sup>A</sup>	12.26 $\pm$ 0.53 <sup>A</sup>
	Total	31.75 $\pm$ 1.36 <sup>A</sup>	10.41 $\pm$ 0.54 <sup>A</sup>

<sup>A</sup>Means with a common letter are not significantly different  $p < 0.05$

The result obtained of the lamb from relative frequency calculations were that intermediate wool was the one found in most proportion (42 %), follow up by very thick (31,5 %), coarse (21 %) and super-fine (5.5 %).

The wash performance of the wool did not show significant differences among animal biotypes, but the lambs rearing in the pen showed better results than the traditional system (Table 2).

Table 2. Washing performance according to treatment

Treatment	Biotype	Washing performance, % (Mean $\pm$ E.E.)
Field System	H. Down	71.30 $\pm$ 6.81 <sup>A</sup>
	Texel	71.90 $\pm$ 2.57 <sup>A</sup>
	Corriedale	74.83 $\pm$ 2.78 <sup>A</sup>
	Criollo	75.11 $\pm$ 1.06 <sup>A</sup>
	Total	74.60 $\pm$ 0.91 <sup>A</sup>
Confinement	H. Down	77.60 $\pm$ 4.81 <sup>A</sup>
	Texel	78.36 $\pm$ 2.57 <sup>A</sup>
	Corriedale	77.08 $\pm$ 2.78 <sup>A</sup>
	Criollo	80.24 $\pm$ 1.09 <sup>A</sup>
	Total	79.55 $\pm$ 0.91 <sup>A</sup>

<sup>A</sup>Means with a common letter are not significantly different  $p < 0.05$

## Discussion

The objective of efficient management practice is to capitalize on the extremely fast growth lamb period that occurs shortly after birth until puberty. Under the standard condition, a lamb born from a double-purpose mother would reach 350 g of daily weight gain (Troye, 1987; Brand et al., 2017), however, in the present trial very few animals reached those values. In Uruguay, Bianchi et al., (2013) found a similar situation, with lower than expected daily gain periods because of the direct effect of inclement weather conditions, meaning that the performance of the animals, rearing under natural condition, influenced by weather.

On the other hand, the pen rearing system, also has its limitations, the first 15 adaptation days. As observed, in the present trial and by other (Banchemo et al., 2005) the average daily gain was exceptionally low during the adaptation period.

It was also noted no significant differences in the average daily gain among the animal biotypes as express Marin Firmani, (2009), same as Kirton et al., (1995), who expressed that the variation within a particular lamb biotype was more important than that expected among biotypes.



Over the quality findings of lamb wool obtained with this study, the feasibility of production under two production systems is evident. It would not be necessary to wait until one year of age for shearing as expressed by Bianchi et al., (2013), who recommended not keeping a lamb in the field during a year just to shear it, but to sell it, like meat, at fifth or sixth month old. Nevertheless, the results of the present report

concerning both, fibre diameter and wick length, deserves an opportunity. Seeking the use of it as knowing that during the first weeks of life, the maturation of the follicles is faster than the expansion of the skin, fibre density increases rapidly, and in well-fed lambs, they can reach a maximum density at third or fourth weeks of age (Troye, 1987).

### Conclusion

It is concluded that identification of productive characteristics of the different biotypes who inhabit the region and the knowledge of their performance would allow the producer to decide which animal system and biotype use under his own productive

conditions. This will allow obtaining a better economic income, since the production meat and wool production are compatible and the qualities of each type production can be optimize.

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### Literature Cited

- Agüero, D., V. Freire, M. Peralta, M. Vigliocco, y G. Sandoval. 2010. Diagnóstico de la cadena ovina en la provincia de Córdoba, Argentina. *Revista Mexicana de Agronegocios*, 14 (26): 161-177. <https://www.redalyc.org/pdf/141/14111976003.pdf>
- Aylan-Parker, J. and B. A. Mc Gregor. 2002. Optimizing sampling techniques and estimating sampling variance of fleece quality attributes in alpacas. *Small Ruminant Research*. 44: 53-64. [https://doi.org/10.1016/S0921-4488\(02\)00038-X](https://doi.org/10.1016/S0921-4488(02)00038-X)
- Banchemo, G., A. Ganzábal, F. Montossi, A. La Manna, J. Mieres y M. E. Fernández. 2005. Estrategias de terminación de corderos. En *Serie de Actividades de Difusión N° 406*: 31-41. Mayo 2005. INIA La Estanzuela.
- Bayer, W. y A. Petryna. 2012. Engorde de corderos a corral. UNRC. Facultad de Agronomía y Veterinaria. Departamento producción animal cátedra: producción ovina y caprina. (Consulta 11/10/2016). En: [http://www.produccion-animal.com.ar/produccion\\_ovina/ovina\\_y\\_caprina\\_curso\\_fav/08-engorde.pdf](http://www.produccion-animal.com.ar/produccion_ovina/ovina_y_caprina_curso_fav/08-engorde.pdf)
- Bettinotti, M. 2003. La cadena de valor ovina. En O. y Speroni, N. *Producción de corderitos*. Difusión ganadera. Buenos Aires.
- Bianchi, G., G. Garibotto y O. Bentancur. 2000. Producción de corderos pesados precoces en sistemas de cruzamiento terminal con Romney Marsh y razas carniceras. *Cangué*, 18:16-21.
- Bianchi, G. 2001. Utilización de razas y cruzamientos para la producción de carne ovina. En: *Curso Internacional en salud y producción ovina* Universidad Austral de Chile. Facultad de Ciencias Veterinarias. Escuela de Graduados. Valdivia, Chile. pp. 53-69.
- Bianchi, G., J. Rivero y F. Robaina. 2013. Feed lot de corderos: cinco años de experiencia en la "Cassinoni" de Facultad de Agronomía. *El Agropecuario*. Revista del Diario "El País". Montevideo. Uruguay. pp. 34-
- Brand, T.S., E. J. Van der Westhuizen, D. A. Van der Merwe, L. C. Hoffman. 2017. Effect of days in feedlot on growth performance and carcass characteristics of Merino, South African Mutton Merino and Dorper lambs. *South African Journal of Animal Science*. 47(1):26-33 <https://www.ajol.info/index.php/sajas/article/view/151621>
- De Gea, G. 2004. *El ganado lanar en la Argentina*. Ed. Universidad Nacional de Río Cuarto. 246 p.
- Frank, E. N., M. V. H. Hick, C. D. Gauna, H. E. Lamas y M. G. Molina. 2006. Effects of age class, shearing interval, fleece and color type on fiber quality and production in Argentinean Llamas. *Small Ruminant Research*. 61: 141-152. <https://doi.org/10.1016/j.smallrumres.2005.07.005>



- Frank, E. N., M. V. H. Hick, A. Prieto, y M. F. Castillo. 2009. Metodología de identificación cualitativa y cuantitativa de fibras textiles naturales. Serie Documentos Internos SUPPRAD N° 1, Red SUPPRAD  
[https://www.ucc.edu.ar/portalucc/archivos/File/Agropecuarias/SUPPRAD/2010/Documentos\\_Inter nos/METOIDENTIFICACIONCUALIYCUANTITATIVAFIBRASTEXTILES.pdf](https://www.ucc.edu.ar/portalucc/archivos/File/Agropecuarias/SUPPRAD/2010/Documentos_Inter nos/METOIDENTIFICACIONCUALIYCUANTITATIVAFIBRASTEXTILES.pdf)
- Garibotto, G., G. Bianchi, G. Oliveira, J. Franco, O. Bentancur, M. Platero, J. Nin, y J. Morros. 1999. Cruzamiento terminal sobre Corriedale en el Uruguay. Peso, composición y calidad de canal en corderos sacrificados a los 145 días de edad. ITEA 95: 248-258.
- Garibotto, G., G. Bianchi, G. Caravia, G. Oliveira, J. Franco y O. Bentancur. 2000. Desempeño de corderos Corriedale y cruza faenados a los 5 meses de edad. características de la canal. *Agrociencia*, 4 (1): 64-69.  
<http://www.fagro.edu.uy/agrociencia/index.php/directorio/article/view/586>
- Goizueta, M.E., M. Calvi, E. H. Rivera, y G. Ghezan. 2013. Análisis de la cadena de carne ovina en Argentina. Área Estratégica de Economía y Sociología. INTA N° 11. pp. 12-16.
- Gómez, M.B. 2017. Caracterización del potencial lanero y productivo de los biotipos ovinos presentes en la Región Central Argentina. Tesis Doctoral Universidad Católica de Córdoba, 113 pp.
- Gómez, M. B., M. Castillo, M. H. V. Hick, M. F. Castillo, y E. N. Frank. 2017. Revalorización de las aptitudes laneras de los biotipos ovinos de la región central Argentina. *Revista Archivos de Zootecnia*, 66 (255): 357-361.  
<https://www.uco.es/ucopress/az/index.php/az/article/view/2511>
- Gómez, M. B., M. Castillo, M.V.H. Hick, M. F. Castillo, E. N. Frank. 2019. Características de la calidad de lana en corderos bajo dos sistemas productivos (campo-corrал). 42° Congreso Argentino de Producción Animal. Bahía Blanca, Buenos Aires. *Revista Argentina de Producción Animal*. 39(1): 94.  
<http://ppct.caicyt.gov.ar/index.php/rapa/article/view/16418/45454575768680>
- Hick, M.H.V., E. N. Frank, M. F. Castillo, A. Prieto y M. del R. Ahumada. 2016. Determinación del potencial textil de poblaciones primarias (criollas) de rumiantes menores en áreas desfavorecidas. *Revista Argentina de Producción Animal*, 36 N° 2: 91-102.  
<http://ppct.caicyt.gov.ar/index.php/rapa/article/view/10219/9221>
- InfoLEG. 2001. Ley 25.422 Honorable Congreso de la Nación Argentina. Ganadería ovina recuperación-régimen. Publicada en el Boletín Oficial. (29): 641 pp. 1-2.
- INTA. 1987. Inventario integrado de los recursos de la provincia de La Pampa. Instituto Nacional de Tecnología Agropecuaria, Universidad Nacional de la Pampa, 1987. 493 pp.
- Kirton, A. H., J. N. Carter, D. P. Clarke, G. J. K. Sinclair, D. M. Mercer, and A. Duganzich. 1995. Comparison between 15 ram breeds for export lamb production. Live weights, body components, carcass measurements, and composition. *New Zealand Journal of Agricultural Research*. 38: 347-360.  
<https://doi.org/10.1080/00288233.1995.9513136>
- Lamb, P. 1998. Fibre Metrology of Wool and its Applicability to Alpaca. In: Brash, L.D and I.M. Davison, 1998 (Eds.). *Fibre Science and Technology: Lessons from the Wool Industry*. Proc. of a Conf. held at CSIRO. Animal Production Prospect, N SW, Australian. pp. 13-20.
- Madeley, T., R. Postle, and T. Mahar. 1998. Physical Properties and Processing of Fine Merino Lamb's Wool, Part I: Wool Growth and Softness of Handle, *Textile Research Journal*, 68 (8): 545-552.  
<https://doi.org/10.1177/004051759806800801>
- Marin Firmani, G. 2009. Características de peso y de corderos Merinos precoces, Suffolk Down y sus cruza. Tesis maestría Agronomía, Universidad de Chile. p. 35.
- Martinez Gonzalez, S., J. Aguirre Ortega, A. A. Gómez Danés, M. Ruíz Félix, C. Lemus Flores, H. Macías Coronel, L. A. Moreno Flores, S. Salgado Moreno, y M. H. Ramírez Lozano. 2010. Tecnologías para mejorar la producción ovina en México. *Revista Fuente*, (5): 41-51.  
<http://fuente.uan.edu.mx/publicaciones/02-05/5.pdf>
- Mazzola, H.A. 2008. Recuperación de las majadas ovinas en el territorio bonaerense. Sitio Argentino de Producción Animal. (Consulta 26/09/2016).  
[http://www.produccion-animal.com.ar/produccion\\_ovina/produccion\\_ovina/82-pdf](http://www.produccion-animal.com.ar/produccion_ovina/produccion_ovina/82-pdf)
- Mueller, J.P. 2000. Mejoramiento genético de la lana. INTA Bariloche. Tercer Congreso Lanero Argentino, Trelew.
- Rae, A. and R. Bruce. 1973. Correction for relative humidity in wool fiber diameter measurement. In: *The W I R A textile data book*. WIRA. A1.

- SENASA. 2018. Indicadores ganaderos. En: <http://www.senasa.gov.ar/indicadores.php?in=1> (Consulta 05/07/2017).
- Troye, F.C.I. 1987. Manual del ovejero mesopotámico. E.E.A. INTA Mercedes (Corrientes). [http://www.produccion-animal.com.ar/libros\\_on\\_line/21-ovejero\\_mesopotamico/01-tapa\\_prologo\\_indice.pdf](http://www.produccion-animal.com.ar/libros_on_line/21-ovejero_mesopotamico/01-tapa_prologo_indice.pdf) (Consulta 11/10/2016).