Effect of management practices in the productive performance of three sheep breeds in the Chiloé Archipelago, Chile

M.E. Martínez [1*], C. Calderón[1], H. Uribe[2]and R. de la Barra[1]

[1]Instituto de Investigaciones Agropecuarias, O´Higgins 415-A of. 14, Castro, Chiloé, Chile.
[2]Facultad de Ciencias Agronómicas, Universidad de Chile, Avda. Sta Rosa nº 11315, La Pintana, Santiago, Chile.
*Corresponding autor tel/ fax +56 65 630656. E-mail: eugemartinez.inia@gmail.com

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Abstract

The effect of the application of winter supplementation (experiment A), deworming (experiment B) and foot trimming (experiment C) in three sheep breedsfound in the Chiloé Archipelago (Chile): Chilota (CH), Romney Marsh (RM) and Suffolk Down (SD) was evaluated with the aim of assessing the productive performance of the exotic breeds (RM and SD) in relation to the native one (CH) under the agro-ecological conditions of the Archipelago. Ninety (A), 108 (B) and 41 (C) sheep from the three mentioned breeds were used for the study. In experiment A, sheep were divided into three groups; two received two levels of prepartum supplementation, while the third did not receive supplementary food. The weight of lambs wasmeasuredat 100 days after birth. In experiment B, animals were divided into 4 groups; three received different deworming treatments, while the fourth was not dewormed. In this case, the weight of lambs was also measured at 100 days after birth. In experiment C, sheep did not undergo foot trimming for eight months; once this time was passed, the incidence and level of injury of each hoof was observed. In absence of prepartum supplementation of ewes and deworming treatment in both sheep and lambs, Chilota lambs showed higher weights at 100 days when compared to RM and SD lambs. In the other way, in absence of hoof trimming, Chilota sheep showed a lower incidence of moderate and severe hoof lesions in comparison with RM and SD. Results show that, under the agroecological conditions of the Chiloé archipelago, Chilota sheep breed evidence a greater adaptation since in absence of managing practices it proved out to be more productive and resistant in comparison with two introduced sheep breeds.

Keywords: prepartum, hoof trimming, Chilota sheep breed, Chile.

Introduction

Natural environments that constitute the vast majority of the world´s sheep grazing lands are characterized by marked seasonal fluctuations in climate and resources availability throughout the year. Understanding animal adaptations to landscapes has always been an important aspect of the nutritional ecology of ruminants (Demment and Van Soest, 1985; Hoffmann, 1989). Nevertheless, the trend of ruminant production in the world has been towards specialization and intensification, and producers have emphasized production at the expense of profit without linking ecologically the animals to the landscapes they inhabit.In this context, public policies usually support producers in the use of a reduced number of specialized breeds in order to reach the market needs and obtain higher economic returns (Rodriguez et al. 2006).Most programs have either resorted to cross-breeding with exotic breeds or importing live animals. One example of this trend in the Chiloé archipelago, were, in the last years, some high productive breeds like Romney Marsh and Suffolk Down have been introduced (Calderónet al. 2009).Both breeds come from wet environments with swampy grounds and are thought to show a high rusticity expressed like resistance to parasitism and foot diseases.

Nevertheless, sheep existed previously in Chiloé. First sheep were introduced in the Archipelago in the sixteenth century, during Spanish colonization, and it is believed that these animals were not managed and were forced to survive in the original forest under very harsh and heterogeneous environmental conditions (de la Barra and Ulloa, 2011). Environmental heterogeneity is recognized as an important influencing the evolution of fitness-related traits in the wild, and it is known that environmental conditions experienced by the individuals can shape their development (Charmantier and Garant, 2005, Nussey et al, 2007; Robinson et al. 2009). Extensively managed animals living in harsh and unfavourable environments need specific adaptations that promote survivability; therefore, harsh conditions promote these changes (Hoffmann and Hercus, 2000; Wilson et al. 2006), and it have been suggestedthat sheep adapted to less intensive management have evolved more efficient behavioural and physiological mechanisms to enhance lamb survivability in harsh environments than have more managed sheep breeds (Dwyer and Lawrence, 2005). Chilota sheep is a descendant from those first sheep arrived with Spaniards (de la Barra et al. 2011) and suffered an adaptation process to the harsh agro-ecologicalconditions of the archipelago; this, in addition to a strong process of inbreeding, lead to the conformation of an eventually more productive and rustic kind of sheep under these conditions. This sheep population combine, in a unique genotype, traits inherited from their ancestors (as for example, the high milk production (Martínez et al. 2011) shaped by the environmental and management conditions in which they have been raised. De la Barra et al. (2010) have pointed out that Chilota possesses a highest genetic diversity than SD and RM and have identified a high number of own alleles that are absent in the other breeds, which reinforces the hypothesis of the adaptation. There are many testimonial data around the world pointing to different degrees of resistance or tolerance to disease in local/ indigenous livestock breeds in landscapes in which they are faced to many diseases and harsh ambient conditions. Creole ruminants seem to have developed specific adaptation to the use of roughage in a harsh environment (Berbigier and Sophie, 1986); the overall productivity and longevity of Creole breeds is higher than other breeds (Naves et al. 2001; Naves, 2003), due to the good reproduction and suckling abilities of creole breeds: deseasonality, high prolificacy and low mortality rate (Alexandre et al. 2001). They also were found to be highly resistant to internal parasites (Mandonnet et al. 2001; Naves 2003) and foot diseases (Skerman and Moorehouse, 1987; Bishop et al. 1999).On the other hand, introduced breeds, with elevated productivity but alsohigh requirements, have been selected under controlled environmental conditions and have nutritional demands that exceeded the capacity of the forage resource to meet their needs. In addition, exotic breedsdon´t show the same adaptive characteristics to the environments in which they are introduced as compared to local breeds developed or selected in those areas (Carneiro et al. 2010).

The existence of a sheep breed adapted to the local conditions could be of great interest for the producers, and a particular attention should be given to local adaptation. In 1998, the FAO set out to change the predominant strategy, throughout the world, of massive development and diffusion of highly specialized ruminant breeds, giving more attention to the maintenance and the improvement of the adaptation of the indigenous breeds in developing countries which have been seriously underestimated. Managing programs must associate improvement of the productivity and conservation of the local adaptation, and the adapted genetic material should form the base of the improvement of the agricultural production systems. Producers who choose to reduce costs by breeding sheep with natural resistance to local conditions are likely to see cost savings on the long term.

At least, nine sheep breed resistant to parasites/worms and 14 resistant to foot rot have been informed to DAD-IS (Domestic Animal Diversity Information System) from FAO, much of them indigenous or creole breeds. This ability of the local breeds to produce in local harsh conditions, due to their rusticity and their productivity in relation to the environment should be fully evaluated, and knowledge about these local adapted breeds is needed; nevertheless, the scientific knowledge about them is scarce or mostly declared by means of unscientific reports (FAO, 2009).

The Chiloé archipelago is a group of 26 islands located in the south of Chile. Rainfall average is high (2.070 mm year^{-1}). The average of annual relative humidity ranges between 80 and 85%, with low frequency of frost. Soils are wet and soft. (de la Barra et al. 2011). Maximum temperatures of 30ºC in summer and minimum of 5ºC in winter (Montiel, 2003) lead to a shaped seasonal pattern on forage productions. Is spite of the introduction of high productive exotic breeds in the sixties, sheep production in Chiloé has been traditionally linked to small familial farming systems using low technology and have showed moderate to low production (Peña et al. 2011), due to the absence of managing techniques (deworming and foot trimming, among others) and mainly because of subnutrition problems in the months where the production of forage is low, usually coincident with the highest requirements of sheep (late pregnancy and early lactation) (Neculmán, 1991; Sepúlveda et al.1997, Frutos et al. 1998). In Chiloé, most sheep are raised under an agro-pastoral system in which the low cost feeding (grazing of poor rangelands) is the most usual situation (Sepúlveda, 1999), and supplementation, although with an increasing trend, is still limited (Peña et al. 2011).Small producers in Chiloé often lack of knowledge about basic sheep management; in addition, insufficient veterinary assistance on the more isolated islands and the costs of supplementary feeds and drugs make malnutrition, infection with internal parasites and foot diseases, and their interactions, the major concerns associated with the widespread of perinatal deaths and low birth and weaning weights of lambs, that lead to low production and substantial monetary losses (de la Barra and Bravo, 2006).Rusticity is the basis for a sustainable and economically viable production system in places like Chiloé where, for the above reasons, external inputs should be minimal and the animal should have enough “authonomy” to adapt to a production system in which human interventions are limited (FAO, 1998). Therefore, the existence of a sheep breed adapted to the local conditions of the archipelago could be of great interest.

Given the background, our hypothesis was that, since Chilota sheep has suffered an adaptation process to the harsh agroecological conditions of the Chiloé archipelago in absence of managing practicessince its introduction 450 years ago, it can have developed a natural resistance to some of the major concerns affecting sheep production in the archipelago like seasonal food shortages and low quality forage resources, gastrointestinal worms or foot diseases. Based on that, we wanted to assess the productive performance of Chilota sheep breed in comparison with the two more widespread sheep breeds on the archipelago (SD and RM) under different management practices.

The aim of this work was, therefore, to evaluate the effect of the application of different levels of winter supplementation, deworming treatment and foot trimming in three common sheep breeds in Chiloé archipelago to compare the productive performance of the two exotic breeds with the creole local one, under the agroecological conditions of the archipelago.

Materials and methods

Experiment A: Effect of winter food supplementation on lamb weaning weight

Ninety sheep belonging to same experimental flock were used for the study: 30 Chilota, 30 Suffolk Down and 30 Romney Marsh sheep; all ewes were in second parity, had similar body condition score and a single birth (1 lamb per partum).

On the last third of pregnancy (June 2007), sheep were divided into three groups and received daily three different individual feed supplements. The first one consisted on 300 g/d of improved naturalized prairie hay (R300). The second group ration consisted on 500 g/d of improved naturalized prairie hay and 200 g/d of oats (R500). The third group was maintained without supplementation as a control (R0). Fresh water and trace mineral salt blocks were always available to sheep *ad libitum*. During the study, all groups were free-ranged in an improved naturalized prairie with 9 ton MS/ha, composed by 70% of *Holcuslanatus* and 15% of *Trifoliumrepens* as main species. Sheep were enclosed at 20:00h every day, and supplements were offered at this moment. The weight of ninety 100-day old male lambs was evaluated. Results were subjected to an analysis of variance where weight was modelled as a function of breed plus the residual effect, using the GLM procedure from SAS (SAS Institute, Cary, NC).

Experiment B: Effect of deworming on lamb weaning weight

The study was conducted in 108 sheep belonging to same experimental flock (Centro experimental INIA Butalcura, Chiloé, Chile), according to procedures approved by the INIA Animal Care and Use Committee: 36 Chilota, 36 Suffolk Down and 36 Romney Marsh sheep; all ewes were in second parity, had similar body condition score and a single birth (1 lamb per partum). In October 2006, all the experimental sheep were cleared of their gastrointestinal parasite burden by anthelminthic treatment with ivermectin at a dose rate of 10 mg/Kg body weight. In March 2007, sheep´s oestrum was sincronized by means of progesterone intravaginal devices. Throughout the study, sheep were maintained free-ranging on improved naturalized grasslands, and during the last two months of pregnancy sheep additionally received 100g oats and 2 Kg silage per sheep per day. Fresh water and trace mineral salt blocks were always available to sheep *ad libitum*.

Four treatments were applied (9 sheep per breed per treatment). On the 3D treatment, the animals received three dewormings, with alternation of two antihelminthic products in order to avoid resistances. The first treatment took place one month before mating (February 2007) and Fenbendazole at a dose rate of 300 mg/50 Kg body weight was used. The second one was carried out one month before lambing (July 2007) with Ivermectin at a dose rate of 10 mg/Kg body weight, and the third deworming was applied two months after lambing in both sheep and lamb (October 2007) using Fenbendazole at a dose rate of 300 mg/50 Kg body weight. On the 2D treatment, the animals received two dewormings: The first one was applied one month before mating (February 2007) using Fenbendazole (identical doses). Two months after lambing (October 2007), both sheep and lamb were treated with Ivermectin (identical doses). On the 1D treatment, one month before mating (February 2007) sheep received Fenbendazole (identical doses). On the 0D treatment, the animals received no further treatment in addition to the basic deworming.After lambing, lambs were kept with their dams, and weighed 100 d postpartum by means of using this value as indicative of the global productive effect of deworming. Weight data were subjected to a mixed model analysis of variance using the GLM procedure on the SAS programme (SAS Institute, Cary, NC). The fixed effect of breed was tested against the random effect of animal using the test option in the GLM program. Differences between breeds were assessed by comparison of least square means.

Experiment C: Effect of absence of hoof trimming

The study was conducted in 41 sheep belonging to same experimental flock (Centro experimental INIA Butalcura, Chiloé, Chile), according to procedures approved by the INIA Animal Care and Use Committee: 17 Chilota, 17 Suffolk Down and 17 Romney Marsh sheep; all ewes were in second parity, had similar body condition score and a single birth (1 lamb per partum). Throughout the study, sheep were maintained free-ranging on improved naturalized grasslands and during the last two months of pregnancy sheep additionally received 100g oats and 2 kg silage per sheep per day. Fresh water and trace mineral salt blocks were always available to sheep *ad libitum*. In November 2006, all the hoofs of each experimental sheep were trimmed, applying afterwards copper naphtenate directly to the feet of sheep by means of a brush. Sheep were allowed to free-ranging together under the same environmental conditions, without night enclosure, and no hoof treatment was subsequently carried out. In July 2007, the health status of each hoof was examined, establishing three levels of lesion: mild (BEN) when rot was detected only under the nail and it disappeared when trimmed; moderate (INT): when rot was located under the nail and in the inter-digital space, with presence of death skin and moderate fetidness; and severe (VIR): when abundant rotten matter and strong fetidness were observed.

The relative risk of undergoing the three levels of hoof lesions in Suffolk Down and Romney Marsh breeds relative to Chilota breed was estimated. To study the odd ratios of undergoing hoof diseases between breeds, data were analyzed by means of logistic regression using the Proc Logistic procedure of the Statistical Analysis System program (SAS Institute, Cary, NC). The statistical significance of the regression model was confirmed by the Wald chi-square test.

Results

Experiment A: Effect of winter food supplementation on lamb weaning weight

When the response of the three analysed sheep breeds to food supplementation during last third of pregnancy was compared Chilota lambs showed a significantly higher weaning weight ($P<0.01$) when no supplementation was offered to their dams, whereas no differences were found for Romney Marsh and Suffolk Down breeds (Table 1). When 300g of grass hay were offered to sheep, significant differences

(P<0.01) were found between the three breeds studied, with Suffolk Down lambs showing the highest weaning weight and Chilota lambs showing the lowest one. When R500 (grass hay plus oats grain) was administered to sheep, Suffolk Down lamb showed the highest (P<0.01) weaning weight, with no significant differences between Romney Marsh and Chilota breed lambs.

Table 1. Lamb weight ± s.d. (100d) for the different breeds and supplementation levels.

Treatment	Chilota	Romney Marsh	Suffolk Down
R0	24.8±1.14[a]	21.3±0,87[b]	22.2±1.13[b]
R300	28.0±0.82[c]	29.1±0.88[b]	30.0±1.12[a]
R500	33.5±0.68[b]	33.4±0.89[b]	36.6±0.60[a]

[a,b,c] Within the same row, means with different superscript differ (P<0.01).

Experiment B: Effect of deworming on lamb weaning weight

In absence of deworming and when only one deworming prior to mating were carried out (treatments SD and 1D), Chilota breed lambs showed a significantly higher (P<0,01) weaning weight than the other two breeds studied (Table 2). However, the performance of two deworming treatments (2D) produced the opposite effect, i. e., Chilota breed lambs were significantly (P<0.01) lighter than those of the two other breeds, with no differences between them. When three dewormings were applied (treatment 3D), the heaviest lambs (P<0,01) were Suffolk Down, followed by Romney Marsh, being in this case the Chilota breed the least heavy lambs.

Table 2. Lamb weight ± s.d. (100d) for the different breeds and anthelmintic treatments.

Treatment	Chilota	Romney Marsh	Suffolk Down
SD	22.6±0.74[c]	21.1±1.15[b]	17.4±1.36[a]
1D	24.6±0.85[c]	23.1±1.11[b]	18.9±1.48[a]
2D	24.7±1.02[a]	26.4±0.95[b]	27.1±1.45[b]
3D	25.6±0.93[a]	28.5±0.82[b]	30.1±1.44[c]

[a,b,c] Within the same row, means with different superscript differ (P<0.01).

Experiment C: Effect of absence of hoof trimming

In our study, when sheep did not undergone trimming for seven months, it was observed that the three breeds presented the same risk (P>0.05) of suffering from mild lesions (Table 3). However, SD and RM had a higher risk tan Chilota (P<0.01) of moderate lesions, with no differences between them. Both Suffolk Down and Romney Marsh breeds showed increased risk (P<0.01) of suffering from severe lesions, but in this case, there were differences between them; RM was four times more likely than Chilota (odd ratio= 4.004), while the probability of developing severe lesions in SD was about 19.5 times greater than Chilota (odd ratio 19.489).

Table 3. Chi square parameters and odd ratio risk of foot lesions in Romney Marsh and Suffolk Down breeds *vs.*Chilota breed for the three levels of lesion analyzed.

Level	**X^2 (wald)**	**P value**	**Breed**	**Odd ratio**	**95% C. I.**
LEV	1.7598	0.4148	Romney Marsh *vs*Chilota	0.404	0.105-1.561
LEV	1.7598	0.4148	Suffolk Down *vs*Chilota	0.551	0.148-2.055
MOD	12.1438	0.0023	Romney Marsh *vs*Chilota	12.234	2.633-56.845
MOD	12.1238	0.0023	Suffolk Down *vs*Chilota	11.405	2.433-53.467
VIR	12.6610	0.0018	Romney Marsh *vs*Chilota	4.004	0.883-18.166
VIR	12.6610	0.0018	Suffolk Down *vs*Chilota	19.489	3.773-100.664

C. I.: Confidence Interval.

Discussion

Effect of winter food supplementation on lamb weaning weight

Small ruminants inhabiting harsh environments represent a climax in the capacity to adjust to these areas (Hoffmann, 1989). In temperate areas, weather fluctuations along the year lead to a clear seasonal pattern in the availability (quantitative and qualitatively) of feed resources. In such conditions, and given that the environmental response may influence the evolution of traits in the wild (Robinson et al. 2009) to the use of roughage in a harsh environment. Creoleruminants seem to have developed specific adaptations to the use of roughage in harsh environments (Berbigier and Sophie, 1986), and there exist examples in the literature that point to the fact that some breeds of small ruminants which are indigenous to some areas are able to utilize low quality high fiber food more efficiently than exotic breeds by means of a higher nutritional efficiencyrelated to ruminal microorganisms, hormones or other mechanisms (Tisserand et al. 1991; Silanikove et al. 1993 & 2001; Chilliard et al. 2000).Sheep in Chiloé, when possible, eat diets composed of tree-leaves and shrubs (Gallardo et al.unpublished data) which ensure the food supply all year around. The evolution of the different feeding strategies suggest that the digestive efficiencies of certain breeds are optimal under grazing conditions where their adaptive skills can be fully expressed (Hoffmann, 1989). This is in accordance with Naves (2003), who stated that the post-weaning growth of the creole cattle is high in comparison to the known results with other breeds in Latin America. Since Chilota is a Creole breed, is expected that it can make a better use of this low quality diet in comparison with the introduced breeds, and obtain higher weaning weights in absence of supplementation, as it has been observed in our work.

The higher weight of lambs whose dams were supplemented was expected and in concordance with authors like Sepúlveda et al. (1997, 2000), who stated that the administration of feed supplements to sheep at the time of the highest requirements (late pregnancy and early lactation) exert a positive effect on lamb´s birth weight and the subsequent growing rate since it enhances the milk production on the first month of lactation. On the other side, nutritional deficiencies during pregnancy can have adverse consequences for the offspring (Rhind et al. 1989; Abecia et al. 2006), and sheep able to efficiently use the low quality resources would foremost result in healthier ewes that can produce lamb**s** without compromising their welfare (Rauw et al. 2010). The ability of Chilota to cope with scarce and low quality food resources can be the result of its adaptive process. The level of underfeeding within a flock is not constant due to the individual variability of requirements and the competition between animals (Bocquier et al. 1995). In such a situation, all the adaptive mechanisms are of considerable importance in determining animal productivity and, in many instances, its survival. The ability to wean heavier lambs, probably coming from the ability to produce higher amounts of milk from low quality resources gave their offspring more opportunities to survive, while it is expected that the individuals who did not have that ability were not able to survive; this way, Chilota breed is nowadays the representative of those who could be adapted to the food shortages in the archipelago. In fact, it is now known that Chilota breeds produces 69% more milk than SD in early lactation (Martínez et al. 2011). This phenomenon is also observed in other local/ adapted breeds (Atti et al. 2004; Rooke et al. 2010).

Effect of deworming on lamb weaning weight

Gastrointestinal parasitism causes decreased fertility in adult sheep and death of lambs (Perry et al. 2002; Mandonnet et al. 2005), besides having negative effects in lamb´s birth weight (Isakovich et al. 1981), milk production, and, consequently, the growing rate of lambs (Gruner and Cabaret, 1985; Sackett et al. 2006). In addition,gastrointestinal parasites exacerbate the effect of other pathologies and make sheep less resistant to illness and contribute to mortality in malnourished hosts (Gulland, 1992). Native or non-improved small ruminant breeds which are adapted to environments where parasites naturally occur show a higher degree of natural resistance/ tolerance in comparison with introduced breeds (Illius et al. 1995; Mugambi et al. 1997;Mandonnet et al. 2001; Coltman et al. 2001; Chiejina et al. 2009) and are more productive even with high parasitic burdens (Baker et al. 1999). The biological basis of this resistance is currently under research; nevertheless, the differences in susceptibility to parasites exist, both between breeds and between individuals of the same breed, which can show different levels of infection within a herd (Seed and Sechelski, 1989; Morales et al. 1998; Sandoval et al. 1998; Baker, 1998). In sheep, this ability to suppress the development or establishment of the parasites (resistance) or the ability to cope with the physiological effects of infection (resilience) is hereditary (Gray, 1987; Bishop and Morris, 2007), and therefore is logical to think that from the first sheep arrived to the Chiloé archipelago, those less affected by parasitic burdens produced more milk and were able to sire lambs and bequeath this capacity to their offspring (Gray, 1987; Mandonnet, 1995; Baker, 1999). It can be also thought that Chilota sheep have suffered natural selection without antihelmintic treatments, and some degree of natural resistance could have been originated and inherited by subsequent generations. As expected, anti-helminthic treatment in pregnant sheep and on both sheep and lamb produced increased weaning weights (Table 2), as it has been stated by others (Johnstone et al. 1999). Productive performance increases when levels of parasitism decreases and enhanced maternal nutrition (Barger, 1999, Kidane et al. 2010). However, antihelmintic treatments are not performed on the appropriate frequency, (Peña et al. 2011), and this can lead to the emergence of drug-resistant parasites, decreasing the efficiency of treatments and increasing the environmental impact (Jackson and Coop, 2000; Kaplan, 2004).The sustainable control of diseases caused by internal parasites in sheep must not rely totally on drug treatment, but must incorporate alternative approaches as the use of locally breeds (Woolaston and Windon, 2001).

Differences observed in our work (Table 2) show a natural resistance of Chilota sheep to parasitism expressed as heavier weaning weights of non-treated Chilota lambs. This resistance can have genetic or environmental causes, due to diet, foraging habits, or level of exposure (Min and Hart, 2003, Cai and Bai, 2009). In accordance to this, SD and RM sheep breeds need more supplies (antihelmintic drugs) to obtain the same productive performance. Our results confirm and and extend previous reports on the superiority of the local breeds worldwide (Khaldi, 1989, Gamble and Zajac, 1992, Wanyangu et al. 1997, Yilmaz et al. 2003), but scientific research to determine the causes of this resistance are still needed.

Effect of absence of hoof trimming

Hoof lesions in sheep mainly occur in temperate areas where the soil is smooth, with great accumulation of water, as is the case of Chiloé archipelago. These lesions generate pain, and, very commonly, chronic or acute lameness which prevent the normal movement of affected individuals, affecting the intake of food and consequently reducing the productivity. This kind of lesions is rarely lethal, but affected sheep are difficult to handle and treatments are expensive. In Chiloé, health management appointed to control hoof diseases is scarce, and there is a widespread lack of knowledge about the right time to carry out it. Affected animals are usually not treated, and prematurely removed from the flock, since they are less productive (Peña et al. 2011). The existence of a breed with natural resistance to these lesions could be of great interest (Woolanston and Windon, 2001).

In our work, sheep were not submitted to hoof trimming for seven months, and Chilota showed the lowest probability of mild and severe hoof lesions. The results are concordant with those observed by others (Emery et al., 1984, Skerman and Moorehouse, 1987, FAO, 2009) who show that there are sheep breed more resistant that others, because they have been selected in humid environments, with high rainfalls throughout the year, as is the case in Chiloé. Sheep suffering from hoof pain have difficulties at mating; lame female sheep does not allow the male to mount on them; on the other side, the lame ram cannot efficiently work during mating season. From the first sheep arrived to the archipelago, those more resistant to hoof lesions were able tomate and leaved this resistance to their offspring. In Chiloé, RM and SD breeds demand more supplies and care to maintain the same hoof health status. Nevertheless, studies to determine the causes of the resistance in Chilota sheep are required.

Conclusion

In temperate environmentswere producers are not used to carry out managing practices routinely, as is the most widespread situation in Chiloé archipelago, particular attention should be given to animal breeds with adaptation to the local environment. Although adaptation and hardiness of small ruminant local breeds (especially goats) in a known fact, more insight is needed in the case of sheep. The ability of Chilota sheep to produce heavier lambs than SD and RM in absence of managing practices, given its adaptation and resistance, makes this breed a good alternative to producers in Chiloé. Genetic and physiological mechanisms responsible for this adaptation and rusticity are still unknown, and further research is needed to clarify them in depth.

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