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Information Day 2024

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Outeniqua Research Farm Information Day 2024

Virtual Event

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Preface

The COVID-19 pandemic pushed us into the world of virtual meetings and online events, a big change for those of us who love discussing our science while standing in the milking parlour or in our pastures. It took some getting used to, but who would have thought that four years later, we would find ourselves in a similar situation—this time because of an animal disease outbreak?

At the Outeniqua Research Farm near George, we were excited to share our latest research and show you our cows and pastures in person. Unfortunately, due to the circumstances, we're connecting with you virtually again this year. We also miss the chance to say a heartfelt goodbye in person to Prof. Robin Meeske, Specialist Scientist in Animal Sciences, who retired on August 30th after 29 years of dedicated service at Outeniqua. We are incredibly grateful for his remarkable contributions and will honour his legacy as we move forward with new ideas and projects, under the leadership of his successor, whom we hope to appoint soon.

Outeniqua Research Farm is the only one of its kind in the country, and despite serious budget challenges, we are committed to sustaining the important work we do. Over the past year, Outeniqua has continued to welcome visits from scientists, student groups, and representatives from the animal feed, dairy, and pasture seed industries, both locally and internationally. The research teams here have consistently demonstrated their expertise at both national and international levels, motivating us to keep sharing our knowledge with the local dairy industry.

Our scientists have the unique opportunity to work directly within the production stream and share ideas with local farmers and advisors during study group meetings. This collaboration ensures that our researchers stay well-informed and connected to the real-world challenges and needs of the dairy industry. For this continuous partnership, we are sincerely grateful. We value your participation in our research process and extend an open invitation to visit us at Outeniqua once the shadow of Foot and Mouth Disease has passed. Together, we can enhance our research efforts to support the profitability and sustainability of the dairy industry.

The virtual Outeniqua Information Day 2024 will be available on our website, with a link provided for easy access to the presentations and our annual booklet containing the latest research results.

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Unravelling the forage quality of pasture mixtures under grazing

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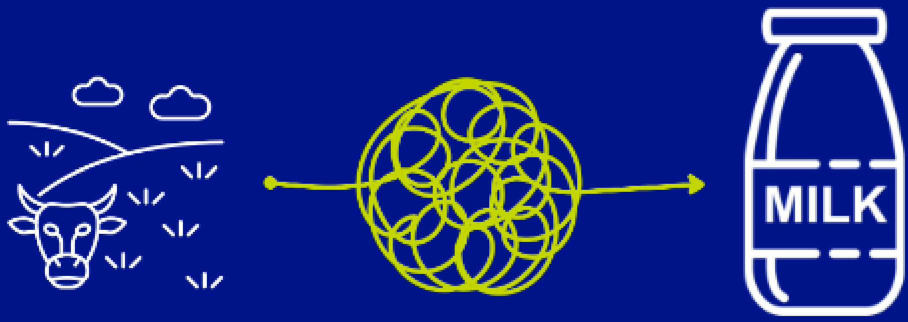

Introduction

Results from a farmlet study conducted on the Outeniqua Research Farm (2019 to 2022) indicated that the inclusion of forage herbs and legumes in pasture mixtures could improve milk yield per cow from spring to autumn compared to the traditional kikuyu-ryegrass system. The full results of this study can be accessed by **clicking on this link** or scanning this QR code:

In the above mentioned article is was hypothesized that the higher milk yield was associated with the forage herb component of the respective mixtures. As result the eventual loss of this component led to a lower milk yield from the forage herb mixture systems during year 3. However, forage quality data was not yet available to determine what the primary drivers of milk yield were in terms of forage quality, or how it was impacted by changes in botanical composition. **The aim of this article is thus to unravel the interactions and correlations between milk yield, pasture composition and forage quality parameters.**

Materials and methods

Three pasture types were evaluated during this study:

1. **KIKRYE:** A traditional kikuyu-ryegrass system where kikuyu is over-sown with ryegrass during autumn.
2. **FESC_PL MIX:** Whole area planted to a pasture mixture consisting of Tall Fescue, plantain and red clover.
3. **LUC_HERB MIX:** Whole area planted to a mixture consisting of Lucerne, chicory, plantain and ryegrass.
4. **MONOC:** Consisted of two separate areas allocated to a monoculture sward of Tall Fescue or plantain, respectively, but grazed as one system.

Since this article is aimed at developing a better understanding of pasture mixtures, only the first three systems will be discussed.

Each system was allocated a 5 ha farmlet that was grazed by its own mini-herd of 25 Jersey cows throughout the year. All systems were fertilized at a rate of 30 kg/ha after each grazing.

Forage quality sampling occurred on monitor strips (1 strip per 0.5 ha) during each grazing cycle. A total of three samples (of 0.098 m2 each) were cut at a height of 50 mm per strip at each sampling date. Samples were dried at 70°C for 72 hours to a constant mass and weighed to determine the DM content (%). The samples were pooled within a strip and milled (SWC Hammer mill, 1mm sieve). Samples were analysed by Near Infrared Spectroscopy (NIR) for a total of 36 forage quality parameters (Dairyland Laboratories, USA).

Only Neutral detergent fiber (NDF), Acid detergent fiber (ADF), Lignin content (%), Total Fatty Acid (TFA) content, Crude Protein Content (CP), Non-structural carbohydrates (NSC) and Non Fiber Carbohydrates (NFC) results will be discussed here.

Potential dry matter intake (DMI) was calculated as: DMI = (12/NDF) x 450 /100; where 450 is the weight of the cow. Metabolizable content (ME) was calculated as ME = (1.01 x digestible energy - 0.45) * 41.8; where DE = TDN x 0.04409.

Botanical composition was estimated by placing three 0.098 m2 rings randomly per monitor strip before grazing/cutting and cutting samples to a height of 50 mm above ground during each grazing cycle. The three samples were pooled, thoroughly mixed; a grab sample of approximately 500 g taken and then separated into the relevant fractions for each pasture type as described in Table 1.

Data analysis

Data was analysed using Microsoft Excel. Monthly and seasonal averages with corresponding standard errors were calculated.

Correlations were drawn up between monthly forage quality parameters and daily milk yield per cow within each system. In turn, correlations were drawn up between botanical composition components and forage quality parameters on a per sample basis.

Correlations were classed as:

- Strong: 0.9 to 1
- High: 0.70 to 0.89
- Moderately high: 0.50 to 0.69
- Moderately low: 0.30 to 0.49
- Weak: <0.30

In terms of milk yield, only forage quality parameters that were high (>0.70) will be discussed. For botanical composition only correlations that were moderately high and above (>0.50) will be discussed.

Results and Discussion

The two mixtures containing forage herbs and legumes tended to have a higher ME during the summer/ autumn period than KIKRYE during the first two years (Figure 1) . **Summer and autumn was also when the ME content of KIKRYE dropped below the recommended levels of 10.5 MJ ME/kg DM for a high producing dairy cow (NRC 2001).** The KIKRYE system in turn tended to have a higher ME content during winter, although ME would not be limiting in terms of milk production for any of the systems during winter.

Table 1. Components into which botanical composition samples were fractioned

System	Sown components	Volunteer/weed grasses	Broadleaf weeds	Volunteer legumes
KIKRYE	Kikuyu Ryegrass	*Paspalum urvillei** *Eragrostis plana** *Sporobolus africanus** *Bromus catharticus** *Poa pratensis** *Other**	All	All
FESC_PL MIX	Tall Fescue Plantain Red clover	Same as above* Ryegrass Kikuyu	All	White clover Trefoil
LUC_HERB MIX	Lucerne Plantain Chicory Ryegrass	Same as above* Kikuyu	All	White clover Trefoil

The **DMI of KIKRYE tended to be lower** than for the forage herb based pastures throughout (Figure 2). This could reduce the need to supplement the intake of animals on the forage herb mixtures with other feed sources like concentrates, maize silage or hay when pasture supply is not limiting.

The only noticeable trend in terms of CP (Figure 3) between treatments was that the CP of CHIC_LUC was higher during summer and autumn. It is likely that this was due to the lucerne component, but this was not confirmed by the correlation analysis. This coincides with the period when CP content may fall below the recommended level of 18% on the other two systems.

The NDF (Figure 4) and ADF (Figure 5) profiles of the three pasture systems followed similar patterns, being higher in KIKRYE than forage herb mixtures, particularly during summer and autumn. Of interest was that the CHIC_LUC and FESC_PL mixes both had higher lignin contents (Figure 8) during the study, irrespective of lower fiber (ADF and NDF) contents.

Non structural carbohydrates (NSC) consist of sugars, starches, fructans and organic acids, acting as a big source of energy in pasture based dairy systems. The non-fiber carbohydrates (NFC) content is a calculated value that also gives and indication of starch and sugar content, but includes pectin. The NFC of the forage herb systems was higher than for KIKRYE throughout, while NSC was lower. It is thus likely that these pastures contained higher levels of pectin than KIKRYE. Pectin is a source of energy for rumen microbes, and thus advantageous for rumen health.

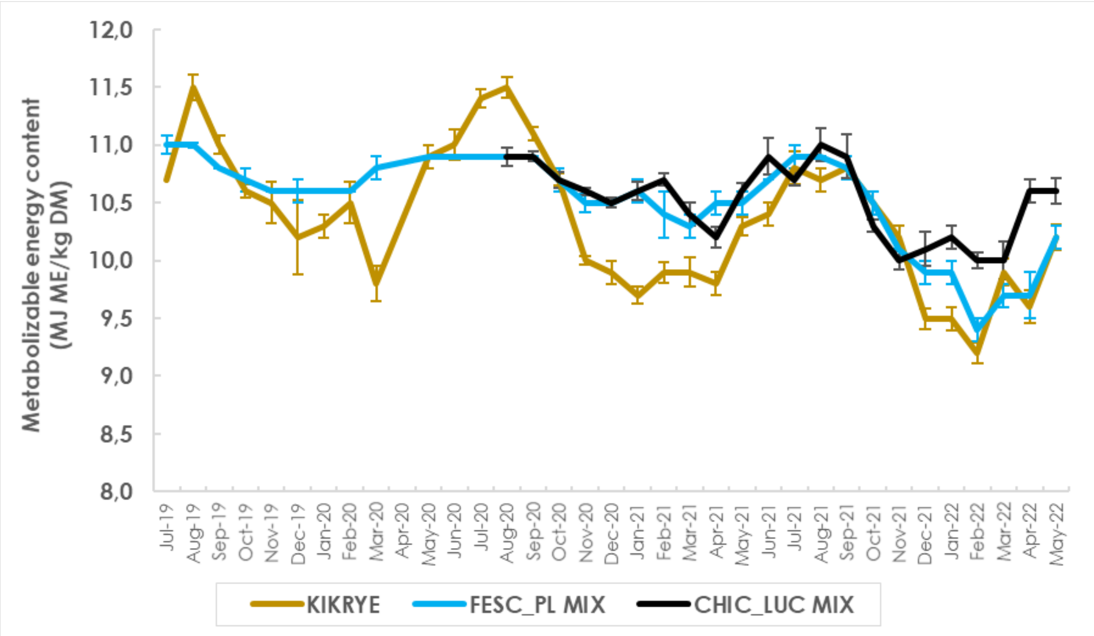

Figure 1. The monthly Metabolizable Energy (ME) content (MJ ME/kg DM) of pasture systems during the study

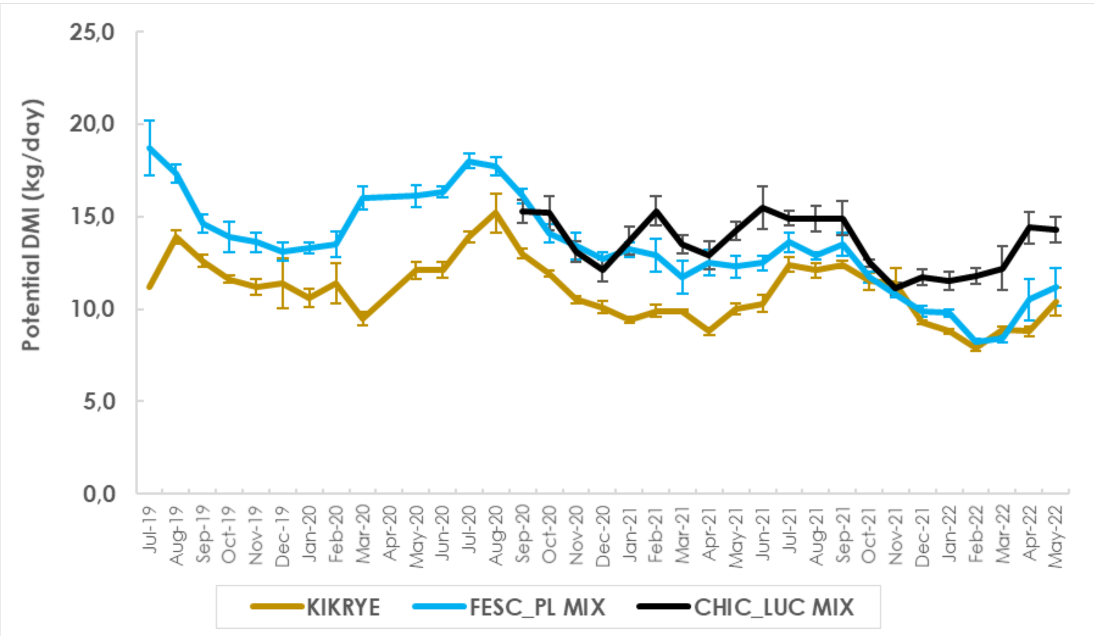

Figure 2. The monthly potential dry matter intake (DMI) for a 450 kg cow of pasture systems evaluated during the study

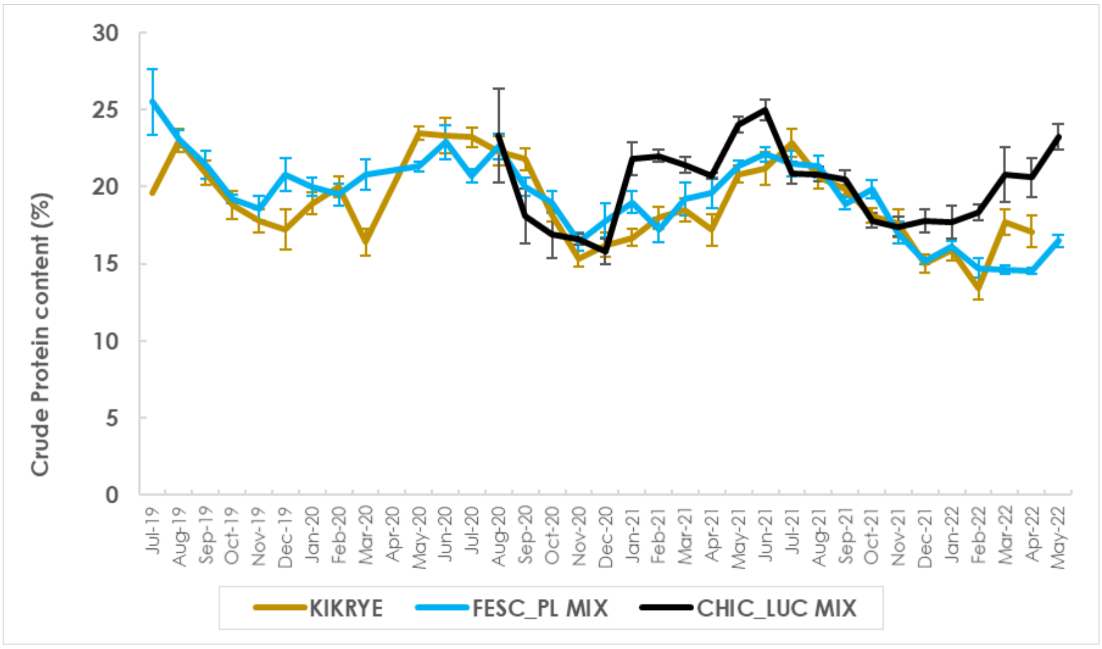

Figure 3. The monthly Crude Protein (CP) content of pasture systems evaluated during the study

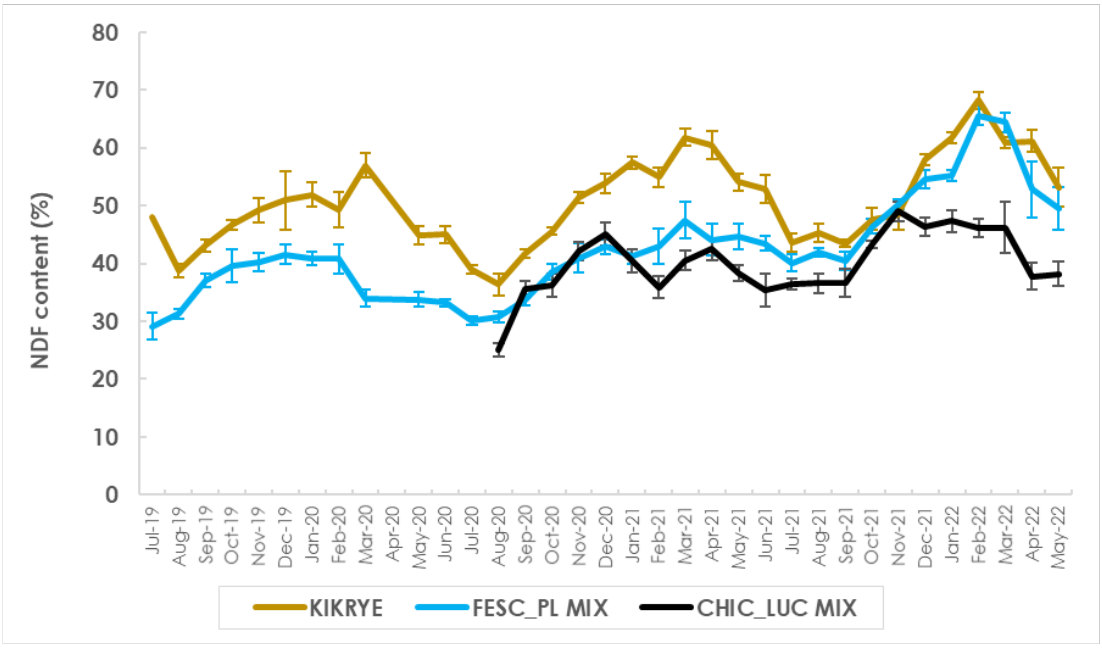

Figure 4. The Neutral Detergent Fiber (NDF) content of pasture systems evaluated during the study

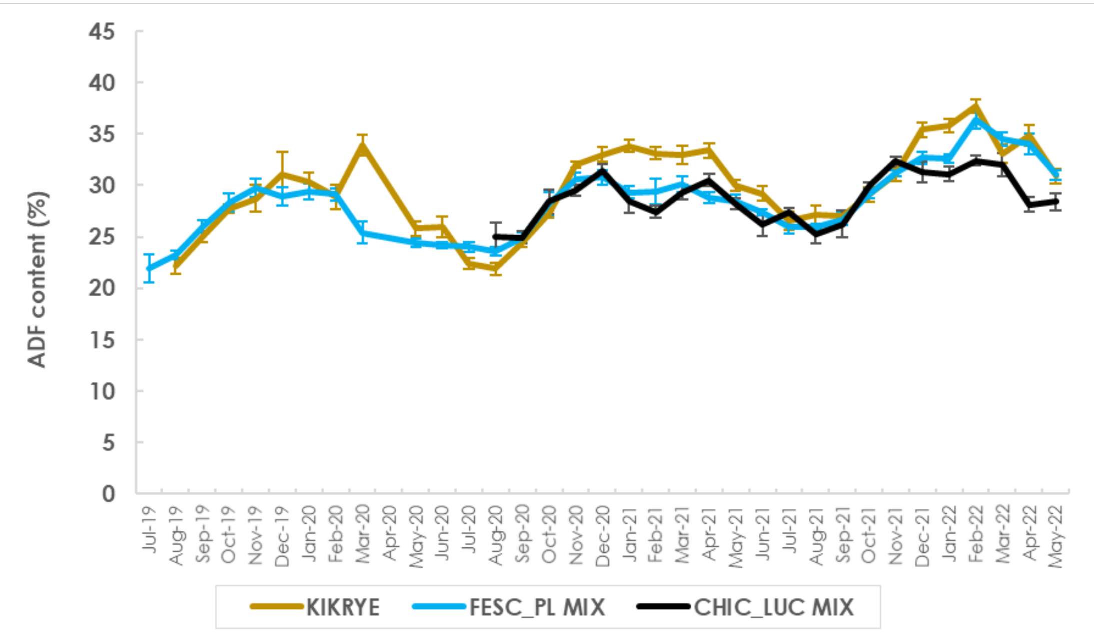

Figure 5. The Acid Detergent Fiber (ADF) content of pasture systems evaluated during the study

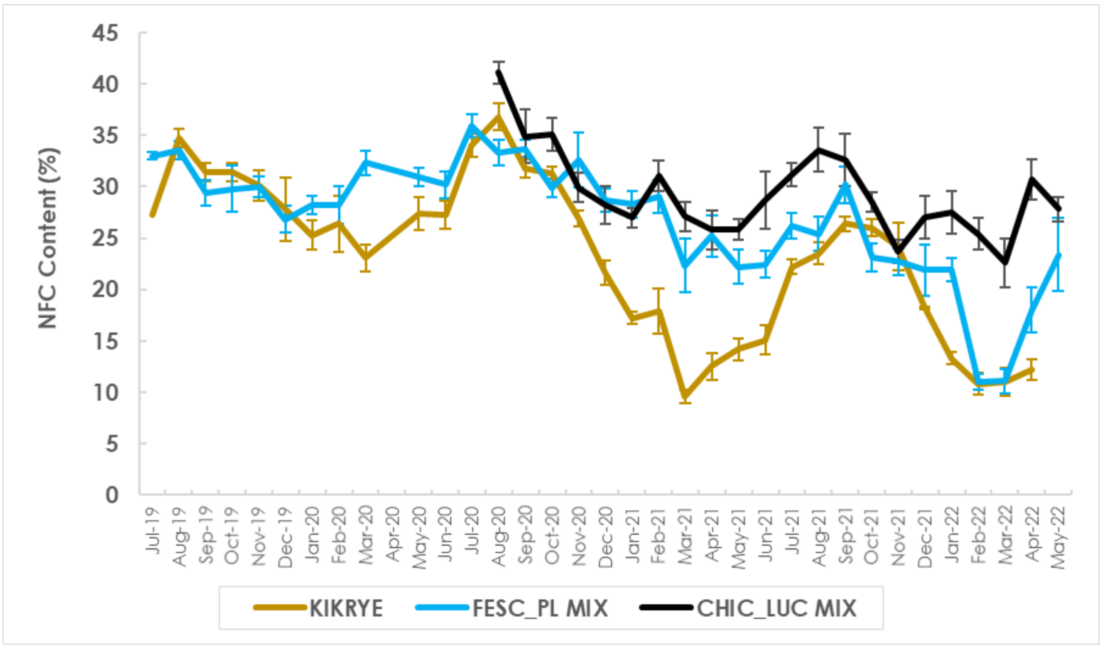

Figure 6. The Non-Fiber Carbohydrate (NFC) content of pasture systems evaluated during the study

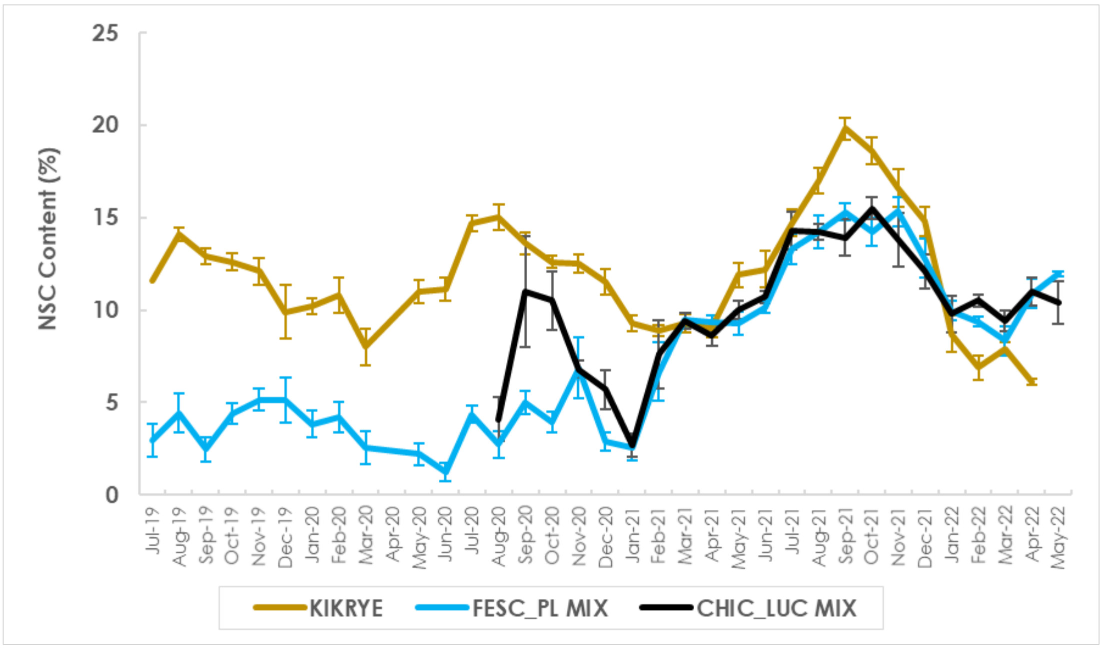

Figure 7. The Non-Structural Carbohydrate (NSC) content of pasture systems evaluated during the study

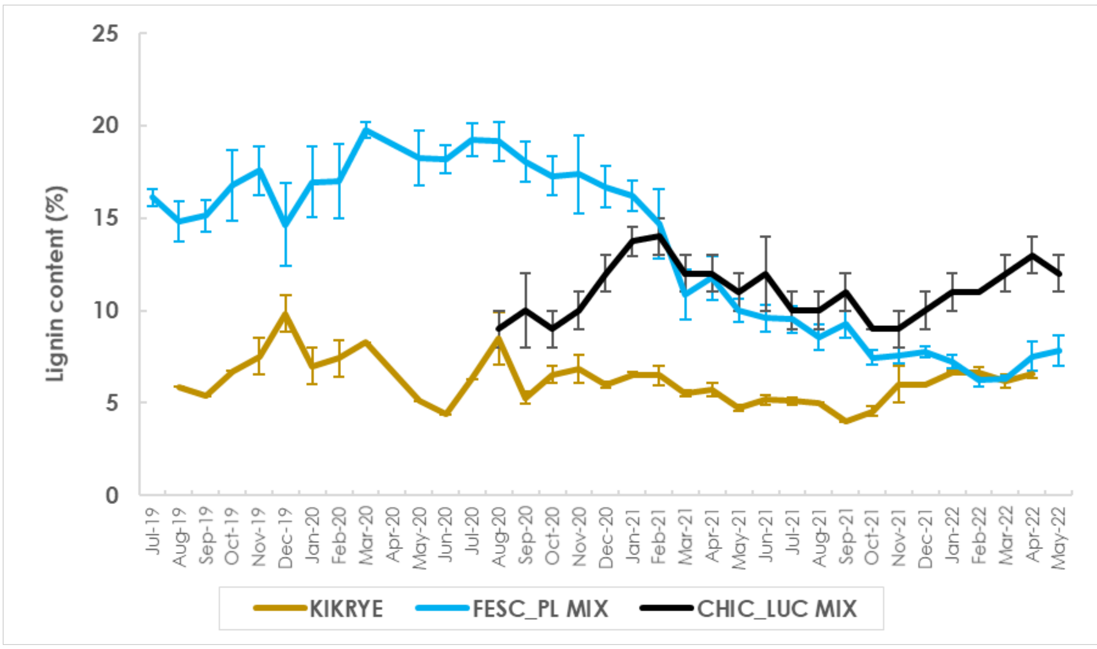

Figure 8. The Lignin content of pasture systems evaluated during the study

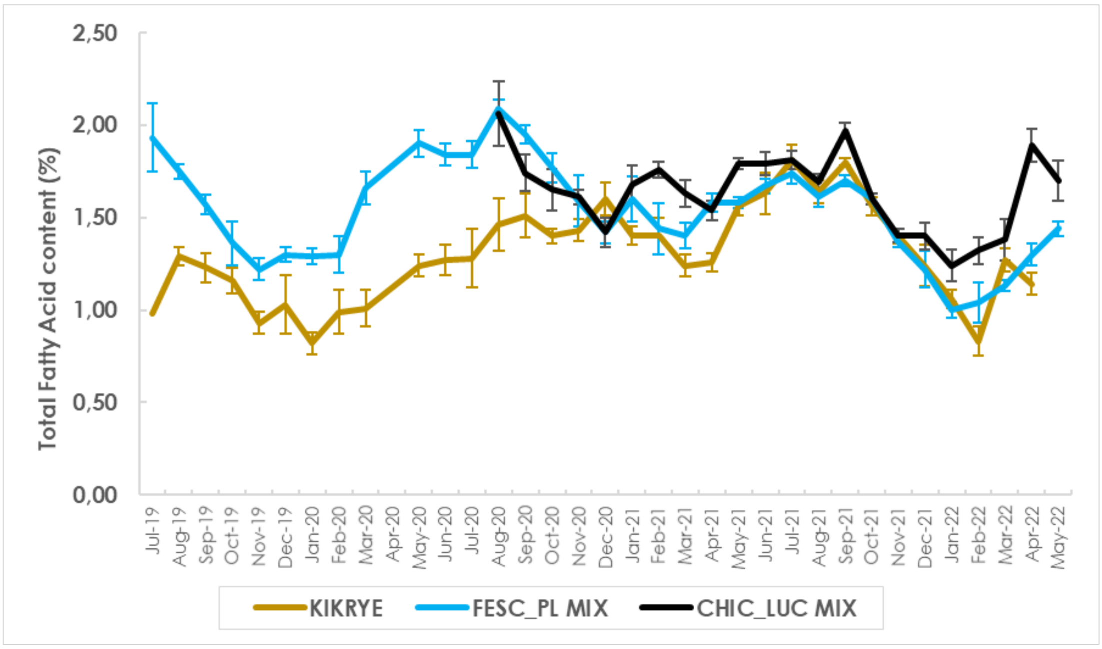

Figure 9. The Total Fatty Acid (TFA) content of pasture systems evaluated during the study

Kikuyu-ryegrass: correlations

The correlation between the monthly forage quality parameters and milk yield for KIKRYE are shown in Table 2. The parameters that were highly correlated with milk yield were NFC, NDF and DMI. The correlation of these parameters with botanical composition components is shown in Table 3.

Milk yield was found to be positively correlated with NFC, indicating that a increase in NFC in Kikuyu-ryegrass pastures has a positive effect on milk yield. As per the correlations in Table 3, NFC increases when the ryegrass component increases and decreases when the kikuyu component becomes dominant. The NDF content showed an inverse pattern to that of NSC i.e. it negatively impacted milk yield as it increased had a strong positive correlation with the kikuyu content.

In addition to resulting in an increase in the NDF content of pasture, a high kikuyu content also resulted in severely lowered DMI on the system (correlation: -0.41), often to below 9 kg DM/cow/day. **At that level, KIKRYE would only meet half the intake requirement (18 kg DM/day) of a 450 kg dairy cow.**

Correlations indicate that forage quality is strongly associated with the seasonal seesaw between ryegrass and kikuyu as the dominant component. **As expected, kikuyu is thus the main constraint to forage quality and milk yielding ability in a kikuyu-ryegrass pasture system.**

Table 2. The correlation between mean monthly milk yield per cow and forage quality parameters of kikuyu-ryegrass pasture

Strength of Correlation	Correlation with mean monthly milk yield (L/cow/day)		
High correlation	NFC (0.81)	NDF (-0.72)	DMI (0.71)
Moderate high	NSC (0.68)	ME (0.61)	ADF(-0.61)
Moderate low	NFC (0.38)		
Low	CP(0.21)	TFA (0.18)	Lignin(0.04)

Table 3. The correlation between forage quality parameters and pasture components of kikuyu-ryegrass pasture

	Correlation of forage quality with component contribution (%)			
	Kikuyu	Ryegrass	Weedy grasses	Broadleaf weeds
NFC	-0.55	0.53	-0.17	-0.07
NDF	0.47	-0.49	0.28	0.02
DMI	-0.41	0.42	0	-0.22

Table 4. The correlation between mean monthly milk yield per cow and forage quality parameters of Fescue_Plantain_Red clover pasture

Strength of Correlation	Correlation with mean monthly milk yield (L/cow/day)			
High correlation	ME (0.71)			
Moderate high	NFC (0.65)	NDF (-0.62)	CP(0.59)	DMI (0.55)
Moderate low	ADF (-0.59)	Lignin (0.44)	TFA (0.40)	
Low	NSC (-0.17)			

Table 5. The correlation between forage quality parameters and pasture components of Fescue_Plantain_Red clover pasture

	Correlation of forage quality with component contribution (%)				
	Plantain	Fescue	Red clover	Weedy grasses	Broadleaf weeds
ME	0.58	-0.30	0.10	-0.60	0.11
NFC	0.55	-0.33	-0.21	-0.63	0.05
NDF	-0.61	0.36	-0.13	0.61	-0.10

Fescue_Plantain_Red Clover: Correlations

The correlation between the monthly forage quality parameters and milk yield for FESC_PL MIX are shown in Table 4. The only parameter that was highly correlated with milk yield was ME. The correlation of ME, as well as NFC and NDF (ranked second and third in terms of correlation with milk yield, respectively) with botanical composition components is shown in Table 4.

It is commonly accepted that ME is a strong driver of milk yield per cow, and the correlations in Table 4 show that this is also the case for FESC_PL MIX. The ME content of this mixture was highly correlated with the plantain content. **More detailed analysis of the data showed that once plantain content dropped below 60%, ME tended to decrease below 10.5 MJ ME/kg DM is summer and autumn.** The high negative correlation between ME and weedy grasses should also be noted. This resulted in ME dropping to as low as 9.4 MJ ME/kg DM when kikuyu contributed to more than 20% of the pasture composition by the summer of year 3.

As expected, plantain had a negative correlation with NDF, resulting in NDF increasing progressively as the plantain content declined and grass content increased. Plantain could thus be a potential species selected for mixtures if the aim is to reduce NDF content of pastures, particularly in summer/autumn. This will likely stimulate pasture intake during this period. Red clover showed low correlation with all of the forage quality parameters.

The inclusion and maintenance of a plantain component at 60% in a mixture can improve the ME content and DMI of pastures, particularly during summer and autumn.

Table 6. The correlation between mean monthly milk yield per cow and forage quality parameters of Fescue_Plantain_Red clover pasture

Strength of Correlation	Correlation with mean monthly milk yield (L/cow/day)				
High correlation					
Moderate high					
Moderate low	ME (0.39)	ADF (-0.36)	Lignin (-0.34)		
Low	NSC (0.24)	DMI (0.23)	CP(-0.21)	TFA (0.21)	NDF (-0.17)

Table 7. The correlation between forage quality parameters and pasture components of Chicory_Lucerne_Ryegrass pasture

	Correlation of forage quality with component contribution (%)				
	Chicory	Ryegrass	Lucerne	Weedy grasses	Broadleaf weeds
ME	0.00	0.29	-0.23	-0.30	0.09
ADF	0.06	-0.13	0.15	0.19	-0.16
Lignin	0.38	0.32	0.16	0.36	-0.02

Chicory_Lucerne_Ryegrass: Correlations

The correlation between the monthly forage quality parameters and milk yield for the CHIC_LUC MIX are shown in Table 4. All forage quality parameters had a moderately low to very low linear correlation with milk yield. Potential reasoning behind this is that the relationships are either non-linear, or a more complex model will be required to predict interactions. Nevertheless, the correlations between ME, ADF and Lignin are still shown in Table 7.

Chicory was found to be a major component of the mixture during summer of year 1, lucerne in the summer of year 2 and ryegrass in the winter of year 1. Yet, they were relatively poorly correlated with the ME content of the CHIC_LUC MIX. This could indicate that because this system oscillates rapidly between components that are of a relatively high forage quality, fluctuations are poorly explained by one single pasture component or species. Better quantification of botanical composition could also clarify this issue. As with the other systems, weedy grasses were negatively correlated with ME, and their ingression into pastures should be prevented.

Conclusions

Changes in forage quality of pasture mixtures are highly dependent on changes in botanical composition, with a clear impact on milk production. This is particularly true in systems where individual components differ greatly in their forage quality *viz.* kikuyu vs. temperate species.

Plantain was found to be a good species to increase ME and DMI intake in pasture mixtures, but would need to be maintained at more than 60% of the pasture composition. This project again highlights how problematic kikuyu is in terms of use as a dairy pasture, resulting in high NDF levels that limit DMI and lowered ME content, in turn leading to low milk production per cow.

Red clover: preliminary results evaluating grazing type cultivars

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Introduction

Until recently the red clover varieties used in South Africa were all of the annual-type which typically lasts at most 18 months. The work done on pastures systems for dairy using mixed pastures clearly showed the limitations of these annual type red clovers for such systems where the other components such as plantain and tall fescue are more perennial. The loss of the legume component is thus a limitation for an otherwise high potential mixed pasture. (van der Colf, Ammann, Meeske 2021; van der Colf, Ammann, Meeske 2022). After a visit from Prof Stansilav Hejduk from Mendel University, who showed us their data on grazing-type red clover cultivars, we decided to start evaluation trials of such cultivars at Outeniqua. Various South African seed companies then a contributed seed to the trials, originating from Eastern Europe (15 cultivars), New Zealand (3 cultivars) and USA (2 cultivars). Of these three are tetraploid and 12 are diploid types.

Eastern European varieties

Bonus, Chaldene, DFL-TDP, Euphoria, Garant, Gert, Gregale, Hajan, Hammon, Himalia, Kallichore, Megalic, Pasima, Respect, SG-C91

New Zealand varieties

Amigain, Morrow, Relish

USA varieties

USA: Barduro, Dynamite

According to the 2023 recommended list publication of Agroscope, Switzerland (Suter et al 2023), the cultivars Bonus, Garant, Hammon and Respect are annual types.

Suter et al (2023) report that the red clover grazing types in a mixture with grass, at infrequent defoliation and without added N, produce 10% higher yield than a white clover/grass mixed pasture.

In Australia the Dairy Aus 3030 project (2020) recommends red cover for improved summer production especially in mixed pastures with plantain or chicory and a grass. It is considered more adaptable than lucerne and tolerant of more frequent grazing. Red clover is not as drought tolerant as lucerne but can tolerate wet conditions better.

Evaluation procedures

Parameters determined and assessed:

- Yield
- Flowering (ratings)
- Disease incidence (ratings)
- Sward density (ratings)
- Sward height at harvest to nearest 5cm

Plot size: 2.1 m x 6m, net plot size 1.3m x 4.7m

Mower blade height: 5cm (Agria mower)

A sample of approximately 500g is taken across the length of each net plot for DM determination, after which the total net plot material is raked and weighed. Samples for DM are dried at 70°C.

Establishment dates and locations

Plots were sown in 15cm rows at a depth of 3cm.

Trial Tp1: 14 March 2023 at Outeniqua Research farm, field LH2-6

Trial Tp2: 12 April 2023 at Outeniqua Research farm, field LH2-8

The harvest intervals are shown in Table 1.

Summary of observations after the first year

- Some grazing type cultivars are winter active, while most are winter dormant (Figure 1)
- Peak yield is in spring (Table 2 and 5; Figure 2 and 5)
- Winter dormant cultivars have best summer yield (Figure 3 and 6)
- Green leaf and ground cover best in grazing types (Figures 9, 10 and 11)
- Possibly a mixture of the two types would give good yield distribution and ground cover

References

- Persistence will be evaluated going forward

Dairy Australia 3030 Project (2020). www.dairyaustralia.com.au

Suter D, Frick R, Hirschi HU. 2023. Liste der empfohlenen Sorten von Futterpflanzen 2023-2024. Agroscope Transfer Nr. 460/2023

Van der Colf J, Ammann SB, Meeske R. 2021. The integration of forage herbs into systems: lessons learnt from farmlet studies. Outeniqua Information day, Milk Production from Planted Pastures 2021.

Van der Colf J, Ammann SB, Meeske R. 2022. Forage herbs and mixtures: impact of inclusion on pasture system productivity. Outeniqua Information day, Milk Production from Planted

The most important information, regarding the original objectives of finding more persistent grazing type red clover cultivars, will hopefully be realised in years two and three of the trials.

Table 1. Harvest intervals, number and dates for TP1 and TP2

TP1			TP2		
Days to harvest	Harvest number	Date	Date	Harvest number	Days to harvest
*	Cut 1	08/05/2023			
67	Cut 2	14/07/2023	03/07/2023	Cut 1	
71	Cut 3	12/09/2023	12/09/2023	Cut 2	71
36	Cut 4	18/10/2023	18/10/2023	Cut 3	36
35	Cut 5	22/11/2023	22/11/2023	Cut 4	35
27	Cut 6	19/12/2023	19/12/2023	Cut 5	27
30	Cut 7	18/01/2024	18/01/2024	Cut 6	30
39	Cut 8	26/01/2024	26/01/2024	Cut 7	39
62	Cut 9	29/04/2024	29/04/2024	Cut 8	62

***The first harvest was not weighed due to a high weed content.**

Table 2. Red clover (*Trifolium pratense*), **Tp1**, Evaluation at Outeniqua Research Farm

Planted: 14 March 2023 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Winter 2023		Spring 2023		Summer 2023/24		Total Cuts 2-9	Green leaf area Jan 2024 10 days regrowth	Green leaf area Apr 2024 21 days regrowth
		Yield	Height (cm)	Yield	Height (cm)	Yield	Height (cm)	Yield	%	%
Amigain	D	**1.84** ab	21	5.75 bc	28	4.60 bcd	30	**13.24** abcd	46.1 cde	72.3 bcd
Barduro	D	1.68 b	21	**6.37** ab	40	**4.77** abcd	38	**13.91** ab	40.9 ef	60.7 e
Chaldene	D	0.4 de	10	5.17 cd	25	3.98 d	27	10.34 ef	42.0 ef	68.3 cde
DLF-TPD 23007	D	0.92 c	11	5.68 bc	26	**5.02** abc	32	12.33 bcd	**58.7** ab	**79.9** ab
Euphoria	D	0.41 de	11	5.75 bc	26	4.64 bcd	32	11.60 def	41.8 ef	64.0 de
Garant	D	0.65 cd	13	5.75 bc	32	4.62 bcd	36	11.70 cdef	52.9 bcd	**75.7** abc
Hammon	T	0.76 cd	13	**6.30** ab	32	**5.25** ab	37	**13.27** abcd	51.5 bcd	**80.4** ab
Himalia	D	0.77 cd	13	**6.12** ab	33	**5.40** ab	38	**13.28** abcd	**57.3** ab	73.1 bcd
Kallichore	D	0.81 c	12	**6.33** ab	32	**5.60** a	36	**13.57** abc	**63.4** a	**85.0** a
Megalic	D	0.9 c	14	5.97 b	32	4.52 bcd	33	12.19 bcde	39.5 ef	73.8 bcd
Morrow	D	**1.95** ab	22	**6.40** ab	36	**5.09** abc	37	**14.42** a	46.0 cde	**81.7** ab
Oregon Red (C)	D	**2.13** a	29	**6.72** a	39	4.22 cd	42	**14.25** a	37.5 f	61.9 e
Pasima	D	0.73 cd	12	**6.07** ab	29	**5.12** abc	33	**12.75** abcd	53.3 bc	**81.9** ab
Relish	D	**1.96** ab	23	**6.31** ab	32	4.23 cd	32	**13.77** ab	41.8 ef	67.4 cde
LSD (0.05)		0.39		0.74		0.95		1.90	8.42	9.88
CV %		21.7		7.5		11.9		8.9	10.5	8.0

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant. Green leaf area was determined with the Canopeo App.

Table 3. **Red clover** (*Trifolium pratense*), **Tp1**, Evaluation at Outeniqua Research Farm

Planted: 14 March 2023 **Growth rates** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 2 14/7/2023	Cut 3 12/9/2023	Cut 4 18/10/2023	Cut 5 22/11/2023	Cut 6 19/12/2023	Cut 7 18/1/2024	Cut 8 26/2/2024	Cut 9 29/4/2024
Amigain	D	**7.2 ab**	**28.4 a**	**74.5 abc**	62.1 d	69.6 cd	**66.3 abc**	**33.1 abcd**	17.0 a
Barduro	D	2.5 cdef	**31.5 a**	**78.3 abc**	**76.2 abc**	63.2 d	**70.5 ab**	**37.2 abc**	17.6 a
Chaldene	D	2.2 ef	5.3 bc	59.9 d	67.0 cd	75.1 bcd	50.1 d	27.0 cd	12.7 a
DLF-TPD 23007	D	5.0 bc	12.1 b	65.5 cd	71.2 bcd	**85.8 ab**	**69.0 ab**	**34.0 abcd**	11.5 a
Euphoria	D	1.7 ef	6.0 bc	65.9 bcd	**75.2 abc**	**83.4 abc**	**64.6 abcd**	28.7 cd	13.0 a
Garant	D	2.4 def	10.2 bc	**72.5 abcd**	66.6 cd	**86.0 ab**	**63.7 abcd**	27.6 cd	11.0 a
Hammon	T	3.4 cdef	11.2 bc	**77.8 abc**	**74.2 abc**	**95.6 a**	**75.9 a**	**35.2 abcd**	15.4 a
Himalia	D	4.2 cdef	10.1 bc	**76.7 abc**	72.6 bcd	**87.2 ab**	**69.3 ab**	**42.6 a**	16.1 a
Kallichore	D	3.3 cdef	12.1 b	**76.8 abc**	**76.9 abc**	**82.7 abc**	**75.3 a**	**41.7 ab**	13.4 a
Megalic	D	4.6 cdef	12.3 b	67.6 bcd	**79.4 ab**	76.4 bcd	**62.1 abcd**	31.0 bcd	12.9 a
Morrow	D	**8.2 a**	**29.0 a**	**81.3 a**	71.7 bcd	77.0 bcd	**65.7 abc**	**42.4 a**	15.9 a
Oregon Red (C)	D	**7.6 a**	**33.9 a**	**76.1 abc**	**83.8 a**	80.1 bc	51.6 cd	29.5 cd	18.9 a
Pasima	D	3.4 cdef	10.5 bc	**72.1 abcd**	**75.4 abc**	**88.5 ab**	**76.0 a**	29.7 cd	13.4 a
Relish	D	**7.5 ab**	**32.2 a**	**78.6 ab**	**72.5 abc**	69.8 cd	59.1 bcd	28.9 cd	17.1 a
LSD (0.05)		2.6	7.5	12.8	10.4	15.1	14.8	11.1	NS
CV %		36.8	26.9	10.8	8.4	11.3	13.5	20.2	33.4

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant.

Table 4. Red clover (*Trifolium pratense*), **Tp1**, Evaluation at Outeniqua Research Farm

Planted: 14 March 2023 **Flower heads (%)** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 2 14/7/2023	Cut 3 12/9/2023	Cut 4 18/10/2023	Cut 5 22/11/2023	Cut 6 19/12/2023	Cut 7 18/1/2024	Cut 8 26/2/2024	Cut 8 Leaf:stem ratio*	Cut 9 29/4/2024
Amigain	D	0	0	3.3 bc	0	0	18.3 c	30.6 c	-	14.2 bc
Barduro	D	0	0	**7.5 a**	0	3.3 b	**54.2 a**	**66.7 a**	0.79	**29.6 a**
Chaldene	D	0	0	1.7 bc	0	0	1.7 e	20.8 cd	-	12.5 bc
DLF-TPD 23007	D	0	0	1.7 bc	0	0	3.3 e	16.7 d	1.50	3.3 d
Euphoria	D	0	0	1.7 bc	0	0	12.5 cd	45.8 b	-	10.0 bcd
Garant	D	0	0	0	0	0	7.5 de	16.7 d	1.34	3.3 d
Hammon	T	0	0	0	0	0	5.8 de	12.5 d	-	1.7 d
Himalia	D	0	0	0	0	0	4.2 e	16.7 d	-	7.5 cd
Kallichore	D	0	0	1.7 bc	0	0	3.3 e	12.5 d	1.22	1.7 d
Megalic	D	0	0	0	0	0	5.8 de	14.2 d	-	1.7 d
Morrow	D	0	0	**5 ab**	0	**5 a**	41.4 b	**66.7 a**	0.92	**29.2 a**
Oregon Red (C)	D	0	0	0	0	0	12.5 cd	**58.1 ab**	1.94	16.7 b
Pasima	D	0	0	1.7 bc	0	0	3.3 e	10.0 d	-	2.2 d
Relish	D	0	0	3.3 bc	0	0	16.7 c	**57.9 ab**	1.33	16.7 b
LSD (0.05)		-	-	3.7	-	1.3	8.2	12.3	-	8.6
CV %		-	-	113.9	-	134	37.5	23.8	-	49.2

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant *** only determined for some cultivars**

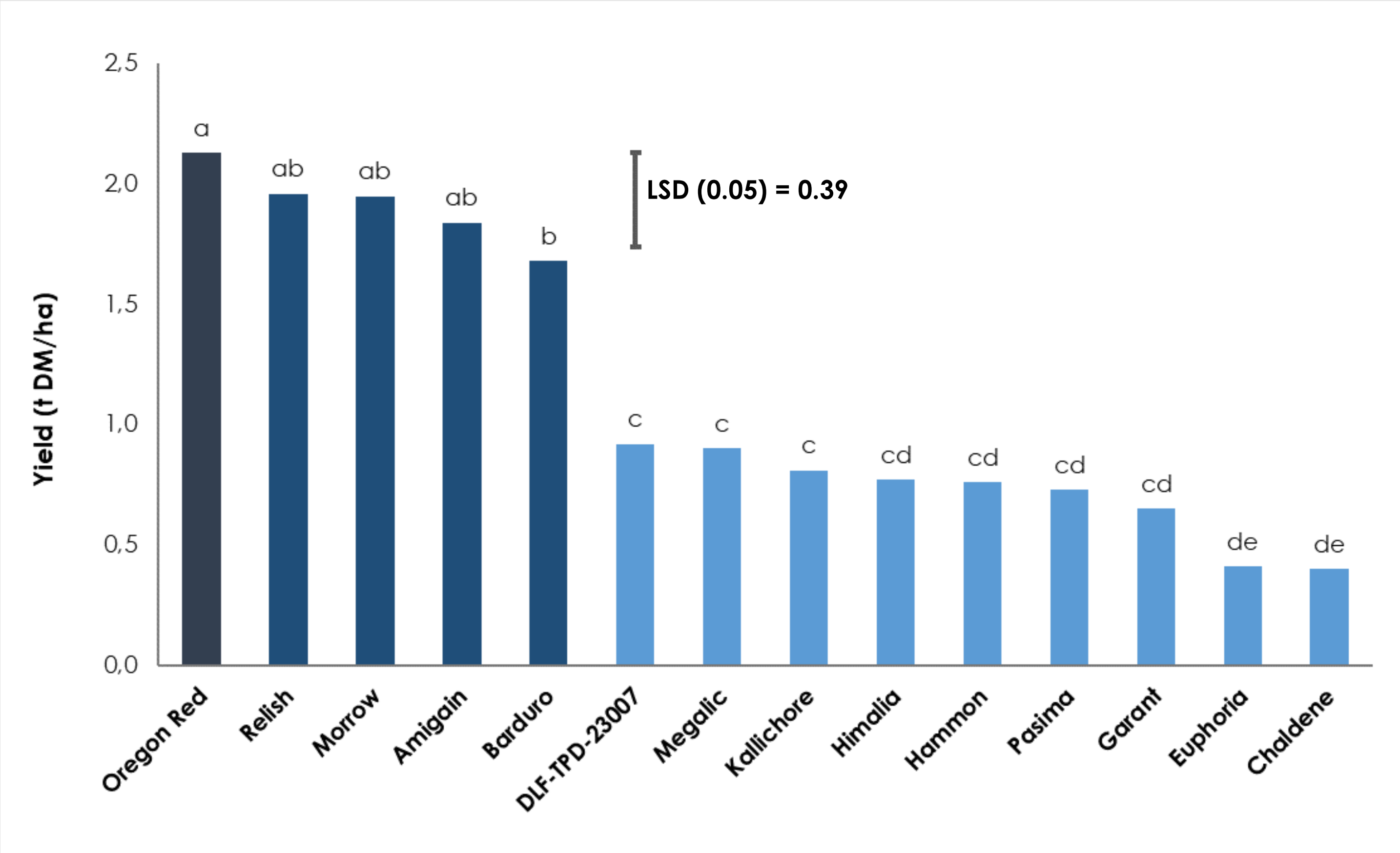

Figure 1. Winter yield (t DM/ha) for red clover trial Tp1 planted on 14 March 2023.

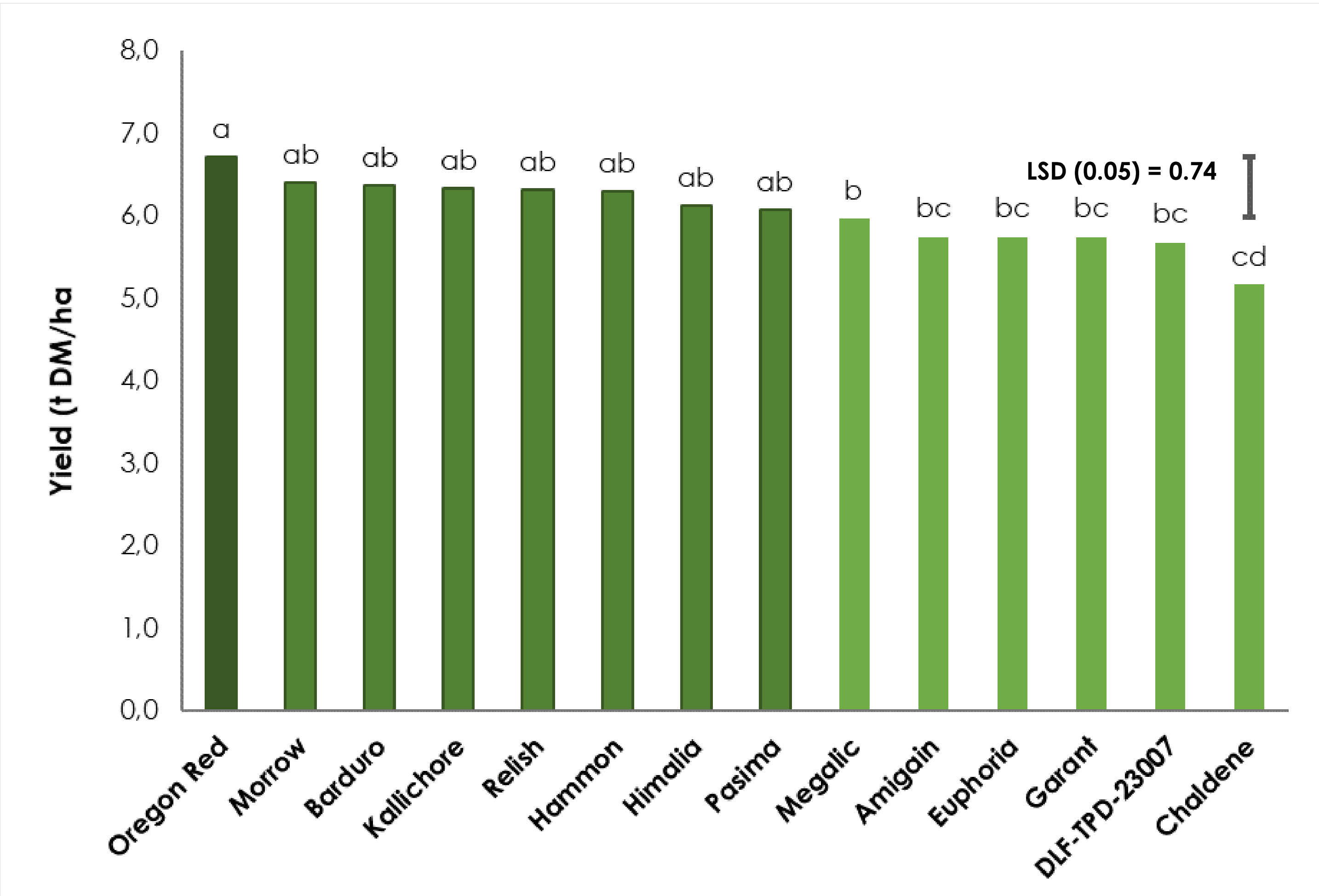

Figure 2. Spring yield (tDM/ha) for red clover trial Tp1 planted on 14 March 2023.

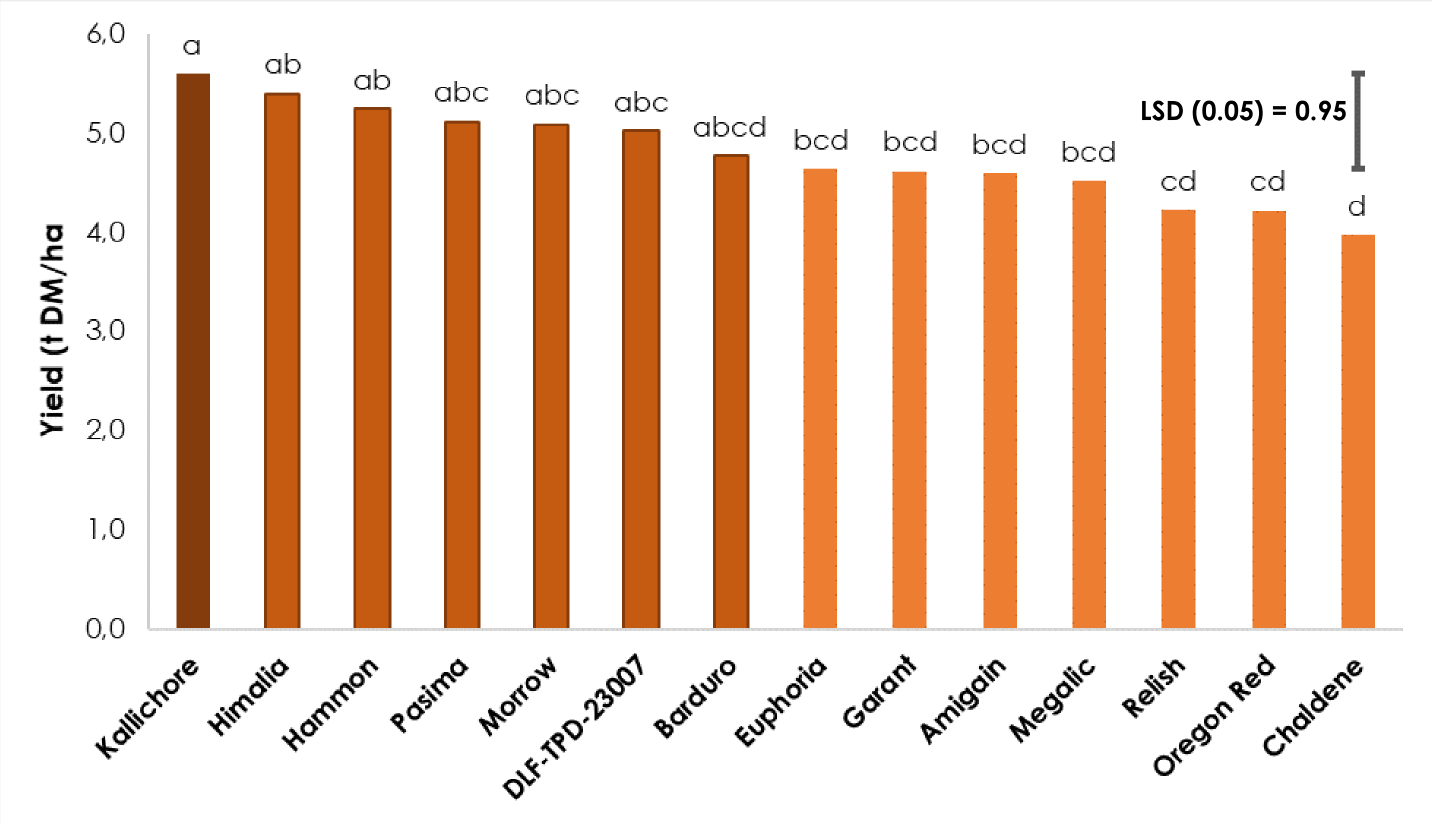

Figure 3. Summer yield (t DM/ha) (year 1) for red clover trial Tp1 planted on 14 March 2023.

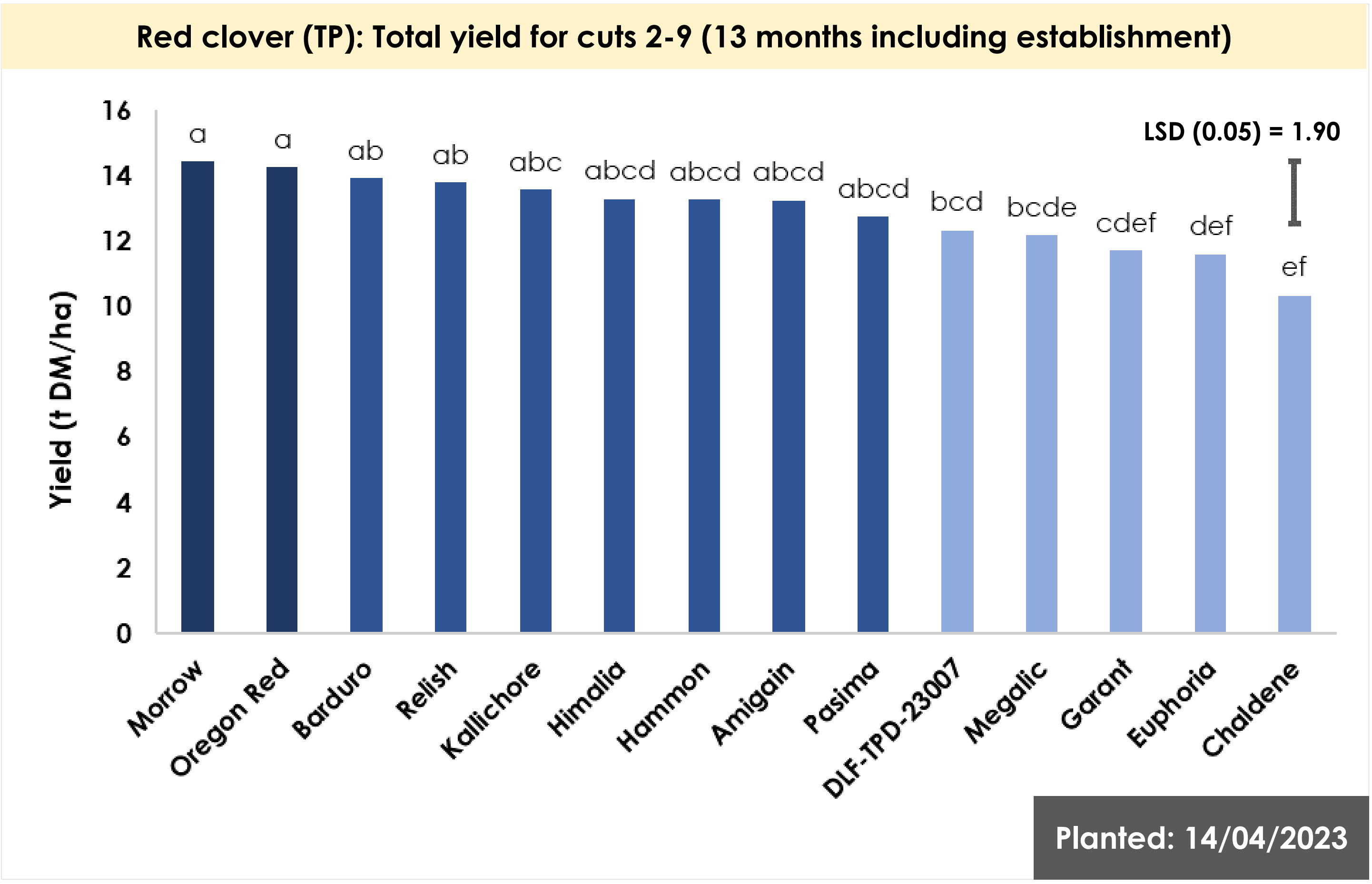

Figure 4: Total yield (tDM/ha) for harvests 2 to 9 for red clover trial Tp1 planted on 14 March 2023. *Harvest 1 was excluded from the data due to weed content.

Table 5. Red clover *(Trifolium pratense)*, **Tp2,** Evaluation at Outeniqua Research Farm

Planted: 12 April 2023 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Spring 2023		Summer 2023/24		Total Cuts 2-8	Green leaf area Jan 2024 10 days regrowth	Green leaf area Apr 2024 21 days regrowth
		Yield	Height (cm)	Yield	Height (cm)	Yield	%	%
Barduro	D	7.73 b	32	6.93 bcde	50	16.19 cd	41.3 e	68.1 f
Bonus	D	6.90 c	23	6.79 cde	43	14.47 ef	62.7 b	**81.7 abcd**
Dynamite	D	**9.48 a**	36	6.88 bcde	49	**17.34 ab**	54.5 c	76.0 cde
Garant	D	6.97 c	24	6.61 de	44	14.54 ef	61.8 b	**84.6 a**
Gert	T	7.07 bc	23	**7.74 a**	49	15.80 cd	**71.6 a**	**85.1 a**
Gregale	T	5.79 d	22	7.07 bcde	46	13.79 f	63.7 b	**82.9 ab**
Hajan	D	5.87 d	22	7.14 bc	44	13.87 f	53.7 cd	77.2 bcde
Oregon Red (C)	D	**9.40 a**	37	6.95 bcde	50	**17.92 a**	47.2 e	73.7 ef
Relish	D	7.52 bc	28	6.51 e	40	15.75 cd	47.4 de	75.3 de
Respect	D	7.27 bc	26	7.04 bcd	46	15.21 de	64.8 b	**86.1 a**
SG-C91	D	7.80 b	25	**7.36 ab**	49	16.42 bc	64.3 b	**82.3 abc**
LSD (0.05)		0.75		0.52		1.08	6.35	6.75
CV %		5.92		4.37		4.08	6.48	5.0

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant. Green leaf area was determined with the Canopeo App.

Table 6. Red clover (*Trifolium pratense*), **Tp2**, Evaluation at Outeniqua Research Farm

Planted: 12 April 2023 **Growth rates** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 2 14/7/2023	Cut 3 12/9/2023	Cut 4 18/10/2023	Cut 5 22/11/2023	Cut 6 19/12/2023	Cut 7 18/1/2024	Cut 8 26/2/2024
Barduro	D	13.7 bc	90.9 abc	77.5 ab	97.3 c	90.9 bcd	60.3 ab	**24.6 a**
Bonus	D	7.4 cde	73.9 d	79.0 ab	117.8 ab	96.4 bc	42.4 d	12.7 d
Dynamite	D	**30.2 a**	**100.3 a**	78.1 ab	124.6 ab	83.0 d	51.8 abcd	15.7 bcd
Garant	D	7.7 cde	74.5 d	79.3 ab	120.0 ab	92.6 bcd	40.0 d	15.4 bcd
Gert	T	10.3 cd	70.6 d	82.3 ab	115.5 abc	103.0 ab	**63.1 a**	15.8 bcd
Gregale	T	4.6 de	49.3 e	80.3 ab	109.3 abc	102.3 ab	49.2 bcd	15.1 bcd
Hajan	D	2.1 e	50.8 e	86.6 ab	108.6 abc	**112.2 a**	43.9 d	13.7 d
Oregon Red (C)	D	**30.2 a**	92.1 ab	84.8 ab	**121.9 a**	88.0 cd	51.1 abcd	**25.3 a**
Relish	D	17.5 b	82.6 bcd	74.9 b	101.0 bc	91.8 bcd	47.1 cd	20.7 ab
Respect	D	10.3 cd	76.9 cd	80.5 ab	118.4 ab	98.0 bc	47.6 bcd	14.4 cd
SG-C91	D	13.0 bc	85.4 abcd	80.6 ab	**122.6 a**	92.3 bcd	58.1 abc	20.2 abc
LSD (0.05)		7.1	15.1	10.3	18.4	12.3	13.0	6.2

Shaded BOLD = highest yielding, **Light shaded** = similar to highest**. Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant

Table 7. Red clover (*Trifolium pratense*), **Tp2**, Evaluation at Outeniqua Research Farm

Planted: 12 April 2023 **% Flower heads** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 2 14/7/2023	Cut 3 12/9/2023	Cut 4 18/10/2023	Cut 5 22/11/2023	Cut 6 19/12/2023	Cut 7 18/1/2024	Cut 8 26/2/2024
Barduro	D	0	5 a	0	5 a	25 a	62.5 a	33.3 a
Bonus	D	0	1.7 b	0	0	5 bc	16.7 cde	7.5 cd
Dynamite	D	0	0	0	0	7.5 b	25 bc	10 bc
Garant	D	0	0	0	0	7.5 b	14.2 cde	7.5 cd
Gert	T	0	0	0	0	0	5 e	1.7 d
Gregale	T	0	0	0	0	3.3 bc	10 de	1.7 d
Hajan	D	0	0	0	0	7.5 b	16.7 cde	4.2 cd
Oregon Red (C)	D	0	1.7 b	0	0	3.3 bc	33.3 b	16.7 b
Relish	D	0	0	0	0	8.3 b	33.3 b	16.7 b
Respect	D	0	0	0	0	5 bc	20.8 bcd	7.5 cd
SG-C91	D	0	0	0	0	3.3 bc	16.7 cde	5 cd
LSD (0.05)			2.0			6.1	14.0	8.3

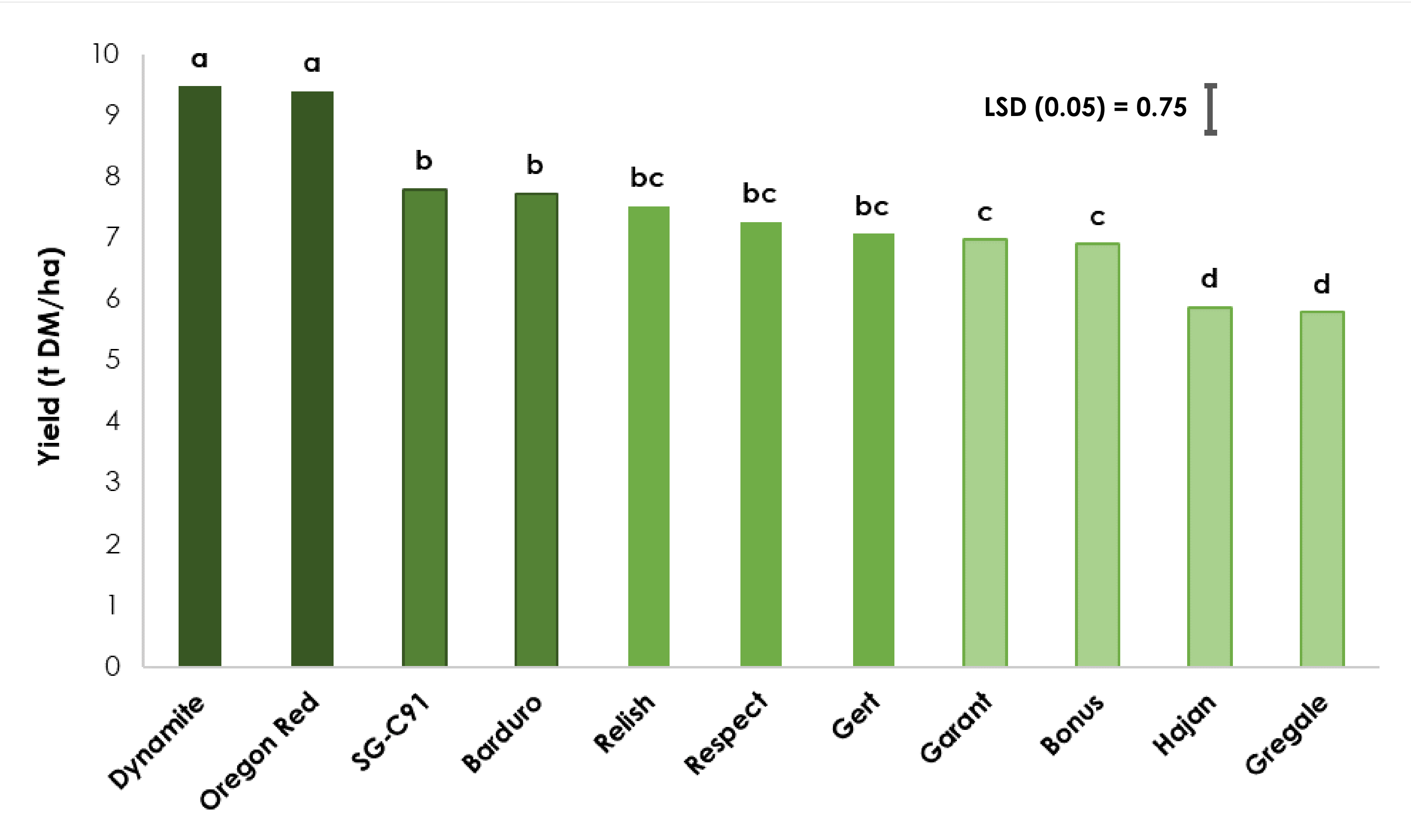

Figure 5. Spring yield (tDM/ha) for red clover trial Tp2 planted on 12 April 2023.

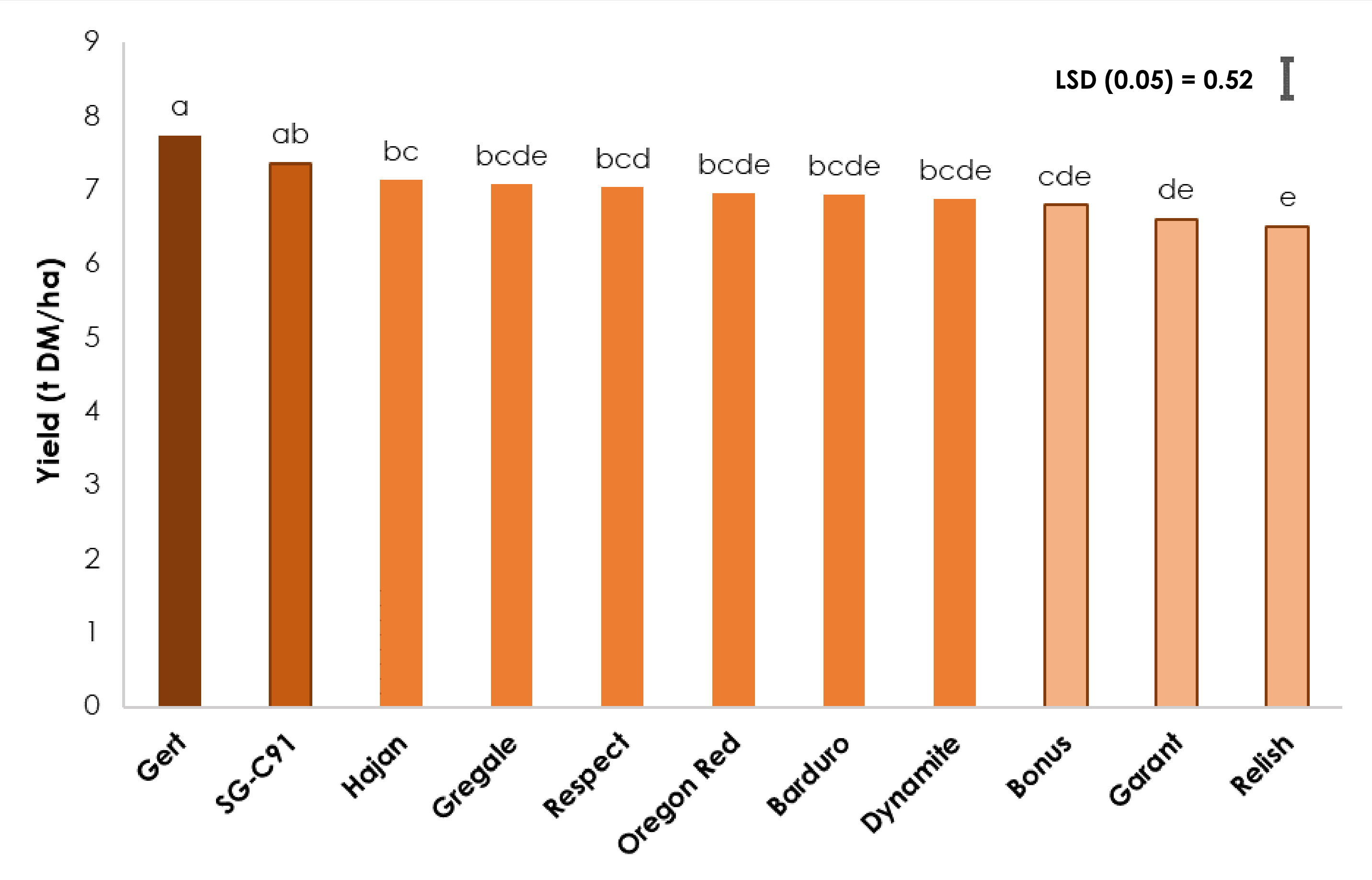

Figure 6. Summer yield (tDM/ha) (year 1) for red clover trial Tp2 planted on 12 April 2023.

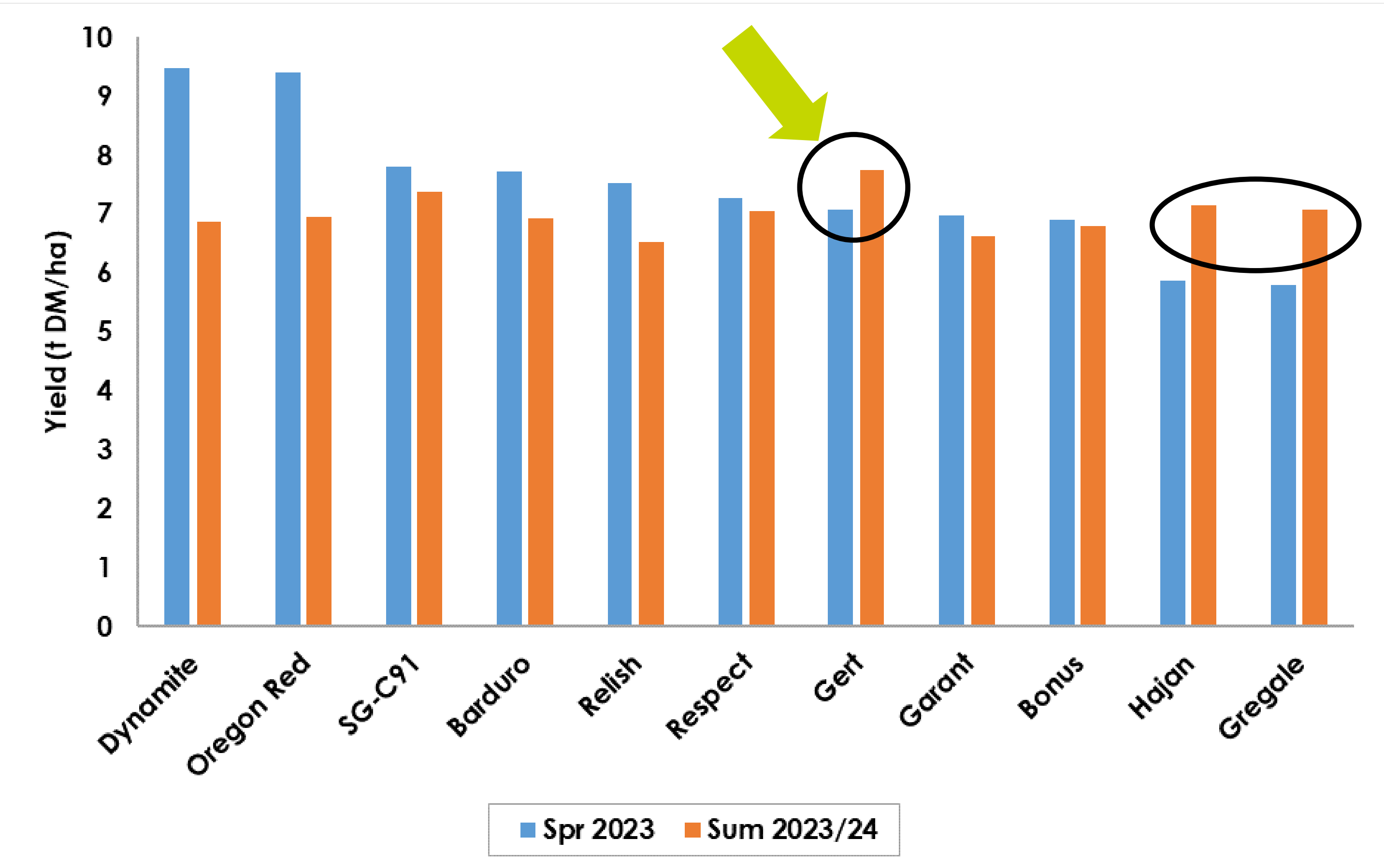

Figure 7. Spring and summer yield of Tp2 **with most cultivars having a superior yield in spring except Gert, Hajan and Gregale with a higher summer yield.**

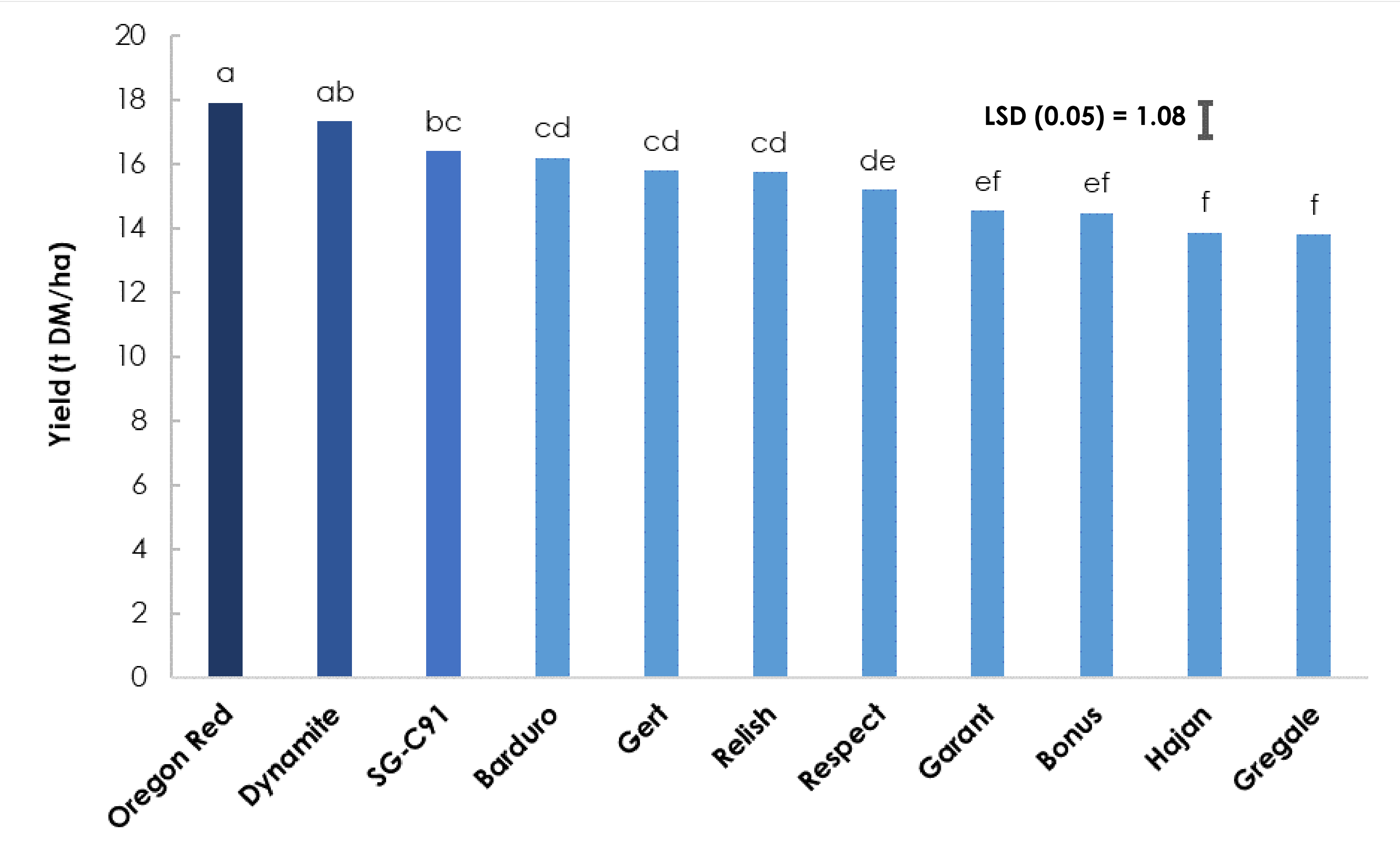

Figure 8. Total yield (tDM/ha) for harvests 2 to 8 for red clover trial Tp2 planted on 12 April 2023. Harvest 1 was excluded from the data due to weed content.

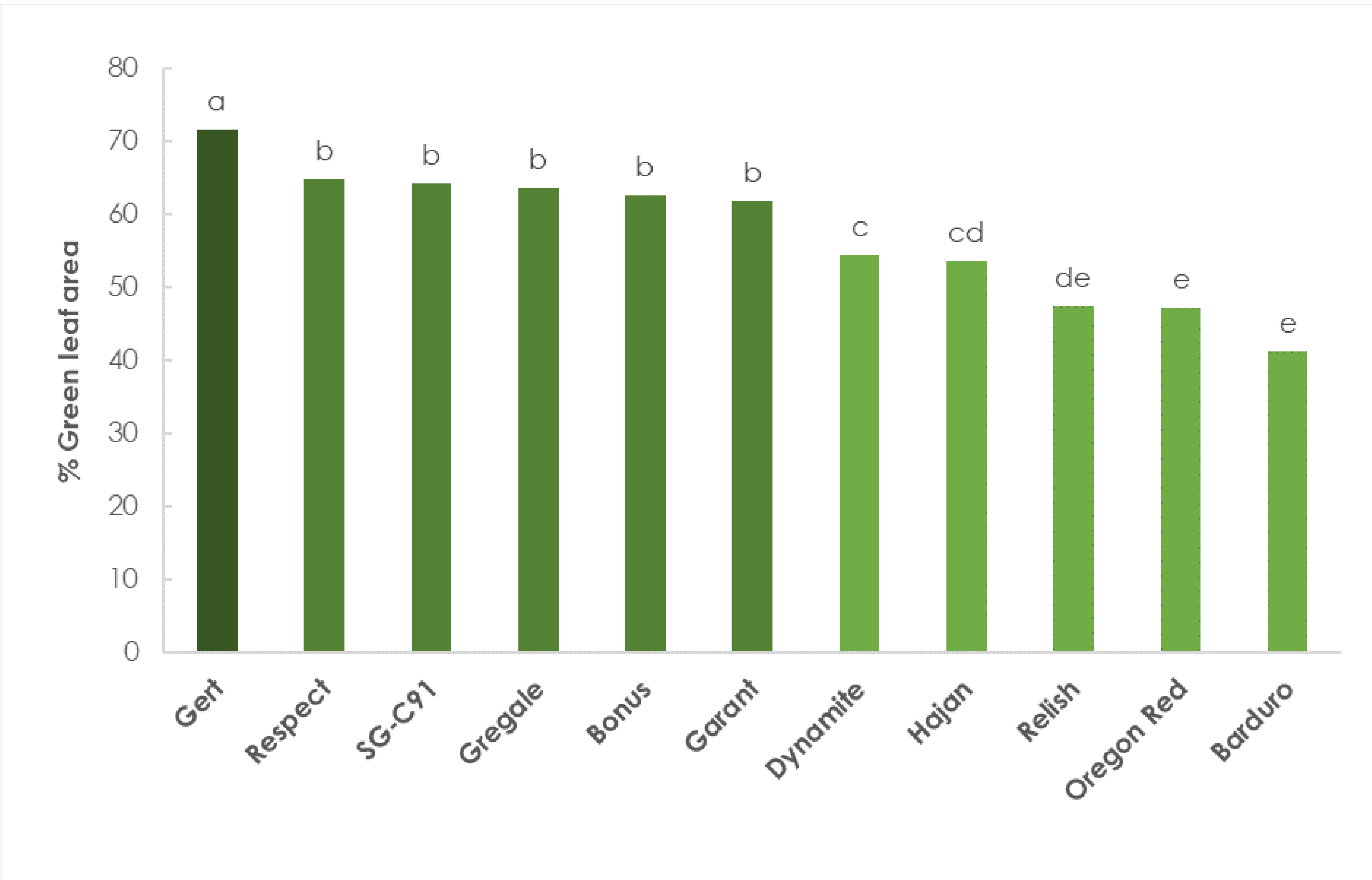

Figure 9. Green leaf area measured with the Canopeo App for trial Tp2 at 10 days regrowth in January 2024.

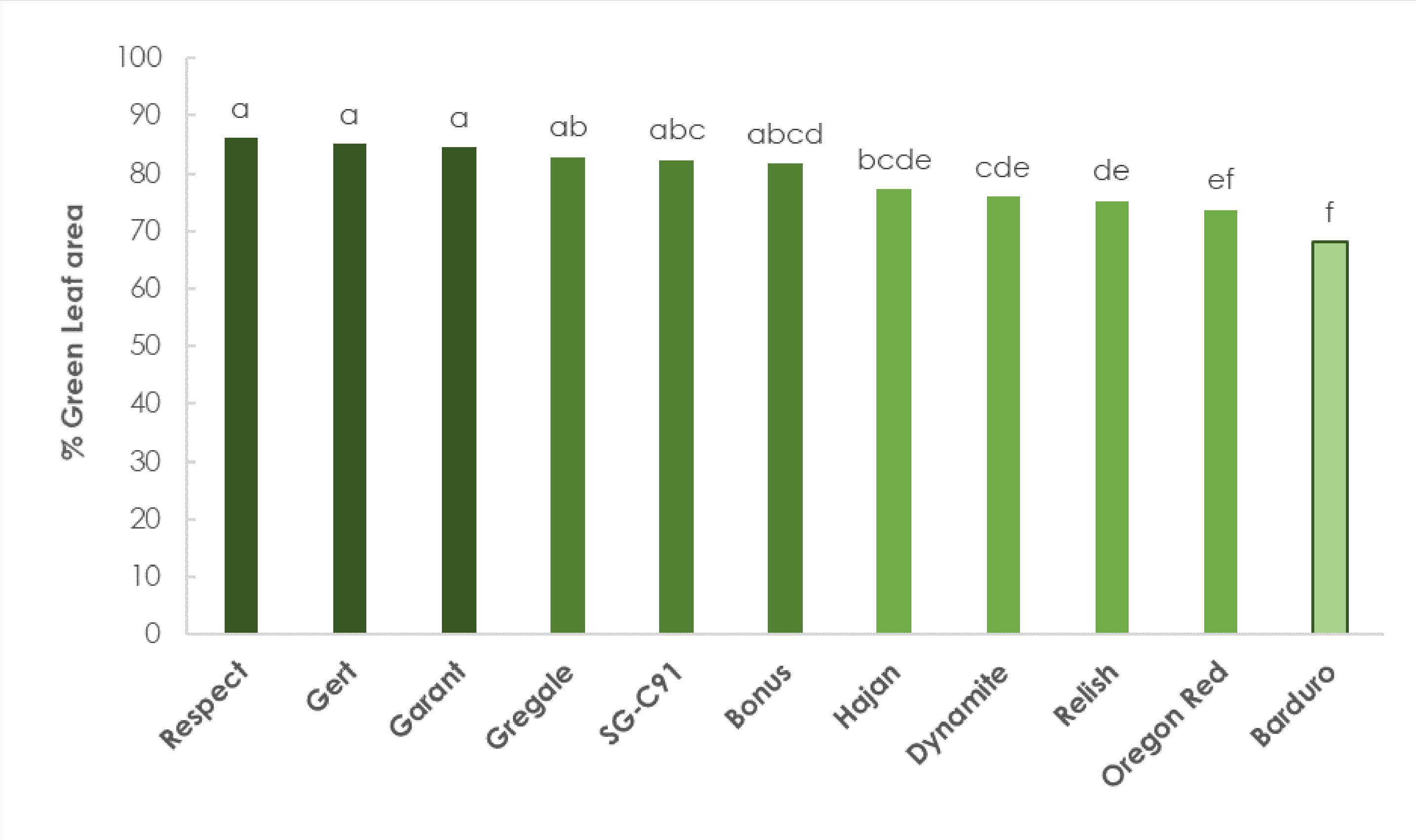

Figure 10. Green leaf area measured with the Canopeo App for trial Tp2 at 21 days regrowth in April 2024.

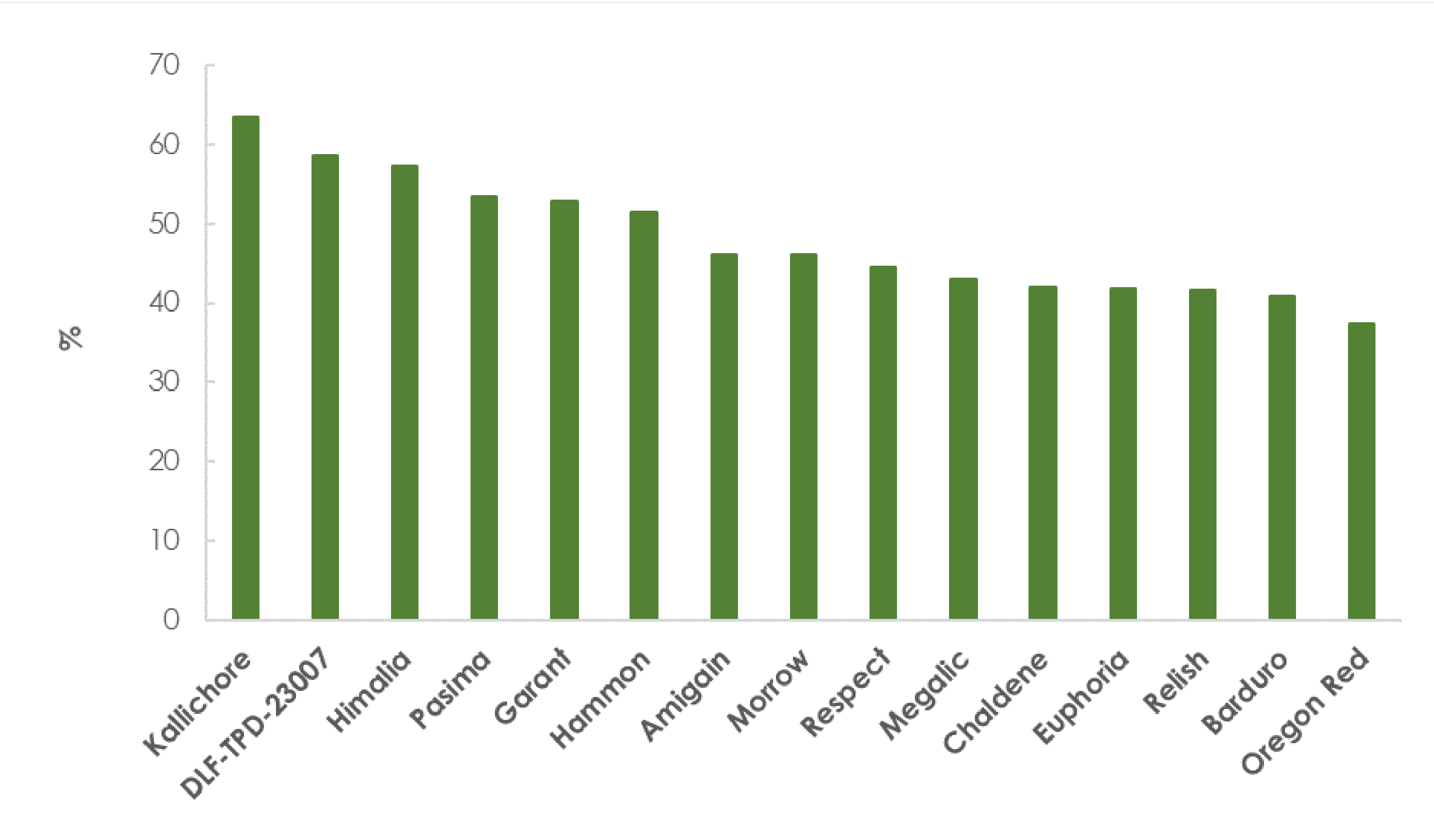

Figure 11. Green leaf area measured with the Canopeo App for trial Tp1 at 10 days regrowth in January 2024.

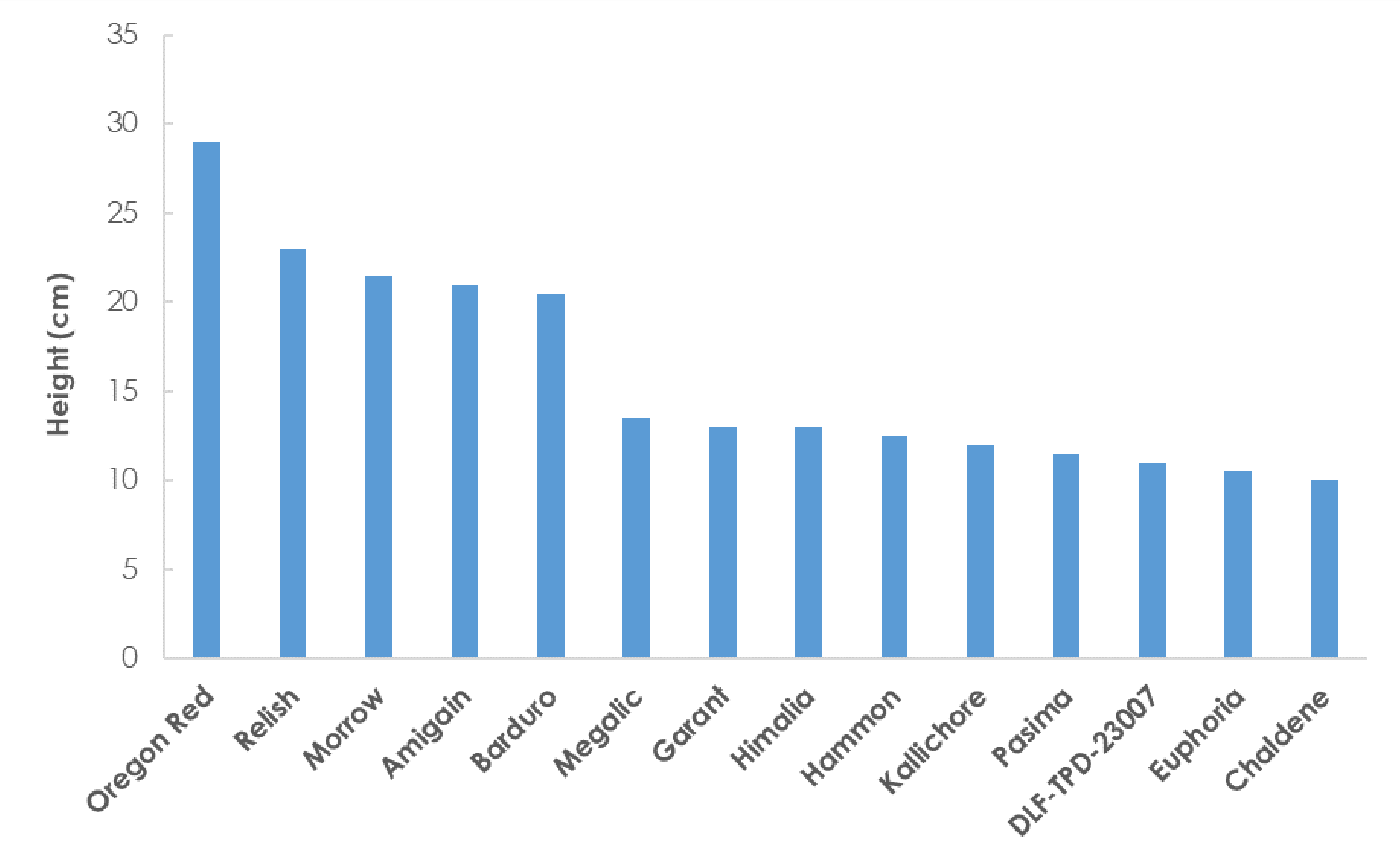

Figure 12. Plant height for Tp1 in winter 2023.

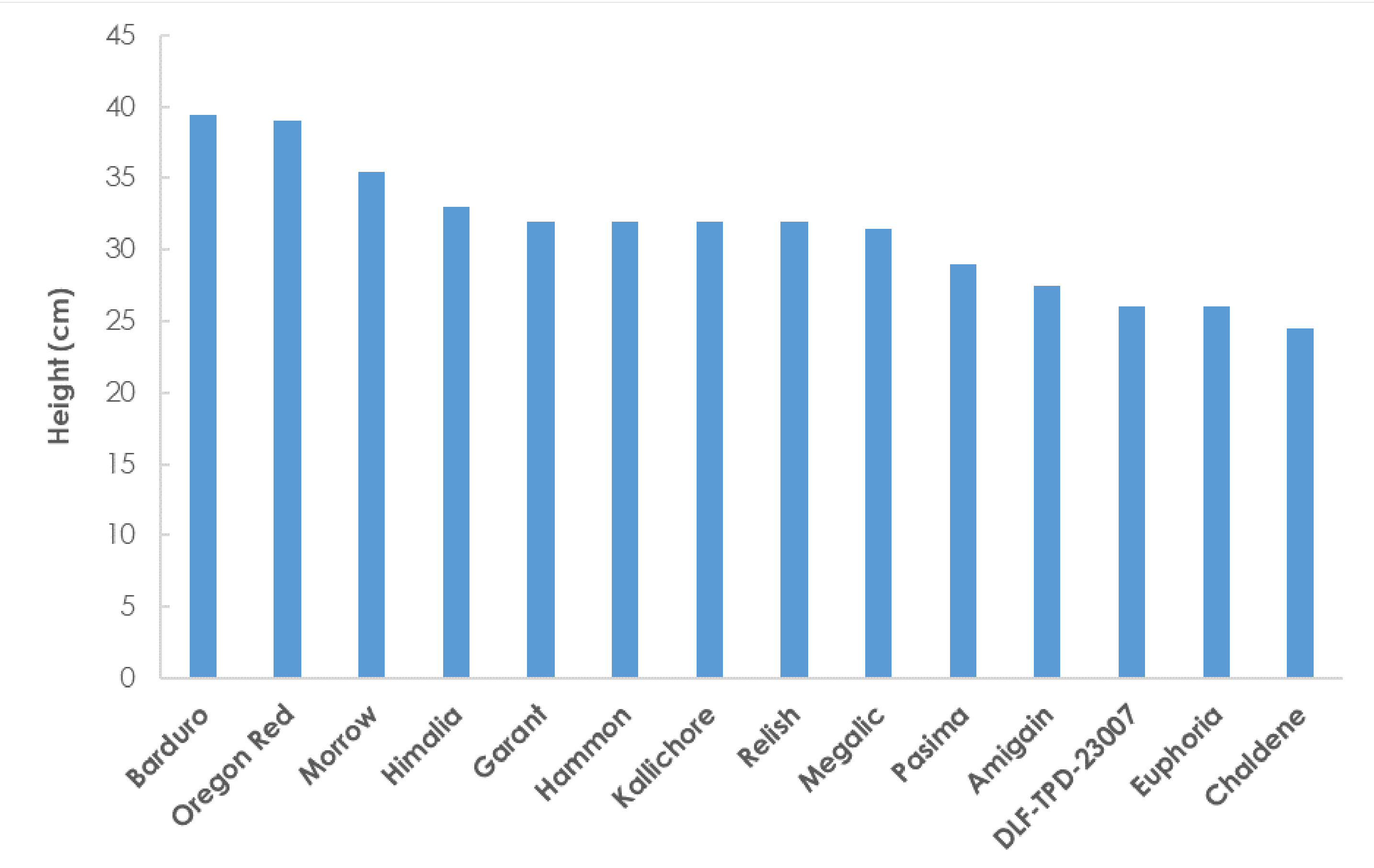

Figure 13. Plant height for Tp1 in spring 2023

Changes in forage quality of plantain during regrowth

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Introduction

The grazing cycle of intensively used dairy pastures is important in the overall productivity and efficiency of the pasture system. The criterion mostly used to decide on the grazing cycle, is physiological stage of the plant, to optimise yield and persistence. Forage quality is also an important criterion and for species like ryegrass, for instance, it is known that the forage quality and the three-leaf stage are closely linked. In the case of plantain, the physiological stage is less important in terms of persistence and yield. **In this study a sequence of samples were taken following defoliation to determine the forage quality of plantain (*Plantago lanceolata*) as the regrowth phase progresses and ascertain the optimal timing of grazing in terms of forage quality.**

Sampling

Plantain plants (cv. Agritonic, Tonic and Captain) from an established sward on the Outeniqua Research Farm were defoliated and sampled on a weekly basis for a period of 6 weeks during winter. No plant was sampled more than once. Approximately 400g of pasture was cut at 50mm stubble height and weighed we; dried at 70°C and weighed dry. Samples were then milled with a hammer mill, using a 1mm sieve.

Results

Samples were analysed using NIRS (Dairyland Laboratories, Inc.)

Crude protein (CP) and water soluble carbohydrate (WSC) values followed the expected trends, i.e. CP decreased over time and WSC initially decreased and then increased to a peak, followed by a decreasing trend thereafter.

Crude protein stayed within a reasonable range from week 1 to 5, peaking at week 2 at 22.6% (SE = 0.61; SE: Standard Error). The CP content at week 6 tended towards the low end, but was still reasonable at 16.9% (SE = 0.41). For weeks 5 and 6 CP was significantly lower than for weeks 1 to 4, with weeks 4 and 5 at 20.7% (SE = 0.63) and 18.3% (SE = 0.45), respectively, but in the acceptable range for dairy cow requirements.

Water soluble carbohydrate (WSC) content increased from week 3 at 10.6% (SE = 0.55), peaking at week 5 with 14.3% (SE = 0.88). There was no significant difference between weeks 4 and 5, with week 4 at 12.4% (SE = 1.27). The WSC content decreased to 13.2% (SE = 0.70) at week 6, and onwards.

The WSC:CP ratio follows the S-curve. The ratio peaked at week 5 at 0.8:1 (SE = 0.07) and then leveled off.

Neutral detergent fibre (NDF) content showed a quadratic trend relative to weeks after defoliation. The lowest value, 30.8% (SE = 0.99) was at week 4, but all NDF values were highly favourable. Acid detergent fibre (ADF) content also followed a quadratic function, with the lowest value, 22.4% (SE = 0.12) at week 5, although not differing statistically from all other weeks, with the exception of week 1. Lignin decreased linearly from 18.7% (SE = 0.71) to 15.7% (SE = 0.46).

Summary

The data shows that the main quality parameters informing decision making for defoliation interval are WSC and CP, with the most favourable ratio (according to this dataset) at week 5 (thus a 35 day rotation). Initial nitrogen (N) fertilization was done 4 days after defoliation. An earlier application may have led to an earlier peak in the WSC:CP ratio.

HOW FLEXIBLE IS THE GRAZING WINDOW FOR PLANTAIN?

From a CP and NDF perspective, this pasture can be grazed between a 21 and 35 day interval, with no negative effects. However, when taking WSC into account, a 28 to 35 day cycle would be favourable. This trial should be repeated in spring/summer with more extensive sampling.

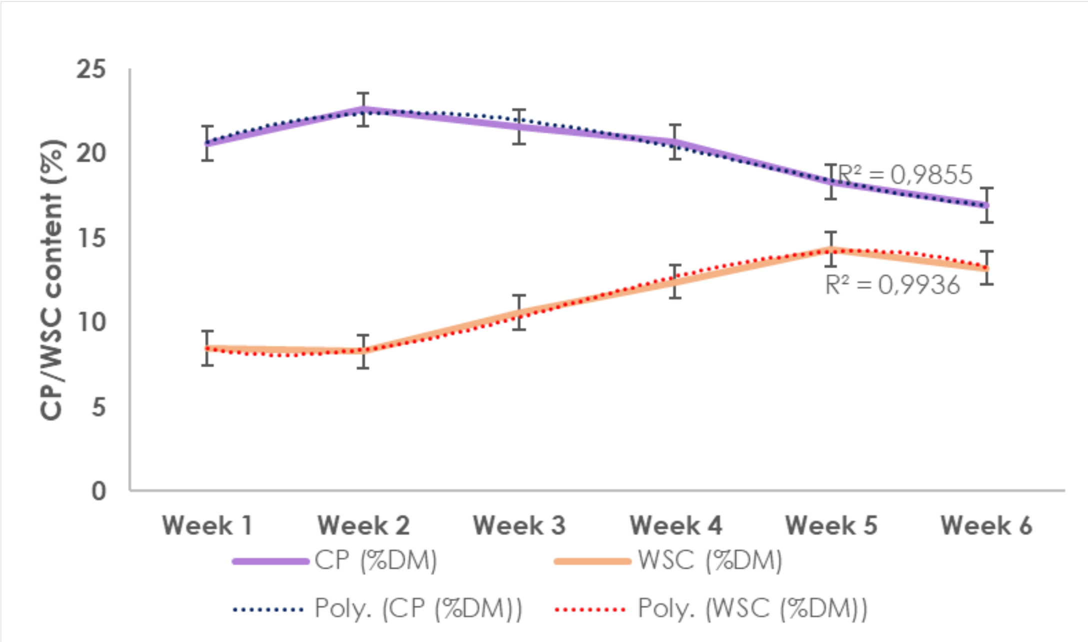

Figure 1. Mean weekly crude protein (CP) and water soluble carbohydrate (WSC) content of plantain (1/8/2022 to 5/9/2022)

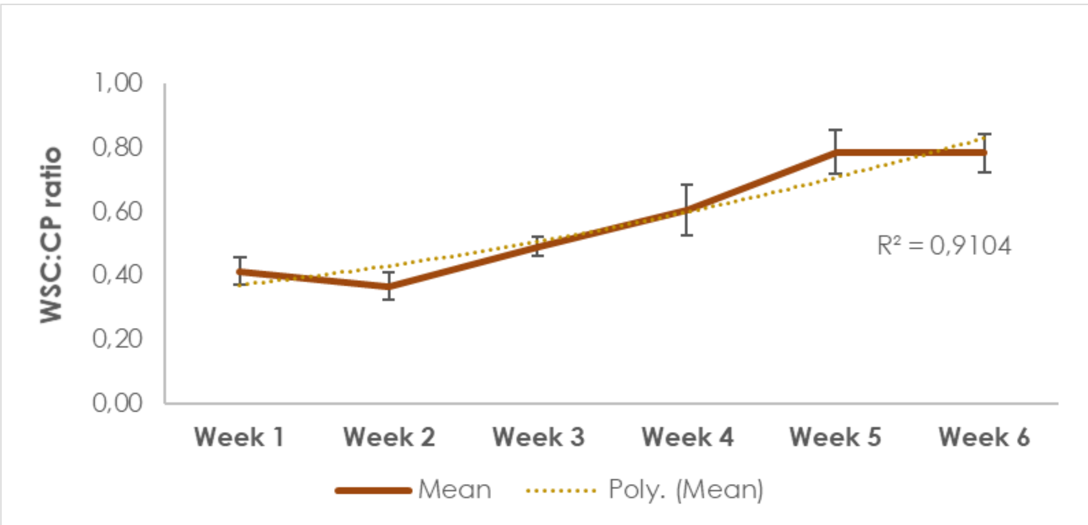

Figure 2. Mean weekly WSC:CP ratio of plantain (1/8/2022 to 5/9/2022)

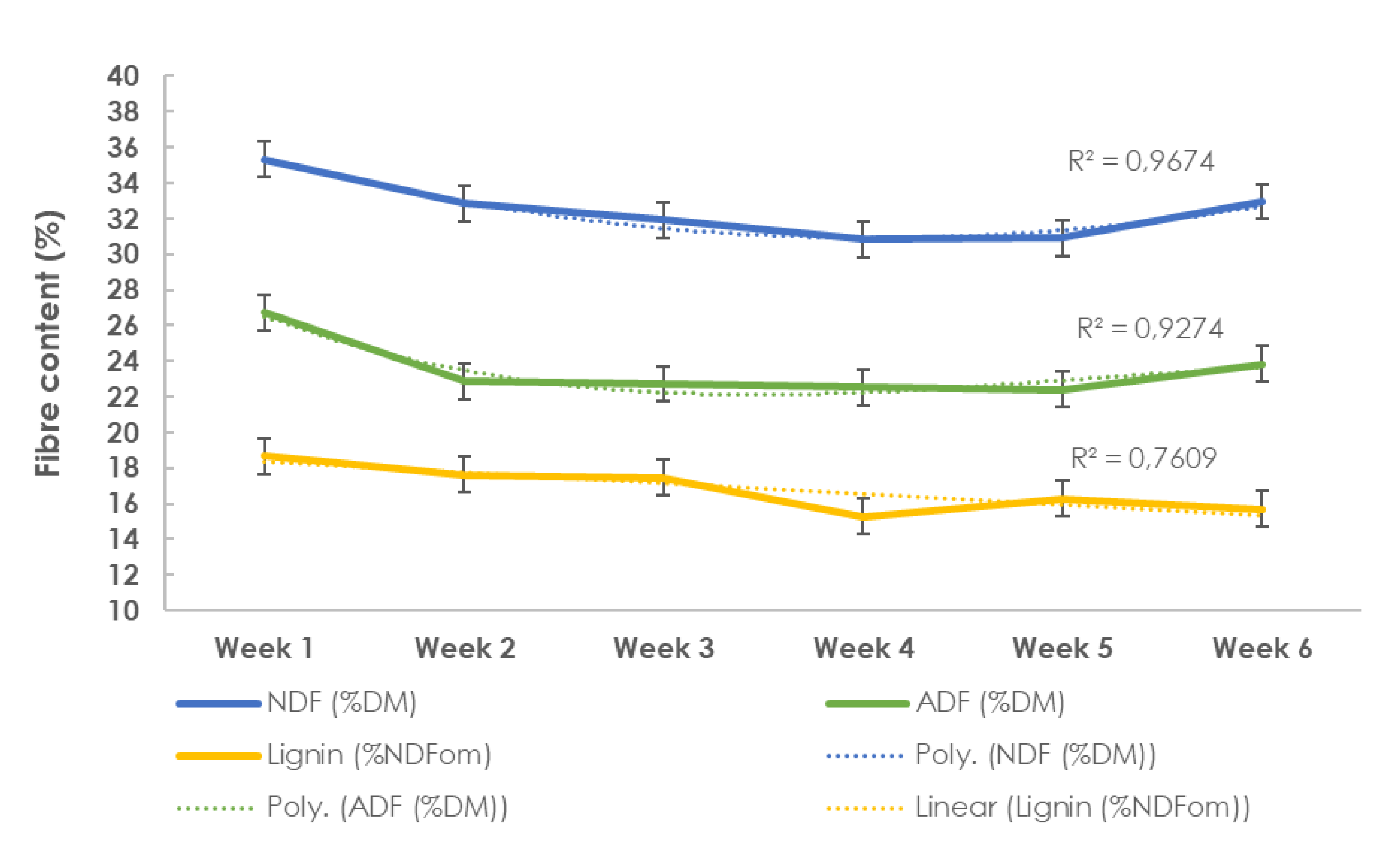

Figure 3. Mean weekly neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin content of plantain (1/8/2022 to 5/9/2022)

Cocksfoot (*Dactylis glomerata*) cultivar evaluation results for 2022 to 2024

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Introduction

Dairy production in the Southern Cape is based primarily on planted irrigated pastures. The correct selection of both species and cultivars plays a vital role in ensuring that an adequate forage supply is available throughout the year (fodder flow) and that the species/cultivars are adapted to the environmental and climatic conditions of the region.

Cocksfoot (*Dactylis glomerata*), as an alternative for perennial ryegrass or tall fescue pastures is currently being investigated. The cultivar evaluation is the key starting point to determine the potential of cocksfoot for dairy pasture systems. The deeper root system of cocksfoot compared to perennial ryegrass is an important consideration as is the higher temperature tolerance. The potential of cocksfoot as an intensive dairy pasture needs to be determined in terms of persistence and yield stability over years. According to Suter et al (2013) is a good addition to mixtures where the grass component consists of ryegrass. The cocksfoot will provide persistence as the ryegrass is lost from the mixture, especially under more challenging conditions related to temperature and soil moisture. Dairy NZ (2023) also recommend cocksfoot as a component in a mixed pasture but as a minor component, not least due to its lower feed value. They also cation about using older cultivars which have the tendency to become dominant in the mixture over time and replace the more digestible components. Forage quality is an important consideration. By evaluating cocksfoot at Outeniqua we can gather climate specific yield and persistence data, an important decision making factor.

Trial management

Cocksfoot was sown at 18kg/ha. It is harvested at the 4 leaf stage, except if canopy closure happens before plants reach the 4 leaf stage, to avoid leaf death at the base and shading of the crown. The trial is cut at a height of 5cm to simulate grazing by dairy animals. Potassium (K) and nitrogen (N) fertilizer are applied after each harvest to account for nutrient removal and growth.

Varieties evaluated

The trial consists of 14 cultivars: Adremo, Aldebaran, Archibaldi, Aurus, Bardarus, Captur, Dascada, Donata, Echelon, Inavale, Oberon, Olathe, Savvy, Sparta.

WHAT IS COCKSFOOT?

Cocksfoot is a temperate, tufted grass. It is deep rooted, drought tolerant and adapted to most soil types. It is not tolerant of waterlogging and high humidity but can tolerate high temperatures

Varieties can be categorized into the following types:

Temperate types
Hispanica types (sometimes referred to as Mediterranean types)
Intermediate types

Table 1. Cocksfoot (*Dactylis glomerata*), Dg1, Cultivar Evaluation, Outeniqua Research Farm

Planted: 7 March 2022 **Seasonal Yield** (t DM/ha), **Growth rate** (GR) (kg DM/ha/day)

T = Temperate, I = Intermediate, M = Mediterranean/Hispanica

Cultivars	Type	Autumn 2022		Winter 2022		Spring 2022		Summer 2022/23		Autumn2023		Total Year 1	
		Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR
Adremo	M	**2.52 a**	**29.7**	3.44 cdef	37.4	8,74 abc	96.1	5.05 abcd	56.1	5.01 ab	54.5	**19.76 a**	**54.1**
Aldebaran	T	2.21 abcd	26.0	3.27 def	35.5	7,67 d	84.3	4.52 cdefg	50.2	4.01 bcd	43.6	17.67 cd	48.4
Archibaldi	M	2.18 abcde	25.6	4.29 ab	46.6	8,64 abc	94.9	4.46 defg	49.5	4.71 abc	51.2	19.57 ab	53.6
Aurus	T	2.19 abcde	25.8	3.60 bcde	39.1	8,20 abcd	90.1	4.27 efg	47.5	4.23 abcd	45.9	18.26 cd	50.1
Bardarus	-	1.89 cde	22.3	**4.50 a**	**48.9**	8,39 abcd	92.3	4.68 abcdef	52.0	**5.24 a**	**57.0**	19.46 ab	53.3
Captur	I	2.47 ab	29.0	4.08 abc	44.3	**8,92 a**	**98.0**	3.87 g	43.0	3.68 cd	40.0	19.34 ab	53.0
Dascada	I	1.73 def	20.4	2.71 fg	29.5	8,76 abc	96.3	5.06 abcd	56.3	4.30 abcd	46.7	18.27 bc	50.1
Donata	T	2.09 abcde	24.6	2.19 g	23.8	7,94 bcd	87.3	4.06 fg	45.1	3.24 d	35.2	16.28 d	44.6
Echelon	-	1.21 f	14.2	3,26 def	35.4	8,71 abc	95.7	5.25 ab	58.3	4.52 abc	49.1	18.43 abc	50.5
Inavale	-	1.93 bcde	22.7	2,89 efg	31.3	**9.15 a**	**100.6**	4.92 abcde	54.7	5.00 ab	54.4	18.89 abc	51.8
Oberon	-	1.67 ef	19.6	3,74 abcd	40.6	8.56 abcd	94.1	4.61 bcdef	51.2	4.53 abc	49.2	18.57 abc	50.9
Olathe	-	2.35 abc	27.7	2,13 g	23.1	**9.02 a**	**99.1**	**5.35 a**	**59.4**	5.03 ab	54.7	18.85 abc	51.6
Savvy	-	2.16 abcde	25.4	4,09 abc	44.5	8.84 ab	97.1	3.88 g	43.1	4.52 abc	49.1	18.97 abc	52.0
Sparta	I	1.84 cde	21.7	2,78 fg	30.2	7.83 cd	86.1	5.20 abc	57.8	4.35 abc	47.3	17.66 cd	48.4
LSD (0.05)		0.54	6.4	0.78	8.42	0.97	10.7	0.68	7.59	1.08	11.8	1.47	4.02
CV %		16.0		13.8		6.8		8.8		14.5		4.7	

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**

NS = non-significant

Table 1. Cocksfoot (*Dactylis glomerata*), Dg1, Cultivar Evaluation, Outeniqua Research Farm

Planted: 7 March 2022 **Seasonal Yield** (t DM/ha), **Growth rate** (GR) (kg DM/ha/day)

T = Temperate, I = Intermediate, M = Mediterranean/Hispanica

Cultivars	Type	Autumn 2023		Winter 2023		Spring 2023		Summer 2023/24		Autumn 2024		Total Year 2	
		Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR
Adremo	M	5.01 ^{ab}	54.5	**1.03 ^{a}**	**11.2**	5.17 ^{ab}	56.8	3.59 ^{abc}	39.9	1.63 ^{ab}	21.4	**14.80 ^{a}**	**42.4**
Aldebaran	T	4.01 ^{bcd}	43.6	0.67 ^{b}	7.2	4.23 ^{d}	46.4	3.29 ^{abcd}	36.6	1.57 ^{ab}	20.6	12.20 ^{e}	34.9
Archibaldi	M	4.71 ^{abc}	51.2	**1.03 ^{a}**	**11.3**	4.55 ^{bcd}	50.0	**3.77 ^{a}**	**41.9**	**1.91 ^{a}**	**24.1**	14.06 ^{ab}	40.3
Aurus	T	4.23 ^{abcd}	45.9	**1.13 ^{a}**	**12.2**	5.10 ^{abc}	56.0	3.65 ^{ab}	40.5	**1.92 ^{a}**	**25.2**	14.10 ^{ab}	40.4
Bardarus	-	**5.24 ^{a}**	**57.0**	**1.08 ^{a}**	**11.8**	4.38 ^{cd}	48.1	3.58 ^{abc}	39.8	1.73 ^{ab}	22.7	14.27 ^{ab}	40.9
Captur	I	3.68 ^{cd}	40.0	**1.07 ^{a}**	**11.6**	4.81 ^{abcd}	52.9	3.18 ^{bcd}	35.3	1.45 ^{b}	19.1	12.74 ^{cde}	36.5
Dascada	I	4.30 ^{abcd}	46.7	0.61 ^{b}	6.6	4.39 ^{cd}	48.2	3.02 ^{d}	33.6	1.81 ^{ab}	23.8	12.31 ^{e}	35.3
Donata	T	3.24 ^{d}	35.2	0.61 ^{b}	6.7	4.15 ^{d}	45.6	2.28 ^{e}	25.4	0.69 ^{c}	9.1	10.28 ^{f}	29.5
Echelon	-	4.52 ^{abc}	49.1	0.65 ^{b}	7.1	4.97 ^{abc}	54.6	3.07 ^{cd}	34.1	1.75 ^{ab}	23.0	13.22 ^{bcde}	37.9
Inavale	-	5.00 ^{ab}	54.4	0.78 ^{b}	8.4	4.86 ^{abcd}	53.4	3.21 ^{bcd}	35.6	**1.95 ^{a}**	**25.7**	13.85 ^{abc}	39.7
Oberon	-	4.53 ^{abc}	49.1	0.77 ^{b}	8.4	4.51 ^{bcd}	49.5	3.68 ^{ab}	40.9	1.74 ^{ab}	22.9	13.49 ^{bcde}	38.6
Olathe	-	5.03 ^{ab}	54.7	0.77 ^{b}	8.5	**5.37 ^{a}**	**59.0**	3.0 ^{d}	33.3	**1.90 ^{a}**	**25.0**	14.17 ^{ab}	40.6
Savvy	-	4.52 ^{abc}	49.1	**1.08 ^{a}**	**11.8**	4.45 ^{bcd}	48.9	3.62 ^{abc}	40.2	1.88 ^{ab}	24.7	13.67 ^{abcd}	39.2
Sparta	I	4.35 ^{abc}	47.3	0.63 ^{b}	6.9	4.58 ^{bcd}	50.4	2.93 ^{d}	32.6	1.66 ^{ab}	21.9	12.50 ^{de}	35.8
LSD (0.05)		0.23	11.8	0.23	2.5	0.74	8.1	0.56	6.26	0.45	6.0	1.31	3.76
CV %		14.5		16.4		9.4		10.2		16.0		5.9	

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**

NS = non-significant

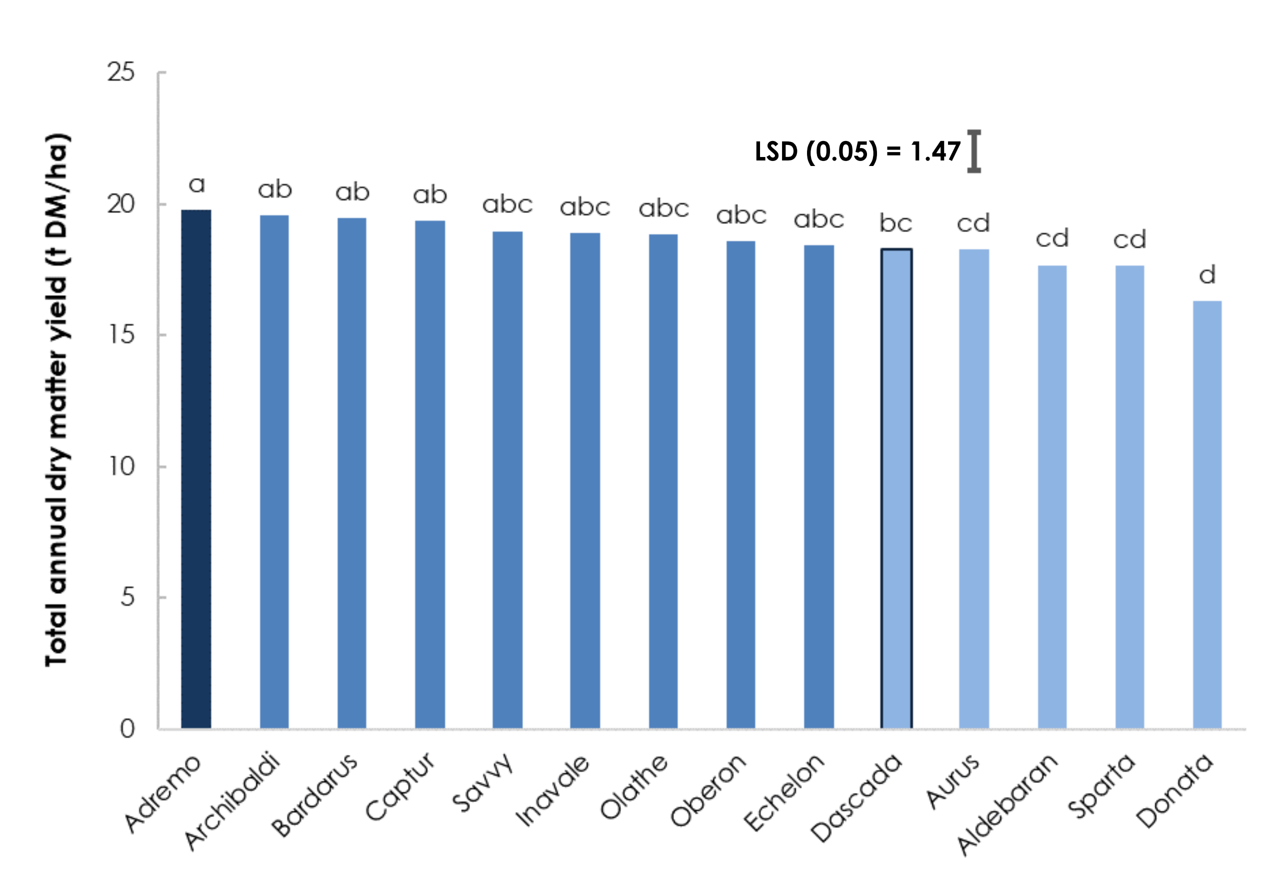

Figure 1. Total dry matter yield for cocksfoot cultivars in the first year from establishment in March 2022 to end of February 2023.

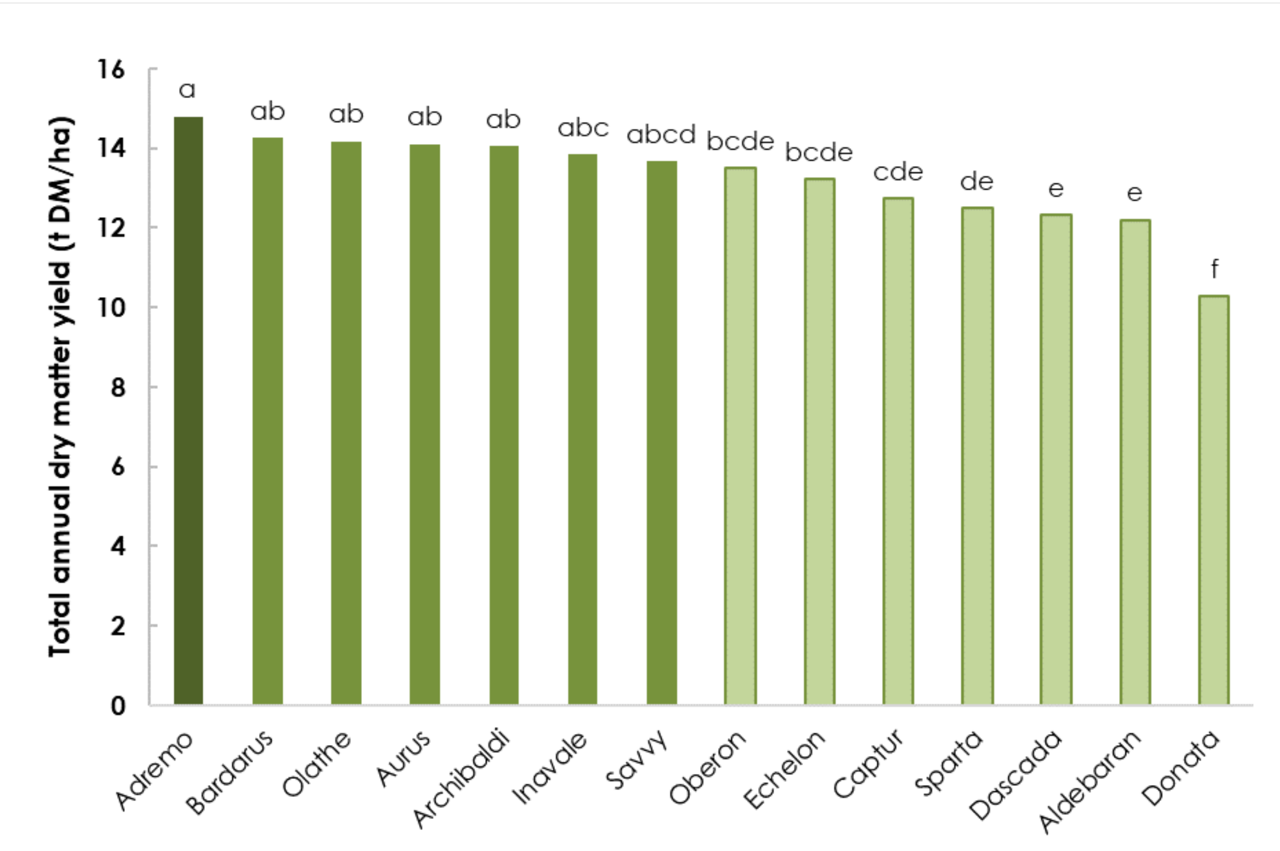

Figure 2. Total dry matter yield for cocksfoot cultivars in the first year from establishment in March 2023 to end of February 2024.

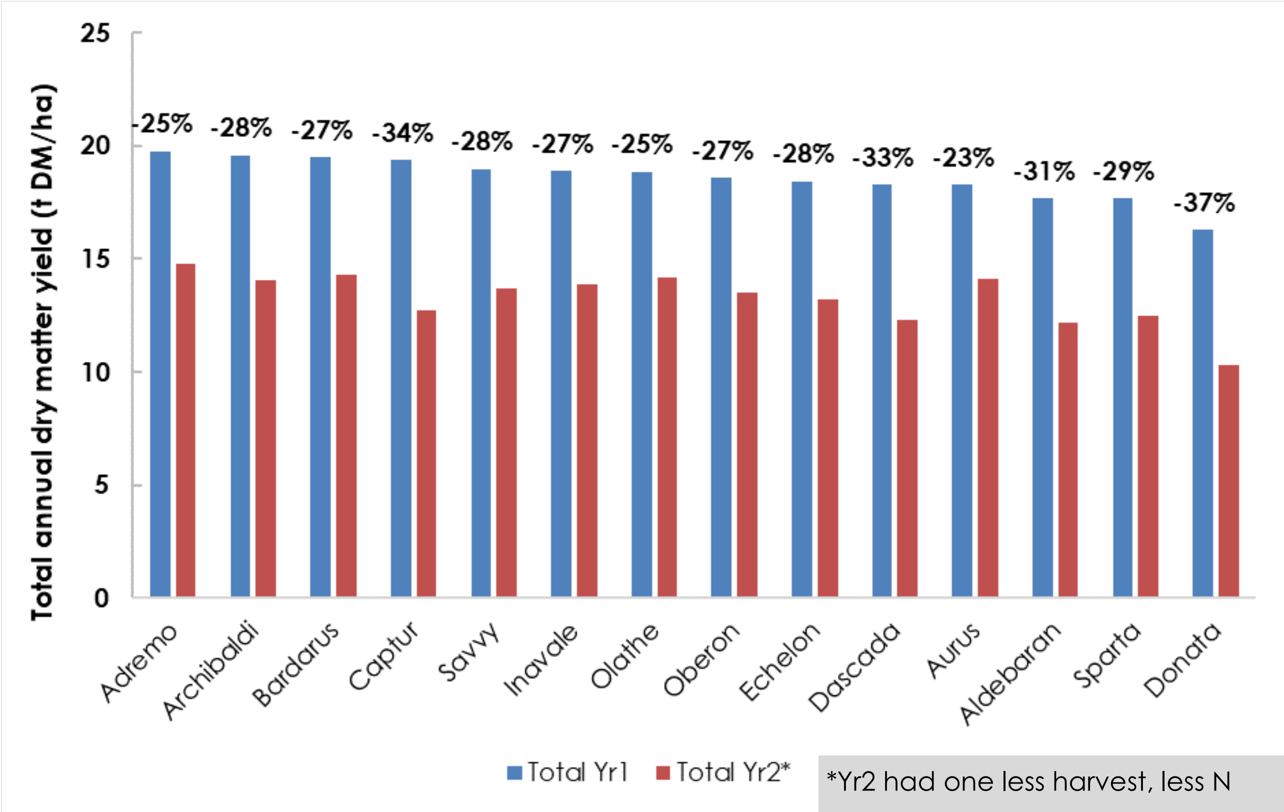

Figure 3. Total DM yield for the first and second year showing the % decrease in yield during the second year with 10 harvests in the first year and 8 harvests in the second year.

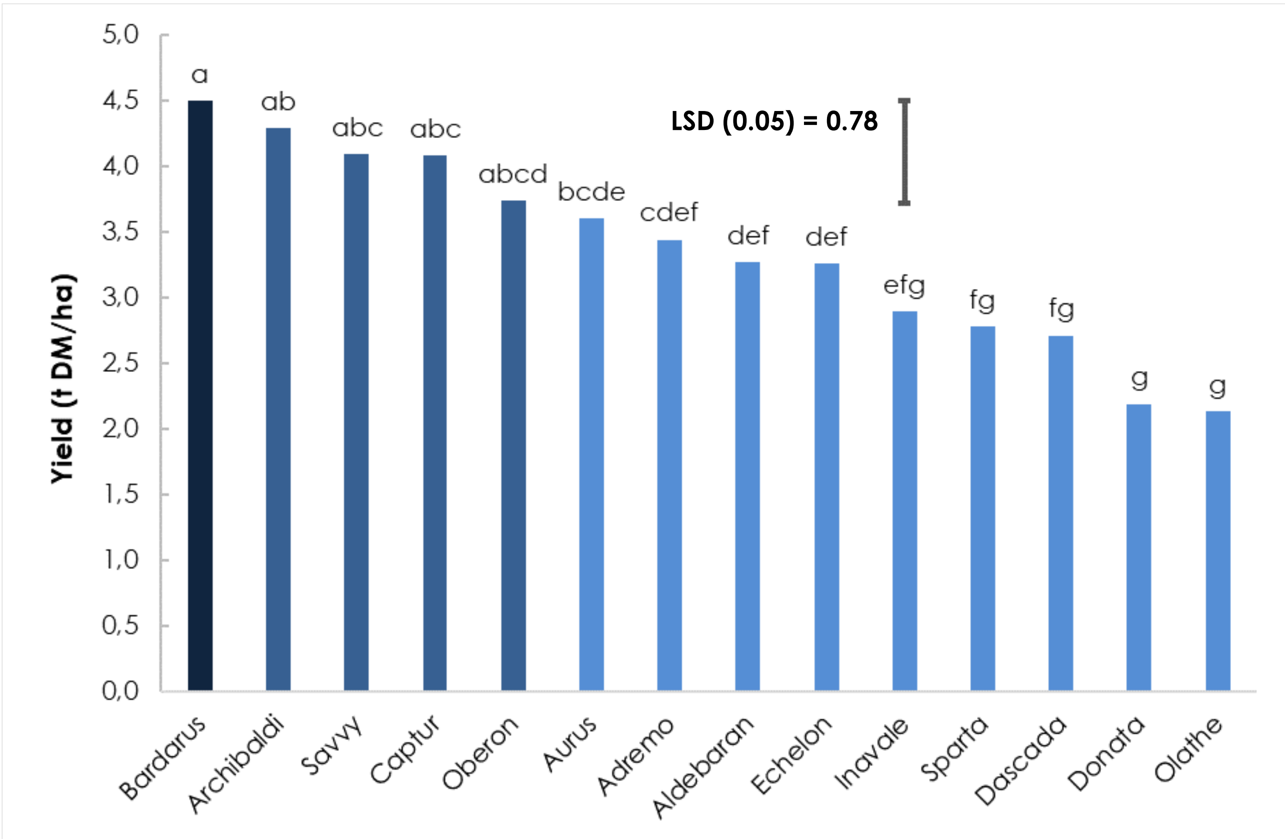

Figure 4. Winter DM yield during the first year showing the winter growth activity of cultivars.

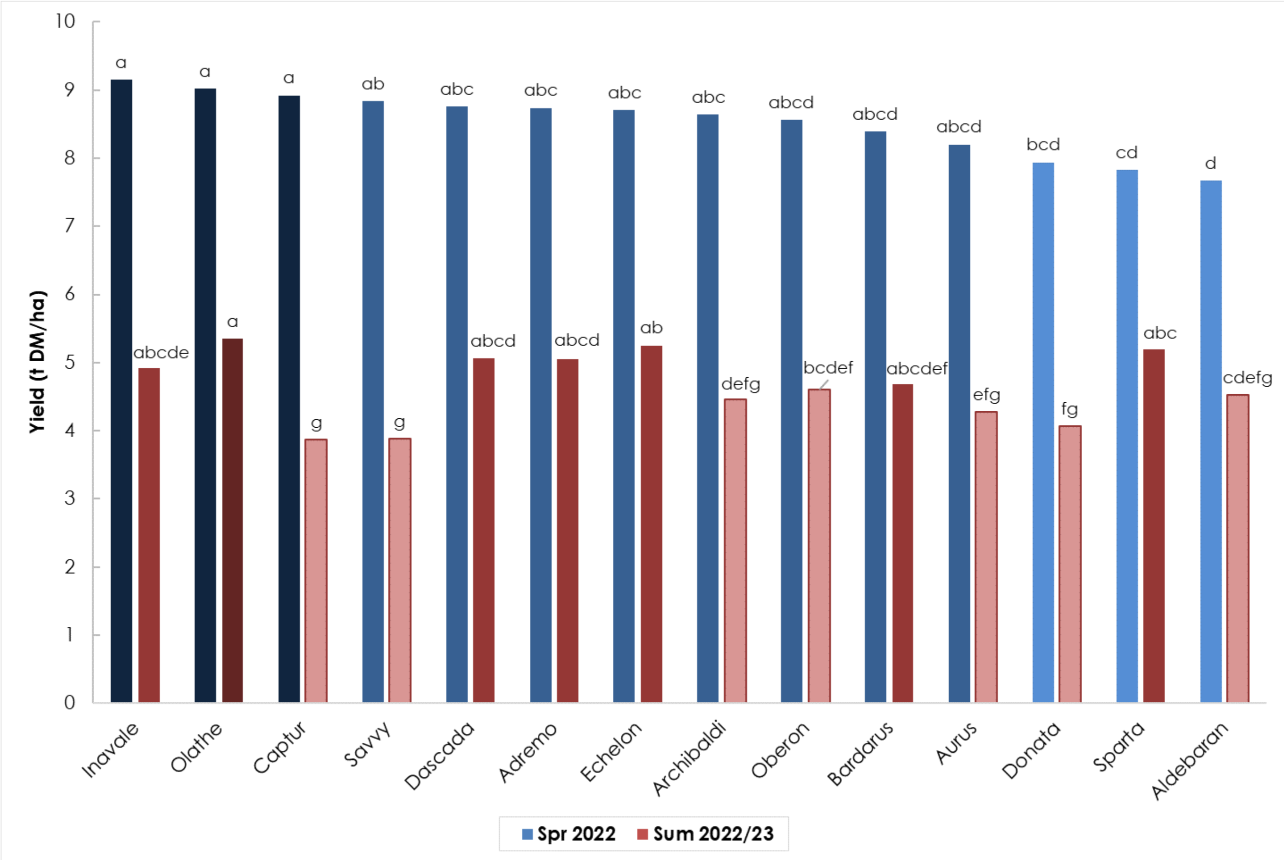

Figure 5. Spring and summer yield during the first year showing spring to be the peak season for growth.

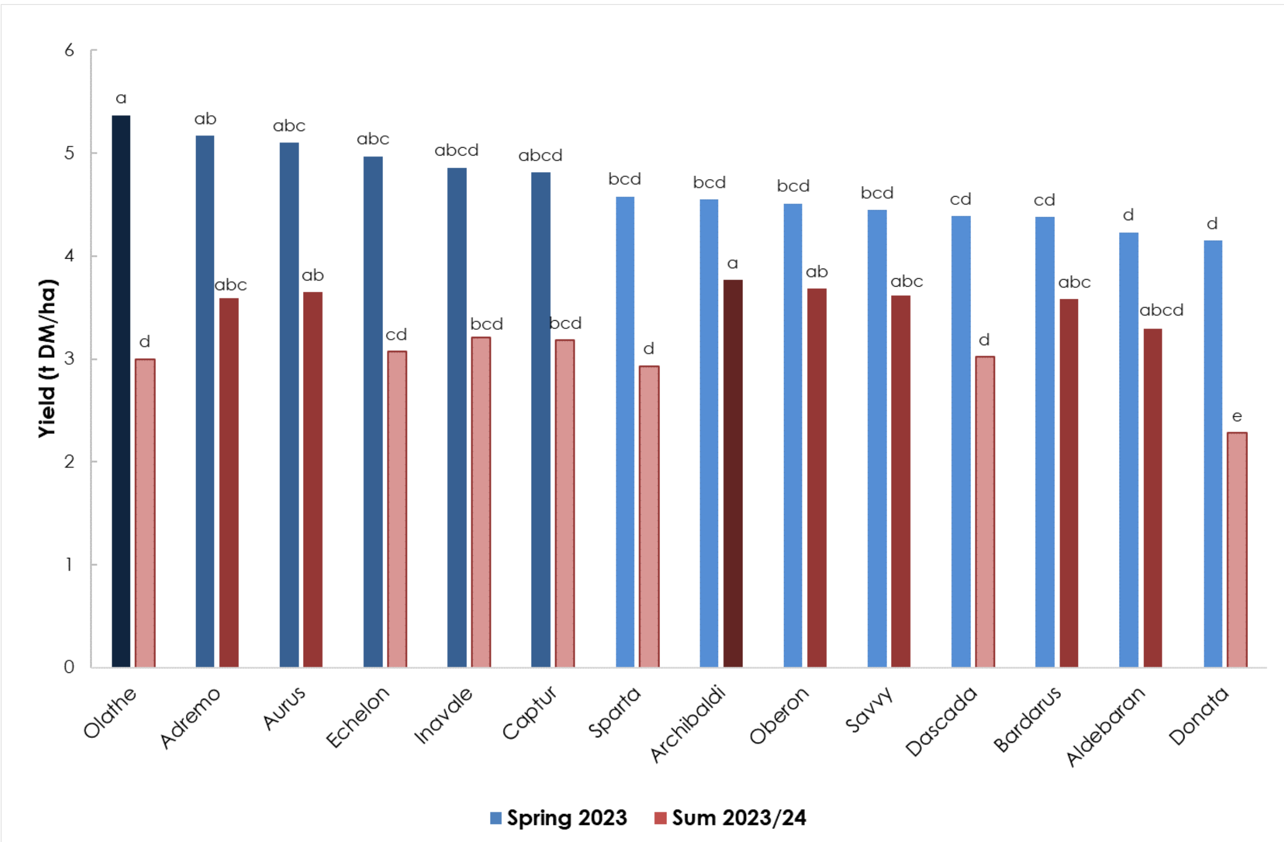

Figure 6. Spring and summer yield during the second year showing spring to be the peak season for growth.

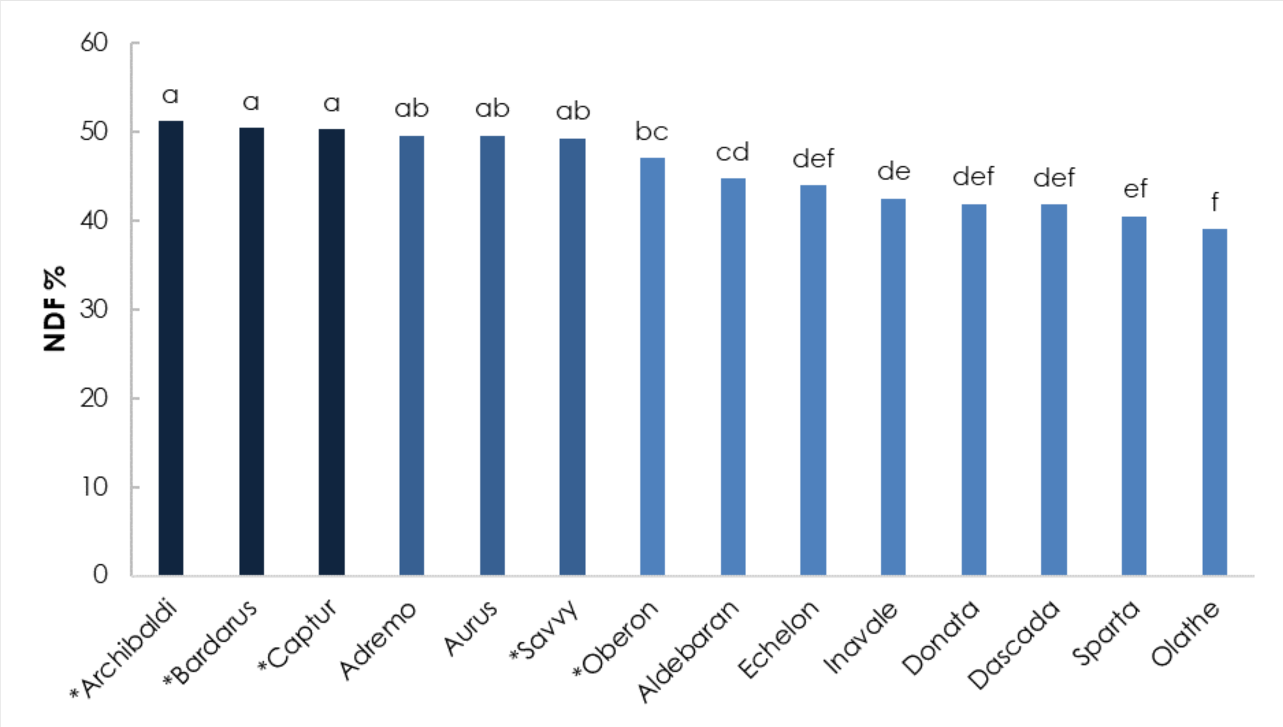

Figure 7. NDF % for early winter growth. Cultivars with an * are the highest yielding.




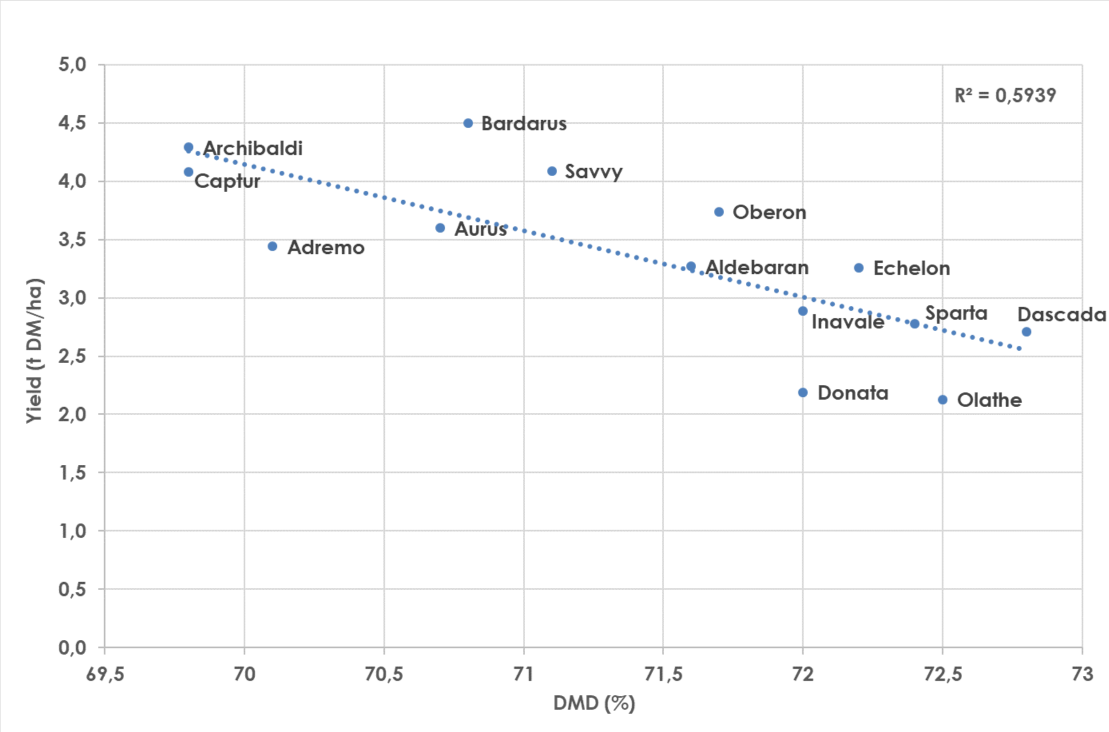

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Figure 8. Relationship between digestibility and yield for early **WINTER 2022.**

The data for the first winter shows the group of cultivars on the top left with high yield and lower digestibility, while cultivars on the bottom right have lower yield but better digestibility. **Bardarus and Savvy stand out as higher yielding, while still reasonable maintaining reasonable digestibility.**

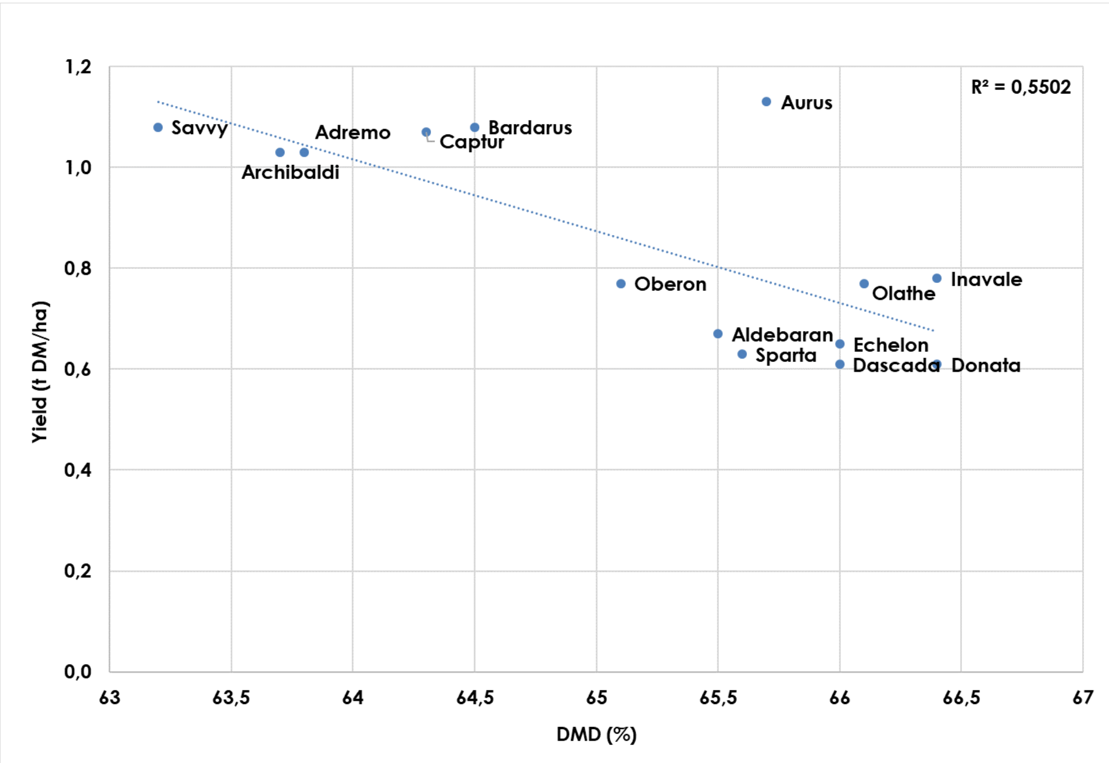

Figure 9. Relationship between digestibility and yield for early **WINTER 2023.**

During the second year the two distinct groupings of higher yield with lower digestibility and lower yield with higher digestibility are even more extreme. Aurus is the exception to these groupings, still maintaining a high yield and reasonable digestibility.

Table 2: Cocksfoot (*Dactylis glomerata*), Dg1, Cultivar Evaluation, Outeniqua Research Farm
Planted: 7 March 2022 **Rust/leaf disease** (ratings based)

T = Temperate, I = Intermediate , M = Mediterranean/Hispanica

Cultivars		Cut 2 19/4/22	Cut 3 13/7/22	Cut 4 30/8/22	Cut 5 12/10/22	Cut 6 14/11/22	Cut 7 13/12/22	Cut 8 16/1/23	Cut 9 23/2/23	Cut 10 30/3/23	Cut 11 15/5/23	Cut 12 18/7/23	Cut 13 18/7/23	Cut 14 10/11/23	Cut 15 11/12/23	Cut 16 15/1/23	Cut 17 29/2/24	Cut 18 4/4/24	Cut 19 15/5/24
Adremo	M	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0
Aldebaran	T	0	0	0	0	0	0	0	0	8	29	0	0	29	0	0	0	4	0
Archibaldi	M	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0
Aurus	T	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Bardarus	-	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0
Captur	I	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0
Dascada	I	0	0	4	50	0	0	0	0	4	13	17	0	21	0	0	0	21	0
Donata	T	0	0	0	4	0	0	0	0	0	42	4	0	25	0	0	0	13	17
Echelon	-	0	0	0	4	0	0	0	0	0	17	25	0	13	0	0	0	0	0
Inavale	-	0	0	0	0	0	0	0	0	0	0	4	0	13	0	0	0	0	0
Oberon	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olathe	-	0	0	4	42	0	0	0	0	0	13	0	0	17	0	0	0	13	4
Savvy	-	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0
Sparta	I	0	0	75	83	0	0	0	0	71	79	42	0	33	0	0	0	25	25

Table 3: Cocksfoot (*Dactylis glomerata*), Dg1, Cultivar Evaluation, Outeniqua Research Farm

Planted: 7 March 2022 **Reproductive tillers/Flowering** (Ratings based)

T = Temperate, I = Intermediate , M = Mediterranean/Hispanica

Cultivars		Cut 2 19/4/22	Cut 3 13/7/22	Cut 4 30/8/22	Cut 5 12/10/22	Cut 6 14/11/22	Cut 7 13/12/22	Cut 8 16/1/23	Cut 9 23/2/23	Cut 10 30/3/23	Cut 11 15/5/23	Cut 12 18/7/23	Cut 13 18/7/23	Cut 14 10/11/23	Cut 15 11/12/23	Cut 16 15/1/23	Cut 17 29/2/24	Cut 18 4/4/24	Cut 19 15/5/24
					Piping	Piping + Heading	Heading							Piping + Heading	Heading	Heading			
Adremo	M	0	0	0	13	8	0	0	0	0	0	0	0	0	0	4	0	0	0
Aldebaran	T	0	0	0	0	0	4	0	0	0	0	0	0	0	4	0	0	0	0
Archibaldi	M	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aurus	T	0	0	0	0	33	0	0	0	0	0	0	0	79	0	13	0	0	0
Bardarus	-	0	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Captur	I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dascada	I	0	0	0	0	13	4	0	0	0	0	0	0	21	4	0	0	0	0
Donata	T	0	0	0	0	0	4	0	0	0	0	0	0	4	8	4	0	0	0
Echelon	-	0	0	0	8	13	4	0	0	0	0	0	0	4	0	0	0	0	0
Inavale	-	0	0	0	13	13	0	0	0	0	0	0	0	33	0	0	0	0	0
Oberon	-	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Olathe	-	0	0	0	17	13	0	0	0	0	0	0	0	63	0	0	0	0	0
Savvy	-	0	0	0	4	0	0	0	0	0	0	0	0	17	0	0	0	0	0
Sparta	I	0	0	0	0	13	0	0	0	0	0	0	0	25	0	0	0	0	0

Discussion and conclusions

- Good total annual yield, especially in the 1st year , but reasonably good in 2nd year.
- **Highest yielding group Year 1:**

  Adremo, Archibaldi, Bardarus, Captur, Savvy, Inavale, Olathe, Oberon, Echelon
- **Highest yielding group in year 2:**

  Adremo, Bardarus, Olathe, Aurus, Archibaldi, Inavale, Savvy
- Spring is the peak season (potential for silage) in terms of pasture yield.
- Summer not as good as expected, thus cocksfoot should be combined with a forage herb and legume
- Some cultivars are winter dormant especially the cultivars Olathe, Donata, Dascada, Sparta, Inavale
- Good yield was associated with lower forage quality (to be confirmed with spring and summer samples in the future).
- For the 2022 and 2023 sampling none of the cultivars were flowering. However, at the 2023 sampling Dascada, Echelon and Sparta had significant levels of leaf disease (Figure 8 and 9).
- Some cultivars had reduced sward density in the second year, especially Donata and Captur.

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Ammann S. 2023. Elite perennial ryegrass trial (Lp6) 2022 at Outeniqua Research Farm.

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The best cocksfoot cultivars could be used in mixtures, preferably on outer fields. It is, however, important to ensure that seeding rate is not too high to avoid cocksfoot from becoming the dominant and out-competing other pasture species/components.

Perennial ryegrass cultivar evaluation results: 2022 to 2024

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Introduction

The perennial ryegrass (*Lolium perenne*) elite cultivar evaluation trial (Lp6) was planted on 22 March 2022 at the Outeniqua Research Farm. The aim of the trial is to evaluate the recent perennial ryegrass cultivars being used for intensive dairy pastures or ones that are about to enter the market together with cultivars that have shown promising results in the previous evaluation trial. This trial provides local data to assist farmers with choosing cultivars best adapted to the coastal region. Since all perennial ryegrass cultivars are imported, this data provides insight into the genetic potential and adaption for the southern Cape region. This data is specific for autumn 2022 (March) to May 2024 but some cultivars, especially the better performing ones, are evaluated in successive trials, which means some have also been in previous trials. For previous data refer to the Outeniqua Information Day booklets for 2018, 2019, 2020 2021, 2022. The current trial, Lp6, of which the first two years data are reported here, is continuing to determine productivity for a third year provided the sward density remains at an acceptable level.

Cultivars evaluated

The trial consists of 18 cultivars of which 13 are diploid, one is tetraploid and four Lolium-type Festuloliums (FL) which are also tetraploid.

Diploid cultivars:

24Seven, Bowie, Boyne, Delika, Govenor, Goyave, Kimbuku, Legion, Maxsyn, One50, Platform, Sequel

Tetraploid cultivars:

Base, Achilles (FL), Perseus (FL), Rockstar (FL), Splice (FL)

Parameters reported in this article

- Total DM yield
- Seasonal DM yield
- DM content
- Flowering behaviour
- Persistence / sward density
- Disease incidence (mainly crown rust)

Trial management

The diploids were sown at 25 kg/ha while the tetraploids were sown at 30kg/ha. The evaluation is done in a small plot trial cut with a reciprocating mower at 5cm where material from the entire net plot is weighed and sampled. The trials are top-dressed with nitrogen and potassium fertilizer after each harvest to account for nutrient removal.

The **harvest cycle** is determined according to physiological stage being **3-leaf or in spring canopy closure.** As the first cultivars reach these stages, the trial is harvested.

Since leaf emergence rate is mainly driven by temperature, as well as radiation intensity, water and nutrient availability (Chapman 2016), most cultivars reach the 3-leaf stage at a similar time.

Results and discussions

Total annual dry matter yield

Total yield **(Table 1)** is important, especially on farms that have the means to conserve the surplus as silage for later use. The establishment and input costs are also similar regardless of yield, hence the importance of choosing the cultivars with the best yield to get a better return on the establishment and input costs. The input costs being mainly fertilizer and irrigation. Total yield is given for both year 1 and year 2 as well as the 2 years combined. In terms of yield stability over years, all cultivars had a lower yield in the second year but of the nine best performing from the first year, six did so in year two.

Total seasonal dry matter yield

Seasonal yield data **(Table 1)** is of value for optimising fodder flow requirements especially for the more challenging seasons which are generally winter and summer/beginning of autumn. The question is whether there are cultivars with both good winter and summer yield. Alternatively it is advisable to plant paddocks to different cultivars to take advantage of different seasonal yield distributions and to spread risk. Alternatively other species like forage herbs can be used to boost summer production. A high yielding spring cultivar can for instance be considered for silage making of the surplus production. Other options are mixed swards.

For perennial ryegrass it is also important to assess how the seasonal yield distribution changes over years i.e. is the seasonal yield distribution different in the second year compared to the first year. The seasons most affected by reduced yield in the second year are winter and summer. In this particular trial the winter yield was substantially lower in the second winter compared to the first winter. The summer yield for year 2 was very cultivar specific with some even yielding more in the second summer than the first summer. This must however be looked at in relation to total yield.

Growth rate

Growth rate data **(Table 1)** gives an indication of whether there is sufficient feed available to sustain a dairy herd. E.g. assuming a 450kg cow requiring 10 kg/ DM/day intake from grazing and assuming a stocking rate of 4 cows/ha, then the required growth rate would have to be at least 40kg DM/ha/day.

The remaining data for this trial will be made available in a final report once the trial is completed.

Table 1. Perennial ryegrass (*Lolium perenne*), Lp 6, Elite Evaluation, Outeniqua Research Farm
Planted: 22 March 2022 **Seasonal Yield** (t DM/ha), **Growth rate (GR)** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2022		Winter 2022		Spring 2022		Summer 2022/23		Autumn 2023		Total Year 1	
		Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR
24Seven	D	1.51 fg	35.0	4.00abcd	43.5	4.97 e	54.6	3.35defg	37.3	1.52 efg	16.5	13.8 efg	43.8
Achilles	FL	**1.94 a**	**45.2**	3.73 d	40.6	5.40 abcde	59.3	3.88 abcd	43.1	1.62 defg	17.6	15.0 cdef	47.3
Base	T	1.61 cdefg	37.5	4.34 ab	47.1	5.39 abcde	59.2	3.63 cdef	40.4	1.62 defg	17.5	15.0 bcdef	47.3
Bowie	D	1.76 abcde	41.0	3.60 d	39.2	5.33 cde	58.5	2.63 h	29.3	1.29 g	14.1	13.3 g	42.1
Boyne	D	1.83 abc	42.4	3.77 d	41.0	5.38 bcde	59.1	2.98 h	33.1	1.51efg	16.4	13.9 efg	44.1
Delika	D	1.83 abc	42.5	3.92 bcd	42.6	5.42 abcde	59.6	3.48 cdefg	38.7	1.84 abcde	20.0	14.6 cdef	46.3
Delika Mix		1.59 defg	37.0	4.31 abc	46.9	5.42 abcde	59.6	3.36 defg	37.4	1.84 abcde	20.0	14.7 cdef	46.5
Govenor	D	1.48 g	34.4	**4.46 a**	**48.5**	5.88 abc	64.6	3.92 abc	43.6	1.83 bcde	19.9	15.7 abc	49.8
Goyave	D	1.71 bcdef	39.6	3.64 d	39.5	5.16 de	56.7	3.26 efg	36.2	1.98 abc	21.5	13.8 fg	43.6
Kimbuku	D	1.50 fg	35.0	3.87 bcd	42.0	**6.01 a**	**66.1**	3.13 fgh	34.8	1.60 defg	17.4	14.5 defg	45.9
Legion	D	1.82 abc	42.3	4.33 ab	47.1	5.78 abcd	63.5	4.23 ab	47.0	2.08 ab	22.6	16.2 ab	51.2
Maxsyn	D	1.55 efg	36.0	4.01 abcd	43.6	5.98 ab	65.6	3.94 abc	43.8	1.81 bcde	19.7	15.5 abcd	49.0
One50	D	1.72 abcdef	40.0	4.31 abc	46.8	5.55 abcde	61.0	3.99 abc	44.3	1.89 abcd	20.5	15.6 abcd	49.3
Perseus	FL	1.81 abcd	42.1	3.74 d	40.7	5.51 abcde	60.5	3.57 cdef	39.7	1.80 bcde	19.5	14.6 cdef	46.3
Platform	D	1.73 abcdef	40.1	**4.44 a**	**48.3**	5.67 abcd	62.3	**4.35 a**	**48.3**	**2.17 a**	**23.7**	**16.2 a**	**51.2**
Rockstar	FL	1.92 ab	44.7	3.84 cd	41.8	5.39 abcde	59.2	3.82 abcde	42.5	1.69 cdef	18.4	15.0bcde	47.4
Sequel	D	1.90 ab	44.1	4.05 abcd	44.0	4.99 e	54.9	3.77 bcde	41.9	1.83 bcde	19.9	14.7cdef	46.6
Splice	FL	1.80 abcd	41.9	3.95 bcd	43.0	5.52 abcde	60.7	3.31 efg	36.8	1.41 fg	14.1	14.6 cdef	46.1
LSD (0.05)		0.23	5.23	0.47	5.13	0.63	6.93	0.56	6.20	0.34	3.71	1.20	3.79
CV%		7.89	7.88	7.08	7.07	6.92	6.93	9.37	9.37	11.8	11.8	4.88	4.87

Shaded BOLD = highest yielding, **Light shaded** = similar to highest**. Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant

Table 1 cont. Perennial ryegrass (*Lolium perenne*), Lp 6, Elite Evaluation, Outeniqua Research Farm
Planted: 22 March 2022 **Seasonal Yield** (t DM/ha), **Growth rate (GR)** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Winter 2023		Spring 2023		Summer 2023/24		Autumn 2024		Total Year 2		Total Year 1+2
		Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield
24Seven	D	2.16 bc	23.5	3.53 d	38.8	1.91 efg	21.2	1.84 cdef	20.0	9.11 cd	25.0	22.95 ef
Achilles	FL	1.67 de	18.1	**4.64 a**	**51.0**	1.64 ghi	18.2	1.61 ef	17.5	9.57 bcd	26.2	24.52 de
Base	T	2.23 bc	24.2	4.05 abcd	44.5	2.06 defg	22.9	1.80 def	19.6	9.95 abcd	27.3	24.92 bcde
Bowie	D	1.89 cde	20.5	3.74 bcd	41.1	1.80 fgh	20.0	1.13 gh	12.3	8.72 d	23.9	22.04 f
Boyne	D	2.08 bcd	22.6	3.99 abcd	43.8	1.40 hi	15.6	0.85 h	9.2	8.98 d	24.6	22.93 ef
Delika	D	2.21 bc	24.0	4.26 abc	46.8	2.34 abcde	26.0	2.10 bcd	22.8	10.64 abc	29.2	25.29 abcd
Delika Mix		2.26 bc	24.6	4.28 abc	47.0	2.17 cdef	24.1	1.95 cdef	21.2	10.56 abc	28.9	25.25 abcd
Govenor	D	2.16 bc	23.5	4.04 abcd	44.4	2.60 abc	28.9	2.22 bc	24.1	10.63 abc	29.1	26.37 abc
Goyave	D	2.13 bc	23.2	4.38 ab	48.1	2.31 bcde	25.7	2.01 cde	21.8	10.79 ab	29.6	24.55 cde
Kimbuku	D	1.96 cde	21.3	3.83 bcd	42.1	1.97 efg	21.9	2.02 cd	21.9	9.37 bcd	25.7	23.88 def
Legion	D	2.47 ab	26.8	3.90 bcd	42.9	**2.78 a**	**30.9**	**2.65 a**	**28.8**	**11.23 a**	**30.8**	**27.39 a**
Maxsyn	D	**2.72 a**	**29.6**	4.12 abcd	45.3	2.23 bcdef	24.8	1.79 def	19.5	10.89 ab	29.8	26.36 abc
One50	D	2.19 bc	23.8	4.02 abcd	44.2	2.52 abc	28.0	2.22 bc	24.1	10.61 abc	29.1	26.18 abc
Perseus	FL	1.57 e	17.1	3.97 abcd	43.6	1.66 ghi	18.4	1.53 fg	16.6	8.99 d	24.6	23.62 def
Platform	D	2.22 bc	24.1	3.64 cd	40.0	2.63 ab	29.2	2.48 ab	27.0	10.67 ab	29.2	26.86 ab
Rockstar	FL	1.59 e	17.3	3.93 bcd	43.2	1.23 ij	13.7	0.95 h	10.3	8.45 d	23.2	23.42 def
Sequel	D	2.41 ab	26.2	3.95 abcd	43.4	2.48 abcd	27.6	2.18 bcd	23.7	10.68 ab	29.3	25.39 abcd
Splice	FL	2.28 abc	24.8	4.41 ab	48.5	0.82 j	9.1	0.31 i	3.4	8.91 d	24.4	23.50 def
LSD (0.05)		0.44		0.71		0.45		0.40		1.54		2.25
CV%		12.6		10.5		13.4		13.7		9.3		5.5

Shaded BOLD = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant

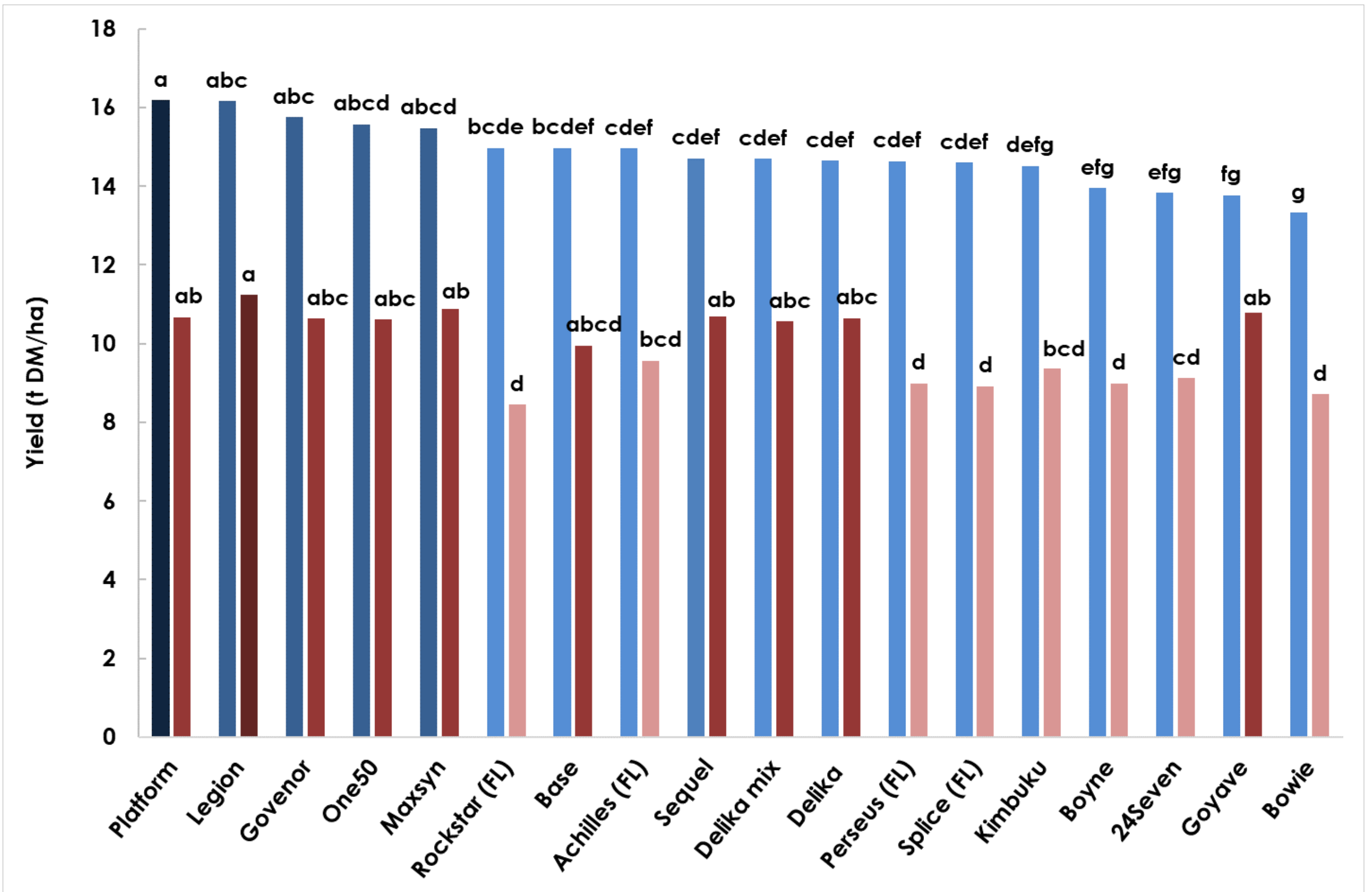

Figure 1. Perennial ryegrass annual yield, comparing the first year with the second year. The first year includes the establishment phase in autumn.

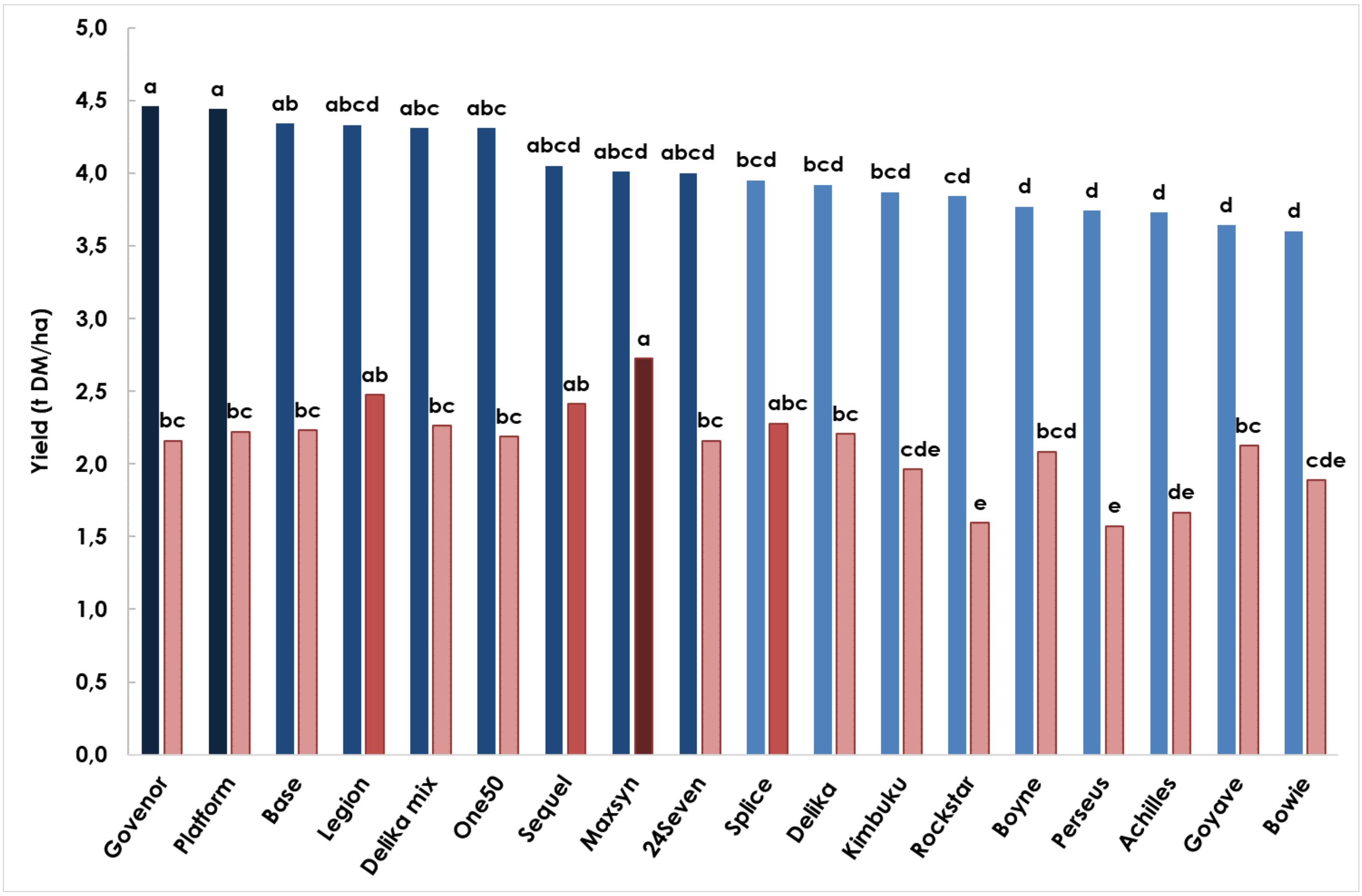

Figure 2. Perennial ryegrass winter yield (Jun, Jul, Aug) comparing the first (2022) and second (2023) winter season.

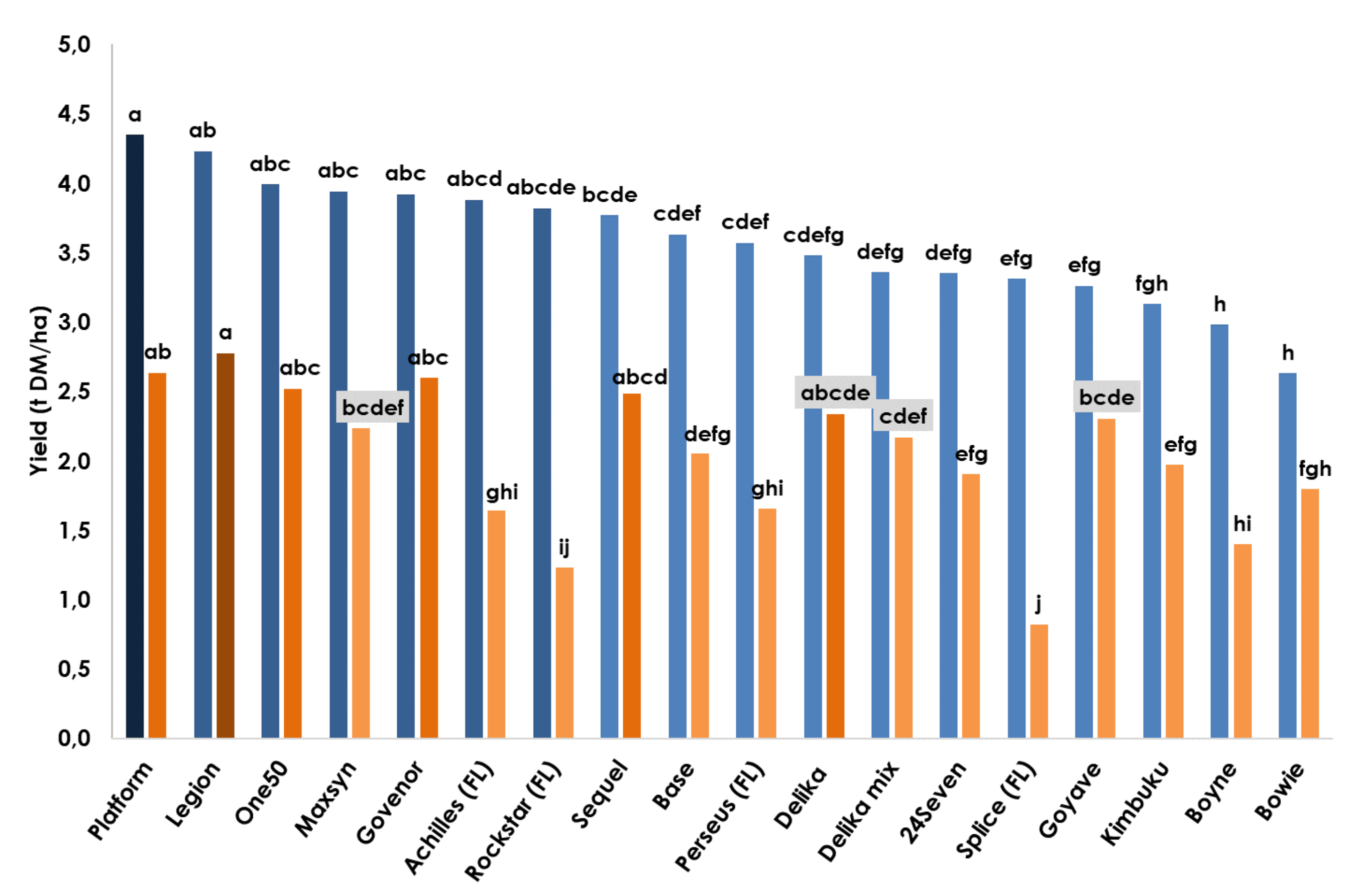

Figure 3. Perennial ryegrass summer yield (Dec, Jan, Feb) comparing the first (2022/23) and second (2023/24) summer season.

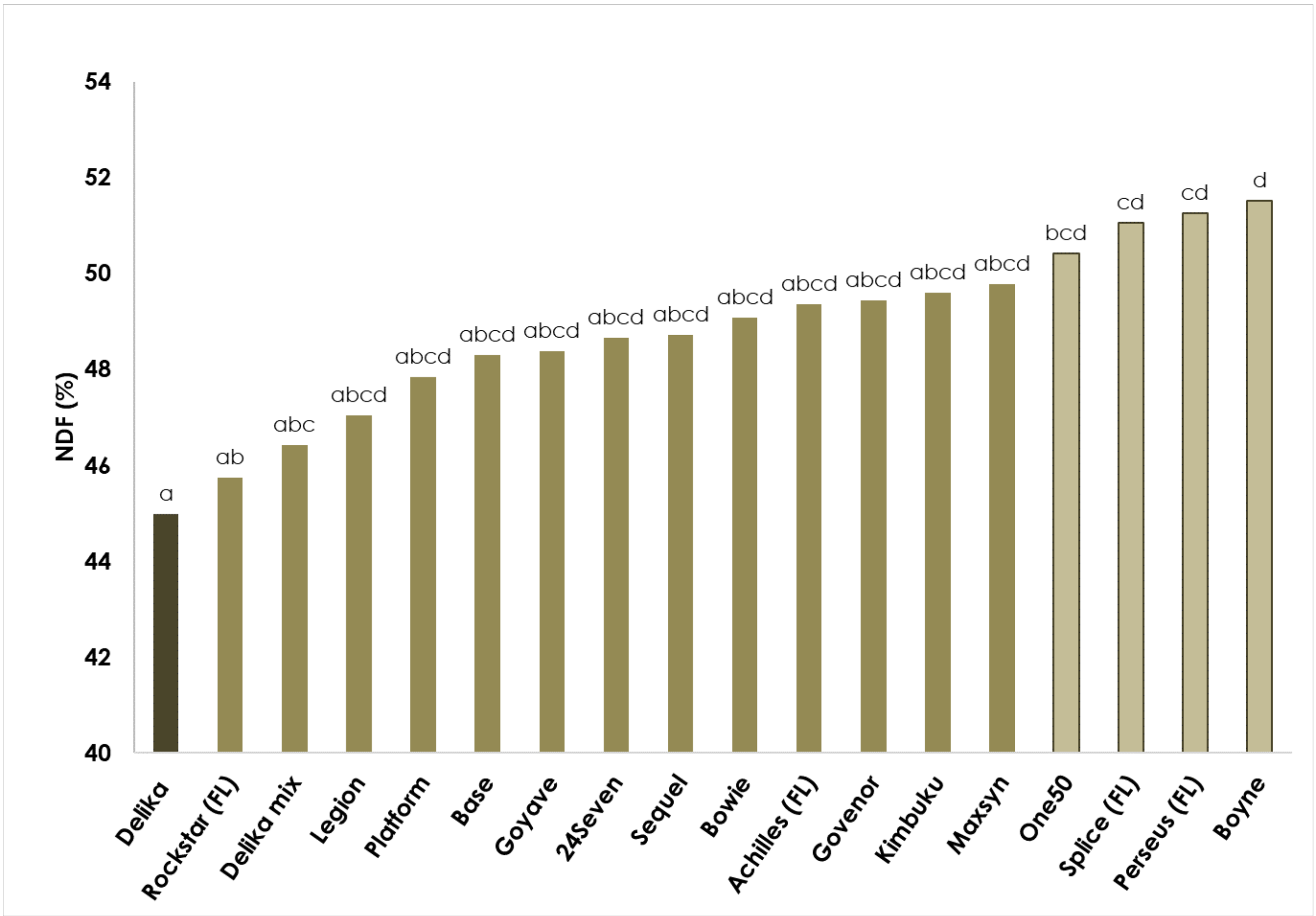

Figure 4. Neutral Detergent Fiber (NDF) values (%) for perennial ryegrass in late spring (November 2022) of the first year.

Conclusions

- If the assumption is made that you have Jersey dairy herd stocked at 4 cows/ha and requiring 10kgDM/cow/day from grazing
  - **Growth rates** of only the highest yielding cultivars in winter and summer were sufficiently high
  - Towards the end of summer (February) and into autumn the growth rates were too low
- In the second year after establishment, the total annual DM yield was insufficient, hence oversowing would still be required.
- Plant population is very low in late summer, only recovering in late autumn as it gets cooler.

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Perennial ryegrass would best be used in a mixture with summer active species such as forage herbs and legumes.

Increasing pasture intake by allocating additional plantain pasture to cows before morning milking

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Introduction

The trend towards intensification in the dairy industry results in concentrates forming a larger proportion of pasture-based dairy cow diets. This results in a less resilient system dependent on the milk-to-feed price ratio. To increase the profitability of pasture-based dairy farming the focus should be placed on increasing dry matter intake (DMI) from pasture. Pasture DMI is affected by many factors such as the level of concentrate feeding and its effect on the substitution rate, animal and pasture characteristics including pasture allocation and quality. A possible approach to increase DMI from pasture is the partial substitution of concentrate with a high-quality, rapidly-degradable pasture, such as the forage herb plantain (*Plantago lanceolata*). The lower neutral detergent fibre (NDF) content of plantain will allow higher intake, as the NDF content and the digestibility of NDF of a forage determine the rumination time and potential DMI. **The aim of the study is: To determine if allocating additional plantain pasture into a ryegrass-dominant pasture-based production system will increase pasture DMI, increase milk production and allow feeding concentrate at a lower level without reducing milk production.**

Materials and methods

The trial was carried out in spring 2023 in the Western Cape Province of South Africa on the Outeniqua Research Farm (33˚ 58´ 38´´S and 22˚ 25´ 16´´E). With an annual rainfall of 730 mm and a temperate climate, the George area is well suited for pasture-based dairy production systems. Ethical clearance for this study was received from the REC (Research Ethics Committee) on 7 August 2023. Reference number: ACU-2023-27 575.

Sixty lactating Jersey cows were chosen after a pre-trial period of two weeks consisting of 80 cows. The remaining 60 cows were blocked according to 4% fat-corrected milk, days in milk, lactation number and live weight. Cows within blocks were then randomly allocated to one of four treatment groups. This study was a factorial design with two pasture treatments (ryegrass only and ryegrass with additional plantain pasture) and two levels of concentrate (4 or 6 kg/cow/day) with 15 cows per treatment. Treatments were as follows:

- **RGPL6:** Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 6 kg concentrate/cow/day.

- **RG6:** Cows grazed ryegrass day and night and were supplemented with 6 kg concentrate/cow/day.
- **RGPL4:** Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 4 kg concentrate/cow/day.
- **RG4:** Cows grazed ryegrass day and night and were supplemented with 4 kg concentrate/cow/day.

Cows from the treatments grazed as two groups of 30 cows on different ryegrass pasture blocks in the same paddock. Random assignment of blocks ensured ryegrass pasture of equal quality to cows from different treatments. Ryegrass pasture was allocated at 14 kg DM/cow/day for both groups. The cows from the RGPL4 and RGPL6 treatments were moved to plantain pasture one hour before the morning milking at 6:00. Cows from RG4 and RG6 stayed on ryegrass. The plantain pasture was allocated at 2 kg DM/cow/day available pasture. Fresh pasture was allocated after each milking.

The area allocated was calculated based on the estimated pasture yield. Pasture heights were measured by taking 100 rising plate meter (RPM) readings on each pasture strip before and after grazing using an RPM, method as described by (Lile *et al.*, 2001). The pasture yield was estimated from the average pasture height of 100 readings by using the following linear regressions estimated from previous trials held at Outeniqua Research Farm: Ryegrass: Y= (103 X H) – 261 (Van Wyngaard, 2018) Plantain: Y = (66.4 x H) – 287 (Pretorius, 2022) Where Y = Pasture yield in kg DM/ha and H = average RPH height. The Afimilk automatic feeders were used during this trial to allocate specific quantities of concentrate to different cows during each milking session. The composition of the concentrate is presented in Table 1, and is typical of concentrates fed to cows on pasture in the southern Cape.

Table 1. Ingredients and nutrient composition of concentrate, fed at 4 or 6 kg/cow/day to Jersey cows grazing perennial ryegrass or perennial ryegrass and moved to plantain pasture

Ingredient	g/kg As is
Maize	500
Hominy chop	154
Wheaten bran	115
Soya oilcake	157
Molasse syrup	30
Feed lime	33
Salt	5
MgO	3.9
Premix*	2.4
Nutrient Specs	g/kg DM
Dry matter	887
Crude protein	158
Metabolisable energy MJ/kg	12.2
Neutral detergent fibre	148
Starch	463
Ether extract	36.1
Ca	13.5
P	4.5
Mg	5.1

* Vitamin/mineral premix (Vit A: 6000000IU, Vit D: 1000000 IU, Vit E: 8000IU, Mn 50 g, Zn 100 g, Cu 20 g, I 1.7 g, Se 0.3 g and carrier Dolomite carrier: 440g)

Twice a week, one sample was taken from each of the two respective ryegrass pastures, and one sample from plantain pasture. Pasture samples were collected on sampling days from the strip where the cows would be grazing next. Pasture samples were collected by placing a ring with a diameter of 35,4 cm at three different locations chosen at random. The pasture was cut 30 mm from the ground to have representable samples of pasture that are available for the cows. After cutting the pasture by hand with scissors, the samples were collected and placed inside brown paper bags. Over the five-week trial period, a total of 10 samples of both ryegrass pastures and 10 plantain samples were taken. Concentrate samples were taken once every week through a grab sample. The grab samples were taken at random from different feeders.

Outeniqua research farm has a 20-point Waikato/ Afikim swing-over milking machine that was used to milk and record milk production of cows. Cows from the four different treatments were moved to the dairy as one group. Cows were milked twice daily at 07h00 and 14h30 and strip grazed the rest of the 24 hours of the day. Composite milk samples were collected once a week during the morning and afternoon milking sessions. On sampling days, the milking system was fitted with sampling bottles to collect a representative sample for each cow. Composite milk samples were collected based on the milk yield ratio (2/3 in the morning and 1/3 during afternoon milking). Milking samples of 16 ml in the morning and 8 ml in the afternoon were pooled to form composite samples for each cow on that sampling day.

The body condition score (BCS) of all cows in the study was done by the same technician at the start and the end of the study. A scale from 1 to 5 with increments of 0.25 was used to condition score cows (Ferguson *et al*., 1994). One represents a cow that is severely thin and 5 represents a cow that is over-conditioned. Scoring was done by looking at cows and palpating the cover over the ribs and transverse process. Cows were weighed (Tru-Test EziWeigh 2, Serial no. 542707) on two consecutive days before the start of the study and again on two consecutive days at the end of the study. Weighing of cows took place after the afternoon milking.

All cows included in the trial were fitted with an Aficollar around the neck. The Aficollar provides data on cow behaviour, specifically rumination time, eating time, group behaviour, health monitoring and heat detection. The Aficollar integrates with the Afifarm herd management software on the farm, allowing milk

Figure 1. Cows were fitted with Aficollars to evaluate grazing behaviour

sensor integration. Any variation in a cow's production or behavioural parameters, whether compared to the cow's historical data or the average data of the entire herd, is flagged within the system.

All samples, pasture and concentrate, were dried at 60˚C for 72h to remove any moisture. Samples were weighed before and after drying, pasture (Adam AE598733, accurate to 0.1 g) and concentrate (LCD series Model EJ-12001C, accurate to 0.1 g). After drying the DM content of each pasture for each sampling day was calculated. Samples were milled using a 1mm screen with a Retsch GmbH5657 Laboratory mill (Retch GmbH 5657 Haan, West Germany). Subsequently, the milled sample from the ryegrass and plantain pastures was pooled every week and stored in airtight plastic jars. Resulting in a total of 5 plantain samples (one each week) and 10 ryegrass pasture samples (one each week for the different ryegrass camps). The milled concentrate samples were pooled every second week and stored in airtight plastic jars.

The milled samples were analysed for DM (AOAC, Method 930.15) and ash (AOAC, 2002: 942.05). The ANKOM200 was used for analysis of NDF and acid detergent fibre (ADF) as described by (Goering & Van Soest, 1970). The analysis for crude protein (CP) of all the pasture and concentrate samples was done with LECO FP828 as described by (AOAC, Method 990.03). The fat content of the samples was done with a VELP Fat Extraction Apparatus as described by (AOAC, Method 2003.05). The acid detergent lignin (ADL) was done on the residue left after determination of the ADF as described by (Goering & Van Soest, 1970). The gross energy (GE) of the samples was determined by burning samples in a Bomb-Calorimeter, method as described by (AOAC, 1990; AFRC, 1993). The pasture and concentrate samples were sent to Elsenburg (Animal Science Feed and Plant Production Laboratories, Western Cape Department of Agriculture) for mineral analysis, method described by (ALASA, 1998).

All milk samples were sent to Merieux Nutriscience Pty (Ltd) for analysis. Samples were analysed using a Milkoscan FT 6000 machine (Foss Electric, Denmark) for fat, protein, lactose, milk urea nitrogen (MUN) and somatic cell count (SCC). The production data including milk yield, milk composition, body weight and body condition was analysed as a randomised block design with 15 blocks as replicates. Data were analysed using the General linear model (GLM) procedure of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). Shapiro-Wilk test was performed on the standardized residuals from the model to verify normality (Shapiro and Wilk, 1965). The treatment effects in the model were assumed to be fixed. The blocks and the residual term error were assumed to be random. Least Square Means (LS means) were calculated to compare treatments.

Results and discussion

The nutrient composition of both the ryegrass pastures and plantain pasture taken over the five-week trial period is presented in Table 2. The two different ryegrass pastures had a lower CP content than expected. A CP content of 220 g/kg DM was documented by Van der Colf et al. (2015) in the spring and 179 g/kg DM in the summer. A higher metabolisable energy (ME) and in vitro dry matter digestibility (IVDMD) than expected for both ryegrass pastures were found in this study. Lower values were documented by Steyn et al. (2012) who reported ME value of 10.9 MJ/kg DM and an IVOMD of 787 g/kg DM. In contrast, van der Vyver et al. (2019) reported high ME and IVOMD values of 13.9 MJ/kg DM and 915 g/kg DM, respectively.

The macro and micro mineral composition of the different ryegrass pastures and plantain pasture is presented in Table 3. The total mineral composition, indicated by the ash value, is similar between the different ryegrass pastures (88.1 vs 79.1 g/kg DM). The higher mineral composition of plantain, especially

Table 2. Mean and standard deviation of composite samples of two different ryegrass and plantain pastures taken over a five-week trial period (n=5)

Nutrient composition[1] (g/kg DM)	Ryegrass	Ryegrass (moved to plantain)	Plantain
DM	162 ± 18.4	159 ± 16.2	112 ± 18.4
IVDMD %	88.6 ± 1.46	87.9 ± 4.27	69.4 ± 4.86
ME (MJ/kg)	12.8 ± 0.16	12.5 ± 0.85	9.6 ± 0.68
CP	158 ± 19.2	157 ± 19.0	143 ± 28.0
NDF	508 ± 31.9	484 ± 18.0	407 ± 33.8
ADF	297 ± 24.1	281 ± 33.1	298 ± 33.3
EE	48.0 ± 6.51	45.2 ± 6.01	39.8 ± 13.93
ADL	82.7 ± 30.08	79.6 ± 25.89	199.7 ± 43.84
NDICP (g/kg NDF)	48.8 ± 17.37	51.9 ± 19.16	113.9 ± 29.53
ADICP (g/kg ADF)	29.6 ± 10.27	25.2 ± 7.38	114.2 ± 17.08

[1]DM – dry matter; IVDMD – in vitro dry matter digestibility; ME – metabolizable energy; CP – crude protein; EE – ether extract; NDF – neutral detergent fibre; ADF – acid detergent fibre; ADL – acid detergent lignin; NDICP – neutral detergent insoluble crude protein; ADICP – acid detergent insoluble crude protein
± standard deviation

Table 3. Mean and standard deviation of mineral content of two different ryegrass and plantain pastures taken over a trial period of five-weeks (n=5)

Mineral composition[1] (g/kg DM or as stated)	Ryegrass	Ryegrass (moved to plantain)	Plantain
Ash	88.1 ± 7.51	79.1 ± 5.15	157.4 ± 9.72
Ca	4.8 ± 1.81	4.2 ± 1.12	21.8 ± 5.33
P	4.0 ± 0.55	3.6 ± 0.30	4.0 ± 1.27
Mg	2.4 ± 0.23	2.4 ± 0.17	3.4 ± 0.15
K	28.8 ± 6.60	32.4 ± 3.31	21.6 ± 1.82
Na	3.7 ± 1.59	3.6 ± 0.95	13.8 ± 4.16
Zn (mg/kg)	28.4 ± 6.78	25.5 ± 0.75	49.5 ± 8.27
Fe (mg/kg)	128.5 ± 20.48	144.6 ± 52.57	156.5 ± 43.59
Mn (mg/kg)	40.5 ± 24.60	40.0 ± 20.91	31.6 ± 8.72
Cu (mg/kg)	4.6 ± 0.35	4.5 ± 1.08	7.3 ± 0.85

[1]Ash – mineral fraction; Ca – calcium; P – phosphor; Mg – magnesium; K – potassium; Na – sodium; Zn – zinc; Fe – iron; Mn – manganese; Cu – copper ± standard deviation

calcium (Ca), is highlighted by a higher ash value of 157 g/kg DM.

Regression equations were used to allocate 14 kg DM/cow/day available ryegrass pasture and 2 kg DM/cow/day available plantain pasture. The actual amount of available pasture based on the pre-grazing RPM height of ryegrass and plantain pasture can be seen in Table 4 to be 15.1 kg DM/cow/day available ryegrass pasture and 1.6 kg DM/cow/day available plantain pasture. From the 15.1 kg DM/cow/day ryegrass pasture offered, the cows grazing ryegrass only and cows grazing ryegrass and moved to plantain pasture had a similar ryegrass pasture intake of 9.2 and 9.5 kg DM/cow/day, respectively. A similar ryegrass pasture intake was reported by (Van der Vyver, 2019) when cows grazed ryegrass day and night and received 6 kg of concentrate. Of the 1.6 kg DM/cow/day plantain pasture offered, the cows consumed 1.2 kg/cow/day.

Table 4. Mean and standard deviation of mineral content of two different ryegrass and plantain pastures taken over a trial period of five-weeks (n=5)

Parameter[1]	Ryegrass	Ryegrass (Moved to plantain)	Plantain
Pre-grazing			
RPM reading	26.2 ± 5.30	25.7 ± 4.40	34.8 ± 6.72
Average yield (kg DM/ha)	2441 ± 553	2331 ± 891	1925 ± 461
Pasture offered (kg DM/cow/day)	15.1 ± 2.14	15.1 ± 2.27	1.6 ± 0.40
Post grazing			
RPM readings	11.4 ± 1.34	11.2 ± 1.32	12.1 ± 1.92
Yield (kg DM/ha)	910 ± 140	891 ± 137	514 ± 135
Pasture removed (kg DM/ha)	1531 ± 521	1440 ± 365	1411 ± 466
Pasture intake (kg DM/cow/day)	9.2 ± 2.21	9.5 ± 1.93	1.2 ± 0.38

[1]RPM – rising plate meter; DM – dry matter; ha – hectare
± Standard deviation

The milk production data is shown in Table 5. Both treatments where additional plantain pasture was allocated to cows had higher milk production compared to ryegrass only. The more substantial increase in milk production between cows from RG4 and RGPL4 ($P=0.0009$) compared to RG6 and RGPL6 ($P=0.04$) indicates a larger contribution of the plantain pasture at a lower concentrate level. There was no significant difference ($P=0.59$) between the milk production of cows on RGPL4 and RG6 treatments, suggesting that it is feasible to replace 2 kg of concentrate with a high-quality pasture without causing a reduction in milk production. The difference in milk production between cows grazing ryegrass only and fed 4 kg concentrate (RG4) and cows grazing ryegrass and fed 6 kg of concentrate (RG6) ($P<0.002$) is explained by Bargo *et al.* (2002) suggesting that feeding concentrates at a lower level will result in lower milk production due to a decrease in energy intake.

No difference was observed in the milk fat % between the four different treatments ($P>0.05$). A lower milk fat percentage can be expected at a higher concentrate level due to the lower effective NDF intake of cows (Walker *et al.*, 2004). Other studies reported a decrease in the milk fat percentage as the proportion of plantain was increased in the diet of cows (Box *et al.*, 2017). The similar milk fat % between different treatments in this study suggests that the inclusion of the plantain pasture was small enough to not cause a decrease in milk fat % and the NDF value of the plantain in this study was higher than expected. No significant difference ($P>0.05$) in milk protein % was observed between treatments. The milk protein of the four different treatments ranged from 39.1 to 39.8 g/kg. These milk protein % values fall within acceptable ranges for jersey cows grazing pasture and fed concentrate (NRC, 2001). The milk lactose % of all four treatments (Table 5) was within the range of acceptable values stipulated by NRC (2001), which is 47.0- 48.0 g/kg. Similar milk lactose percentages were documented between different treatments. The lower milk lactose in the cows receiving 4 kg of concentrate and no additional plantain pasture can be a result of the lower ME content of the diet offered to the cows. The ideal MUN value should be between 8 and 12 mg/dl (Kohn, 2007). Both the treatments where additional plantain pasture was allocated to cows showed a lower MUN value ($P<0.05$). This indicates a lower crude protein intake, or a lower nitrogen use efficiency of cows grazing plantain pasture. Both the plantain and ryegrass pasture had lower crude protein levels than expected (Table 2). The lower protein value can be expected at higher NDF values. A study done by Navarette *et al.* (2018) reported lower MUN values between cows grazing plantain-clover mix compared to cows grazing ryegrass-white clover. There was no difference in the SCC of cows from four different treatments ($P>0.05$). The SCC was well under the >300 x 10^3 cells/ml milk indicating healthy udders and milk safe for human consumption.

It is difficult to make any conclusion on the body weight changes in a relative short trial period of 5-weeks (Table 6). All the cows across the four treatments gained body weight in this trial, as expected since cows in the trial were pregnant and in early to mid-lactation. The more substantial increase in body weight when additional plantain pasture is allocated to cows receiving 4 kg of concentrate compared to 6 kg ($P=0.003$ vs $P=0.52$) highlights the larger contribution of allocating additional plantain pasture at a lower concentrate level. An increase in body condition was observed for cows on RGPL6 treatment compared to the RG4 treatment ($P=0.04$). The higher energy intake and pasture DMI of cows from the RGPL6 treatment is most likely the result of the increase in BCS.

Table 5. The effect on milk production and milk components when additional plantain pasture is allocated before morning milking to Jersey cows grazing ryegrass day and night and receiving 4 or 6 kg of concentrate daily

	Treatment[2]				SEM[3]	P value contrast[4]					
Parameter[1]	RGPL6	RG6	RGPL4	RG4		1vs	1vs3	1vs4	2vs3	2vs4	3vs4
	1	2	3	4							
Milk yield (kg/cow/day)	20.1^{a}	19.2^{b}	19.1^{b}	17.5^{c}	0.30	0.04	0.01	<0.01	0.59	<0.01	<0.01
ECM (kg/cow/day)	25.2^{a}	24.4^{a}	24.2^{a}	22.2^{b}	0.47	0.23	0.14	<0.01	0.78	<0.01	<0.01
FCM (kg/cow/day)	23.0^{a}	22.3^{a}	22.2^{a}	20.4^{b}	0.47	0.25	0.22	<0.01	0.94	0.01	0.01
Milk components											
Milk fat (%/cow/day)	4.98	5.06	5.17	5.19	0.159	0.72	0.39	0.36	0.62	0.57	0.95
Milk fat (kg/cow/day)	1.00^{a}	0.97^{ab}	0.97^{ab}	0.90^{b}	0.028	0.49	0.55	0.01	0.92	0.06	0.05
Milk protein (%/cow/day)	3.91	3.98	3.93	3.93	0.065	0.45	0.83	0.87	0.58	0.55	0.97
Milk Protein (kg)	0.78^{a}	0.76^{ab}	0.74^{b}	0.68^{c}	0.013	0.26	0.03	<0.01	0.29	<0.01	<0.01
Milk lactose (%)	4.81^{ab}	4.86^{a}	4.82^{ab}	4.74^{b}	0.032	0.32	0.85	0.13	0.42	0.01	0.09
MUN (mg/dl)	7.41^{b}	8.52^{a}	7.11^{b}	9.02^{a}	0.329	0.02	0.53	<0.01	<0.01	0.29	<0.01
SCC (x 10^3/ml)	279	91	124	152	46.2	0.55	0.91	0.76	0.62	0.36	0.67

[1]ECM – energy corrected milk; FCM – 4% fat corrected milk; MUN – milk urinary nitrogen; SCC – somatic cell score

[2]RGPL6 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 6 kg concentrate/cow/day; RG6 - Cows grazed ryegrass only and allocated 6 kg concentrate/cow/day; RGPL4 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 4 kg concentrate/cow/day; RG4 - Cows grazed ryegrass only and allocated 4 kg concentrate/cow/day

[3]SEM – standard error of mean

[abc] – similar superscripts indicate similar means in the same row

[4]Significant difference = (P<0.05); Not significant difference = (P>0.05)

Table 6. Body weight and body condition score change over the trial period of cows allocated additional plantain pasture and receiving 4 or 6 kg of concentrate

Parameter[1]	Treatment[2]				SEM[3]	P value contrast[4]					
	RGPL6	RG6	RGPL4	RG4		1vs2	1vs3	1vs4	2vs3	2vs4	3vs4
	1	2	3	4							
Body weight (BW)											
BW before (kg)	391	385	386	399	8.897	0.66	0.73	0.54	0.92	0.29	0.34
BW after (kg)	423	414	423	424	8.748	0.53	0.97	0.90	0.50	0.45	0.93
Change in BW (kg)	+32[ab]	+30[b]	+37[a]	+26[b]	2.468	0.52	0.17	0.08	0.05	0.27	0.003
Body condition score (BCS)											
BCS before	2.28[a]	2.25[b]	2.25[b]	2.25[b]	0.011	0.04	0.04	0.04	1	1	1
BCS After	2.30[a]	2.27[ab]	2.27[ab]	2.25[b]	0.017	0.17	0.17	0.04	1	0.49	0.49
Change in BCS	+0.02	+0.02	+0.02	0	0.019	1	1	0.54	1	0.54	0.54

[1]BW – body weight; BCS – body condition score

[2]RGPL6 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 6 kg concentrate/cow/day; RG6 - Cows grazed ryegrass only and allocated 6 kg concentrate/cow/day; RGPL4 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 4 kg concentrate/cow/day; RG4 - Cows grazed ryegrass only and allocated 4 kg concentrate/cow/day

3SEM – standard error of mean

[abc] – similar superscripts indicate similar means in the same row

There was continuous monitoring of cow behaviour, specifically rumination and eating time, with collars fitted around the neck of all cows included in this study. The daily eating time (min) and rumination time (min) for each cow were monitored continuously and documented in Table 7. The data collected allowed for the continuous comparison of the average eating and rumination times (min) between cows from different treatment groups, as well as the hourly comparison between cows grazing ryegrass only and cows grazing ryegrass and moved to plantain pasture before the morning milking, as seen in Figure 1, for specific hours of the day. It is evident from Figure 1 that the increase in milk production when cows were moved to plantain pasture before morning milking mainly occurred due to an increase in grazing time, potentially increasing dry matter intake. This is supported by Bargo *et al*. (2003) who stated that dry matter intake from pasture is mainly dependent on bite rate, bite mass and grazing time. The cows from treatment 1 and 3 were moved to plantain pasture at 5:30 until morning milking at 7 o'clock. This increase in the eating activity of the cows when they are moved to the plantain pasture indicates that there is space available in the rumen in the early morning hours before milking. Cows were returned to a new patch of ryegrass after the morning milking at 8:30, as indicated by the increase in eating activity of both groups of cows. The slightly lower eating activity of the cows that were moved to the plantain pasture in the early morning may indicate a small substitution effect between ryegrass and plantain pasture. However, this decrease in eating activity is much smaller than the initial increase in activity in the morning when the cows are on plantain pasture.

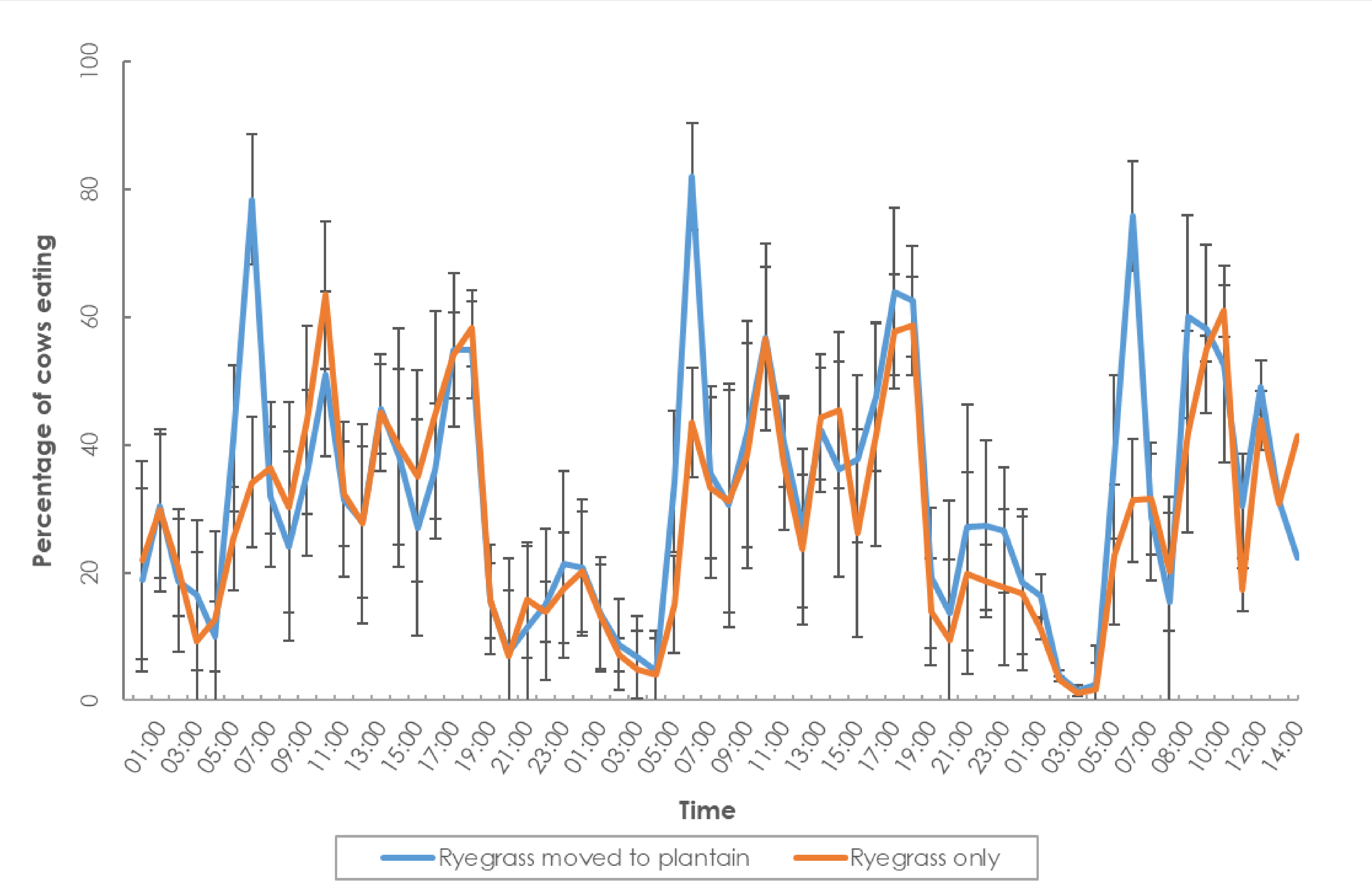

Figure 1. The percentage of cows eating for cows allocated additional plantain pasture before morning milking and cows only allocated ryegrass pasture monitored hourly using Aficollar

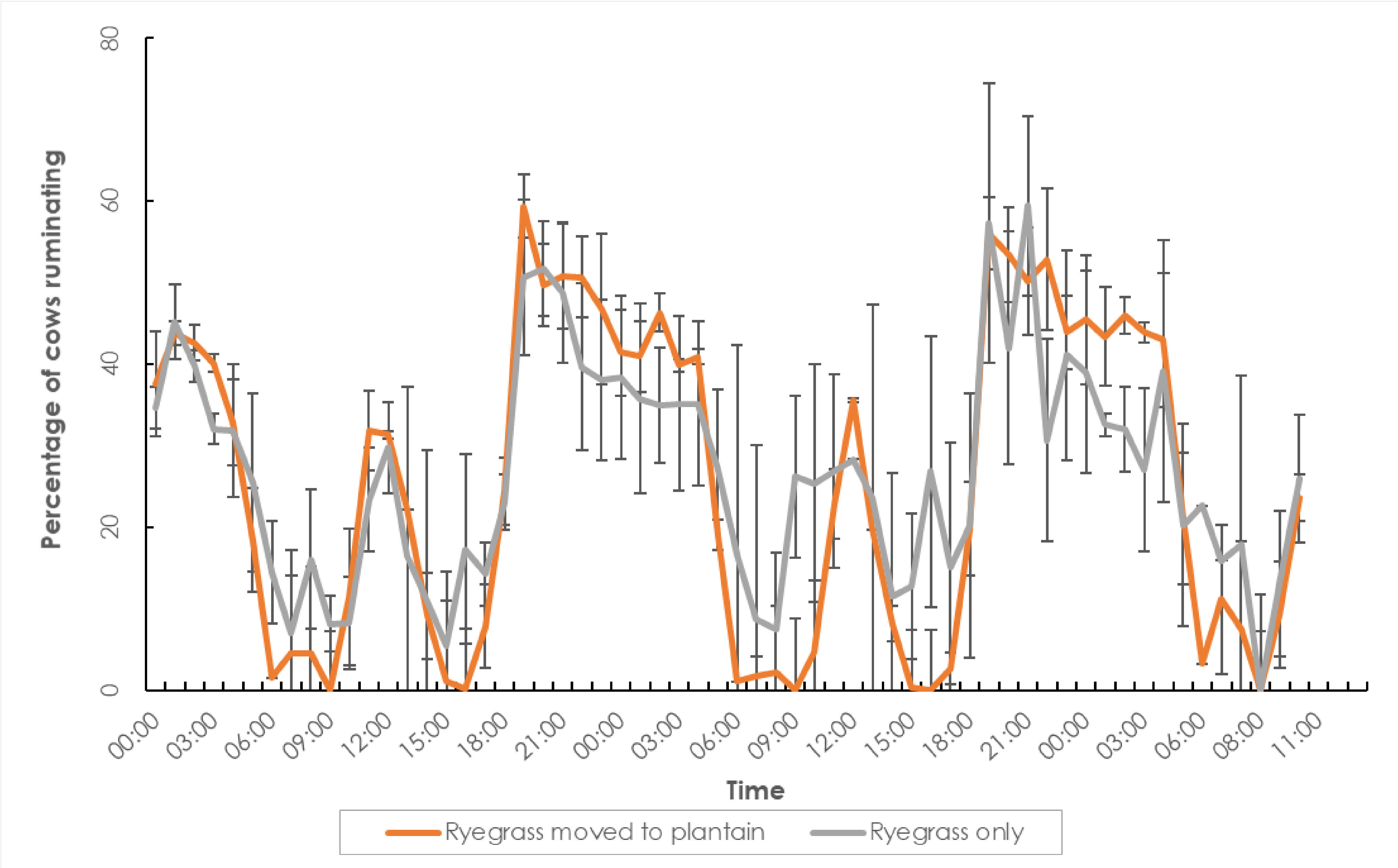

Figure 2. The percentage of cows ruminating of cows allocated additional plantain prior to morning milking and cows only allocated ryegrass pasture monitored hourly using Aficollars,

Table 7. Mean and standard error of eating and rumination time (min/24 hours) between cows of different treatments

Parameter	Treatment[1]				SEM[2]	P value contrast[3]					
	RGPL6	RG6	RGPL4	RG4		1vs2	1vs3	1vs4	2vs3	2vs4	3vs4
	1	2	3	4							
Eating time (min/24hours)	420	406	431	409	25.10	0.71	0.77	0.77	0.50	0.93	0.56
Rumination time (min/24hours)	363	369	374	346	26.77	0.88	0.77	0.67	0.87	0.56	0.47

[1]RGPL6 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 6 kg concentrate/cow/day; RG6 - Cows grazed ryegrass only and allocated 6 kg concentrate/cow/day; RGPL4 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 4 kg concentrate/cow/day; RG4 - Cows grazed ryegrass only and allocated 4 kg concentrate/cow/day
[2]SEM – standard error of mean [3]Significant difference = ($P<0.05$); No significant difference = ($P>0.05$)

Table 8. Effect of allocating additional plantain pasture to cows before morning milking on eating time and rumination time (min/24 hours) when feeding 4 or 6 kg of concentrate, respectively

Comparison	Behaviour parameter[1]	
	Eating time (min/24hours)	Rumination time (min/24hours)
Effect of plantain pasture when 4 kg of concentrate is allocated	+21.0	+27.7
Effect of plantain pasture when 6 kg of concentrate is allocated	+13.4	-5.7

There was no difference in daily eating time (min) between different treatments ($P>0.05$), as seen in Table 7. This is partly owing to the large variation in eating time. The average daily increase in eating time when additional plantain pasture was allocated when cows were fed 4 or 6 kg of concentrate is 21 and 13.4 min/day, respectively (Table 8).

Table 9 shows a simulation for a 100-ha farm comparison across different treatments. The stocking rate viable for each treatment is calculated on the following assumptions: Ryegrass growth rate = 42.5 kg DM/ha/day; Plantain growth rate = 59.7 kg DM/ha/day. Pasture DMI based on pre- and post-grazing RPM readings is not accurate, as this value represents the average pasture intake of cows grazing as one group and thus does not take into account the effect that the amount of concentrate feeding has on pasture DMI. Pasture DMI of cows from various treatments was calculated based on substitution effect between the amount of concentrate fed and pasture DMI, back calculated from milk production and from pre- and post-grazing RPM readings. Pasture DMI of cows from various treatments (kg DM/cow/day) were:

- RGPL6: RG = 9.46; PL = 0.42
- RG6: RG = 9.46
- RGPL4: RG = 10.92; PL = 0.64
- RG4: RG 10.92

Conclusion

Cows allocated additional plantain pasture before morning milking had higher pasture DMI resulting in higher milk production. The benefit of additional plantain pasture was more pronounced when concentrates were fed at a lower level. It is thus plausible to partially substitute concentrate with a high-quality pasture without causing a reduction in milk production. This resulted in a substantial increase in profit per cow/day.

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Table 9. Economical aspects of feeding concentrate at different levels and partially replacing concentrate with plantain pasture simulating a 100-ha dairy platform farm for each treatment

Parameter[1]	Treatment[2]			
	RGPL6	RG6	RGPL4	RG4
Number of cows on 100 ha farm	435	449	373	389
Milk yield (L/cow/day)	20.08	19.20	18.97	17.47
Milk yield (L/herd/day)	8734.8	8620.8	7075.8	6795.8
Milk price (R/L)	R 7.87	R7.96	R7.94	R7.94
Milk income (R/cow/day)	R158.03	R152.83	R150.62	R138.71
Milk income (R/herd/day)	R68742.88	R68621.57	R56181.93	R53958.89
Difference of plantain on 4 and 6 kg concentrate respectively (R/herd/day)	R121.31	0	R2223.04	0
Concentrate price (kg)	R6.10	R6.10	R6.10	R6.10
Concentrate amount (kg/cow/day)	6	6	4	4
Concentrate amount (kg/herd/day)	2610	2694	1492	1556
Concentrate cost (R/cow/day)	R 36.60	R36.60	R24.40	R24.40
Concentrate cost (R/herd/day)	R15921.00	R16433.40	R9101.20	R9491.60
Ryegrass cost (R/kg DM)	R2.38	R2.38	R2.38	R2.38
Plantain cost (R/kg DM)	R1.98	R1.98	R1.98	R1.98
Ryegrass intake (kg DM/cow/day)	9.46	9.46	10.92	10.92
Plantain intake (kg DM/cow/day)	0.42	0	0.64	0
Ryegrass pasture cost (R/cow/day)	R22.51	R22.51	R25.99	R25.99
Plantain pasture cost (R/cow/day)	R0.83	R0.00	R1.27	R0.00
Total cost (R/cow/day)	R23.35	R22.51	R27.26	R25.99
Pasture cost (R/herd/day)	R10154.99	R10109.15	R10167.83	R10109.95
Difference (R/herd/day)	R45.84	R0.00	R57.88	R0.00
Margin over feed cost (R/cow/day)	R98.09	R93.72	R98.96	R88.32
Increase in profit (R/cow/day)	R4.37	R0.00	R10.64	R0.00
Margin over feed cost (R/herd/day)	R42666.89	R42079.02	R36912.90	R34357.34
Increase in margin over feed cost compared to control (R/herd/day)	R587.87	R0.00	R2555.56	R0.00

[1]R – South African Rand
[2]RGPL6 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 6 kg concentrate/cow/day; RG6 - Cows grazed ryegrass only and allocated 6 kg concentrate/cow/day; RGPL4 - Cows grazed ryegrass day and night and were moved to plantain pasture before morning milking. Cows were supplemented with 4 kg concentrate/cow/day; RG4 - Cows grazed ryegrass only and allocated 4 kg concentrate/cow/day.

AOAC 990.03 Protein (Crude) in Animal Feed Combustion Method

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The effect of *Aspergillus oryzae* fermentation product on production parameters, rumen environment, and fibre degradation of jersey cows grazing ryegrass-dominant pasture

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Introduction and background

In many countries, the sub-therapeutic use of antibiotics, or ionophores, is prohibited due to associated health concerns (Sallam *et al.*, 2020; Martin & Nisbet, 1990; Varel *et al.*, 1993; Kellems *et al.*, 1990). Consequently, there is a demand for non-antibiotic products that can be fed to cattle to enhance feed efficiency (Sallam *et al.*, 2020; Martin & Nisbet, 1990; Varel *et al.*, 1993; Kellems *et al.*, 1990). Feed efficiency in pasture-based systems is dictated by fibre degradability, which is influenced by various factors such as pasture quality, pasture allowance, rate of passage, and physical fill factor (Doyle *et al.*, 2005).

Milk production, being energy-intensive, requires supplementary feeding in pasture-based systems, typically in the form of concentrate fed in the milking parlour (FAO, 2023). The composition of a cow's diet significantly impacts the rumen environment, subsequently impacting the milk production, as well as the concentrations of milk fat and milk protein (Muller *et al.*, 2007). The pH of the rumen and the volatile fatty acids (VFA) produced is an indication of how well the rumen is functioning (Muller *et al.*, 2007). Concentrate feeding leading to a decline in ruminal pH, alters microbial composition and diminishes fibre degradability (Muller *et al.*, 2007), affecting milk fat synthesis (Dalley, 2000).

Amaferm is a prebiotic manufactured by BioZyme ®, Inc. It is in the form of a dried fermentation extract of the fungus Aspergillus oryzae, that is freeze-dried on bran (Zhang *et al.*, 2022). Previous studies reported that Amaferm (Aspergillus oryzae fermentation product (AOFP)), contains metabolites that stimulate the fungal and bacterial activity in the rumen. This increases the growth rate and rhizoid branching of the fungi, which results in increased breakage of the lignin-hemicellulose bonds and an increase in the production of fibre degrading enzymes that break down hemicellulose and cellulose (Borneman *et al.*, 1992; Chang *et al.*, 1999; Orpin, 1977; Schmidt *et al.*, 2004; Varel *et al.*, 1993; Wubah, 2004). It also stimulates the activity of the lactate utilizing bacteria in the rumen (*Megasphaera elsdenii* and *Selenomonas ruminantium*), thereby increasing lactate uptake in the rumen (Sallam *et al.*, 2020; Nisbet & Martin, 1990). The increased activity of lactate utilizing bacteria when AOFP is fed, will assist in mitigating the post-feeding drop in ruminal pH caused by feeding concentrate (Frumholtz *et al.*, 1989; Nisbet & Martin, 1990; Van Soest *et al.*, 1991).

Cantet *et al.* (2019) carried out a meta-analysis on studies performed *in vivo*, and on total mixed ration (TMR) -based dairy systems and found that AOFP supplementation led to an increase in dry matter intake (DMI) and fat corrected milk (FCM) (0.390 kg/day and 1.028 kg/day, respectively). Supplementation of AOFP has shown potential in improving fibre degradability in various studies (Sun *et al.*, 2013; Nocek *et al.*, 2011; Chen *et al.*, 2004; Gomez-Alarcon *et al.*, 1991), but its impact varies depending on a few factors, such as the forage type and quality, supplementation level and environmental conditions. Previous research suggested that AOFP supplementation doesn't affect ruminal pH, total VFA production or the proportion of VFA in the rumen (Caton *et al.*, 1993; Gomez-Alarcon *et al.*, 1990; Higginbotham *et al.*, 2004; Sivert & Shaver, 1993a; Sievert & Shaver, 1993b; Wiedmeier *et al.*, 1987; Zhang *et al.*, 2022), although exceptions exist.

The majority of research on AOFP supplementation has been conducted on TMR systems, while research in pasture-based systems is lacking. Given the significant differences between TMR systems and pasture-based systems in terms of production dynamics, further investigation is warranted to assess the effects of AOFP supplementation in pasture-based dairy systems. Previous studies suggest that AOFP may enhance fibre degradability and promote a more stable rumen pH. If these findings hold in pasture-based systems, AOFP supplementation could potentially increase fibre degradability, leading to increased DMI and potentially more efficient milk production. The aim of this study was to determine the impact of AOFP on milk composition, milk production, rumen environment, and fibre degradability in Jersey cows grazing ryegrass/kikuyu pasture.

Materials and methods

Animals, experimental design and treatments

The trial was conducted at Outeniqua Research farm in George, South Africa. It consisted of a production study and a rumen study. The cows used in the trial, were selected from a group of 60 lactating cows, based on various parameters including milk production, milk composition (milk fat, protein, lactose, and SCC), lactation number, and days in milk. Data on these parameters were collected during a 2-week pre-trial period. Using this data and the data on previous lactations, thirty-four cows were selected (17 cows per treatment), blocked, and randomly allocated to one of two treatments for the production study. The cows were fitted with coloured ear tags to facilitate a smooth process of dividing the two treatment groups before each milking.

Treatments were as follows:

- Control: Cows received 6 kg per cow per day of a pelleted dairy concentrate (16 % CP and 12.3 MJ ME/kg DM)
- AOFP treatment – Cows received 6 kg per cow per day of a dairy concentrate (16 % CP and 12.3 MJ ME/kg DM) with AOFP: Amaferm mixed in at 500 g/tonne (3 g/cow/day).

Production study

Cows underwent a 3-week adaptation period followed by a 6-week measuring period. Cows strip-grazed kikuyu/ryegrass (ryegrass-dominant) pasture and were milked twice a day. The respective dairy concentrates were fed in the milking parlour during milking (3 kg twice a day at 06:00 and 14:00). The composition of the dairy concentrates can be seen in Table 1. Clean water was available ad libitum. The pasture strips were measured using a rising plate meter (RPM) (www.jenquip.co.nz) and 100 readings per strip were taken in a zig-zag pattern. The available pasture pre- and post-grazing was then estimated using a linear regression equation specific to the farm and season $Y = (102.99 \times H) - 260.79$ (Y = Pasture available kg DM/ha; H = Average pasture height reading on the

Table 1. Ingredients and calculated nutrient composition of the two concentrates fed at 6kg (as is) per cow per day

Parameter	Treatments[3]	
	Control	AOFP
Ingredients (kg/ton as is)[1]		
White maize fine	500	500
Soya oilcake	147	148
Bran	159	156
Hominy Chop	118	120
Molasses	40	40
Limestone	27	27
Salt	4	4
Magnesium Oxide	1.1	1.1
Vitamin premix	4	4
AOFP / Amaferm	0	0.5
Nutrient Specifications (% DM)[2]		
DM	87.7	87.7
CP	16.0	16.0
ME (MJ/kg)	12.3	12.3
NDF	16.1	16.0
Starch	46.1	46.1
Fat	3.56	3.56
Ca	1.14	1.14
P	0.50	0.50
Mg	0.46	0.46

[1]AOFP – Amaferm – *Aspergillus oryzae* fermentation product (BioZyme ®, Inc.); Vitamin premix - 4kg pre-mixed pack (Vit A: 6000000IU, Vit D: 1000000IU, Vit E: 8000IU, Mn 50g, Zn 100g, Cu 20g, I 1.7g, Se 0.3g and carrier Dolomite: 440g).
[2]DM – Dry matter; CP – Crude protein; ME – Metabolisable energy; NDF – Neutral detergent fibre; Ca – Calcium; P – Phosphor; Mg – Magnesium
[3]Control – Standard dairy concentrate; AOFP – Standard dairy concentrate with 0.5 g/kg Amaferm added.

RPM) (Van Wyngaard, 2018). The pasture allocated to the cows was continuously adapted based on the pre -and post-grazing RPM heights to reach a post-grazing height of 10-12 RPM units. Three hours after entering the paddock, the number of cows lying down, and ruminating were observed to ensure sufficient pasture was allocated.

Cows were weighed (Tru-Test Ezi-Weigh 2; serial no. 542707; ±1 % accuracy) twice on two consecutive days, at the start and the end of the trial. After weighing, body condition scoring was done by a trained technician according to the methods of Wildman et al. (1982) with a scale of 1-5, where a score of one is thin and a score of five is fat.

Pasture samples were taken once a week for the duration of the trial by randomly placing a metal ring that is 360 mm in diameter, and then cutting the grass inside the ring at a height of 30 mm above the ground. Three samples were taken each week and were placed in brown bags. After sampling, the bags were weighed and then dried in a Labcon oven at 60℃ for 72 hours. Concentrate samples were collected once a week, weighed, and dried in a Labcon oven at 60℃ for 72 hours. After the DM of the samples was determined, the samples were pooled for every two weeks. All samples were milled through a Wiley mill with a 1mm sieve at Outeniqua research farm and then stored for quality analysis. Samples were analysed in the laboratory at the Department of Animal Science, Stellenbosch University, to determine the DM (AOAC, 2002; Method 934.01), organic matter (OM; AOAC, 2002; Method 942.05), neutral detergent fibre (NDF; Goering & Van Soest, 1970), acid detergent fibre (ADF; Goering & Van Soest, 1970), crude protein (CP; AOAC, 2002), ether extract (EE; AOAC, 2002;

Method 920.39), gross energy (GE), macro and micro mineral content of the feed. Mineral analyses were done at Elsenburg according to the ALASA (1998) dry Ashing method 6.1.1.

An Afimilk management system was used in the milking parlour for accurate measurement and record-keeping of daily milk production. A 20-point Waikato / Afimilk swing-over milking machine with electronic meters was used to milk the cows. Milk samples were taken once a week during the morning and afternoon milking sessions and a composite sample with a ratio of 16 ml morning milking and 8 ml afternoon milking, was preserved with Bronolab (W-II). Milk samples were analysed for fat, protein, lactose, somatic cell count (SCC), and milk urea nitrogen (MUN).

Rumen study

For the rumen study, six rumen fistulated cows were used in a cross-over design with two treatments and two periods. A 21-day adaptation period separated each 7-day measuring period.

Rumen pH was recorded for 72 hours with TruTrack pH Data Loggers (Model pH-HR mark 4, Intech Instruments LTD, New Zealand) placed in a radiator house attached to a cannula plug, that was fitted in the cannula. This enabled measuring of rumen pH with 10-minute intervals. The pH loggers were calibrated before the first measurement period using a pH 4.0 and pH 9.0 buffer. After calibration, the pH logger was tested at a pH of 7.0.

Rumen fluid samples were collected from rumen-fistulated cows using a modified suction pump. Sampling took place at 06:00, 14:00, and 21:00. After collection, the pH of the rumen samples was measured and recorded using a WTW pH 340i meter and WTW Sentix®41 pH electrode (www.xylemanalytics.com). After collection, rumen samples were filtered through a double-layered cheesecloth into Erlenmeyer flasks. Rumen samples were then poured into air-tight containers, marked, and frozen for VFA (Siegfried et al., 1984) and rumen ammonia nitrogen (NH_3-N; Broderick & Kang, 1980) analysis.

An *in sacco* dacron bag study was carried out according to Cruywagen (2006), to estimate DM and NDF degradability of ryegrass/kikuyu pasture after 6,18, and 30 hours after incubation. The rate of NDF degradability was calculated using the Van Amburgh, et al. (2003) method.

2.4 Dry matter intake study

Pasture DMI was estimated using titanium dioxide (TiO_2) as an external marker. Ten cows per treatment (n = 10 x 2) were selected randomly and dosed with gelatine capsules containing 3 g of TiO_2 (Titanium(IV) oxide 14027; Extra pure, 99-100.5%; M = 79.87 g/mol; CAS-No: 13463-67-7; https://www.sigmaaldrich.com/life science), after each milking. Cows were dosed for 10 days and faecal samples were collected twice daily, the last 5 days of dosing. Faecal samples were dried in a draft oven at 80°C until all samples were dry. Samples were milled using a Willey mill to pass a 1 mm sieve and stored for analysis. Samples were analysed for TiO_2 concentration by Bemlab (https://www.bemlab.co.za/). The indigestible NDF (iNDF) of the concentrate, pasture, and faecal samples were determined according to the methods described by Valentine et al. (2018). Faecal excretion and pasture DMI were calculated using formulas from De Souza et al. (2015) and Cabral et al. (2014), respectively.

Statistical analysis

Production data

The two treatments were randomly assigned to 17 block replicates in a randomized complete block design. Levene's test confirmed the homogeneity of treatment variances (Levene, 1960), while the Shapiro-Wilk test (Shapiro & Wilk, 1965) validated the normality of standardized residuals. Data were analysed using the General linear model (GLM) procedure of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). The treatment effects in the model were assumed to be fixed. The blocks and the residual term error were assumed random. Least Square Means (LS means) were calculated to compare treatment means.

Rumen data

Two treatments were randomly allocated to 6 cows in a two-period crossover design with 2 sequences. Levene's test confirmed the homogeneity of treatment variances (Levene, 1960), while the Shapiro-Wilk test (Shapiro & Wilk, 1965) validated the normality of standardized residuals. Data were analysed using the General linear model (GLM) procedure of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). The treatment and period effects were assumed to be fixed, while the cow within sequences and residual term errors were assumed random. Least Square Means (LS means) were calculated to compare treatment means.

Dry matter intake data

Data were analysed as a randomized complete block design. Homogeneity of variances was confirmed with Levene's test (Levene, 1960), and normality of standardized residuals was validated using Shapiro-Wilk test (Shapiro & Wilk, 1965). Data were analysed using GLM procedure of SAS software (Version 9.4; SAS Institute Inc, Cary, USA). Treatment effects were assumed to be fixed, while blocks and the residual term error were assumed random. Least square means were calculated to compare treatment means.

Differences were deemed significant if $P \leq 0.05$, and $0.05 < P \leq 0.10$, would indicate a trend toward significance.

Results and discussion

Feed and pasture

The RPM height before and after grazing was 29.98 ± 8.706 and 11.60 ± 2.008, respectively. The pasture had an average pre-grazing yield of 2827 kg DM per hectare and a post-grazing yield of 934 kg DM per hectare. The cows removed 1893 kg DM pasture per hectare. The nutrient composition of the concentrate and pasture can be seen in Table 2. The two concentrates were formulated to have identical nutrient compositions. It is evident that the analysed chemical composition of the concentrates closely aligns with the calculated nutrient specifications with minor differences.

Body weight and BCS

Body weight change was not affected (P=0.10) by treatment. Cows on control treatment gained 36.2 kg while cows on AOFP treatment gained 28.1 kg over the trial period. The increase in body weight of cows on both treatments indicates that cows consumed sufficient feed to meet maintenance and production requirements.

Table 2. Nutrient composition of concentrate and pasture DM (%) (mean±SD) that the cows consumed during the trial

Parameter (% on DM basis)[1]	Treatments[2]		Pasture
	Control	AOFP	
DM	90.8 ± 15.6	90.4 ± 2.7	16.9 ± 10.2
Ash	7.19 ± 0.82	7.39 ± 4.16	11.0 ± 10.7
CP	15.4 ± 2.3	14.5 ± 3.5	16.3 ± 33.1
EE	3.60 ± 2.45	3.61 ± 6.17	4.56 ± 0.12
NDF	16.5 ± 31.8	17.2 ± 20.0	49.4 ± 21.8
ADF	7.51 ± 7.95	7.35 ± 12.11	34.2 ± 37.1
ME (MJ/kg DM)	12.2 ± 0.35	12.2 ± 0.01	10.6 ± 0.05
Calcium (%)	1.17 ± 0.75	1.15 ± 0.49	0.37 ± 0.527
Phosphor (%)	0.44 ± 0.065	0.44 ± 0.137	0.39 ± 0.611
Magnesium (%)	0.39 ± 0.199	0.38 ± 0.180	0.28 ± 0.331
Potassium (%)	0.99 ± 0.373	0.93 ± 0.166	3.60 ± 7.60
Sodium (%)	0.18 ± 0.173	0.18 ± 0.118	0.65 ± 3.118
Manganese (ppm)	142 ± 5	134 ± 8	46 ± 13
Copper (ppm)	28.6 ± 5	30.0 ± 4	4.6 ± 0.8
Iron (ppm)	200 ± 14	212 ± 37	118 ± 23
Zink (ppm)	172 ± 4	167 ± 5	26 ± 7

[1]DM – Dry matter; CP – Crude protein; EE – Ether extract; NDF – Neutral detergent fibre; ADF – Acid detergent fibre; ME – Metabolisable energy
[2]Control – Treatment group that received a standard dairy concentrate; AOFP – Treatment group that received a standard dairy concentrate with 0.5 g/kg Amaferm.

Table 3. Body condition (BC) and body weight (BW) of cows (n = 34) grazing ryegrass-dominant pastures during spring with or without supplementation of AOFP (Amaferm)

Parameter[1]	Treatment		SEM[2]	P-value
	Control	AOFP		
BW before (kg)	393	397	8.062	0.79
BW after (kg)	430	425	9.233	0.71
Change in BW (kg)	36.2	28.1	3.283	0.10
BCS before	2.27	2.27	0.015	1
BCS after	2.27	2.28	0.018	0.58
Change in BCS	0	0.02	0.018	0.58

[1]BW – Body weight; BCS – Body condition score (scale 1-5); BC – Body condition.
[2]SEM – standard error of the mean

Feed and pasture

The average daily milk yield and 4% fat-corrected milk (FCM) did not differ between treatments (P=0.41 and P=0.7, respectively; **Table 4**). There was a tendency (P=0.10) for a 0.23 percentage unit higher milk fat content in cows on the AOFP treatment, but no difference in milk fat yield (kg).

Milk protein and lactose content, MUN, and SCC did not differ between treatments (P>0.1). The MUN values in this study were 6.84 mg/dL on average, normal MUN levels are between 8 and 12 mg/dL, with levels below 8 mg/dL indicative of a shortage in dietary protein (Lim *et al.*, 2020; Ishler, 2023). For a Jersey cow to produce 22 kg milk per day, 16.8% CP is required (Nutrient requirements of dairy cattle: Eight revised edition, 2021). The crude protein content of the pasture grazed by the cows was 16.3%. With an average milk production of 20 kg milk per day, in cows on both treatments, the protein was not underfed. The milk protein and rumen NH_3-N levels were also in acceptable ranges (Ha & Kennelly, 1984; Wilkinson *et al.*, 2020) indicating that dietary protein was sufficient.

Rumen parameters

The diurnal pH fluctuations in the rumen-fistulated cows measured using the TruTrack pH data loggers can be seen in Figure 1. The black arrow indicates the time of concentrate consumption in the milking

Table 3. Body condition (BC) and body weight (BW) of cows (n = 34) grazing ryegrass-dominant pastures during spring with or without supplementation of AOFP (Amaferm)

Parameter[1]	Treatment		SEM[2]	P-value[3]
	Control	AOFP		
Milk yield (kg/cow/day)	20.9	20.4	0.403	0.41
4% FCM (kg/cow/day)	24.1	24.3	0.423	0.70
ECM (kg/cow/day)	26.1	26.2	0.422	0.85
Milk fat (%)	5.06	5.29	0.097	0.10
Milk protein (%)	4.03	4.04	0.042	0.85
Milk lactose (%)	4.78	4.80	0.036	0.74
MUN (mg/dL)	6.93	6.75	0.265	0.64
SCC (x 1000/mL)	116	105	32.646	0.81

[1]FCM – Fat-corrected milk; ECM – Energy-corrected milk; MUN – Milk urea nitrogen; SCC – Somatic cell count.
[2]SEM – standard error of the mean
[3]P-value - P ≤ 0.05 = significant difference; P > 0.05 = no significant difference

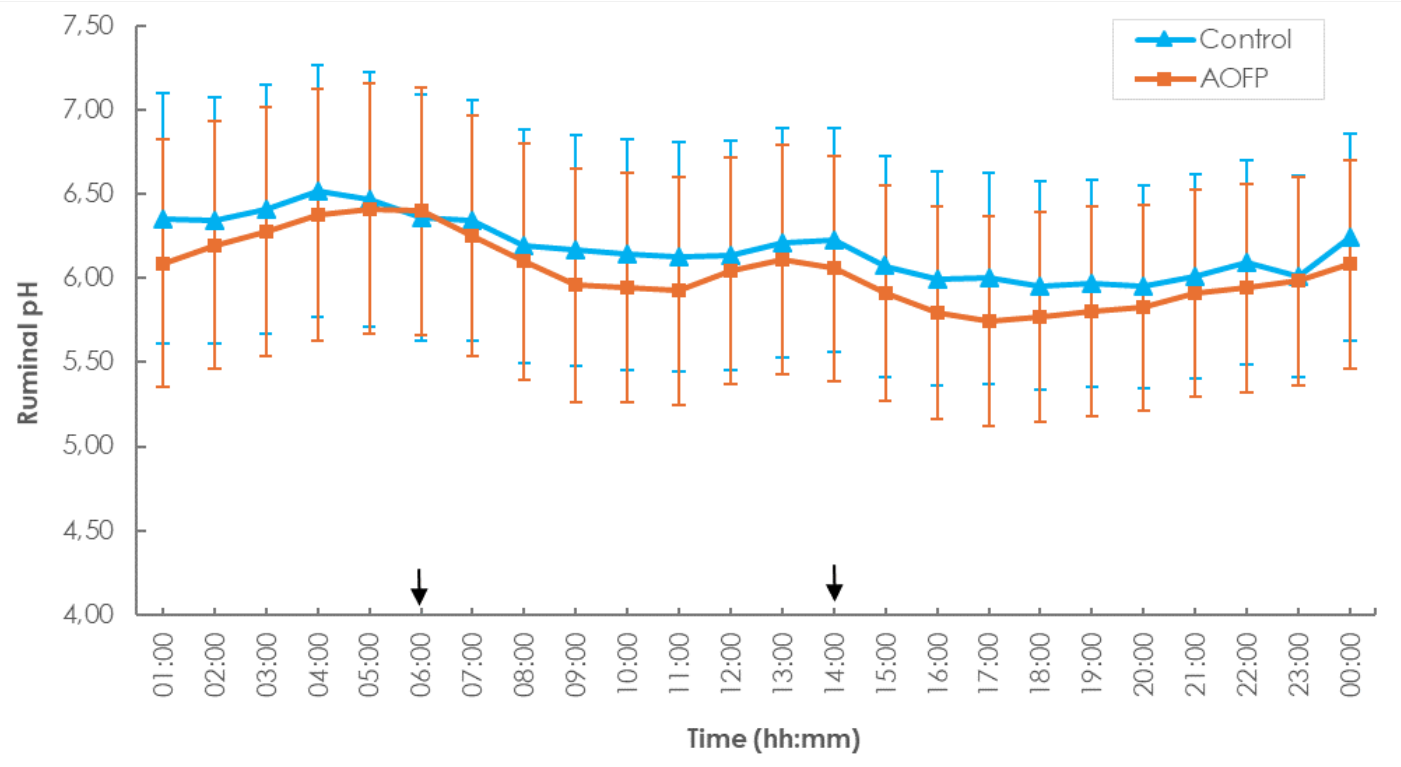

Figure 1. Diurnal fluctuations in ruminal pH of cows (n = 2 x 3) grazing ryegrass-dominant pasture in spring, with or without AOFP supplementation. Error bars represent the SEM.

parlour. A decline in rumen pH can be seen after concentrate consumption. Rumen pH reaches its lowest point in the late afternoon, increasing again after 20:00.

The average rumen pH over 24h was lower (P=0.05) for cows on the AOFP treatment at pH 6.10 compared to pH 6.18 for cows on the control treatment (Table 5). The rumen pH remained within the optimal range for rumen function and did not have a biological impact on the rumen environment.

The VFA concentrations align with what is typically found in pasture-based dairy cows (Bargo et al., 2003). Treatment did not affect VFA concentrations or the acetate-to-propionate ratio (P > 0.05; Table 6). Rumen NH_3-N concentrations were in an optimal range for microbial function (Bargo et al., 2003) and did not differ between treatments (P=0.18; Table 6).

Table 5. Average ruminal pH values measured with a TruTrack data logger and time spent below a specific pH (5.8; 6; 6.2) in Jersey cows (n = 2 x 3) grazing ryegrass-dominant pasture with or without AOFP supplementation

Parameter[1]	Treatment		SEM[2]	P-value[3]
	Control	AOFP		
Average logger pH (24 hours)	6.18	6.10	0.222	0.05
pH 1 hour after milking				
07:30	6.30	6.28	0.037	0.70
15:30	6.05	5.94	0.042	0.14
Time below (h)				
pH 5.8	1.50	4.75	1.630	0.23
pH 6	4.08	8.33	1.275	0.08
pH 6.2	9.45	13.3	0.969	0.05

[1]Time below – the hours that the pH was below a certain level in 24 hours
[2]SEM – standard error of the mean
[3]P-value - P ≤ 0.05 = significant difference; P > 0.05 = no significant difference)

Table 6. Ruminal VFA concentrations (mmol/L) and rumen ammonia-nitrogen (NH3-N) concentrations (mg/dL) of rumen fistulated Jersey cows (n = 3 x 2) with or without AOFP supplementation

Parameter[1]	Treatment		SEM[2]	P-value[3]
	Control	AOFP		
Total VFA (mmol/L)	111.2	111.3	3.721	0.98
Acetate : Propionate	4.45	4.24	0.077	0.12
Acetate (mmol/L)	80.96	80.34	2.570	0.87
Propionate (mmol/L)	18.28	19.06	0.832	0.55
Butyrate (mmol/L)	9.07	8.94	0.198	0.66
Isobutyrate (mmol/L)	0.89	0.87	0.064	0.81
Valerate (mmol/L)	1.35	1.46	0.072	0.35
Iso-Valerate (mmol/L)	0.66	0.65	0.038	0.93
NH_3-N (mg/dL)	11.4	9.94	0.631	0.18

[1]VFA – Volatile fatty acids; NH_3-N – Ammonia Nitrogen
[2]SEM – standard error of the mean
[3]P-value - P ≤ 0.05 = significant difference; P > 0.05 = no significant difference

Table 7. Average percentage (%) of dry matter and neutral detergent fibre degradability of pasture at 6, 18, and 30 hours of incubation and the rate of neutral detergent fibre degradability in rumen fistulated Jersey cows (n = 6) with or without AOFP supplementation.

Parameter [1]	Treatment		SEM[2]	P-value[3]
	Control	AOFP		
DMd				
6 h	47.9	48.1	1.06	0.91
18 h	66.5	66.8	1.63	0.90
30 h	81.5	81.4	0.51	0.85
NDF degradability				
6 h	23.1	24.2	1.71	0.62
18 h	48.2	49.3	2.30	0.77
30 h	70.8	70.5	0.91	0.82
NDF k_d[2] (%/h)	4.36	4.39	0.148	0.88

[1] DMd – dry matter degradability; NDF – Neutral detergent fibre; NDF k_d[2] – Rate of neutral detergent fibre degradation (%/h)
[2]SEM – standard error of the mean
[3]P-value - P ≤ 0.05 = significant difference; P > 0.05 = no significant difference

Dry matter intake

The pasture DMI, total DMI, and DMI as a percentage of body weight of cows on the control and AOFP treatment are presented in **Table 8**. The average daily pasture (P=0.17) and total DMI (P=0.17) did not differ between treatments. The daily pasture intake was 7.42 kg per cow for cows on the control and 8.78 kg per cow for cows on the AOFP treatment. Total daily DMI was 12.9 kg per cow for cows on the control, and 14.2 kg per cow for cows on AOFP treatment. The RPM calculations estimated pasture intake to be 10.7 kg DM per cow per day, and the TiO2 method estimated pasture intake to be 8.1 kg DM per cow per day. Cows consumed 3.2 % DMI per kg BW, aligning with that reported by Bangani *et al.* (2023) for grazing Jersey cows. In contrast to a study conducted by Caton *et al.* (1993), supplementing AOFP did not alter pasture or total DMI.

Table 8. The dry matter intake of Jersey cows (n = 10x2) grazing ryegrass-dominant pasture during Spring.

Parameter[1]	Treatment		SEM[2]	P-value[3]
	Control	AOFP		
Daily faecal output (kg/cow)	2.98	2.92	0.152	0.79
Daily pasture DMI (kg/cow)	7.42	8.78	0.642	0.17
Daily total DMI (kg/cow)	12.9	14.2	0.642	0.17
DMI as % BW	2.97	3.33	0.166	0.16

[1]BW – Body weight; DMI – Dry matter intake
[2]SEM – standard error of the mean
[3]P-value - $P \leq 0.05$ = significant difference; $P > 0.05$ = no significant difference

Conclusion

Supplementation of AOFP at 3 g per cow per day to Jersey cows grazing ryegrass-dominant pasture in spring, did not affect milk production but tended to increase milk fat content. The VFA concentrations, NH_3-N levels, DM and NDF degradability, and DMI were unaffected by AOFP supplementation. Although the rumen pH was lower for the AOFP-supplemented cows, it did not compromise rumen function. It is possible that AOFP supplementation would have a more pronounced effect if the rumen were under greater pressure, such as when high amounts of fermentable carbohydrates are included in the diet, resulting in lower rumen pH. The effect of AOFP on dairy cows varies in the literature, suggesting that various factors, such as the type of system (TMR or pasture-based), pasture type and quality, the level of supplementary feeding, and the composition of the concentrate, may influence the results.

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Update on Foot and Mouth Disease in South Africa

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Introduction

Foot and Mouth Disease (FMD) is a highly contagious disease caused by a virus of the family Picornaviridae, genus *Aphthovirus*. The virus causes blisters and sores in the mouth and on the feet and teats causing difficulty in eating and walking as well as leading to mastitis. Virus is excreted by saliva, urine, faeces and milk and can be spread by direct and indirect contact. This disease mainly affects cattle, pigs, sheep and goats, with an incubation period of 14 days. FMD is a listed disease with the World Organisation for Animal Health and has major trade implications.

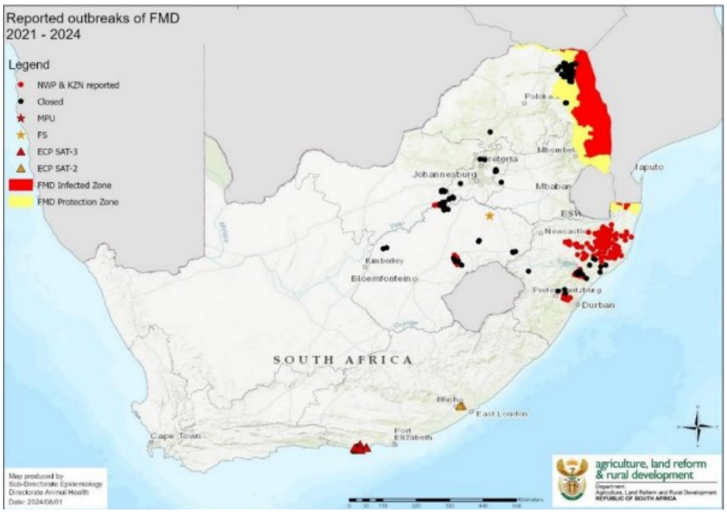
In South Africa only the Southern African Territories serotypes occur (SAT 1, 2 & 3), in other parts of the world other serotypes occur namely A, O, C & Asia 1. FMD is a state controlled disease in terms of the Animal Diseases Act, 1984 (Act 35 of 1984) in South Africa with prescribed control measures for susceptible, contact and infected animals.

History

Prior to January 2019 South Africa had a FMD free zone without vaccination and the FMD infected zone was limited to areas with FMD carrier buffalo.

From 2019 to 2021 three FMD outbreak events occurred in the previously FMD free zone in Limpopo province which were resolved.

May 2021 an outbreak event was reported in KwaZulu-Natal with a SAT 2 virus closely related to a virus found in Limpopo in 2019. There was considerable spread, including to buffalo in Hluhluwe-iMfolozi Park and to Free State.



March 2022 saw an outbreak event in North West that spread to Gauteng, Free State and Mpumalanga, caused by a SAT 3 virus that also caused an outbreak in Vhembe, Limpopo in April 2022.

A national cattle standstill was implemented from 18 August to 8 September 2022 to halt the spread of the virus.

Current situation

- Northern and Western Cape remain free from FMD to date
- Gauteng is regarded as free from FMD as from 13 March 2024
- Limpopo has resolved all FMD outbreaks as of 29 August 2023, but a Disease management area (DMA) remains.
- Mpumalanga has resolved all outbreaks in the previous FMD free zone as of 26 June 2023
- North West is regarded as free from FMD as from 5 March 2024.

- Free State has remaining unresolved outbreaks on commercial breeding herds and stud farms with no evidence of circulating virus with the last reported outbreak on 7 February 2024. DMA was repealed on 8 September 2022.
- KZN unresolved outbreaks remain in communal dip tanks and small-scale farmers, with 5 game reserves affected with the last reported outbreak on 4 July 2024. DMA remains.
- In all outbreaks, mainly cattle have been affected and the role of other cloven-hoofed animals is still being investigated.

Eastern Cape

On 2 May 2024, the first outbreak of FMD was reported in the Humansdorp area of the Eastern Cape and found to be caused by the same SAT 3 virus that caused the multi-province outbreak. Thus far 32 farms have tested positive, these farms have been vaccinated and permission was granted to preventatively vaccinate cattle on a further 37 farms in the area. The last outbreak was reported on 9 July 2024. A disease management area was declared in this area. On 30 May 2024 another outbreak was reported in East London, both a SAT 2 and SAT 3 virus was recovered from this outbreak. So far only two farms have been affected and it seems not to have spread.

Control measures

Control measures consist of movement control, vaccination and controlled slaughter. Resolution of the outbreaks are done following depopulation and disinfection or negative testing 12 months after the outbreak (or vaccination).

Farms within 10km from a positive farm can apply for vaccination but vaccinated farms will be regarded as FMD positive and will thus effectively be placed under quarantine. This means they will need a state vet permit for any movement off the farm and within the first 6 months will only be allowed to slaughter at designated abattoirs and milk will need to be double pasteurized or UHT and may not be exported. Vaccinated farms can still become infected and immunity only lasts approximately 4 to 6 months, thus biosecurity remains crucial.

Biosecurity

Biosecurity measures should include demarcating a biosecure area and only allowing the entry of healthy animals, safe feed and decontaminated vehicles, equipment and personnel.

During the 14 day incubation period animals can spread the virus without showing clinical signs and thus any movements unto farms should be kept to an absolute minimum during this precarious time.

The FMD virus can be inactivated by temperature treatments or by pH treatment. For disinfection, it is important to know whether the active ingredient is effective against the FMD virus, what concentration is effective and what contact time is needed. Furthermore, it is important that organic material (such as mud etc) be first removed, as most disinfectants are not effective in penetrating organic material.

Conclusions

Responsibilities of animal and land owners in terms of the Animal Diseases Act, 1984 (Act 35 of 1984) include that all reasonable steps need to be taken to prevent infection of an animal, to prevent spread of a disease, report any suspicion of a controlled animal disease and if infected, to eradicate the disease.

There is a great risk of FMD introduction to the Western Cape, which would be catastrophic as it endangers food security, trade, jobs and the mental well-being of farmers having to deal with the devastation and experience the loss. It is thus of the utmost importance that all sectors work together to prevent entry of this disease into the Western Cape.