

Selective grazing behavior of Coopworth sheep in New Zealand

Comportamento de pastejo seletivo de ovelhas Coopworth na Nova Zelândia

Comportamiento de pastoreo selectivo de ovejas Coopworth en Nueva Zelanda

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Abstract

This study focused on confirming the grazing selectivity of sheep, more and less selective, in pasture in New Zealand, under two different phenological stages of forage. Two experiments were conducted: 1) Comparison of selective and non-selective sheep in pasture irrigated with perennial ryegrass and white clover. 2) A comparison was performed with selective and non-selective sheep in pasture with a high rate of senescence composed of perennial ryegrass, barley and barnyard grass. The botanical composition of the forage was studied using the point analysis method. The forage canopy height and forage mass were measured using a disk meter. There was no significant difference between treatments in the variables analyzed. In the first experiment there was a lower clover ratio and increased litter ratio for the botanical composition and point analysis. With regards to height, there was a decrease in grazed clover pasture and grazed ryegrass pasture, as well as the forage mass. In the second experiment the grass ratio, clover height and forage mass decreased and the proportion of litter and grazed grass increased. Despite the differences in the botanical and morphological aspects of the pasture, the selective and non-selective sheep showed similar grazing behavior.

Keywords: Perennial ryegrass; Botanical composition; Ingestive behavior; Preference; White clover.

Resumo

Este estudo teve como objetivo confirmar a seletividade de pastejo de ovinos, mais e menos seletivos, em pastagem na Nova Zelândia, sob dois diferentes estádios fenológicos da forragem. Dois experimentos foram conduzidos: 1) Comparação de ovinos seletivos e não seletivos em pastagem irrigada com azevém perene e trevo branco. 2) Foi realizada uma comparação com ovinos seletivos e não seletivos em pastagem com alto índice de senescência composta por azevém perene, cevada e capim-arroz. A composição botânica da forragem foi estudada pelo método de análise pontual. A altura da copa da forragem e a massa de forragem foram medidas com um medidor de disco. Não houve diferença significativa entre os tratamentos nas variáveis analisadas. No primeiro experimento houve menor taxa de trevos e maior de serapilheira para a composição botânica e análise de pontos. Com relação à altura, houve diminuição da pastagem de trevo e pastagem de azevém, bem como da massa de forragem. No segundo experimento a proporção de capim, altura de trevo e massa de forragem diminuíram e a proporção de serapilheira e capim pastejado aumentou. Apesar das diferenças nos aspectos botânicos e morfológicos do pasto, os ovinos seletivos e não seletivos apresentaram comportamento de pastejo semelhante.

Palavras-chave: Azevém perene; Composição botânica; Comportamento ingestivo; Preferência; Trevo branco.

Resumen

Este estudio tuvo como objetivo confirmar la selectividad de pastoreo de ovinos, más y menos selectivos, en pastos en Nueva Zelanda, bajo dos etapas fenológicas forrajeras diferentes. Se realizaron dos experimentos: 1) Comparación de ovinos selectivos y no selectivos en pastizales irrigados con ballica perenne y trébol blanco. 2) Se realizó una comparación con ovinos selectivos y no selectivos en pastos con alto índice de senescencia compuestos por ballico perenne, cebada y pasto de corral. La composición botánica del forraje se estudió por el método de análisis puntual. La altura de copa y la masa de forraje se midieron con un calibrador de disco. No hubo diferencia significativa entre tratamientos en las variables analizadas. En el primer experimento hubo una menor tasa de tréboles y una mayor tasa de hojarasca para composición botánica y análisis puntual. En cuanto a la altura, hubo una disminución en el pasto de trébol, pasto de trébol y pasto de raigrás, así como en la masa forrajera. En el segundo experimento disminuyó la proporción de pasto, altura de trébol y masa de forraje y aumentó la proporción de hojarasca y pasto pastoreado. A pesar de las diferencias en los aspectos botánicos y morfológicos del pasto, las ovejas selectivas y no selectivas mostraron un comportamiento de pastoreo similar.

Palabras clave: Ballica perenne; Composición botánica; Comportamiento ingestivo; Preferencia; Trébol blanco.

1. Introduction

The domestic sheep (*Ovis aries*) is one of the main species of small ruminants, highly adaptable to different climatic conditions, production systems, and existing socioeconomic environments (FAO, 2021). The world production of sheep meat is approximately 15 thousand tons of carcasses/year with a projected growth of 1.2% until 2029, with the main producers being China, India, Australia, and New Zealand, and the largest consuming countries in Asia and Europe (OECD/FAO, 2020). These animals play an important socioeconomic role for the population of the region where they are found, providing them with meat, milk, and skin at low prices (Vilella, 2021).

The efficient use of pastures grazed by herbivores requires an understanding of the animals' grazing preferences and selection. Sheep have an intermediate feeding behavior due to the anatomical adaptations of their mouths that allow this type of grazing, with a preference for grasses, broadleaf plants, herbs, and shrubs (Silva & Abdalla Filho, 2020).

The discrimination by the animals between pastures or pasture components, when there are no restrictions placed on their choice, was defined as the preference (Taylor et al. 1993). However, under natural conditions such a situation rarely occurs in grazing pastures (Hodgson, 1979). On the other hand, selecting the diet must be considered, which is removing some components of the pasture, and not others.

Consequently, forage selection by herbivores often affects the nature and composition of pastures (Venter et al., 2019). Thus, understanding how herbivores graze in homogeneous and heterogeneous areas can help determine the impact of these herbivores on the plant species included in a community and thus improve animal production (Moreno & Mitzi, 2008).

The differences in forage selection by animals can lead to heterogeneity in pastures and these differences may cause variations in the quality and height of pasture, possibly directly influencing the grazing selectivity behavior (Williams, 2006). The Coopworth breed was developed by researchers at the University of Lincoln, New Zealand. The breed originated from the

crossing of Romney Marsh sheep with Border Leicester rams (Keene, 2003), which have dual purpose characteristics, 50% meat and 50% wool. The rams have heavy carcasses (16 to 22 kg) and the wool produced by the sheep ranges from 30-35 micron fiber, with hair of 120 and 200 mm in length.

The objective of this study was to confirm the grazing selectivity of the more and less selective sheep in two phenological stages of forage in New Zealand.

2. Methodology

This study is part of a rigorous sheep research since 2005, a screening of Coopworth sheep according to their selectivity has been conducted, followed by a study that compared the partial preference of the sheep in the two resulting groups, the selective and non-selective sheep for grass and clover pastures.

Two experiments were conducted between February and March at Johnstone Memorial Laboratory, University of Lincoln, located in Canterbury, New Zealand. A calibration curve was obtained between forage mass and height using the pasture disk meter in the area to divide the experimental plots (Santillan et al., 1979). The calibration was performed by selecting three areas of 0.1m² with three different heights per area (high, medium and low). The measurements in these areas were performed with the disk meter, cutting the samples close to the ground. These samples were dried at 60 °C for 48 hours, and after being weighed, the result was extrapolated to one hectare.

Next, the linear trend curve was obtained between the amount of dry matter per hectare and the measurements obtained by the disk meter and its corresponding equation. Using the mean value measured by the disk in the experimental area, in the equation, the quantity of dry matter per hectare was obtained and multiplying this value by the area resulted in the amount of dry matter in the experimental area.

With the value of available forage mass, it was possible to measure the experimental plots that should sustain 4 adult sheep weighing 65 kg in average.

The first experiment occupied an area of 0.3 ha, subdivided into six plots of 0.05 ha with available forage mass in the pre-grazing pasture. The second experiment was subdivided into six plots of 0.03 ha with available forage mass, totaling an area of 0.18 ha. The selective and non-selective sheep, identified in previous studies, were individually confined and given a certain amount of green perennial ryegrass forage with plenty of leaves and stalks. In the second stage they were given perennial ryegrass and white clover (O'Connor, 2005). Thus, the sheep that consumed greater amounts of leaves and white clover were considered selective sheep, while those that consumed stems and ryegrass were considered the non-selective sheep.

The first experiment was conducted in a pasture irrigated with perennial ryegrass and white clover, comparing the selective sheep (T1) and the non-selective sheep (T2).

The second experiment was conducted in a pasture with a high degree of senescence composed of perennial ryegrass, barley and spontaneous plants (barnyard grass), the selective sheep (T1) and non-selective sheep (T2) were compared.

In both tests, the experiment was a randomized block design with the plots subdivided over time, 3 blocks, the plots corresponded to the treatments (s) and the subplots corresponded to the evaluation days. In each experiment 24 Coopworth sheep were used, 12 selective and 12 non-selective sheep. In the first experiment the sheep remained in the experimental plots for 11 days and in the second experiment they remained eight days, with the pasture as the only food available.

The height of the forage canopy was measured every three days, using the measuring stick adapted to the height of the pasture (Barthram, 1986). The average height was considered in centimeters, using the stick to measure the first leaf found in the canopy, measuring the height of the forage species separately in the grazed and ungrazed sites: ungrazed clover, grazed clover, ungrazed ryegrass, grazed ryegrass and litter.

At each assessment, 150 random points were sampled, obtained by shifting the plots. The measurement of the forage

mass was performed using the disk meter. 150 random points in W were measured by shifting the plots. The average forage mass per plot was obtained by the difference between the initial reading, final reading and by dividing by the number of readings. The mass of available forage in each plot was obtained by using this mean value in the calibration equation, which was obtained at the beginning of the experiment.

For the evaluation of the botanical composition, 20 randomly selected subsamples were collected, shifting in W, in the area, and then cut close to the ground in an undefined area. The sample was composed of the sum of the subsamples, which were then stored in plastic bags and identified.

Next, the samples were manually separated into inflorescences of ryegrass, grazed ryegrass, ungrazed ryegrass, grazed clover, ungrazed clover, clover inflorescence, spontaneous plants and dead material. Then, each fraction was stored separately in paper bags and placed in the forced air incubator at a temperature of 65 °C, until they reached constant weight. Following this, the samples were weighed on a 1 gram precision scale, determining the percentage of each component relative to the total sample.

The point analysis technique, according to Hughes (1962), was used to measure the forage species in these plots. The “point analysis” consisted of a metal base device with eight rods set apart and with a pin at each end that moves freely. Once the equipment was placed in position, each rod was moved separately, recording the species and plant part that was touched by the pin. 200 points per picket area were randomly sampled. Next, the percentages of the individual components were calculated: grazed ryegrass, ungrazed ryegrass, grazed clover, ungrazed clover, litter and spontaneous plants.

The statistical analysis and comparison test of means were performed using the Genstat 11 software, considering the 5% level of significance.

3. Results and Discussion

Experiment 1

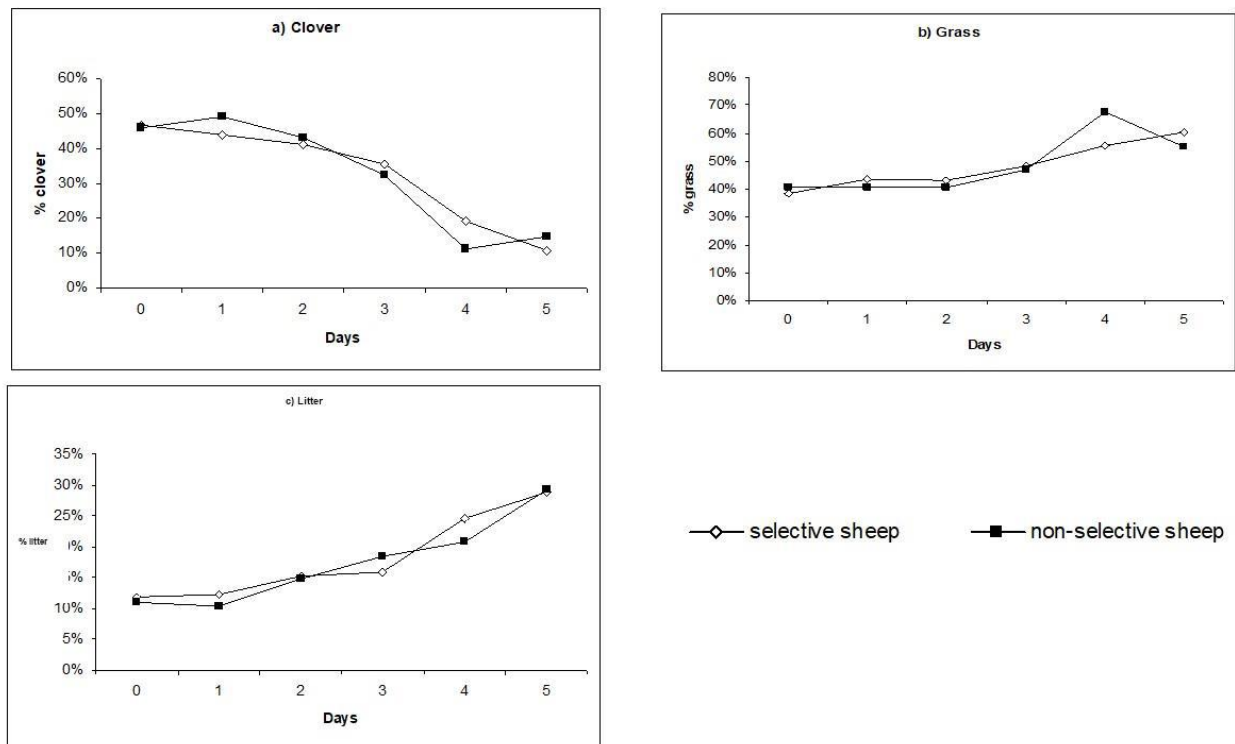
Over time, it was found that in both treatments there was a decrease in the proportion of white clover (Figure 1a) and an increase in the proportion of ryegrass (Figure 1b). This shows that there was probably a greater intake preference for clover, which shows there is no difference between the animals' selection potential.

That legumes tend to have higher levels of lignin, but low cell wall contents, hence a better digestibility (Mott, 1984; Barcellos et al., 2008). When animals are fed only grass, the passage rate is slower when compared to feeding mixed with clover, which can cause a greater preference for legumes.

O'Connor (2005), demonstrated by creep grazing system in the termination of sheep, an increased grazing time in white clover pasture, when compared to ryegrass. A similar situation was obtained when the sheep received a diet containing 62% of white clover with a reduced grazing time in this grass, in which the sheep showed a preference for white clover. The herbivores have the ability to adapt their feeding strategies in order to minimize grazing time without reducing the intake of digestible organic matter (Williams, 2006; Manço, 2020).

The proportion of litter increased during the experiment for the selective sheep as well as for the non-selective sheep (Figure 1c) according to the consumption of green material (ryegrass and clover), suggesting that this portion of the botanical composition is not consumed or is little consumed by sheep.

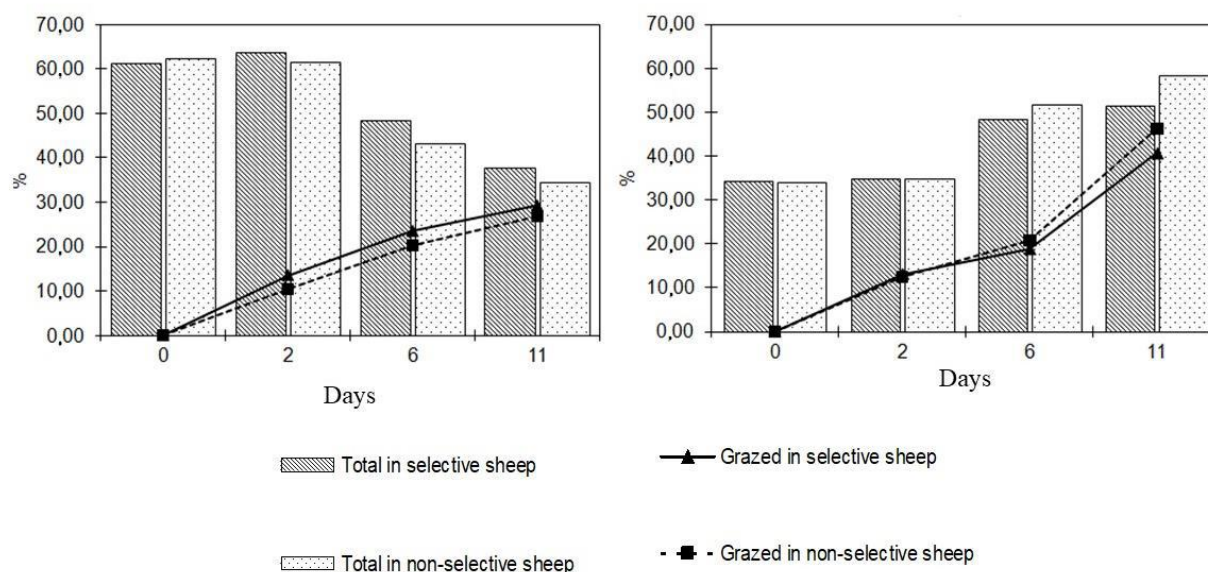
Figure 1 – Percentage change in the pasture’s botanical composition in experiment 1 in the six evaluation days, a) white clover; b) Perennial ryegrass and c) Litter.



Source: Authors.

The greater preference for white clover can be confirmed by the data obtained using point analysis (Figure 2). At the beginning of the experiment there was a higher proportion of white clover in the pasture (62%), while the perennial ryegrass accounted for 34%. Over the days of grazing on the pasture, the portion representing the total of white clover considerably reduced in proportion after the second day of evaluation. At the same time, the grazed white clover ratio increased, corresponding, last day of use, to approximately 78% of white clover in this environment for both treatments.

Figure 2 – Percentage change in the point analysis of grazed or ungrazed grass and legume in experiment 1 in the four evaluation days.



Source: Authors.

During the white clover reduction ratio, there was an increase in the perennial ryegrass ratio, and at the end of the occupation period, the ryegrass accounted for 55% of the pasture. This increase may possibly be related to the sheep's lower grazing intensity for perennial ryegrass, hence confirming the sheep's preference for the legume.

It was concluded that the white clover increase in pastures makes it easier to be selected by sheep, thereby reaching desirable white clover proportions in the diet. However, the animals' increased selection for white clover exhausts its proportion in the pasture, reducing its participation in the diet over time. Correspondingly, different long-term management strategies are required to allow animals to maintain a rich white clover diet.

It is quite plausible that in this experiment the reduction of the amount of white clover from the sixth day of occupation, may have led to this species' reduced selection capacity. This can be observed by the reduced curve corresponding to the grazed clover and the increased curve corresponding to the grazed ryegrass (Figure 2). This indicates that the reduced amount of clover limits the sheep's selection and from that moment on the sheep grazed more the perennial ryegrass.

There was no difference for canopy height in the treatments (Table 1). The average height of ryegrass leaves remained at around 12.33 cm during the evaluation days of the experiment, proving that the sheep had no food restriction. Studies have shown a positive relationship between grazing height and forage mass levels, with pastures maintained at lower grazing intensity presenting greater forage supply (Mezzalira et al., 2012; Silva et al., 2016).

Table 1 – Estimated averages of forage height in experiment 1 in four different evaluation moments.

Height (cm)	Sheep treatments		Days				Effect among days	Effect among treatments	Interaction
	Selective	Non selective	0	2	6	11			
Clover	9,58	9,67	13,40a	11,03b	8,70c	5,37d	<0.001	ns	ns
Grazed clover	9,19	9,01	-	-	9,42a	8,77b	<0.001	ns	ns
Ryegrass	11,81	12,85	13,59	11,98	11,82	11,93	0.03	ns	ns
Grazed ryegrass	8,66	9,27	-	-	9,71a	8,22b	<0.001	ns	ns

- Not evaluated. Lowercase letters in the same row differ between days by Tukey test at 5% significance. Source: Authors.

It was seen that for every 1 cm increase in height of C3 pasture, there is an increase of 100 kg DM/ha in forage mass in the pasture. In this study, the 12 cm pasture had 1200 kg DM of leaves available for the sheep, therefore indicating that, theoretically, there was no consumption restriction due to the lack of fodder. Since, good management of pastures is essential to ensure the supply of quality food and in sufficient quantity to meet the needs of the animals (Souza et al., 2021).

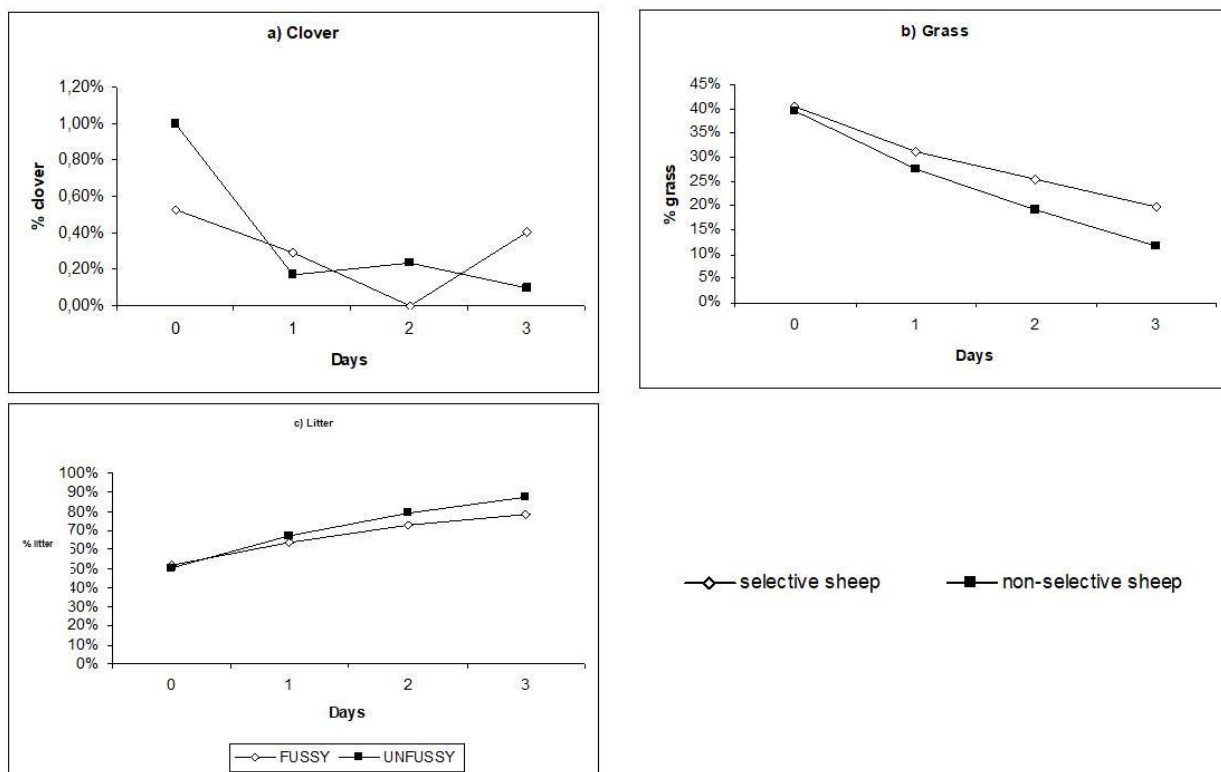
Over the course of the experiment, the clover height decreased from 13 cm to 5 cm. This probably occurred because in each grazing cycle, the animals consume preferentially a portion corresponding to 50% of the upper stratum. Thus, it was concluded that plant height is an important feature in the selection of diets, because despite the animals' preference for clover, this preference may decrease as ryegrass becomes higher than clover.

The height of grazed clover and ryegrass had similar characteristics, reducing the height by a centimeter from the second-to-last day to the last day of evaluation, both with 9 to 8 cm, respectively (Table 1).

Experiment 2

Despite the low amount of white clover in the pastures (1%) at the beginning of the experiment, the intake of this plant species by sheep was observed, taking into account the decrease in proportion of white clover (0.4%) in the last evaluation days (Figure 3a). Studies show that the availability of clover can also affect the proportion of clover consumed in the animals' diet; therefore, the availability of clover in the pasture also decreases. A 40% decrease of the grasses at the beginning of the experiment, to 16% during the pasture's period of occupation was observed (Figure 3b).

Figure 3 – Percentage change in the pasture’s botanical composition in experiment 2, in the four days of evaluation. a) White clover; b) Perennial ryegrass and c) Litter.

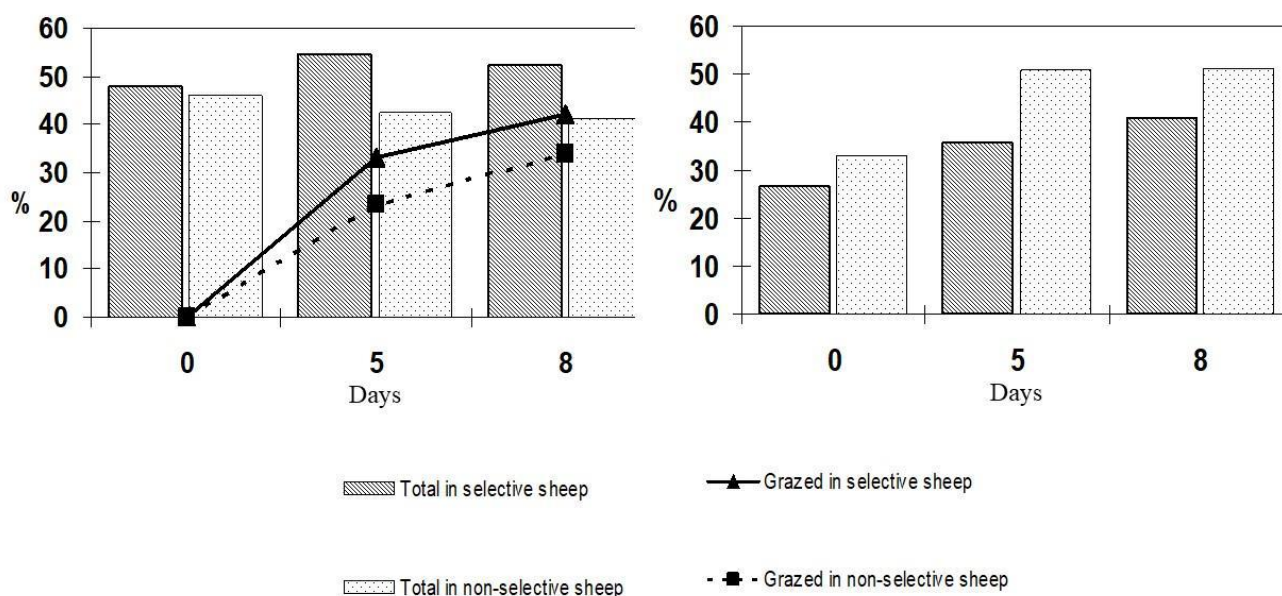


Source: Authors.

In both cases (Figure 3a and 3b), the reduction of clover and grasses in the pasture environment was evidenced by the large presence of litter in the experimental area, confirming that ruminants select first the best quality material for their diet, hence the green forages species, in line with senescent factors (Santos et al., 2008). A 32% increase in the amount of litter was observed (Figure 3c), justifying the sheep’s rejection for this inferior quality material, hence allowing an accumulation of this fraction in the pasture.

In the evaluation of the pasture ratio in the experimental area using the point analysis, there was no difference in the overall proportions of grass, grazed grass and total litter, between selective and non-selective sheep (Figure 4). The total proportion of grass did not change in the evaluation days, displaying an average of 47% of pasture. On the other hand, the proportion of litter increased by 30% to 46% on average, showing the sheep’s rejection for the senescent material.

Figure 4 – Percentage change in the point analysis of the grass and dead material, grazed or not in experiment 2, in the three days of evaluation.



Source: Authors.

There was no difference in height for the forage canopy between treatments, as well as for the height of ungrazed ryegrass, grazed ryegrass and litter during the evaluation days (Table 2).

Table 2 – Estimated averages of forage height in experiment 2 in the three days of evaluation.

Height (cm)	Sheep treatment		Days			Effects between days	Effect between treatments	Interaction
	Selective	Non selective	0	5	8			
Clover	1,38	2,06	5,15 a	1,05 b	0 b	<0,001	ns	ns
Ryegrass	7,37	7,32	8,69	7,47	5,87	ns	ns	ns
Grazed ryegrass	4,56	4,44	4,50	5,03	3,98	ns	ns	ns
Litter	13,9	13,3	13,6	12,6	14,5	ns	ns	ns

Lowercase letters in the same row differ between days by Tukey test at 5% significance. Source: Authors.

The clover height decreased from 5 cm at the beginning of the experiment, to zero at the end of the experiment. It should be noted that the existing amount of clover in the second experiment was small, indicating the sheep's total consumption of this forage species, leaving no legume residues in the pasture. This can be explained by the characteristic of sheep to use their lips a lot to apprehend food, which allows you to cut plants close to the ground (Almeida et al., 2023).

There was no difference between the selective and non-selective sheep for forage mass in both experiments. However, over the days of pasture grazing, forage mass decreased from 3.945 kg DM/ha to 1.854 kg DM/ha in the first experiment and 2.826 kg DM/ha to 1.466 kg DM/ha in the second experiment. Studying the relationship between the pasture and animal performance showed that to maximize the animal production potential, forage mass must be 1600 kg DM/ha to not impair the structural dynamics of grasslands and not limit the animals' forage consumption. Thus, in both experiments there was no restriction of forage availability for the animals.

4. Conclusion

The selective and non-selective sheep showed similar grazing behavior in relation to the botanical and morphological aspects of the pasture. This indicates that probably other factors, in addition to the proportions and characteristics of each pasture component, can influence the animals' food selection when grazing in New Zealand.

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