



## Concentrate supplementation strategies in ryegrass pasture for productive performance in lambs

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### Abstract

This study evaluated the effect of two concentrate supplementation strategies on performance, metabolic profile and economic evaluation of suckling lambs and ewes in ryegrass (*Lolium multiflorum*) pasture. Twenty-seven ewes and 45 lambs were divided into three groups: (1) ryegrass pasture without supplementation - control (CON); (2) CON plus supplemented ewes and lambs at 1% of live weight (SEL), and (3) CON plus creep feeding supplemented lambs at 1% of live weight (CSL). Concentrate use increased ( $p < 0.05$ ) average daily gain (ADG) by 19.95% over CON (21.6 and 18.3% for SEL and CSL, respectively). Concentrate use contributed to minimizing forage quality fluctuation and provided greater ADG stability, mainly when ryegrass nutritional content and digestibility decreased. Blood metabolites profiles did not differ between groups, with exception of phosphorus which was higher for CON than SEL, and calcium which was higher for CSL than CON ( $p < 0.05$ ). Compared to CON, stoking rate values were greater to SEL ( $p < 0.05$ ). Compared to CSL, ewe and total stocking rate were greater ( $p < 0.05$ ) to SEL. Considering the control group as break even feed investment, SEL strategy had a positive economic return, while CSL showed economic losses. Concentrate use increased ADG of lambs and decrease the impact of nutrient quality changes of forage on daily gains, but must be considered that supplemental strategy used could affect negatively economic return.

**Additional keywords:** creep feeding; economic return; metabolic profile; sheep.

**Abbreviations used:** ADG (average daily gain); CON (control group); CP (crude protein); CSL (creep feeding supplemented lambs group); DM (dry matter); EPG (eggs per gram of feces); LW (live weight); NDF (neutral detergent fiber); SEL (supplemented ewes and lambs group); TDN (total digestible nutrients).

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### Introduction

Nutritional management is a major influencing variable in the success of a production system. Indeed, new techniques are being introduced to optimize production, including strategic supplementation practices to meet higher nutritional requirements for ewes and lambs.

Pasture is considered a low-cost feed, however, forage does not have constant productivity and quality during the year. Therefore, supplementation may be used both to meet nutritional deficiencies and to mitigate the fluctuation of dry matter production of forage over the year (Farinatti *et al.*, 2006).

Besides, lamb weight is related to the ewes' nutritional history during pregnancy and lactation periods. Thus,

ewe supplementation at these physiological stages is primordial, due to the relationship between good nutrition and higher milk yield and their effect on the improved development of lambs (Galvani *et al.*, 2014).

Exclusive concentrated supplementation for lambs (creep feeding) can contribute to reduce the time to achieve ideal weight and finishing to slaughter, providing younger animals with better quality carcasses (Zundt *et al.*, 2014; Sousa *et al.*, 2016).

Several authors have reported results regarding the use of creep feeding (Silva *et al.*, 2012; Borges *et al.*, 2013) and supplementation of ewes in late pregnancy and during lactation (Chaturvedi *et al.*, 2010; Castro *et al.*, 2013). However, little research has compared these systems to determine which is more feasible. Thus, this

study aimed to evaluate the effect of supplementation of ewes and/or lambs in development and metabolic profile of lambs and to analyze which system provide better productivity and economic return in an area of Southern Brazil.

## Material and methods

The study was performed in the crop-livestock area of Midwestern State University (Guarapuava, Paraná, Brazil) and approved by Ethics Committee for use of Animals (protocol number: 018/2015). The climate is characterized as mesothermal humid subtropical according to Köppen classification, and the altitude is approximately 1,100 m (Maak, 1968).

The experimental area was 2.4 ha planted with Italian ryegrass (*Lolium multiflorum* cv. Ponteio) and was divided into 12 paddocks. Sowing was performed with no-tillage and seeding rate of 40 kg seed/ha. Base fertilization was performed with 260 kg/ha of a formulated fertilizer 04-20-20 (N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O). Topdressing nitrogen fertilization was performed in a single application after emergence using urea (45-00-00) to obtain 150 kg/ha of nitrogen. During the experimental period average maximum temperature was 21.6 °C, the minimum temperature was 11.4 °C, average rainfall was 140 mm/month and average humidity was 72.5%.

Twenty-seven adult ewes of Texel × Ile de France crossbreed were used; animals had average weight of 70 kg (± 8.9 kg) and were multiparous (second to fifth parity) in late pregnancy. The animals were divided into three groups of nine ewes: control without supplementation (CON), supplemented ewes and lambs (SEL) and creep feeding supplemented lambs (CSL).

A complete randomized block arrangement was adopted in three repetitions. Each repetition consisted of a paddock with homogeneous distribution of animals relative to parturition date and sex of lambs, being one ewe that gave birth to singleton and two ewes that gave birth to twins, totalizing five lambs. Lambs were born from 11 June to 28 June 2015.

Supplementation feed consisted of a commercial concentrate (Golden Sheep, Cooperativa Regional Mista Agrária®, Paraná, Brazil) with nutritional composition: dry matter (DM) 89.2%, crude protein (CP) 20.02%, total digestible nutrients (TDN) 77.53%, neutral detergent fiber (NDF) 29.42%, ash 8.44%, calcium 1.44% and phosphorus 0.54%. The SEL group received concentrate based on 1% of live weight (LW), and began when the animals arrived in the area (03 June 2015) until the end of the experiment (05 October 2015). Lambs had access to the ewes' trough and benefitted

from the supplied amount equivalent to 1% LW of lambs. For CSL group, supplementation was supplied in a privative trough (creep feeding) from the first week of life of the lambs. Concentrate was offered *ad libitum*, performing adjustments based on 10% leftovers up to 1% LW of lambs. The concentrate was supplied at 07:00 and 17:00. All groups had free access to water and mineral salt.

Animals were managed in a continuous grazing system with a variable stocking rate (put-and-take method) to maintain a grazing height between 10-15 cm. This management provided 2,552.7 kg DM/ha average allowance.

On average, forage samples were collected every 24 days for nutritional composition analysis through cuts close to the ground in nine areas of 0.25 m<sup>2</sup>. These samples were homogenized to make one subsample for analysis (Marchesan *et al.*, 2015). Sample was pre-dried in stove with laminar flow at 55°C for 72 h and ground to 1 mm in a Wiley-type mill. Total dry matter, CP and ash was determined according to AOAC (1995) and NDF according to Van Soest *et al.* (1991). Ruminant digestibility of DM and NDF was performed through *in situ* digestibility technique (Vazant *et al.*, 1998). TDN was estimated according to the equation  $TDN = 83.79 - 0.4171 * NDF$  ( $r^2 = 0.82$ ) as proposed by Capelle *et al.* (2001).

Health of the animals was assured by fortnightly clinical evaluation using Famacha method (Malan *et al.*, 2001) and eggs per gram of feces counting (EPG) (Gordon & Whitlock, 1939). Animals with Famacha values  $\geq 3$  or EPG  $\geq 1,000$  were dewormed.

Metabolic profile of lambs was performed in a single collection of blood at the end of the experiment. By cephalic venipuncture, 3 mL of blood were collected and stored in tubes without and with fluoride anticoagulant. Analysis of the energy profile consisted of glucose and cholesterol dosage; protein profile consisted of total protein, albumin and urea; and mineral profile consisted of calcium, phosphorus and magnesium dosage using commercial kits (Labtest®, Diagnostica SA, Minas Gerais, Brazil) following the manufacturer's recommendations.

Individual weighing of animals began at an average age of 11 days, and was performed every 15 days. Animal stocking rate (kg LW/ha) was calculated using average weight of test animals plus weight of regulator animals, multiplied by the number of days in pasture. The result was divided by the number of days in the grazing period.

Economic analysis was based on production per hectare and was made using a revenue simulation of the sale of lambs, based on average sale price in the region (US\$ 30.26 kg/LW) subtracted from

supplementation total cost. Return over feed cost was calculated subtracting total feed cost from total revenue. Finally, considering control group as break even feed investment, return over production gain was calculated from difference between total revenue by animal sale for SEL and CSL subtracted from CON.

Data were submitted to Bartlett's test, and then to analysis of variance followed by Tukey's test for qualitative factor (group) and regression for quantitative factor (period), which tested linear and quadratic models. The analysis was performed using the statistical program SISVAR<sup>®</sup> (version 5.6 for windows; Lavras, Minas Gerais, Brazil).

## Results and discussion

Nutritional values of forage did not show interaction ( $p>0.05$ ) between group and period. Also, pasture characteristics did not differ between groups ( $p>0.05$ ) but showed differences during period. Changes in nutritional composition of forage with advance of pasture use affected DM and NDF digestibility (Fig. 1).

Nutritional variation is likely due to physiological modifications in forage cycle, which causes reduction in leaves proportion, increased stem participation and lignification of plant. This reflects in increased DM and NDF (Marchesan *et al.*, 2015), reduction in ash, CP and TDN (Soares *et al.*, 2013; Marchesan *et al.*, 2015), as verified during evaluations. Furthermore, NDF increases have a negative impact on DM intake and feed digestibility (Allen *et al.*, 2009). Thus, nutritional variation impacted in DM and NDF digestibility, which decreased during the period.

Supplementation produced higher ADG (0.301 and 0.289 kg/day for SEL and CSL, respectively) compared

to CON (0.236 kg/day) ( $p<0.05$ ). The period influenced ADG of lambs ( $p<0.05$ ), and regardless of group, ADG reduced as evaluation period progressed (Fig. 2).

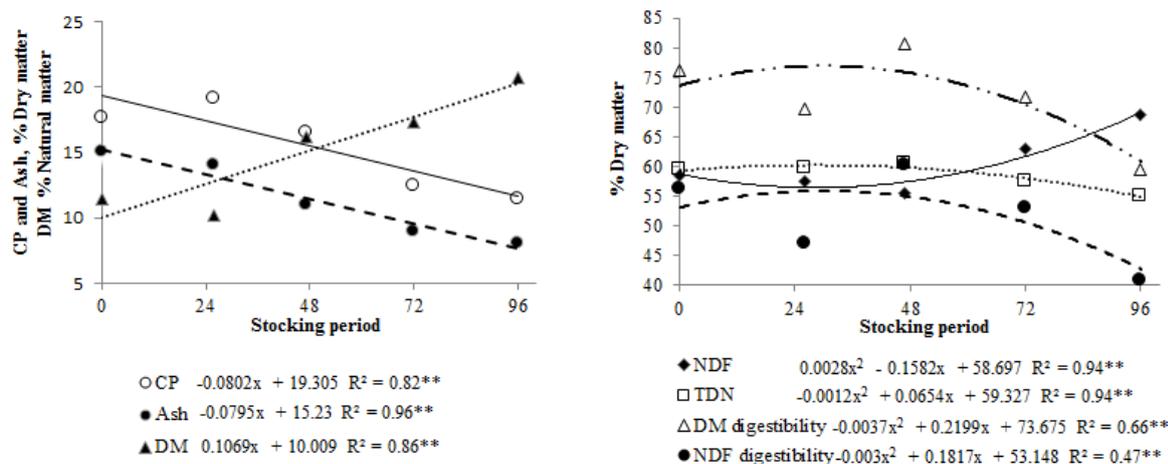
As ryegrass pasture was the base of diet, its fluctuation may be reflected in performance of the animals as a result of DM intake and the quality parameters of forage. Equivalent findings were confirmed by Ribeiro *et al.* (2009) at similar procedures and climatic conditions.

In addition to pasture variation, authors such Tonetto *et al.* (2004) and Frescura *et al.* (2005) justify ADG reduction due changes in eating habits and less reliance on mother's milk for lambs. It is consistent with the findings of this study because despite ADG reduction, it only becomes significant ( $p<0.10$ ) after 60 days (Fig. 2). Lactation peak in a ewe occurs around one month after lambing; at 60 days, ewe has reached 75% of its total milk production (Pacheco & Quirino, 2008), and thus, ADG of lambs becomes more dependent on solid feed.

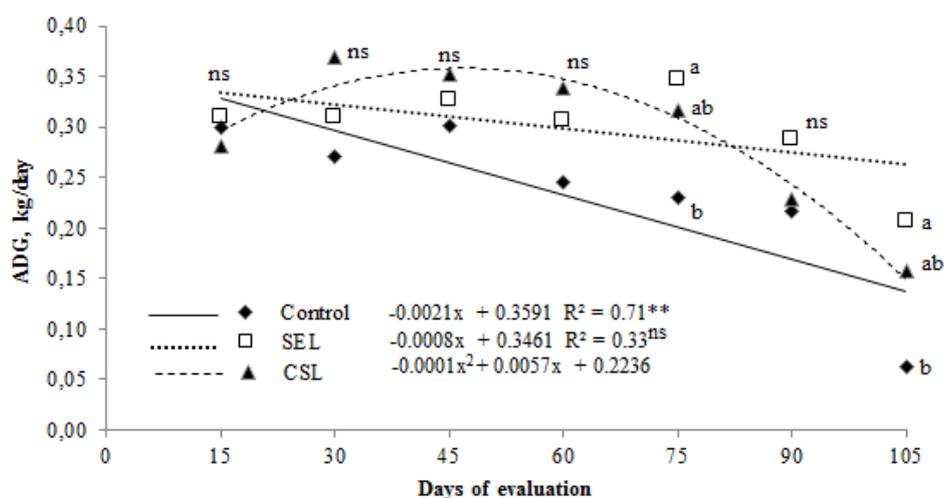
Despite variations in pasture quality, SEL and CSL groups sustained ADG better, as CON decreased 75.4% in ADG from first to the last weighing, while SEL and CSL reduced 34.2% and 48.4%, respectively. This is justified by concentrate contribution, which, in addition to promoting higher nutritional level, reduced seasonal effects of grazing variations (Farinatti *et al.*, 2006).

Regarding metabolic profile (Table 1), there were significant differences ( $p<0.05$ ) only for calcium which was higher for CSL than CON, and phosphorus which was higher for CON than SEL. Also, parameters presented the same behavior in all groups, indicating that the different systems did not promote significant changes in the profiles.

Calcium values were lower than the reference range proposed by Kaneko (2008), however, in reference limits cited by González *et al.* (2000), from 8.1 to 10.02



**Figure 1.** Average levels of crude protein (CP), ash, dry matter (DM), neutral detergent fiber (NDF), total digestible nutrients (TDN), DM digestibility and NDF digestibility during the pasture use period. \*\*Significant at  $p<0.01$ .



**Figure 2.** Average daily gain (ADG; kg/day) of lambs in the CON (Control), SEL (supplemented ewes and lambs) and CSL (creep feeding supplemented lambs) groups. \*\*Significant at  $p < 0.01$ ; ns = not significant ( $p > 0.10$ ). <sup>a,b</sup>Different letters differ by Tukey's test ( $p < 0.10$ ).

**Table 1.** Mean values of metabolic profiles, stocking rate and economic analysis of lambs under different supplement strategies

	Group <sup>1</sup>		
	CON	SEL	CSL
<b>Blood metabolite<sup>2</sup></b>			
Glucose, mg/dL	63	68	67
Urea, mg/dL	45	50	50
Albumin, g/dL	2.37	2.53	2.59
Total protein, g/dL	6.2	6.0	6.0
Cholesterol, mg/dL	76	86	77
Phosphorus, mg/dL	9.9 <sup>a</sup>	8.6 <sup>b</sup>	8.8 <sup>ab</sup>
Calcium, mg/dL	9.2 <sup>b</sup>	9.5 <sup>ab</sup>	9.9 <sup>a</sup>
Magnesium, mg/dL	2.1	2.2	2.1
<b>Stocking rate</b>			
Average lamb stocking rate, kg LW/ha	379.9 <sup>b</sup>	495.5 <sup>a</sup>	425.7 <sup>ab</sup>
Average ewe stocking rate, kg LW/ha	1,028.7 <sup>b</sup>	1,342.9 <sup>a</sup>	1,068.7 <sup>b</sup>
Average total stocking rate, kg LW/ha	1,408.7 <sup>b</sup>	1,838.4 <sup>a</sup>	1,494.4 <sup>b</sup>
<b>Economic analysis</b>			
Total feed intake, kg	---	1,594.3	472.1
Total feed cost, US\$	---	8,274.41	2,450.19
Lamb production, kg LW/ha	440.7	722.0	472.4
Production gain, kg LW	---	+281.3	+31.7
Total revenue by lamb sale, US\$	13,335.58	21,847.72	14,294.82
Return over feed cost, US\$	13,335.58	13,573.31	11,844.63
Return over production gain, US\$	---	237.73	-1,490.95

<sup>1</sup>Groups: CON, Control; SEL, supplemented ewes and lambs; CSL, creep feeding supplemented lambs. <sup>2</sup>Reference values according Kaneko (2008): glucose (50-80 mg/dL), urea (17-43 mg/dL), albumin (2.4-3.0 g/dL), total protein (6.0-7.9 g/dL), cholesterol (52-76 mg/dL), phosphorus (5.0-7.3 mg/dL), calcium (11.5-12.8 mg/dL) and magnesium (2.2-2.8 mg/dL). <sup>a,b</sup>Means with different letters on the same line differ by Tukey's test ( $p < 0.05$ )

mg/dL, results of this study are within normal limits. Higher phosphorus may be due to animal category, and its bone mobilization due growth (Borburema *et al.*, 2012).

Cholesterol values allow evaluation of milk contribution to energetic level (Fernandes *et al.*, 2012). Thus, discreetly elevated cholesterol concentration observed is likely due to milk intake, which offers large energy amounts as fat. Higher urea concentration is likely due to protein quality of ryegrass and the relationship between energy and protein in diet (Oliveira *et al.*, 2016).

The SEL showed higher stocking rate in all items and presented an average stocking rate higher ( $p < 0.05$ ) than CSL and CON (Table 1). Stocking rate of lambs did not differ between CSL and CON ( $p > 0.05$ ), similarly to verified by Ribeiro *et al.* (2009).

Higher stocking rates in SEL are due to a forage intake substitution effect by ewes, and it is in accordance with Farinatti *et al.* (2006). However, when supplementation is performed exclusively for lambs, Silva *et al.* (2012) also did not find changes in stocking rate because lambs have lower forage intake, which is not large enough to change this parameter.

Concerning the profitability (Table 1), supplemented groups had higher lamb production. However, only SEL gains was enough to pay the investment in concentrate feed (US\$ 5.19/kg), leading to revenue US\$ 237.73 higher than CON, while CSL showed economic losses.

A well-managed ryegrass pasture can provide high ADG of lambs, reducing differences between systems, which may justify the data found in this study. Also, duration of supplementation contributes with higher investment, which in this study was performed from the first week of life in CSL. Although longer supplementation times can provide better evaluation rates, before day 20, supplementation can be irrelevant (Borges *et al.*, 2013). Therefore, beginning supplementation when forage shows less quality could be a good strategy to optimize concentrate use, reducing costs. However, few reports have investigated this topic, and more studies should be performed to elucidate this strategy.

In conclusion, supplementation had a positive effect on ADG of lambs in pasture, although creep feeding strategy did not show economic benefits. However, supplementation of both ewes and lambs promoted an increase in animal stocking rate and had a positive economic return, being a strategy to improve lamb production in raising systems at similar climatic conditions.

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