OUTENIQUA RESEARCH FARM INFORMATION DAY 2023

MILK PRODUCTION FROM PASTURES

PRESENTED BY THE DIRECTORATES PLANT AND ANIMAL SCIENCE

Western Cape Government
FOR YOU

info@elsenburg.com | www.elsenburg.com |
#ForTheLoveOfAgriculture

Contents

Western Cape Government

FOR YOU

Agriculture

INFORMATION DAY

OUTENIQUA RESEARCH FARM

MILK PRODUCTION FROM PLANTED PASTURE

Wednesday, 20 September 2023

Research and Technology Development Services
Western Cape Department of Agriculture, Outeniqua Research Farm, George

Program Director: Dr Chris de Brouwer (Acting Chief Director: Research and Technology Development Services)

08:00-09:00	Registration and viewing of exhibits	
09:00-09:10	Scripture reading and prayer	
09:10-09:15	**Welcoming: Dr Chris de Brouwer**	
09:15-09:30	Measuring forage herbs-keeping it simple	Janke van der Colf
09:30-9:50	Comparing spring-planted to autumn-planted Italian ryegrass – are different planting dates an option?	Sigrun Ammann
09:50-10:10	Tall fescue as a dairy pasture in comparison with perennial ryegrass – production, flowering and forage quality	Sigrun Ammann
10:10-10:25	Effect of Virginiamycin on milk production	Robin Meeske
10:25-10:40	Moringa oleifera as feed supplement to dairy cows	Robin Meeske
10:40-10:55	Outeniqua beef production system	Bertus Myburgh
10:55-11:00	New forage herb project: mixing it up with mixtures and renovation strategies	Janke van der Colf
11:00-11:05	Concluding remarks	
11:00-11:30	**Tea**	
Practical Visits	Cultivar trials: Tall fescue, Red clover(persistent types), Ryegrass, Cocksfoot	Sigrun Ammann
	Pasture mixes with forage herbs	Janke van der Colf
	Increased pasture intake study with plantain	Muller Cronje
	Feed additive study : Amaferm	Cherise Basson
	Beef cow herd with calves	Bertus Myburgh
13:00	**Lunch**	

For more information contact
Hennie Gerber at 044-8033723/7 or
E-mail enquiries to
Janke.vandercolf@westerncape.gov.za

Preface

The Outeniqua Research Farm is celebrating 70 years' service to the agricultural sector during 2023, having been established in 1953. Over the years various farming commodities were studied and researched, from sheep farming, including the establishment of the SA Mutton Merino and the Dormer breeds together with the work conducted at Elsenburg, through the evaluation of cultivars of various crops, including wheat and vegetables to where it is today, a research farm dedicated primarily to the research of dairy production from cultivated pastures and the accompanying research into varieties of pasture crops in support of profitable dairy production under irrigated grazing. We are also excited to share some beef cattle observation studies' results and it is believed that significant useful information will be forthcoming from this work in the fattening of beef cattle from pastures.

The annual Outeniqua Information Days have become a beacon of information sharing about the research being conducted and the results being achieved, all in support of milk production from pastures for big and small scale milk producers alike. The global Covid pandemic of 2022 lead to innovative solutions to the challenges of remaining engaged with the farming community, communicating and conveying new information as soon as possible in the competitive world of milk production. The first "virtual" or online information day was hosted during 2020 and it was very successful and the same formula was again used during 2021. It was decided that the personal interaction between researcher and producer remains crucial and so the 2022 information day was live again. However, the online stream was maintained and the audience both on the day and subsequently online continued to grow through this "hybrid" approach, reaching beyond the borders of the Western Cape while attracting visitors from the Eastern Cape and Northern Cape. The benefit of the online version is that it can also be accessed after the event and serve as a reference and a repository of useful information, presented by the researchers who did the work and have a good understanding of the results and how to use them in practice.

For the 2023 version of the information day the department is doing away with hard copies of the proceedings of the day and have, instead, further embraced the possibilities of technology in making the proceedings available through a QR code. They have also gone back into previous information days' presentations and digitized those in a similar way. One can say it is now possible to carry a library of Outeniqua Information Days' presentations in your pocket via your smartphone for easy access and reference!

The Western Cape Department of Agriculture is committed to do research that is focused on the needs of the agricultural producers in the province and beyond. To this end information days such as the one presented today is, and will always remain, a very vital aspect of research where researchers and producers meet personally, interact and have the opportunity to discuss the challenges and opportunities in the farming sector, ensuring research is focused and relevant in support of efficient and profitable production.

We are very happy to see you all at the 2023 Outeniqua Research Farm for the annual Information Day and I trust you will enjoy the day with us while taking home information to assist with keeping pasture-based dairy farming profitable. We look forward to the next 70 years of focused and relevant research in support of agricultural production!

Dr. Chris de Brouwer

Chief Director: Research and Technology Development Services (Acting)

CONTACT DETAILS

Chris de Brouwer
Acting Chief Director: Research and Technology Development Services
Department of Agriculture
Western Cape Government
Tel: (021) 808 5220 Cell no: 082 3398547
Chris.DeBrouwer@westerncape.gov.za

Prof Robin Meeske
Specialist Scientist: Animal Science
Directorate Animal Science
Department of Agriculture
Western Cape Government
Tel: 044 803 3708 Cell no: 082 908 4110
Robin.Meeske@westerncape.gov.za

Sigrun Ammann
Scientist: Pastures
Directorate Plant Science
Department of Agriculture
Western Cape Government
Tel: 044 803 3726 Cell no: 082 775 8836
Sigrun.Ammann@westerncape.gov.za

Janke van der Colf
Scientist: Pasture Systems
Directorate Plant Science
Department of Agriculture
Western Cape Government
Tel: 044 803 3716 Cell no: 082 774 9164
Janke.VanDerColf@westerncape.gov.za

CONTACT DETAILS

Dalena Lombard
Scientific technician
Directorate Plant Sciences
Department of Agriculture
Western Cape Government
Tel: (044) 803 3729 Cell no: 073 307 4287
Dalena.Lombard@westerncape.gov.za

Lethu Zulu
Scientific technician
Directorate Plant Sciences
Department of Agriculture
Western Cape Government
Tel: (044) 803 3714 Cell no: 083 673 9765
Lethu.Zulu@westerncape.gov.za

Bertus Myburgh
Scientific technician
Directorate Animal Sciences
Department of Agriculture
Western Cape Government
Tel: (044) 803 3706 Cell no: 082 254 8369
Bertus.Myburgh@westerncape.gov.za

Pieter Cronje
Scientific technician
Directorate Animal Sciences
Department of Agriculture
Western Cape Government
Tel: (044) 803 3737 Cell no: 082 392 3612
Pieter.Cronje@westerncape.gov.za

Measuring forage herbs with the rising plate meter– keep it simple

J van der Colf, SB Ammann, R Meeske, LB Zulu, D Lombard

Western Cape Department of Agriculture, Research and Technology Development, Directorate Plant Sciences, Outeniqua Research Farm, P.O. Box 24, George 6530

Janke.vandercolf@westerncape.gov.za

Pasture measurement: define your goals

Articles on the rising plate meter, and on pasture measurement in general, often start out with stating why it is important to measure pastures. **A better question, however, is what the producer or manager is hoping to achieve through pasture measurement.** This speaks particularly to the debate around accuracy vs. simplicity vs. efficiency- and which should be prioritized at the end of the day.

Accuracy versus simplicity

Although accuracy is often the main focus for pasture based research, simplicity and efficiency are a much stronger consideration for commercial producers.

Efficiency relates to how equipment, labor and time costs of measuring pasture, balance out with the benefits, such as a clear data based decision processes and profitability, achieved thereby. For example a rapid, relatively cheap method with a known error (such as the rising plate meter) may be a better option than a highly accurate labour intensive method (such as cutting of quadrats). Scale is also a major consideration, with large commercial enterprises often opting for new satellite imaging software, . These producers understand that accuracy may be subjective with the imaging, software cost may be quite high, but against labour cost is dramatically lowered.

Simplicity refers to both the apparatus itself (training and technical expertise required) and how the results are interpreted. With indirect pasture measurement methods, the coinciding calibration equation selected (and how it has to be changed to adapt to seasonal effects and pasture type) is another major factor that can affect the perceived simplicity of the RPM as a measurement method. In some cases over-complicating calibration equations and data interpretation can reduce the simplicity and eventual implementation of pasture measurement on farm. For this reason, the measurement method, including the calibration equation used, should aim to achieve a balance between accuracy and simplicity. This balance, in turn, is based on how you opt to implement pasture measurement data within your pasture based enterprise.

How are you using pasture measurement on your farm?

Pasture allocation

The first purpose of pasture measurement is to assist in more accurately allocating pastures to animals. In this regard, producers are usually focused on preventing under-allocation of pasture ,as it often has a major and immediate impact on milk yield. However, a longer term impact of under allocation, which is often ignored, is that low residuals will eventually deplete plant reserves. This will result in poor persistence and yield decline of pastures in the long run.

But what about over-allocation? With a strong focus on maintaining high milk yields, this is actually a more common occurrence than under-allocation. However, if pasture residuals are continuously too high after grazing, it will eventually lead to a deterioration in forage quality and lower milk yields. Although mowing is often employed to rectify this issue, it should be used strategically and not become a staple in your management system. The reason is two pronged. Your cow is the most efficient and cost effective method of pasture harvest, with mowers incurring an additional cost in terms of fuel, machine maintenance and labor. In addition, mowing regrowth because you cannot get in quick enough after grazing can affect pasture recovery and persistence. The second reason to use mowing prudently is that you are removing unutilised pasture for which you have already incurred a production cost (nitrogen and water).

When using pasture measurement for pasture allocation, a continuous change in calibration equations could result in you simply chasing your tail the whole time. A more practical approach would be to adapt the allocation per animal (kg/cow/day) based on a combination visual assessment of residuals after each grazing event and how milk yield is affected. For example if milk yield drops dramatically, increase allocation and if residuals are too high, reduce allocation.

Fodder-flow planning

We have all heard the old adage: "You cannot manage what you don't measure", but for pastures it should be rephrased to "You cannot TIMEOUSLY manage what you don't measure". A weekly pasture walk is the most effective way to ensure you are taking the right feed budgeting decisions, namely when you are entering periods of pasture deficit or surplus, pro-actively. On farms where the pasture base is also used for feed conservation (grass silage), this is particularly important to ensure silage is cut early enough to ensure good quality silage and limit wastage. Various approaches are available to aid in this decision making process, such as calculating stock days, pasture wedges and comparing current growth to required growth rates. Although the discussion of these methods is beyond the scope of this paper, they all require an accurate estimation of pasture yield to determine what the balance is between pasture supply and demand.

It is common knowledge that changes in botanical composition and sward structure can affect the calibration equation. However, if changes to the calibration equations are made too frequently, it can result in the continuity of data being reduced on a weekly, seasonal and even annual basis. It is thus a good idea to have a set decision making process in place of when calibration equations are to be adapted. For example it may be based on pasture composition (for example if pasture changes from grass to forage herb dominant) or structure (vegetative to reproductive).

When to graze or cut

The one aspect where the determination of pasture yield should not inform the decision making process, is <u>when</u> a particular paddock should be cut or grazed.

Although feed wedges have become a popular method in this regard, it should be noted that the feed wedge simply ranks paddocks in terms of yield, **<u>NOT</u>** the physiological growth stage. In other words, any aspect negatively impacting the yielding ability of a pasture (for example soil nutrient deficiencies or drought) can incorrectly rank that paddock in your feed wedge for grazing or cutting. For the same reason, pre-grazing target yields are also not suited for this purpose. Leaf emergence rate and leaf number (for grasses) are much more appropriate decision making tools for rotation lengths.

Using the rising plate meter for pasture measurement

The advantages associated with using the RPM for the estimation of pasture DM yield include its robustness, relatively low cost, ease of use, low sensitivity to environmental conditions, the stability of calibration equations across years and seasons (if pasture composition remains similar) and the fact that it is relatively operator friendly, allowing a large number of readings to be taken in a short period of time (Earle and McGowan 1979, Michel 1982, Fulkerson and Slack 1993, Douglas and Crawford 1994, Martin et al. 2005).

The rising plate measures compressed pasture height in "clicks", with each click equaling 0.5 cm. The average measured RPM height is then "plugged" into a calibration equation to calculate the pasture yield (kg DM/ha) at the coinciding height. So are we just measuring pasture height? Technically no– since settling height is also a function of the pasture's ability to withstand compression when a force is placed upon it (Harmoney et al. 1997), and as such anything that affects this compressibility. And this is what the calibration equation should take into account, being adapted to take into account changes in the relationship between RPM readings and the corresponding yield. **Some of these factors that can affect the calibration equation include:**

- Pasture dry matter content, particularly as affected by fiber content. This is one of the primary reasons we often see different seasonal calibrations being recommended as plants transition from vegetative growth to reproductive growth. In reproductive pasture in particular, producers will often find that accuracy of non seasonal equations is reduced.
- Structure of the pasture plants, as it affects how the plate "sits" on the pasture due to density and rigidity of the sward. In general homogenous, dense swards (like plantain and ryegrass monocultures) are easier to measure accurately than stemmy/sparse swards (like lucerne hay swards).
- Botanical composition is a major driver of the change in calibration equations, as it impacts on the vertical structure of the pasture. Also note that in highly heterogeneous pasture mixtures, accuracy can be negatively impacted.
- As mentioned, heterogeneity is a major challenge when trying to accurately measure pasture. According to Murphy et al. (2021) some factors that can further increase heterogeneity and reduce accuracy of calibration equations, above and beyond species composition, and include low N rates, urine and manure patches (on grazed pastures), accumulation of dead material and drought.

So how should one then select the correct RPM calibration if there are so many factors affecting the relationship between pasture height and pasture yield? This question has been debated many times, both by researchers and producers. Recently the debate becoming even greater in the southern Cape of South Africa as complex pasture mixtures containing forage herbs, grasses and legumes have become popular. **The aim of this paper is thus to evaluate RPM calibration equations developed on the Outeniqua Research Farm for forage herb mixtures in terms of accuracy and simplicity.** Specifically, we want to determine if generalized equations can be applied across the myriad of iterations (species combinations) that are seen across farms of these forage herb based mixtures.

Data collection

Farmlet study

From April 2019 to May 2022 a farmlet study was undertaken on the Outeniqua Research Farm to evaluate the whole system production potential of four pasture types viz.:

1. **Kikuyu-ryegrass** (kikuyu over-sown with ryegrass on an annual basis.
2. **Monoculture system:** Plantain (*Plantago lanceolata*) and Tall Fescue (*Festuca arundinacea*) established as monocultures, but grazed within one system.
3. **Plantain based mixture:** A mixture of plantain, Tall Fescue and red clover (*Trifolium pretense*).
4. **Chicory based mixture:** A mixture of chicory (*Chicorium intybus*), Lucerne (*Medicago sativa*) and perennial ryegrass (*Lolium perenne*). (This treatment was only included in year 2 [2020] of the study).

The full details of the farmlet study in terms of grazing management, establishment methods and production data can be found in van der Colf et al. 2022. For the purposes of this paper, we will focus on the latter two mixtures.

Calibration cuts

During the study, calibration cuts for the RPM were taken on monitor strips (approximately nine per pasture type) before grazing or cutting silage throughout the study.

At each cut, the height of the pasture was measured with the RPM at a specific point, a ring of the same size as the RPM plate (0.098m^2) placed over the RPM and all DM within the ring borders cut (t'Mannetjie 2000) to a height of 50 mm. Three samples were cut at a sward height estimated by the operator as low, medium and high, respectively, within each of the 3 sub-plots in a monitor strip per harvest.

Development of different calibration equations

For the purposes of this paper, only linear regressions were evaluated. It has been noted that linear calibration equations, although not always the best fit in terms of accuracy (based on R^2), remain the

Table 1. Methodology for pooling calibration cuts to develop generalised calibration equations

Calibration name	Pooled	Number of equations	Application		
			Species specific	Season specific	Annually
Plantain based_seasonal	Within season	12	x	x	x
Chicory based_seasonal	Within season	7	x	x	x
Forage herb_Seasonal	Across mixtures within season	12		x	x
Plantain based_Annual	Across seasons within mixture	3	x		x
Chicory based_Annual	Across season within mixture	3	x		x
Forage herb based_Annual	Across seasons and mixtures	3			x
plantain based_All	Across years within mixture	1	x		
Chicory based_All	Across years and mixture	1	x		
Fforage herb_All	Across years and mixtures (all data)	1			

simplest and most practical form for producers and when doing weekly walks.

For pasture based research purposes, it is recommended that, at a minimum, calibration equations be developed on a seasonal basis to maximize accuracy. That equated to 12 equations for the plantain based and 7 equations for the chicory based pasture type during the three year period.

It is these seasonal, mixture specific equations that will be viewed as the "gold standard" of calibration equations in this article. All other equation will be compared to it when evaluating accuracy.

In order to simplify calibration equations for application on commercial farms, data was progressively pooled across seasons (Annual), years (All data) and mixtures (Forage Herbs), until one generalized forage herb equation was developed. The pooling methodology for calibration data is shown in Table 1. The basic premise was to reduce calibration equations from 19 for the two pasture types on a seasonal basis to one equation that can be applied across seasons and mixture types.

Comparison of calibration equations

In general, calibration equations are compared in terms of the statistics connected to the equation itself . For example the R^2 - an indication of how much of the variability in yield is explained by a change in RPM height (Bransby and Tainton 1977) is often used to determine the "accuracy" of a calibration equation.

However, the farmlet study, where pre-grazing height was intensively measured, provided the opportunity to determine how different calibration equations would affect predicted pasture yield on a monthly basis in real terms. The importance of this is that pre-grazing pasture height will also vary on a seasonal basis– which can affect the degree to which a calibration equation under- or over-predicts pasture yield within season (Murphy et al. 2021).

The plantain based and chicory based mixture consisted 28 and 26 grazing strips respectively, which were each dived into three subplots (front, middle and back) for RPM measurement. Pre- and post-graze RPM height was determined by tasking approximately 40 RPM readings (plonks) per subplot. The pre- and post-grazing heights for the mixtures taken during the study are shown in are shown in Figure 1 and Figure 2. The pre-grazing pasture heights were then used to calculate the mean pre-grazing pasture yield above 5 cm for the two mixtures over the three years on a monthly basis. This process was repeated for all the different calibration equations listed in Table 1.

Botanical composition

Botanical composition will be estimated by placing three 0.098 m^2 rings randomly within a sub-plot on monitor strips 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 various fractions. For this paper, fractions will be described as grasses, forage herbs, legumes and broadleaf weeds.

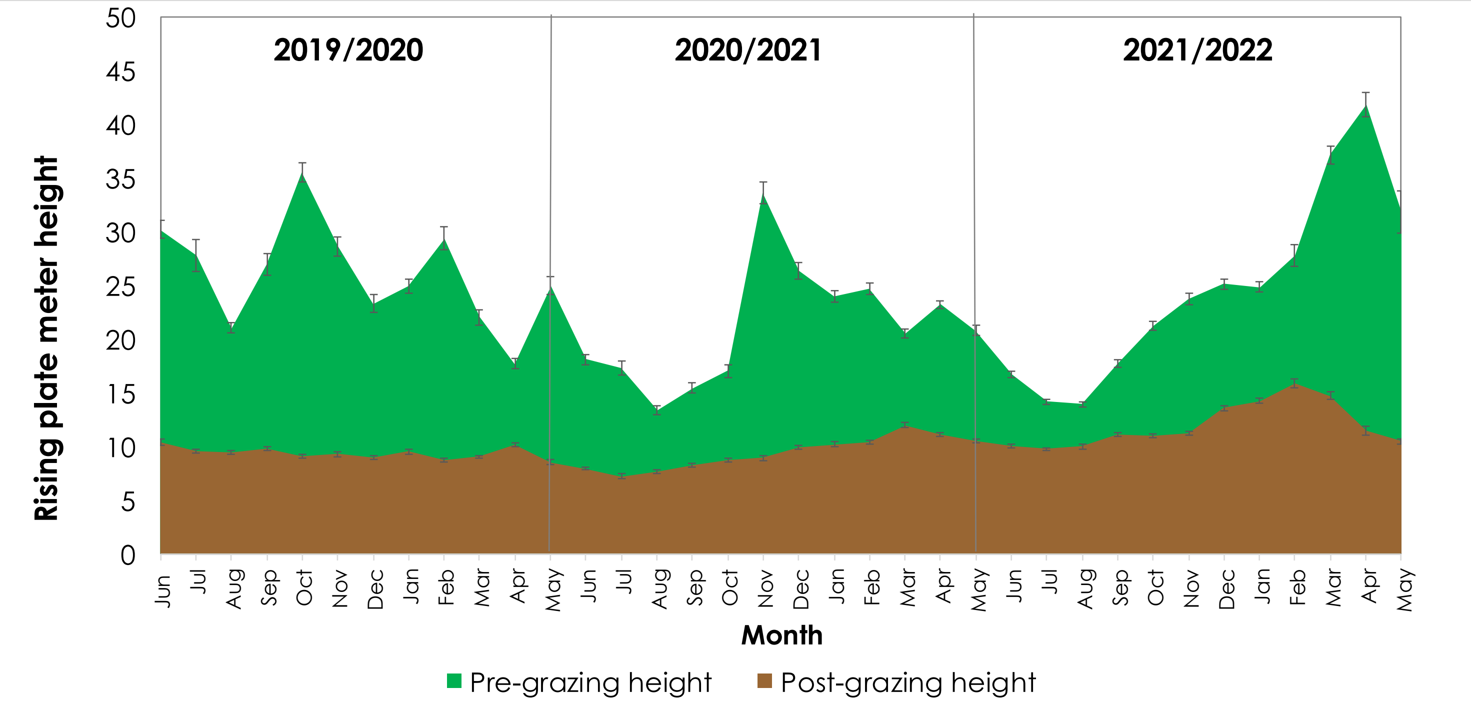


Figure 1. Mean monthly pre- and post-grazing rising plate meter heights for the **plantain based** mixture during the three year study period.

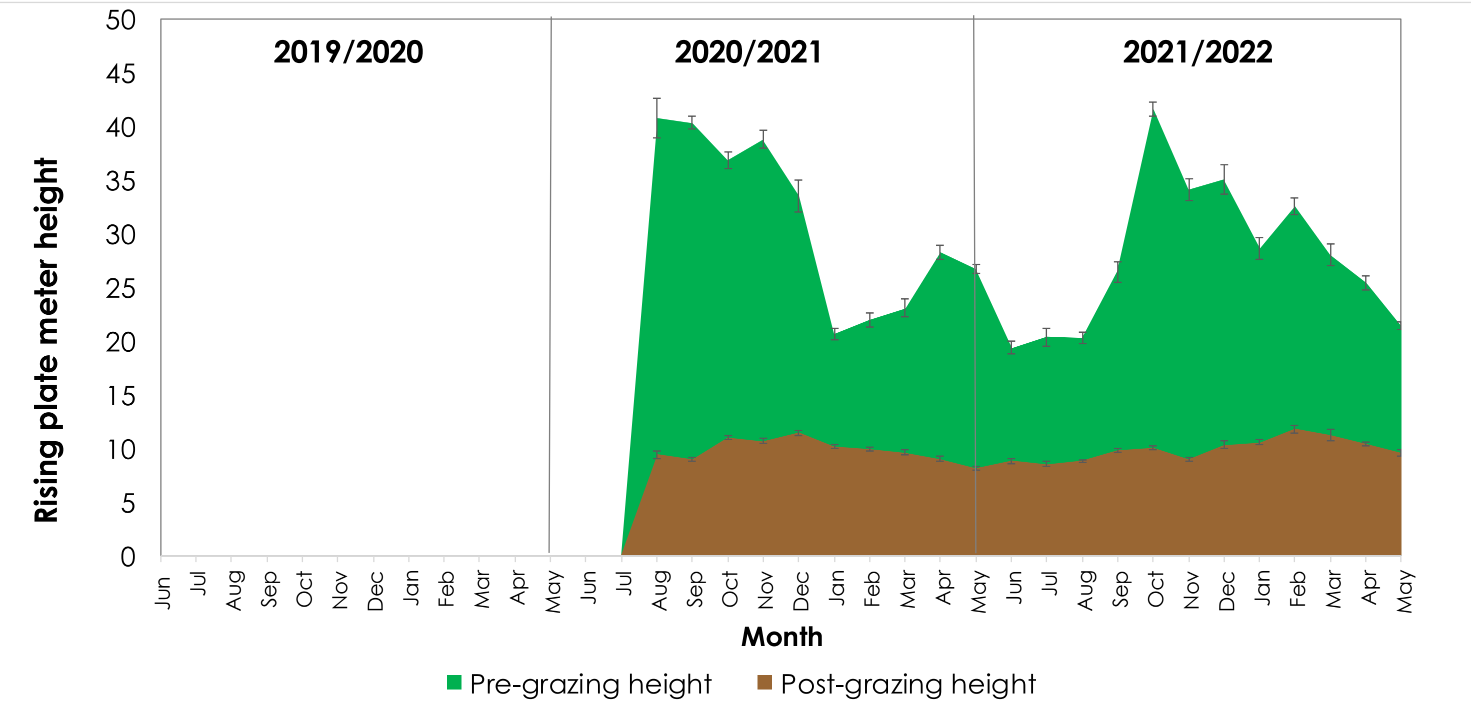


Figure 2. Mean monthly pre- and post-grazing rising plate meter heights for the **chicory based** mixture during the three year study period.

Results

Table 2. Calibration equations developed from farmlet study data for different pasture types , seasons and years during the study period.

Pasture type	Year	Season	Multiplier	Constant	R^2	Samples
Plantain based	1	Winter	50	+86	0.67	342
		Spring	56	+181	0.63	360
		Summer	52	+154	0.68	414
		Autumn	58	-181	0.73	180
		Annual	**54**	**+72**	**0.66**	**1296**
	2	Winter	70	-185	0.73	356
		Spring	76	-341	0.73	432
		Summer	73	-352	0.66	376
		Autumn	63	-291	0.77	357
		Annual	**71**	**-311**	**0.72**	**1519**
	3	Winter	79	-580	0.74	339
		Spring	75	-472	0.81	499
		Summer	80	-349	0.68	305
		Autumn	64	-79	0.68	251
		Annual	**74**	**-391**	**0.75**	**1394**
		All data	**67**	**-281**	**0.70**	**4209**
Chicory based	1	Winter				
		Spring	60	+128	0.41	281
		Summer	54	+128	0.55	427
		Autumn	41	+319	0.54	395
		Annual	**52**	**+163**	**0.49**	**1103**
	2	Winter	69	-339	0.77	284
		Spring	63	-380	0.67	342
		Summer	53	+269	0.46	304
		Autumn	46	+415	0.42	303
		Annual	**56**	**+22**	**0.59**	**1234**
		All data	**55**	**+76**	**0.56**	**2336**
Forage herb based	1	Winter	54	-69	0.70	664
		Spring	59	+47	0.58	855
		Summer	53	+109	0.61	1073
		Autumn	48	+124	0.58	701
		Annual	**54**	**+43**	**0.60**	**3293**
	2	Winter	64	-205	0.76	800
		Spring	62	-92	0.69	936
		Summer	61	+16	0.55	806
		Autumn	56	-47	0.63	858
		Annual	**62**	**-105**	**0.67**	**3400**
	3	Winter	78	-535	0.75	466
		Spring	74	-472	0.82	672
		Summer	83	-466	0.69	484
		Autumn	63	-105	0.72	359
		Annual	**74**	**-392**	**0.75**	**1981**
		All data	**61**	**-109**	**0.66**	**8674**

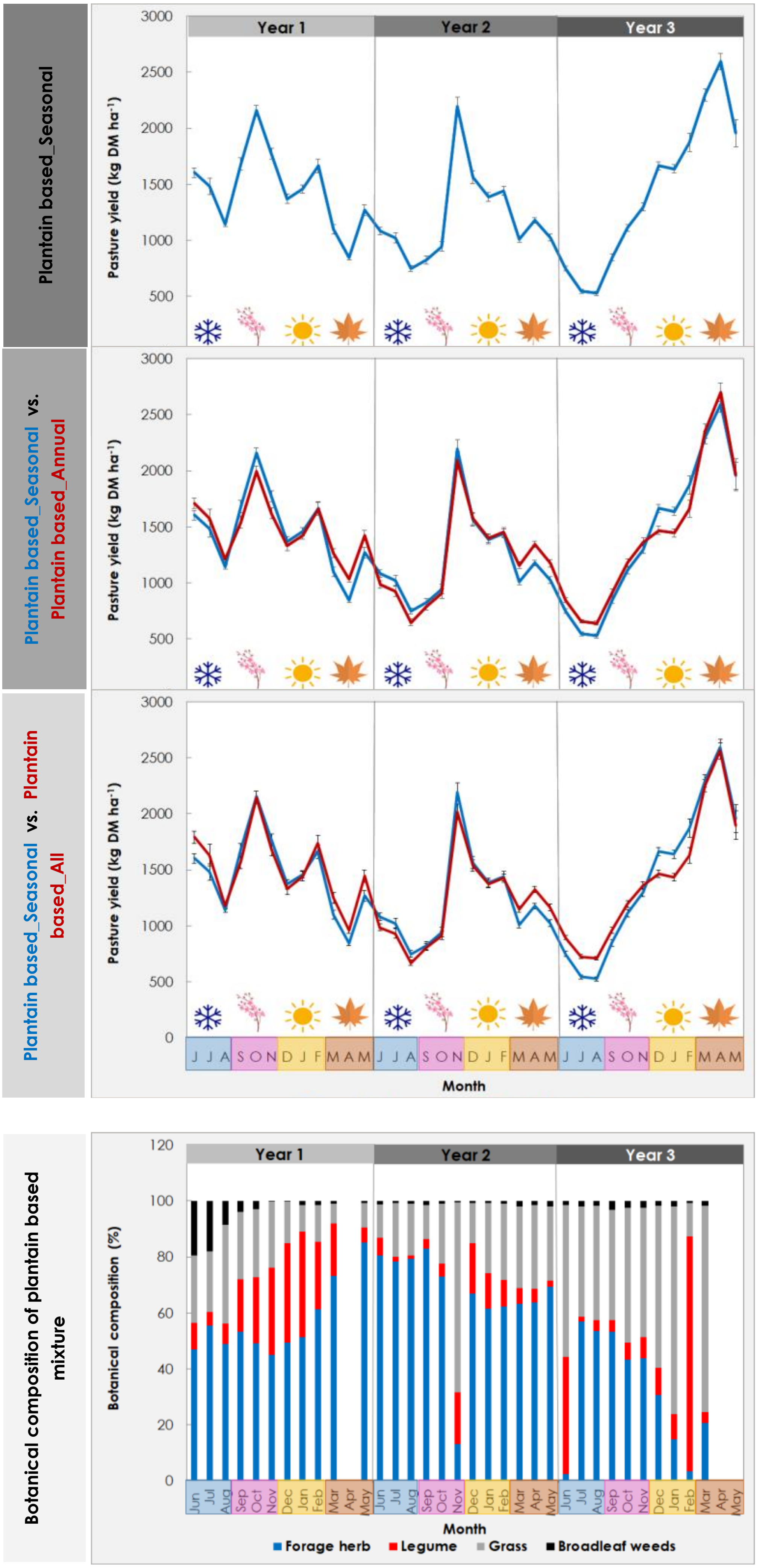


Figure 3. Predicted yields and botanical composition from plantain based calibrations during the study period

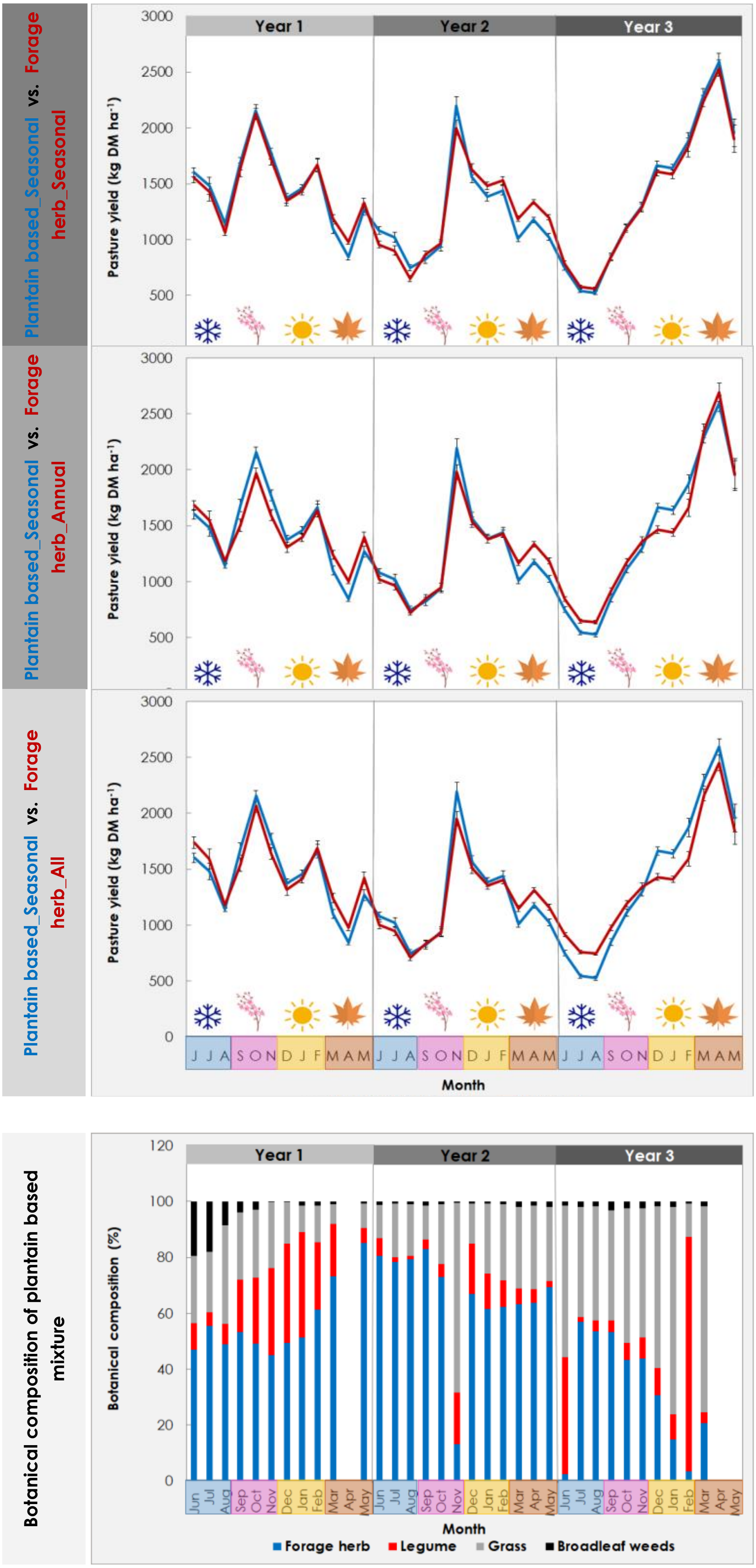
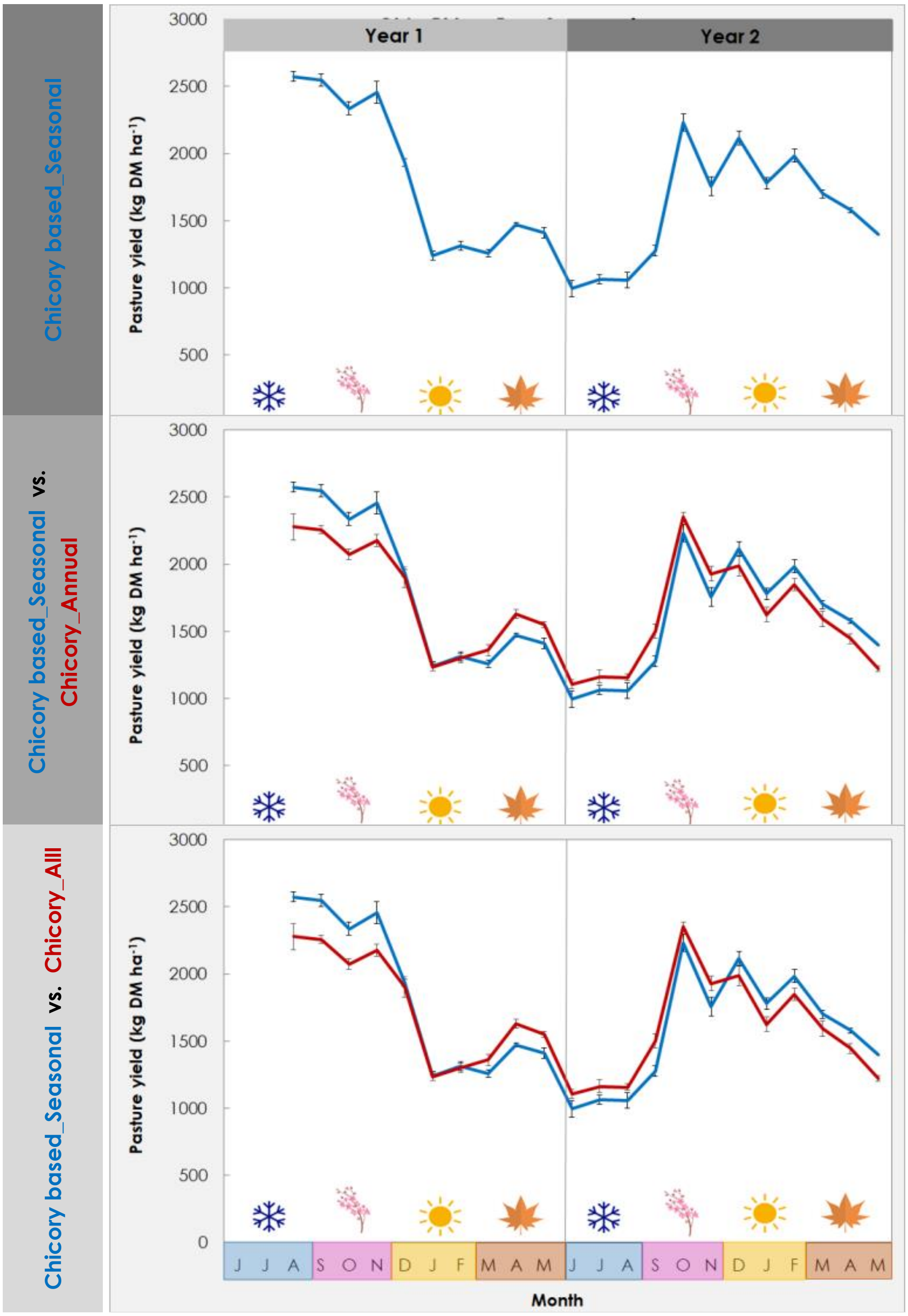


Figure 4. Predicted yields and botanical composition from seasonal plantain based versus forage herb calibrations during the study period



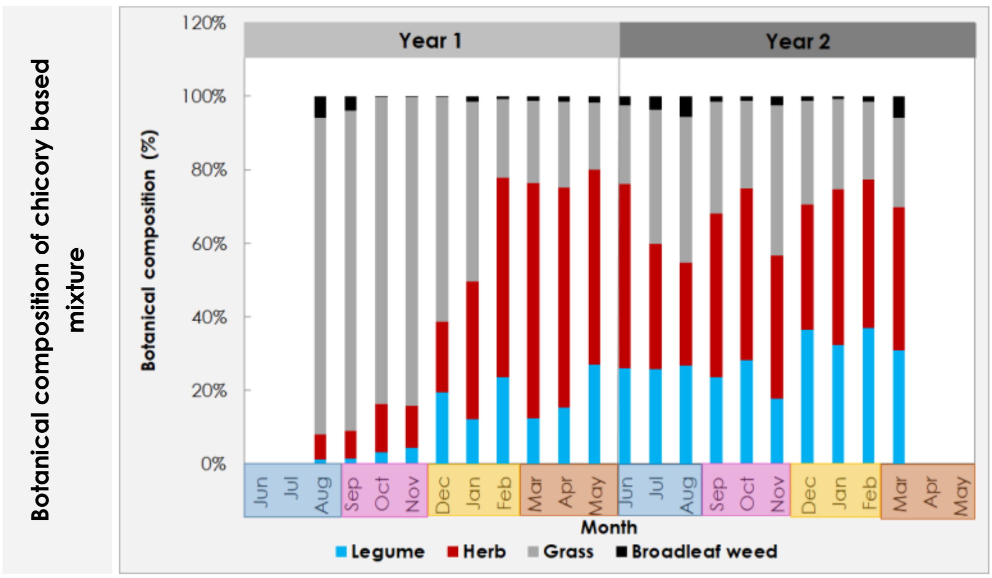


Figure 5. Predicted yields and botanical composition for the chicory based mixture during the study period

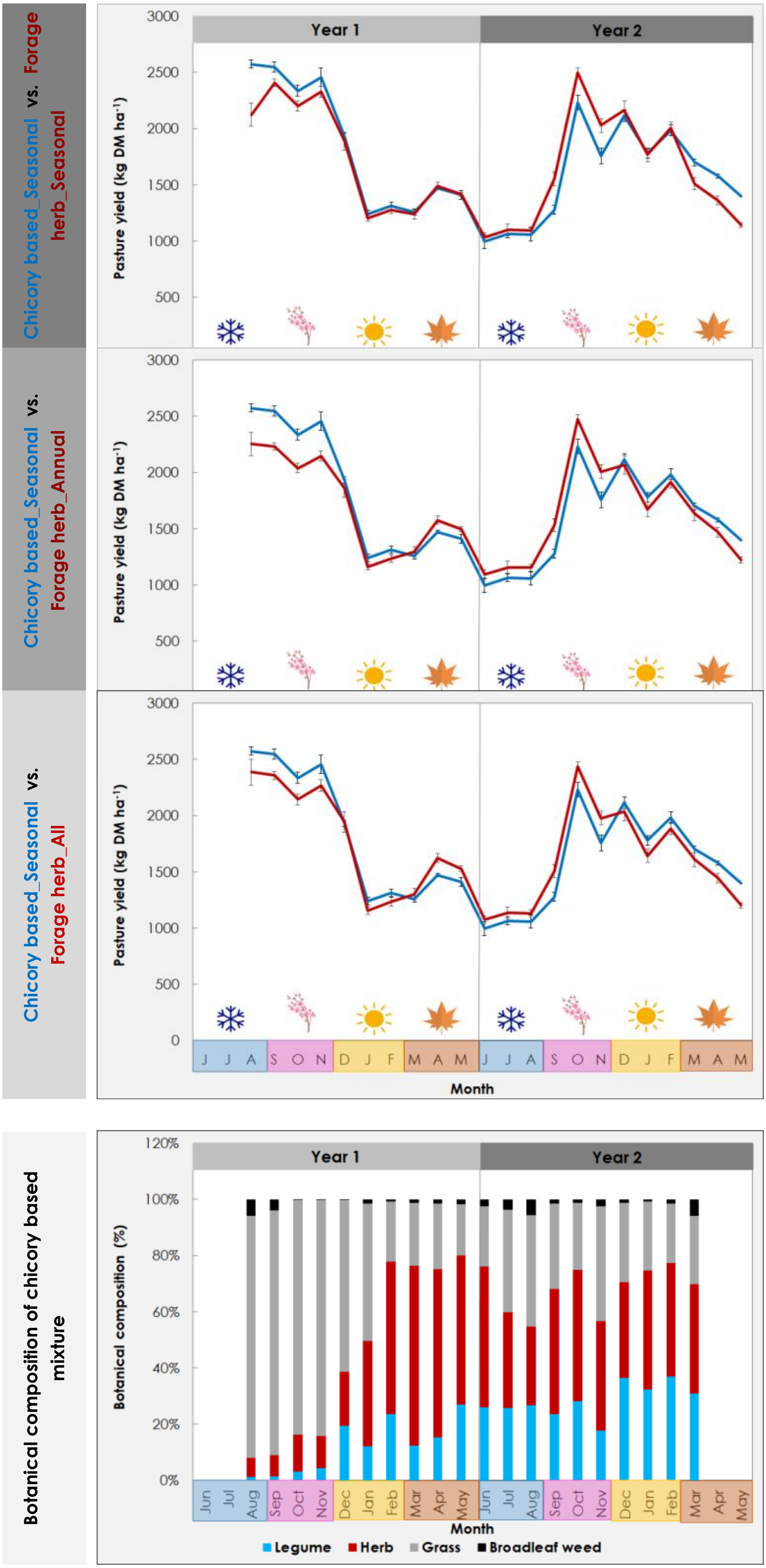


Figure 6. Predicted yields and botanical composition from seasonal chicory versus forage herb calibrations during the study period

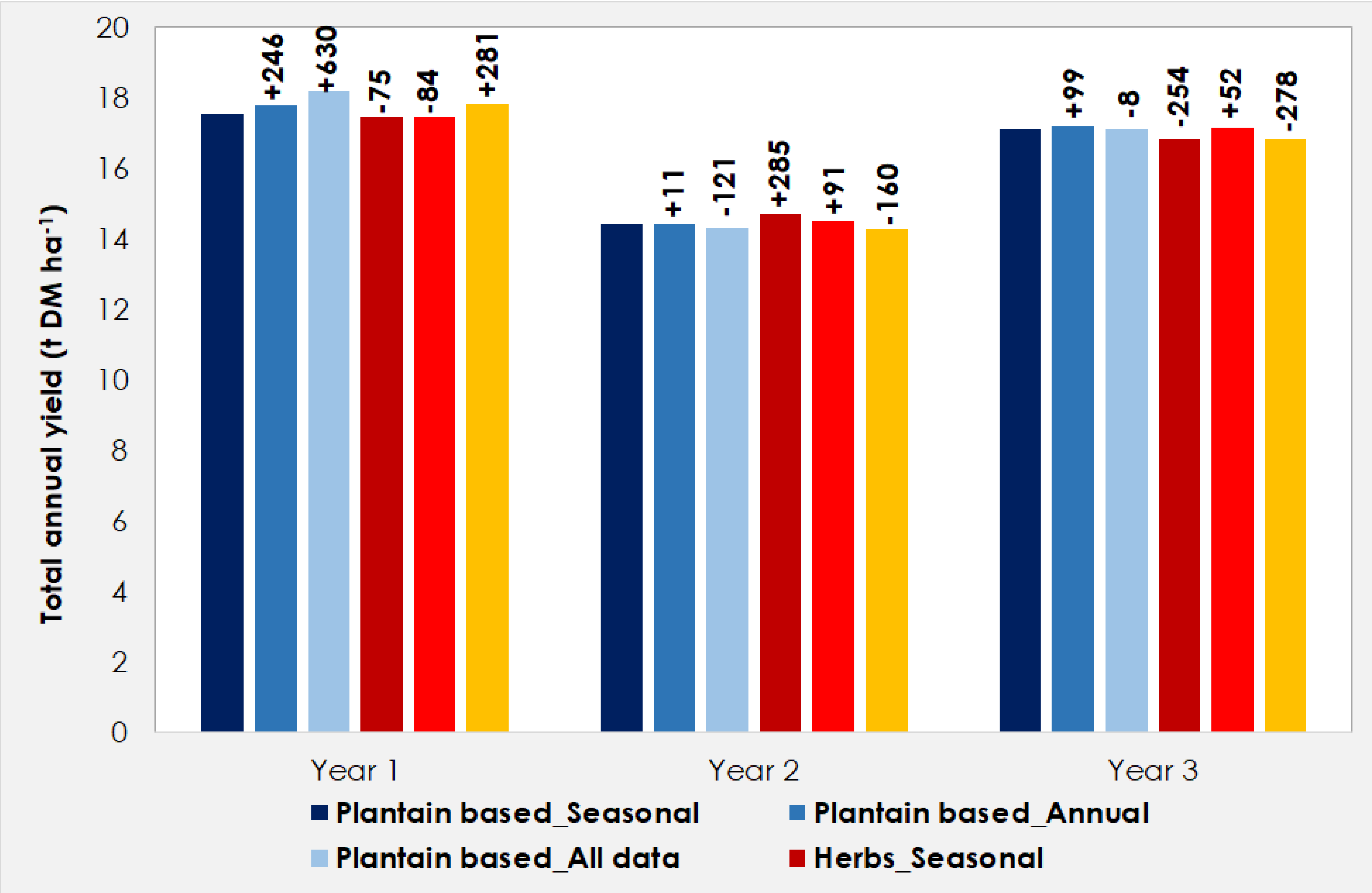


Figure 7. Predicted total annual yields for plantain pasture mixtures from calibrations developed during the study period. Values above bars indicate deviation from yield (kg DM/ha) as predicted by the seasonal plantain based calibration.

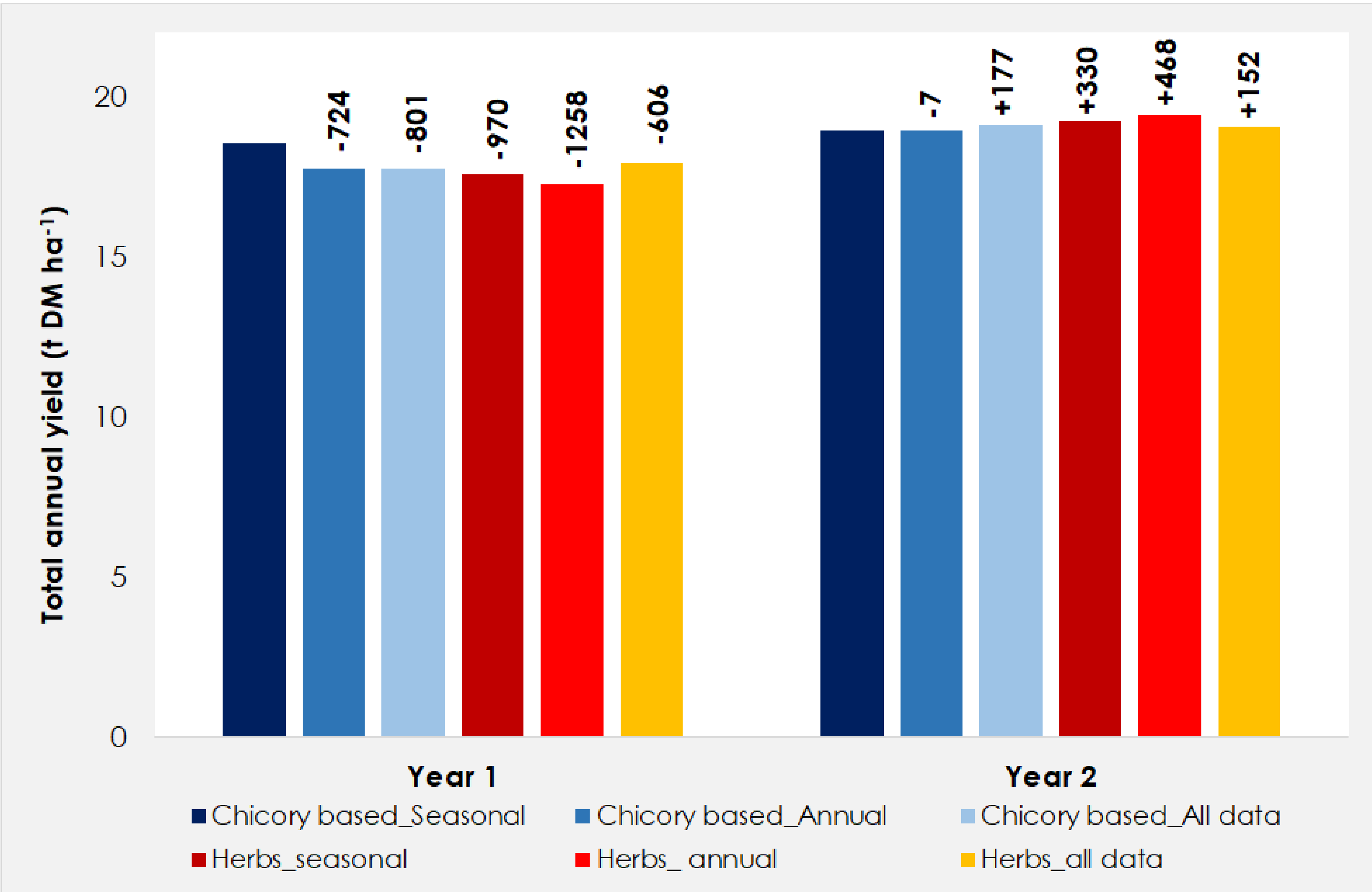


Figure 8. Predicted total annual yields for chicory based pasture mixtures from calibrations developed during the study period. Values above bars indicate deviation from yield (kg DM/ha) as predicted by the seasonal chicory based calibration.

Results

Plantain based mixture calibrations

Figure 7 illustrates the comparative predicted annual yield (t DM/ha/year) when utilizing different iterations of the "Plantain based" calibrations. With the exception of total annual yield predicted by the Plantain based_Annual calibration in year 1, all calibrations estimated a yield within 300 kg DM/ha/year to that of the "Plantain based_Seasonal""calibrations (the 'gold standard'). However, such a comparison does not highlight the shortcomings of a particular calibration equation set within a year or season. This is important because over-estimation in one season, could cancel out under-estimation in another and result in similar yields on an annual basis.

For both the "Plantain based_annual" and "Plantain based_all data" calibrations, there was a tendency to over-estimate yield from autumn of year 2 to winter of year 3 and to under-estimate yield during summer of year 3 (Figure 3). The under-estimation from autumn to winter was likely associated with a change in pasture structure from dense forage herb based pasture in summer to a more open, low growing pasture sward in the winter. In the summer of year 3, as rapid kikuyu ingression occurred, it is likely that these generalized equations could not deal with the notable increase in pasture density associated with kikuyu's growth form.

If a producer does opt to reduce the number of calibration equations to apply to plantain based mixtures, they could simply opt for one over-all equation provided by "Plantain based_All data" [Pasture yield = (67 x RPM height) – 281]. However, it will require that the operator/manager use calculated pasture yields alongside visual observation and evaluation of residuals to adapt allocation during periods when the accuracy of estimation may be reduced.

Of interest is how well the yield estimations of the more generalised "Forage herb calibrations" fit the data (Figure 4). Once again, the seasonally specific "Forage Herb_Seasonal" calibrations provided the best fit, while the "Forage herbs_annual" and "Forage herb_all data" calibrations follow a similar trend of under and over-estimations as for the plantain based calibrations of the same classification.

Chicory based mixture calibrations

Figure 7 illustrates the comparative predicted annual yield when utilizing different iterations of the "Chicory based" calibrations. Of concern is the much greater discrepancies in yield prediction for different calibration equations, particularly in year 1. It is hypothesized that this is due to the much greater changes in botanical composition that occurs in this pasture type than in plantain based pastures during year 1. For the Chicory based mixture sward composition changed from grass dominant in winter/spring to herb dominated in spring/early summer and eventually a balanced grass/legume/herb distribution in late summer/autumn of year 1. A particular period where the under-estimation of yield is concerning when using any of the other calibration equations (Chicory based and Forage Herb based) is the first spring, when the sward is mainly based on ryegrass. It thus appears that for the periods when forage herb pasture mixtures are dominated by ryegrass, generalised forage herb calibrations are not well suited to pasture yield estimation. Of interest though, is that the best alternative to the "Chicory based_seasonal calibrations" (gold standard) in terms of fit, was the "Forage herbs_All data" calibration [Pasture yield = (RPM height x 61) -109].

Summary and conclusions

As mentioned in the introduction, the goal of the producer will likely be the most important consideration when deciding which of the calibration equations developed during this study they will use on farm.

For maximum accuracy, it is recommended that separate species specific seasonal calibrations be utilized.

Although this requires more regular adaptation of calibrations, these equations are the best at handling the changes that occur in forage herb mixtures in terms of sward composition and the associated sward structure.

The "Forage herbs_All data" calibration is ideal if you aim to maximize simplicity. This allows one calibration to be applied to all forage herb based mixtures on your farm, irrespective of the species established, season or year.

The only catch is that the operator will have to be more attentive to when the calibration could be over- or under-estimating and use their experience to adjust pasture allocation (and in turn feed budgeting strategy) accordingly.

References

Bransby DI, Tainton NM. 1977. The disc pasture meter: Possible applications in grazing management. Proceedings Grassland Society of South Africa 12:115-118.

Douglas JT, Crawford CE. 1994. An evaluation of the drop-disc technique for measurements of herbage production in ryegrass for silage. Grass and Forage Science 49: 252-255.

Earle DF, McGowan AA. 1979. Evaluation and calibration of an automated rising plate meter for estimating dry matter dry matter yield of pasture. Australian Journal Agriculture and Animal Husbandry 19: 337-343.

Fulkerson WJ, Slack K. 1993. Estimating mass of temperate and tropical pastures in the sub-tropics. Australian Journal of Experimental Agriculture 33: 865-869.

Harmoney KR, Moore KJ, George JR, Brummer EC, Russel JR. 1997. Determination of pasture biomass using four indirect methods. Agronomy Journal 89: 665-672.

Michell P. 1982. Value of the rising-plate meter for estimating herbage mass of grazed perennial ryegrass-white clover swards. Grass and Forage Science 37:81-87.

Martin RC, Astatkie T, Cooper JM and Fredeen AH. 2005. A comparison of methods used to determine biomass on naturalized swards. Journal of Agronomy and Crop Science 191: 152-160.

Murphy JD, O'Brien B, Hennessy D, Hurley M, Murphy MD. 2021. Evalaution of the precision of the rising plate meter for measuring compressed sward height on heterogenous grassland swards. Precision Agriculture.

`t Mannetjie L. 2000. Measuring biomass of grassland vegetation. In: Field and Laboratory methods for grassland and animal measurement. Eds: `t Mannetjie L, Jones RM. CAB International. Wallingford, UK.

Van der Colf J, Ammann SB, Meeske R. 2022. Forage herbs and mixtures: Impact of inclusion on pasture system productivity. Outeniqua Research Farm Information Day 2022 Booklet. Western Cape Department of Agriculture.

Comparing spring-planted to autumn-planted Italian ryegrass – are different planting dates an option?

Sigrun Ammann*, Dalena Lombard, Lethu Zulu

Western Cape Department of Agriculture, Research and Technology Development, Directorate Plant Sciences, Outeniqua Research Farm, P.O. Box 24, George 6530

*Sigrun.ammann@westerncape.gov.za

Introduction

Most temperate planted pastures are commonly established in autumn. This is favourable from a temperature and weed competition perspective. Both Perennial and Italian ryegrass have a dual induction requirement of vernalization by low temperatures followed by longer or increasing day lengths (Heide 1994). The induction requirements of cultivars range from obligatory to facultative (Cooper 1960.; Evans 1960). Obligate cultivars have a compulsory requirement for cold days, however the number of cold days needed can vary between cultivars, while facultative cultivars do not have a compulsory requirement for cold days and can respond to increasing day length instead.

Thus spring-planting becomes an option for Italian ryegrass cultivars that have a large obligate vernalisation requirement and will only flower after the winter in the following year. Since cultivars are never completely uniform in their genetic make-up there are some cultivars that may have a proportion of plants that are facultative and will thus flower after a spring-planting, rendering them unsuitable for such a planting date.

The Italian ryegrass (*Lolium multiflorum*) elite cultivar evaluation trial, Lm11, was planted on 10 March 2021 at the Outeniqua Research Farm and repeated as a spring planting (Lm12) on 8 September 2021.

In this article the results for the spring-planted trial, Lm12, are presented as seasonal data and additionally comparisons are shown to the autumn-planted trial as well as to perennial ryegrass and forage herbs.

Cultivars evaluated

The trial consists of 20 cultivars of which are all Italian type ryegrass. Of these cultivars 11 are diploid and nine are tetraploid.

- ***Italian diploid***: AgriBoost, Asset, Bond, Fox, Icon, Jackpot, Knight, Sukari, Supercruise, Tabu+, Yolande
- ***Italian tetraploid***: Barcrespo, Barmultra II, Elvis, Impact (synonym Udine), Inducer, Jeanne, Lush, Teanna, Thumpa

Parameters reported in this article

- Total DM yield
- Seasonal DM yield
- Flowering behaviour
- Rust incidence
- Persistence / sward density

Trial management

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

The harvest cycle was determined according to the 3-leaf stage 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

***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.

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 as well as 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 also to spread risk. A high yielding spring cultivar can for instance be considered for silage making of surplus production. Other considerations are for mixed pastures and how the seasonal yield can best be matched with the yield of the other species in the mixture.

***Growth rates* (Table 2)** are important indicators of whether there will be sufficient grazing to support the herd, especially the lactating dairy herd. Lets consider an example of what growth rate might be needed. The cows will preferably be required to graze year round. If we assume a 400kg cow which will eat approximately 16kg DM/day of which 10.5kg DM/day should come from the pasture and we assume a stocking rate of 3.8 cows/ha and a wastage rate of 10%, then we will require a daily growth rate of 44kg DM/ha/day throughout the year. It would mean that in the surplus months any growth above this rate would need to be ensiled for feeding back in the months with the lower growth rate.

Considering the mean growth rate for the entire trial, the maximum stocking rate the best cultivars could support, assuming 10% wastage and an intake of 10.5 kg/cow/day would be 3.5 cows/ha if all excess was ensiled in the two spring seasons.

***Leaf rust incidence* (Table 3)** refers mainly to crown rust (*Puccinia coronata*). According to Clarke & Eagling (1994) and Webb et al (2019) crown rust causes yield loss as well as negative effects on root weight and rooting depth, tiller numbers and leaf area or photosynthetic area. Potter (2007) reported not only reduced yield but also reduced water-soluble carbohydrates and reduced digestibility. Plummer et al (1990) also refers to reduced tiller density and increased tiller death. Carr (1975) reports rust to be a water soluble carbohydrate (WSC) sink that reduces growth and forage quality. Additionally Carr (1975) estimates that 10% leaf rust infection could cause up to 50% decline in WSC concentration. Hence there are advantages to cultivars which are resistant or have a low incidence only.

Rust can be more severe under nutrient deficiency conditions or if growth cycles are allowed to continue beyond the 3-leaf stage. Increased dead leaf matter may also increase facial eczema (McKenzie 1971).

***Flowering behaviour* (Table 4, Table 5)** is important since it results in a higher stem component which implies a higher fibre content and thus lower nutritive value. The percentage of the sward that is reproductive varies significantly between cultivars due to vernalisation (cold days) requirements as does the duration of reproductive tillers in the sward (flowering window). In years with more "cold days" in winter the flowering incidence will be higher. Cultivars that do have a high bolting percentage could for instance be used for paddocks that will be cut for silage although it would also affect the silage quality as opposed to cutting a non-reproductive sward that is leafy. In mixtures with species that are very competitive and tall growing in summer it might be an advantage to have a ryegrass component with a higher bolting percentage as that results in taller plants to compete with the other tall components for example chicory or lucerne.

The majority of Italian ryegrass cultivars that are available have the ability to produce new vegetative

Table 1. Italian ryegrass (*Lolium multiflorum*) **Spring planted**, Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Spring 2021	Rank	Summer 2021/22	Rank	Autumn 2022	Rank	Winter 2022	Rank	Spring 2022	Rank	Summer 2022/23	Rank	Total	Rank
AgriBoost	D	6,10 ab	2	0		0		0		0		0		6.10 f	20
Asset	D	5,00 cd	19	2,52 fg	16	2.62	5	2.94 abcd	10	3.47 e	19	0.47 bc	10	16.86 bcd	12
Barcrespo	T	5,90 ab	4	3,42 abcd	5	2.77	3	**3.18 a**	2	4.12 abcde	5	1.00 abc	5	**20.07 a**	1
Barmultra II	T	5,35 bcd	18	3,56 ab	2	2.95	1	3.02 abc	5	4.48 ab	2	0.45 bc	12	**19.82 a**	3
Bond	D	5,56 abcd	12	3,37 abcd	7	2.39	10	3.13 abc	4	**4.50 a**	1	0.96 abc	6	**19.90 a**	2
Elvis	T	5,61 abcd	11	3,38 abcd	6	2.35	11	2.96 abcd	7	4.12 abcde	6	0		16.52 bcd	14
Fox	D	4,95 d	20	3,44 abcd	4	2.44	8	2.99 abc	6	4.02 abcde	7	0.47 bc	11	18.15 abc	9
Icon	D	5,55 abcd	13	3,33 abcde	8	2.27	12	2.65 abcde	14	4.17 abc	3	0.47 bc	9	18.44 ab	7
Impact/Udine	T	5,85 abc	7	**3.63 a**	1	2.24	13	2.28 e	19	3.90 abcde	11	0.33 c	14	17.98 abc	11
Inducer	T	5,86 abc	5	2,93 defg	13	2.44	9	2.29 e	18	3.75 cde	13	0.88 abc	7	18.01 abc	10
Jackpot	D	5,86 abc	6	2,76 efg	14	2.52	7	**3.20 a**	1	3.46 cde	17	0.35 c	13	14.50 de	16
Jeanne	T	5,47 abcd	17	0		0		2.60 bcde	15	2.82 bcde	12	0		11.89 e	19
Knight	D	5,52 abcd	15	2,53 fg	15	2.24	14	2.94 abcd	9	3.49 de	18	0.30 c	15	16.82 bcd	13
Lush	T	5,49 abcd	16	3,53 abc	3	2.89	2	2.41 de	17	3.57 cde	16	1.22 ab	3	19.11 ab	6
Sukari	D	**6,25 a**	1	3,25 abcde	9	2.61	6	2.96 abcd	8	3.93 abcde	10	1.01 abc	4	19.33 ab	4
Supercruise	D	5,82 abc	8	2,99 bcdef	11	2.68	4	3.13 ab	3	4.14 abcd	4	**1.39 a**	1	19.23 ab	5
Tabu +	D	5,75 abcd	9	2,36 g	17	2.18	15	2.57 cde	16	3.67 cde	14	**1.33 a**	2	15.46 cd	15
Teanna	T	5,74 abcd	10	0		0		2.72 abcde	15	3.58 cde	15	0		12.04 e	18
Thumpa	T	5,52 abcd	14	3,03 bcdef	10	2.16	16	2.74 abcde	12	4.01 abcde	8	0		14.0 de	17
Yolande	D	5.96 ab	3	2.96 cdef	12	2.03	17	2.76 abcde	11	3.99 abcde	9	0.74 abc	8	18.44 ab	8
LSD (0.05)		0.87		0.59		NS		0.56		0.68		0.47		2.95	
CV %		9.3		9.7		20.7		12.0		10.4		8.38		10.7	

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

Table 2. Italian ryegrass (*Lolium multiflorum*) **Spring planted**, Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **Seasonal Growth Rates** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Spring 2021	Rank	Summer 2021/22	Rank	Autumn 2022	Rank	Winter 2022	Rank	Spring 2022	Rank	Summer 2022/23	Rank	Total	Rank
AgriBoost	D	73.5 ^{ab}	2	0		0		0		0		0		12.4 ^{f}	20
Asset	D	60.2 ^{cd}	19	28.0 ^{fg}	16	28.3	5	32.0 ^{abcd}	10	38.1 ^{d}	19	10.8 ^{bc}	10	34.4 ^{bcd}	12
Barcrespo	T	71.1 ^{ab}	4	38.1 ^{abcd}	5	30.1	3	**34.6 ^{a}**	2	45.3 ^{abcd}	5	23.2 ^{abc}	5	**40.8 ^{a}**	1
Barmultra II	T	64.5 ^{bcd}	18	39.6 ^{ab}	2	32.1	1	32.8 ^{abc}	5	49.3 ^{a}	2	10.4 ^{bc}	12	**40.4 ^{a}**	3
Bond	D	67.0 ^{abcd}	12	37.4 ^{abcd}	7	25.9	10	34.0 ^{abc}	4	**45.0 ^{a}**	1	22.5 ^{abc}	6	**40.5 ^{a}**	2
Elvis	T	67.6 ^{abcd}	11	37.6 ^{abcd}	6	25.6	11	32.2 ^{abcd}	7	41.2 ^{abcde}	6	0		33.6 ^{bcd}	14
Fox	D	59.6 ^{d}	20	38.3 ^{abcd}	4	26.5	8	32.5 ^{abc}	6	40.2 ^{abcde}	7	10.8 ^{bc}	11	37.0 ^{abc}	9
Icon	D	66.8 ^{abcd}	13	37.1 ^{abcde}	8	24.7	12	28.8 ^{abcde}	14	45.9 ^{ab}	3	10.9 ^{bc}	9	37.6 ^{ab}	7
Impact/Udine	T	70.6 ^{abc}	7	**40.3 ^{a}**	1	24.4	13	24.8 ^{e}	19	41.2 ^{bcd}	11	7.6 ^{c}	14	36.6 ^{abc}	11
Inducer	T	70.7 ^{abc}	5	32.6 ^{defg}	13	26.5	9	24.9 ^{e}	18	42.9 ^{acde}	13	20.5 ^{abc}	7	36.7 ^{abc}	10
Jackpot	D	70.5 ^{abc}	6	30.7 ^{efg}	14	27.4	7	**34.8 ^{a}**	1	39.1 ^{bcd}	17	8.0 ^{c}	13	29.5 ^{de}	16
Jeanne	T	65.9 ^{abcd}	17	0		0		28.2 ^{bcde}	15	42.0 ^{abcd}	12	0		24.2 ^{e}	19
Knight	D	66.5 ^{abcd}	15	28.2 ^{fg}	15	24.3	14	32.0 ^{abcd}	9	38.3 ^{cd}	18	7.0 ^{c}	15	34.3 ^{bcd}	13
Lush	T	66.1 ^{abcd}	16	39.2 ^{abc}	3	31.4	2	26.2 ^{de}	17	39.2 ^{bcd}	16	28.3 ^{ab}	3	38.9 ^{ab}	6
Sukari	D	**75.2 ^{a}**	1	36.1 ^{abcde}	9	28.4	6	32.2 ^{abcd}	8	43.1 ^{abcd}	10	23.4 ^{abc}	4	39.4 ^{ab}	4
Supercruise	D	70.2 ^{abc}	8	33.2 ^{bcdef}	11	29.2	4	34.0 ^{ab}	3	45.5 ^{abc}	4	**32.3 ^{a}**	1	39.2 ^{ab}	5
Tabu +	D	69.3 ^{abcd}	9	26.2 ^{g}	17	23.7	15	27.9 ^{cde}	16	40.4 ^{bcd}	14	**30.9 ^{a}**	2	31.5 ^{cd}	15
Teanna	T	69.2 ^{abcd}	10	0		0		29.6 ^{abcde}	15	39.3 ^{bcd}	15	0		24.5 ^{e}	18
Thumpa	T	66.4 ^{abcd}	14	33.7 ^{bcdef}	10	23.5	16	29.8 ^{abcde}	12	44.1 ^{abcd}	8	0		28.5 ^{de}	17
Yolande	D	71.8 ^{ab}	3	32.9 ^{cdef}	12	22.1	17	30.0 ^{abcde}	11	43.8 ^{abcd}	9	17.2 ^{abc}	8	37.5 ^{ab}	8
LSD (0.05)		0.87		0.59		NS		0.56		0.68		5.24		2.95	
CV %		9.3		9.7		20.7		12.0		10.4		8.38		10.7	

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

Table 3. Italian ryegrass (*Lolium multiflorum*) **Spring planted**, Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **Leaf rust** (%) (rating based) Individual harvests D = Diploid, T = Tetraploid

Cultivars	Type	Cut 1 27/10/2021	Cut 2 24/11/2021	Cut 3 21/12/2021	Cut 4 19/1/2022	Cut 5 21/2/2022	Cut 6 31/3/2022	Cut 7 4/5/2022	Cut 8 9/6/2022	Cut 9 21/7/2022	Cut 10 24/8/2022	Cut 11 29/9/2022	Cut 12 2/11/2022	Cut 13 6/12/2022	Cut 14 12/1/2022
AgriBoost	D	0	0	0	8.3	-	-	-	-	-	-	-	-	-	-
Asset	D	0	8.3	12.5	62.5	33.3	16.7	4.2	0	0	0	0	0	8.3	18.8
Barcrespo	T	0	0	20.8	33.3	20.8	8.3	4.2	0	0	0	0	0	8.3	4.2
Barmultra II	T	0	0	29.2	58.3	45.8	45.8	8.3	0	41.7	8.3	8.3	16.7	16.7	54.2
Bond	D	0	4.2	20.8	58.3	20.8	20.8	4.2	0	4.2	0	0	0	29.2	41.7
Elvis	T	0	0	25.0	58.3	43.3	45.8	4.2	4.2	37.5	8.3	16.7	29.2	25.0	-
Fox	D	0	0	12.5	66.7	25.0	16.7	0	0	12.5	0	0	8.3	20.8	50.0
Icon	D	0	4.2	16.7	62.5	16.7	12.5	4.2	0	0	0	0	0	4.2	16.7
Impact/Udine	T	0	0	8.3	12.5	12.5	16.7	0	0	8.3	0	0	0	4.2	12.5
Inducer	T	0	4.2	8.3	16.7	16.7	8.3	4.2	0	8.3	0	0	4.2	8.3	16.7
Jackpot	D	0	0	33.3	62.5	20.8	18.8	0	0	8.3	0	4.2	8.3	8.3	12.5
Jeanne	T	0	29.2	**87.5**	**79.2**	54.2	43.8	8.3	8.3	58.3	16.7	33.3	8.3	54.2	-
Knight	D	0	0	16.7	54.2	29.2	16.7	8.3	0	8.3	0	0	0	8.3	25.0
Lush	T	0	0	16.7	12.5	16.7	29.2	8.3	0	4.2	0	4.2	0	8.3	8.3
Sukari	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Supercruise	D	0	4.2	37.5	54.2	45.8	29.2	8.3	0	0	0	4.2	0	8.3	12.5
Tabu +	D	0	0	33.3	66.7	29.2	37.5	8.3	0	16.7	4.2	8.3	4.2	4.2	12.5
Teanna	T	0	33.3	**83.3**	**79.2**	**66.7**	**75**	0	8.3	45.8	12.5	29.2	16.7	41.7	-
Thumpa	T	0	0	29.2	41.7	41.7	33.3	8.3	0	41.7	0	0	0	12.5	0
Yolande	D	0	4.2	25	45.8	20.8	4.2	0	0	12.5	0	0	0	8.3	25.0

Table 4. Italian ryegrass (*Lolium multiflorum*), **Spring planted** Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **Reproductive tillers/bolting** (%) (rating based) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 1 27/10/2021	Cut 2 24/11/2021		Cut 3 21/12/2021		Cut 4 19/1/2022		Cut 5 21/2/2022		Cut 6 31/3/2022	Cut 7 4/5/2022
AgriBoost	D	0	16.7	LP+H	**62.5**	LP	**70.8**	LP	-		-	-
Asset	D	0	4.2	P+LP	4.2	LP	12.5	LP	0		0	0
Barcrespo	T	0	4.2	P	4.2	EP	0		0		0	0
Barmultra II	T	0	0		4.2	P	0		0		0	0
Bond	D	0	0		4.2	EP	0		0		0	0
Elvis	T	0	0		8.3	EP+P+LP	0		0		0	0
Fox	D	0	0		4.2	EP	0		0		0	0
Icon	D	0	0		4.2	P+LP	0		0		0	0
Impact/Udine	T	0	0		0		0		0		0	0
Inducer	T	0	0		12.5	EP+P	0		0		0	0
Jackpot	D	0	4.2	P	8.3	EP+P+LP	0		0		0	0
Jeanne	T	0	0		0		0		0		0	0
Knight	D	0	0		8.3	P	0		0		0	0
Lush	T	0	0		0		0		0		0	0
Sukari	D	0	8.3	P+LP	29.2	EP+P+LP	0		4.2	H	0	0
Supercruise	D	0	0		8.3	EP+P+LP	0		0		0	0
Tabu +	D	0	4.2	P	20.8	EP+P+LP	8.3	LP	4.2	H	0	0
Teanna	T	0	0		12.5	EP+P+LP	0		0		0	0
Thumpa	T	0	0		8.3	EP+P+LP	0		0		0	0
Yolande	D	0	4.2	P	8.3	EP+P+LP	0		0		0	0

Flowering stages: EP = Early piping, P = Piping, LP = Late piping, EH = Early heading, H + Heading

At the early piping stage (EP), the tillers may survive grazing i.e. growth points are not removed, if the grazing residual is not lower than 5cm. A notable increase in fibre content already occurs at the piping (P) stage. At Late piping (LP) and heading (EH, H) there is significant stem formation with the associated reduction in forage quality.

Table 4 cont. Italian ryegrass (*Lolium multiflorum*), **Spring planted** Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **Reproductive tillers/bolting** (%) (rating based) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 8 9/6/2022	Cut 9 21/7/2022	Cut 10 24/8/2022	Cut 11 29/9/2022		Cut 12 2/11/2022		Cut 13 6/12/2022		Cut 14 12/1/2022	
AgriBoost	D	-	-	-	-		-		-		-	
Asset	D	0	0	0	12.5	P	20.8	LP+H	8.3	H	25.0	H
Barcrespo	T	0	0	0	**66.7**	P+LP	**70.8**	LP+H	**62.5**	H	45.8	H
Barmultra II	T	0	0	0	45.8	EP+P	**66.7**	LP+H	54.2	H	16.7	H
Bond	D	0	0	0	41.7	EP+P	20.8	LP+H	12.5	H	12.5	H
Elvis	T	0	0	0	**66.7**	EP+P	50.0	LP+H	**79.2**	H	-	
Fox	D	0	0	0	50.0	P	58.3	LP+H	29.2	H	12.5	H
Icon	D	0	0	0	37.5	P+LP	41.7	LP+H	12.5	H	12.5	H
Impact/Udine	T	0	0	0	45.8	EP+P	45.8	LP+H	29.2	H	12.5	H
Inducer	T	0	0	0	41.7	EP+P	25.0	LP+H	12.5	H	12.5	H
Jackpot	D	0	0	0	29.2	EP+P	50.0	LP+H	41.7	H	25.0	H
Jeanne	T	0	0	0	41.7	EP+P	**75.0**	LP+H	**87.5**	H	-	
Knight	D	0	0	0	37.5	P+LP	37.5	LP+H	29.2	H	37.5	H
Lush	T	0	0	0	20.8	EP	4.2	LP	12.5	H	12.5	H
Sukari	D	0	0	0	**66.7**	P+LP	**83.3**	LP+H	**79.2**	H	**87.5**	H
Supercruise	D	0	0	0	41.7	EP	20.8	LP+H	20.8	H	56.3	H
Tabu +	D	0	0	0	**62.5**	EP+P+LP	**62.5**	LP+H	**66.7**	H	**87.5**	H
Teanna	T	0	0	0	50.0	P+LP	**79.2**	LP+H	**87.5**	H	-	
Thumpa	T	0	0	0	**70.8**	EP+P	**70.8**	LP+H	**66.7**	H	**75.0**	H
Yolande	D	0	0	0	12.5	EP	12.5	LP	8.3	H	12.5	H

Flowering stages: EP = Early piping, P = Piping, LP = Late piping, EH = Early heading, H + Heading

At the early piping stage (EP), the tillers may survive grazing i.e. growth points are not removed, if the grazing residual is not lower than 5cm. A notable increase in fibre content already occurs at the piping (P) stage. At Late piping (LP) and heading (EH, H) there is significant stem formation with the associated reduction in forage quality.

Table 5. Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm

Planted: September 2021 **Days to 50% flowering and flowering % from a spring planting based on individual plants,** D = Diploid, T = Tetraploid

Plants are not defoliated (cut)

Cultivars	Type	Days to 50% flowering Spring planting (median)	Flowering % Spring planting
AgriBoost	D	132	76
Asset	D	153	26
Barcrespo	T	174	10
Barmultra II	T	181	**2**
Bond	D	160	10
Elvis	T	160	10
Fox	D	188	**2**
Icon	D	146	**2**
Impact/Udine	T	160	**4**
Inducer	T	153	**2**
Jackpot	D	170	10
Jeanne	T	181	8
Knight	D	153	26
Lush	T	181	**2**
Sukari	D	157	30
Supercruise	D	146	20
Tabu +	D	153	28
Teanna	T	0	**0**
Yolande	D	0	**0**
Thumpa	T	No data	No data

Cultivars suitable for spring-planting should have below 5% flowering.

daughter tillers after the flowering phase. These are then referred to as Italian ryegrasses with a long growth duration (obligate types). There are also cultivars that do not produce vegetative tillers after the flowering phase and thus end after the bolting phase. In the current trial there is one such cultivar, AgriBoost (facultative type).

Italian ryegrass can also be used for ***spring-planting***. However only the cultivars with a low flowering incidence are suitable for spring-planting since early bolting will negatively affect such a planting.

***Sward density* (Table 6)** gives an indication of persistence especially in the summer months. The cultivars that retain good sward density or plant population throughout the summer are desirable.

***Leaf emergence rate* (Table 7)** depends on leaf growth rate since leaves emerge consecutively, one after the other, once the previous leaf is fully extended. Growth rate is mainly dependent on temperature and soil moisture. If soil moisture is sufficient, then the growth rate is mainly a function of temperature. Defoliation or harvest at the 3-leaf stage is optimal for the plant (carbohydrate reserves, root and tiller growth) and optimal for production since the first leaf dies once the fourth leaf emerges and yield reaches a plateau after the third leaf. The plants can at the earliest be defoliated at the 2.75-leaf stage when necessary. In spring canopy closure should be used as primary criterion to decide on the optimal defoliation time since limiting light penetration into the base of the sward can reduce daughter tiller initiation.

Table 6. Italian ryegrass (*Lolium multiflorum*) **Spring planted**, Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **Sward density (%)** (rating based) Individual harvests D = Diploid, T = Tetraploid

Cultivars	Type	Cut 1 27/10/2021	Cut 2 24/11/2021	Cut 3 21/12/2021	Cut 4 19/1/2022	Cut 5 21/2/2022	Cut 6 31/3/2022	Cut 7 4/5/2022	Cut 8 9/6/2022	Cut 9 21/7/2022	Cut 10 24/8/2022	Cut 11 29/9/2022	Cut 12 2/11/2022	Cut 13 6/12/2022	Cut 14 12/1/2022
AgriBoost	D	100	100	100	63	0	0	0	0	0	0	0	0	0	0
Asset	D	100	100	100	100	92	71	100	100	96	100	100	100	83	50
Barcrespo	T	100	100	100	100	92	79	100	100	96	100	100	100	83	38
Barmultra II	T	100	100	100	100	100	83	100	100	96	100	100	100	92	42
Bond	D	100	100	100	100	100	71	96	100	100	100	100	100	92	63
Elvis	T	100	100	100	100	96	63	92	92	96	100	100	100	88	0
Fox	D	100	100	100	100	96	79	92	100	92	100	100	100	88	32
Icon	D	100	100	100	100	96	88	96	100	96	100	100	100	92	42
Impact/Udine	T	100	100	100	100	100	79	100	100	92	100	100	100	83	25
Inducer	T	100	100	100	100	100	96	100	100	96	100	100	100	100	50
Jackpot	D	100	100	100	100	71	33	83	88	88	100	96	88	42	13
Jeanne	T	100	100	100	100	67	13	75	83	92	100	100	88	38	0
Knight	D	100	100	100	96	88	63	96	100	100	100	100	100	75	19
Lush	T	100	100	100	100	100	96	100	100	100	100	100	100	100	71
Sukari	D	100	100	100	100	96	75	96	96	96	100	100	100	58	75
Supercruise	D	100	100	100	100	100	83	96	100	100	100	100	100	100	44
Tabu +	D	100	100	100	96	88	50	92	96	100	100	100	100	71	63
Teanna	T	100	100	100	100	71	13	46	83	88	100	92	92	21	0
Thumpa	T	100	100	100	100	79	46	83	96	92	100	100	100	63	13
Yolande	D	100	100	100	100	100	75	96	96	92	100	100	100	100	63

Table 7. Italian ryegrass (*Lolium multiflorum*), **Spring planted**, Lm 12, Elite Evaluation, Outeniqua Research Farm

Planted: 8 September 2021 **No. of days per leaf and projected harvest rotation based on 3-leaf stage**

	8 Sep to 27 Oct 2021	27 Oct to 24 Nov 2021	24 Nov to 21 Dec 2021	21 Dec '21 to 19 Jan 2022	19 Jan to 21 Feb 2022	21 Feb to 31 Mar 2022	31 Mar to 4 May 2022
Actual leaf stage at harvest	**3.25**	**2.5**	**3**	**3**	**3**	**3.75**	**3.5**
No. of days/leaf	**15.1**	**11.2**	**9**	**9.7**	**11**	**10.1**	**9.7**
Actual days to harvest	**49**	**28**	**27**	**29**	**33**	**38**	**34**
Projected time to 3-leaf	45	34	27	29	33	30	29
Projected time to 2.75-leaf	41	31	25	27	30	28	27
	4 May to 9 Jun 2022	**9 Jun to 21 Jul 2022**	**21 Jul to 24 Aug 2022**	**24 Aug to 29 Sep 2022**	**29 Sep to 2 Nov 2022**	**2 Nov to 6 Dec 2022**	**6 Dec to 12 Jan 2023**
Actual leaf stage at harvest	**3**	**2.75**	**2.75**	**3.25**	**3.5**	**3.25**	**3.25**
No. of days/leaf	**12**	**15.3**	**12.4**	**11.1**	**9.4**	**11.4**	**11.4**
Actual days to harvest	**36**	**42**	**34**	**36**	**33**	**37**	**37**
Projected time to 3-leaf	36	46	37	33	28	34	34
Projected time to 2.75-leaf	33	42	34	30	26	31	31

Leaf emergence rate depends on leaf growth rate since leaves emerge consecutively, one after the other once the previous leaf is fully extended. Growth rate is mainly dependent on temperature and soil moisture. If soil moisture is sufficient, then the growth rate is mainly a function of temperature. Defoliation or harvest at the 3-leaf stage is optimal for the plant (carbohydrate reserves, root and tiller growth) and optimal for production since the first leaf dies once the fourth leaf emerges and yield reaches a plateau after the third leaf (Fulkerson & Slack 1994, 1995). The plants can at the earliest be defoliated at the 2.75-leaf stage when necessary. In spring canopy closure should be used as primary criterion.

The graph in **figure 1** shows the **seasonal yield for three different trials**. The first trial represented by the blue bars (Lm11) was planted in March 2021. The second trial is a replicate of the autumn planted trial and was planted in September 2021 (Lm12) represented by the red bars. The yellow bars represent the third trial (Lm13) planted in March 2022. The main lessons from the spring-planted trial are that the spring yield was equivalent to that of the earlier autumn planted trial, while the summer yield was better than the autumn planted trial. However the autumn yield 2022 was higher from the newly planted trial under the prevailing climatic conditions at the time. In addition the spring trial did not last to the second summer into autumn. This would mean a yield gap would develop in the summer autumn thus necessitating a planting in the previous autumn.

Thus the yield advantage of the spring planted Italian ryegrass in this case was only limited to the spring/summer following the planting. In a situation where for instance sward density of the autumn-planted trial was lost due to excessive rain and trampling over the winter months, a spring planting could be considered. Under normal circumstances probably not.

In figure 2 the yield data for the equivalent periods for perennial ryegrass (dotted lines), plantain and chicory (solid lines) added to the graph. This data shows that the forage herbs from a yield perspective would be a better option than a spring-planted Italian ryegrass. Forage herbs have been shown in previous trials to perform well from a spring-planting.

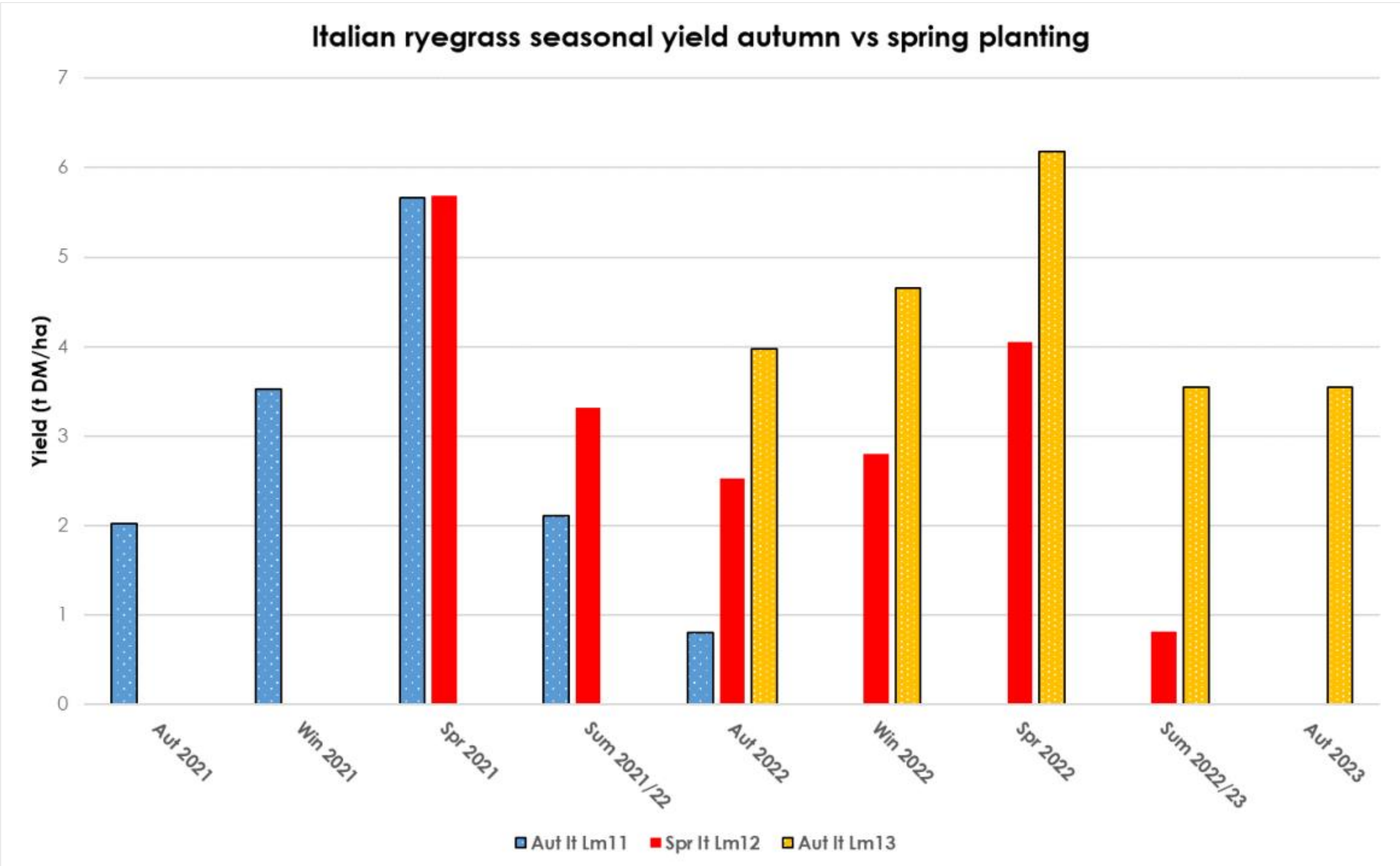


Figure 1. Seasonal yield of the top yielding Italian ryegrass cultivars from three different trials, one spring-planted and two autumn-planted. The blue bars are for trial Lm11 planted in March 2021, the red bars for Lm12 planted in September 2021 and the yellow bars for Lm13 planted in March 2022.

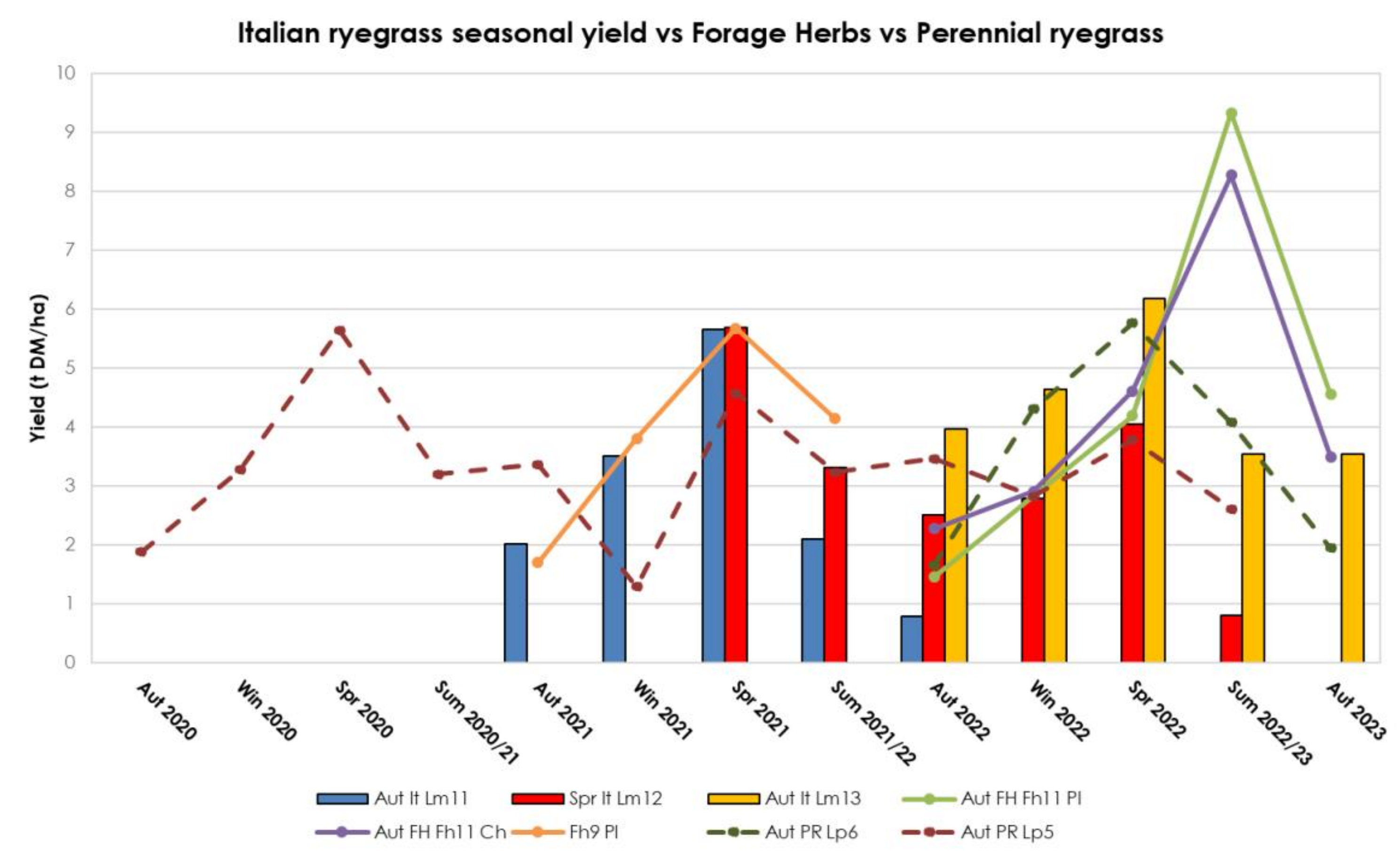


Figure 2. Seasonal yield of Italian ryegrass at three different planting (autumn 2021, spring 2021 and autumn 2022) dates represented by the bars, perennial ryegrass established in autumn 2020 and autumn 2022 represented by the dashed lines. Plantain and chicory is represented by the solid lines an autumn 2021 and autumn 22 planting.

Summary

Total yield

- Highest yielding cultivar: Barcrespo, Bond, Barmultra II
- Cultivars similar to the highest yielding: Sukari, Supercruise, Lush, Icon, Yolande, Fox, Inducer, Impact

Spring yield

- Highest yielding cultivar: Sukari, with almost all except two being similar yielding.

First summer yield

- Highest yielding cultivars: Impact
- Similar yielding: Barmultra II, Lush, Fox, Barcrespo, Elvis, Bond, Icon, Sukari

Winter yield

- Highest yielding: Jackpot and Barcrespo
- Jackpot did however not feature in the best group in both total yield and summer yield.
- Most of the other cultivars were similar to the highest yielding. However the overall winter yield was lower than from the autumn-planted trial.

Second summer yield

- Almost all cultivars already had a low yield at the beginning of December and by mid-January the trial had to be terminated due to low yields or none at all.

No flowering or less than 5% flowering in the first summer: Asset, Barcrespo, Barmultra II, Bond, Fox, Icon. These would be considered favourable for spring establishment from a bolting resistance perspective. Of these only Asset was not in the top yielding group for total yield.

Prolific flowering during second summer with higher stem component for an extended period for most cultivars.

Lush and Yolande, flowed by Asset had the **lowest flowering incidence** during the second summer being below 25%.

Best sward density through summer: Lush, Supercruise, Inducer, Yolande.

Rust incidence:

- Rust occurred from June through to January when the trial was terminated.
- No rust: Sukari
- Low rust: Barcrespo, Icon, Impact, Inducer, Jackpot, Lush, Supercruise, Tabu+

References

Carr JH. 1975. Disease of herbage crops – some problems and progress. Annals of Applied Biology 81: 235 – 279.

Chapman DF. 2016. Using Ecophysiology to Improve Farm Efficiency: Application in Temperate Dairy Grazing Systems. In: Forage Plant Ecophysiology (ed Matthews C). Agriculture 6, 17: 122 – 140.

Clarke RG and Eagling DR. 1994. Effects of pathogens on perennial pasture grasses. New Zealand Journal of Agricultural Research, 37: 319 -327

Cooper JP. 1960. Short-day and low-temperature induction in *Lolium*. Annals of Botany 24: 232-246.

Evans LT. 1960. The influence of temperature on flowering in species of *Lolium* and in *Poa pratensis*. Journal of Agricultural Science 54: 410-416.

Fulkerson WJ & Slack K. 1994. Leaf number as a criterion for determining defoliation time for Lolium perenne: 1. Effects of water soluble carbohydrates and senescence. Grass and Forage Science 49: 373 – 377.

Fulkerson WJ & Slack K. 1995. Leaf number as a criterion for determining defoliation time for Lolium perenne: 2. Effect of defoliation frequency and height. Grass and Forage Science 50: 16 – 20.

Heide OM. 1994. Control of flowering and reproduction in temperate grasses. New Phytologist 128: 347-362.

McKenzie EHC. 1971. Seasonal changes of fungal spore numbers in ryegrass-white clover pasture, and the effect of benomyl on pasture fungi. New Zealand Journal of Agricultural Research 14: 371 – 392

Plummer RM, Hall RL and Watt TA. 1990. The influence of crown rust (*Puccinia coronata*) on tiller production and survival of perennial ryegrass (*Lolium perenne*) plants in simulated swards. Grass and Forage Science 45: 9 – 16.

Potter LR. 2007. Effect of crown rust on regrowth, competitive ability and nutritional quality of perennial and Italian ryegrasses. Plant Pathology 36:455 - 461

Webb C, Stewart A and Harmer M. 2019. Progress in breeding for crown rust (*Puccinia coronata* f.sp. *lolii*) resistance in perennial ryegrasses. Proceedings of the 2019 Agronomy Australia Conference, 25 – 29 August 2019, Wagga Wagga, Australia.

Tall fescue (*Festuca arundinacea*) as a pasture for intensive dairy production compared with perennial ryegrass (*Lolium perenne*)

Sigrun Ammann*, Dalena Lombard, Lethu Zulu

Western Cape Department of Agriculture, Research and Technology Development, Directorate Plant Sciences, Outeniqua Research Farm, P.O. Box 24, George 6530

*Sigrun.ammann@westerncape.gov.za

Introduction

Why should tall fescue (*Festuca arundinacea*) be considered as a pasture species for intensive dairy production if there are species like perennial ryegrass (*Lolium perene*) available? There are various advantages that tall fescue has over perennial ryegrass which makes it an interesting species for the climatic and soil conditions of the southern Cape region.

Tall fescue has a higher temperature tolerance for active growth than perennial ryegrass does. White (1973) gives the optimal temperature range for growth in temperate species as 20 to 25°C. According to Raeside et al (2012), the temperature range for active growth in tall fescue is 30 to 35°C, at which sward density is also retained. Tall fescue can tolerate both dry and wet conditions (Dairy Australia Tall fescue Factsheet) and responds more effectively to summer rainfall than perennial ryegrass does (Raeside et al 2012).

Tall fescue has a far deeper root system than perennial ryegrass and can extract soil moisture from lower soil levels (Garwood and Sinclair 1979). This imparts greater drought tolerance associated with the volume of roots present at lower soil levels than is the case for perennial ryegrass (Garwood and Sinclair 1979).

The trial data from the Outeniqua Resarch Farm has shown tall fescue to have good persistence with a stable yielding capacity over time and additionally a compact flowering window (Ammann et al 2022). Tall fescue can tolerate a flexible grazing rotation with regard to leaf number, from two to the four leaf stage (Donaghy et al 2008; Kaufononga et al 2017). The best forage quality is achieved at the lower leaf stage while the highest dry matter production is realized at the higher leaf stages (Donaghy et al 2008).

Overall these characteristics point to a more robust species that is adapted to a wide range of conditions. This can be of value in the Southern Cape, which is not a summer rainfall area but rather year-round rainfall skewed towards being drier in summer.

In order for a species to be used as an alternative to perennial ryegrass, the yield needs to be comparable

Data used in this comparison

as does the forage quality.

The data for the comparison is taken from trials at the Outeniqua Research Farm. They were all planted on the same field with the same soil type and received the same irrigation.

The trials from which data for the significantly ($p<0.05$) highest yielding cultivars is taken and their associated planting dates are as follows:

- Tall fescue (Fa1) planted 10 March 2017 compared with perennial ryegrass trial Lp2, planted 10 March 2017.
- Tall fescue trial Fa2, planted 3 March 2020 and perennial ryegrass trial Lp5, planted 5 March 2020.

Harvest intervals were as follows:

- Tall fescue: 2.25 leaf
- Perennial ryegrass: 2.75 to 3 leaf, and in spring canopy closure if it occurred before the target leaf stage.

Forage quality data used is the mean of all the data for the statistically ($p<0.05$) highest yielding cultivars in the various trials using the NIRS Dairyland (CalLabs) AMTS method.

Results

1. Dry matter yield

Dry matter yield comparisons are shown for the two three-year periods autumn 2017 to summer 2019/20 and autumn 2020 to summer 2022/23. The graph in figure 1 shows that for the trials established in March 2017, the perennial ryegrass had a higher yield in the establishment autumn as well as the second winter

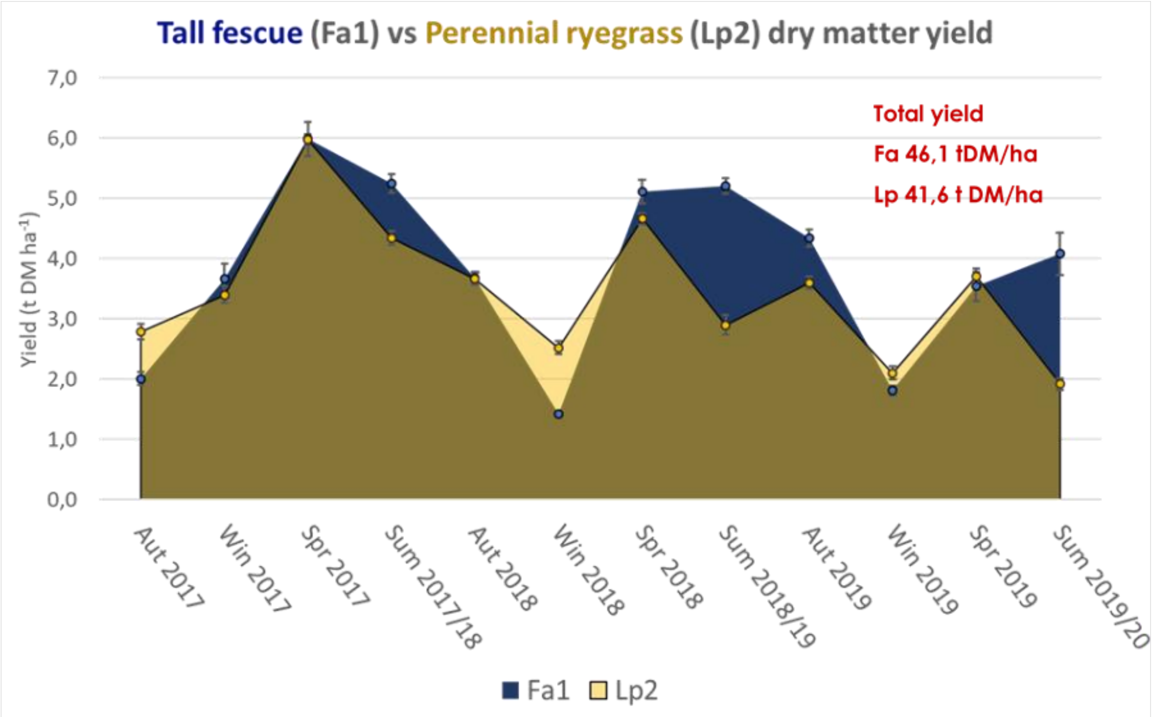


Figure 1. Seasonal dry matter yield comparison of tall fescue (blue area, trial Fa1, and perennial ryegrass (brown area), trial Lp2, for the period autumn 2017 to summer 2019/20.

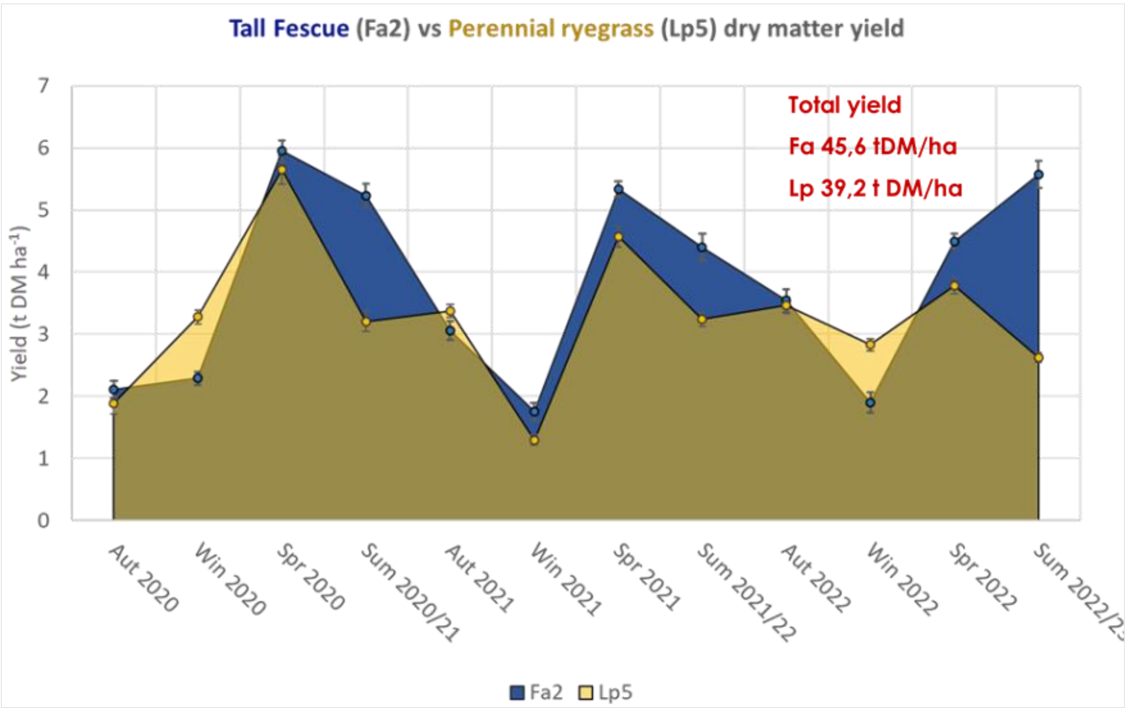


Figure 2. Seasonal dry matter yield comparison of tall fescue (blue area, trial Fa2, and perennial ryegrass (brown area), trial Lp5, for the period autumn 2020 to summer 2022/23.

and to a small extent also the third winter. The tall fescue had the superior yield in the first summer, the second spring, summer and autumn and the third summer. In total this amounted to a dry matter yield of 46.1 t DM/ha for tall fescue over the three period and 41.6 t DM/ha for the perennial ryegrass.

In the second trial period shown in figure 2, the autumn yield for both species was the same (SE overlapping), while the perennial ryegrass was superior in the first and third winter. However during the second winter the tall fescue was superior in yield. The tall fescue for this particular three-year period had a higher yield for all the warmer months, spring and summer. The total yield over the three years was 45.6 t DM/ha for the tall fescue and 39.2 t DM/ha for the perennial ryegrass.

The accumulated yield shown in figures 3 and 4 below shows the tall fescue yield starting to outperform the perennial ryegrass in the second summer, after 18 months in the first trial period, while in the second trial period the tall fescue had a greater yield accumulation already from the first summer onwards. The yield accumulation is linear with an R^2 of 0.99 in all cases.

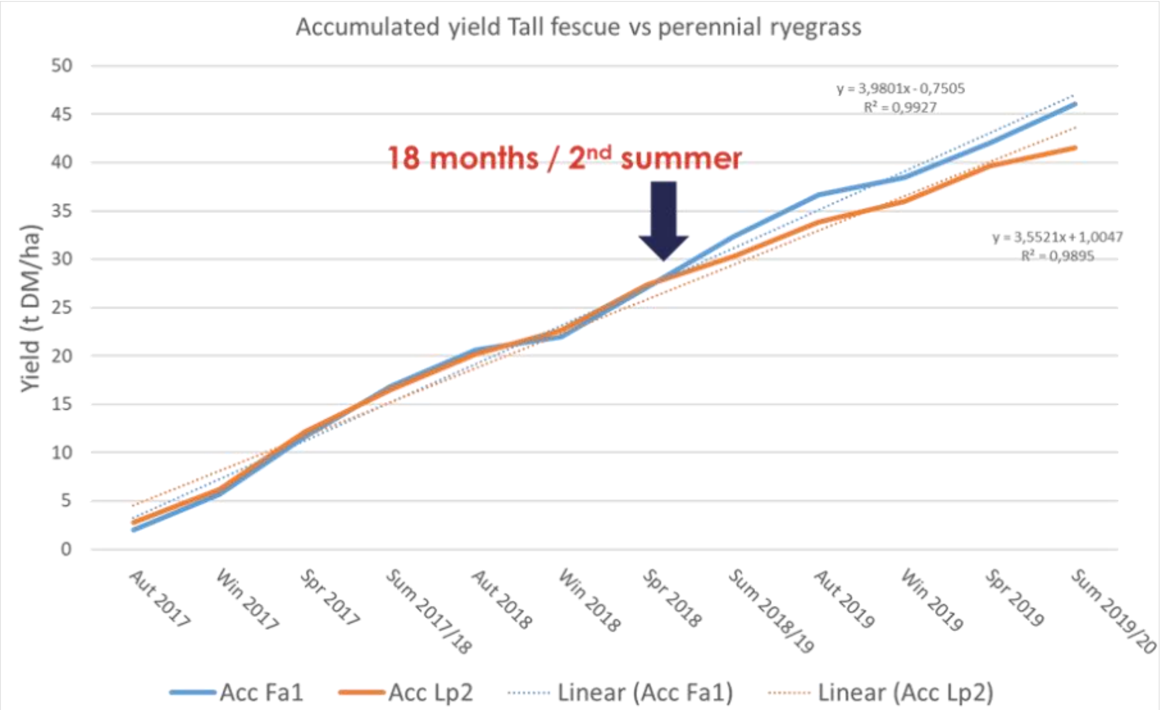


Figure 3. Yield accumulation for the first trial period autumn 2017 to summer 2019/20 with the tall fescue shown with the blue line and the perennial ryegrass with the orange line.

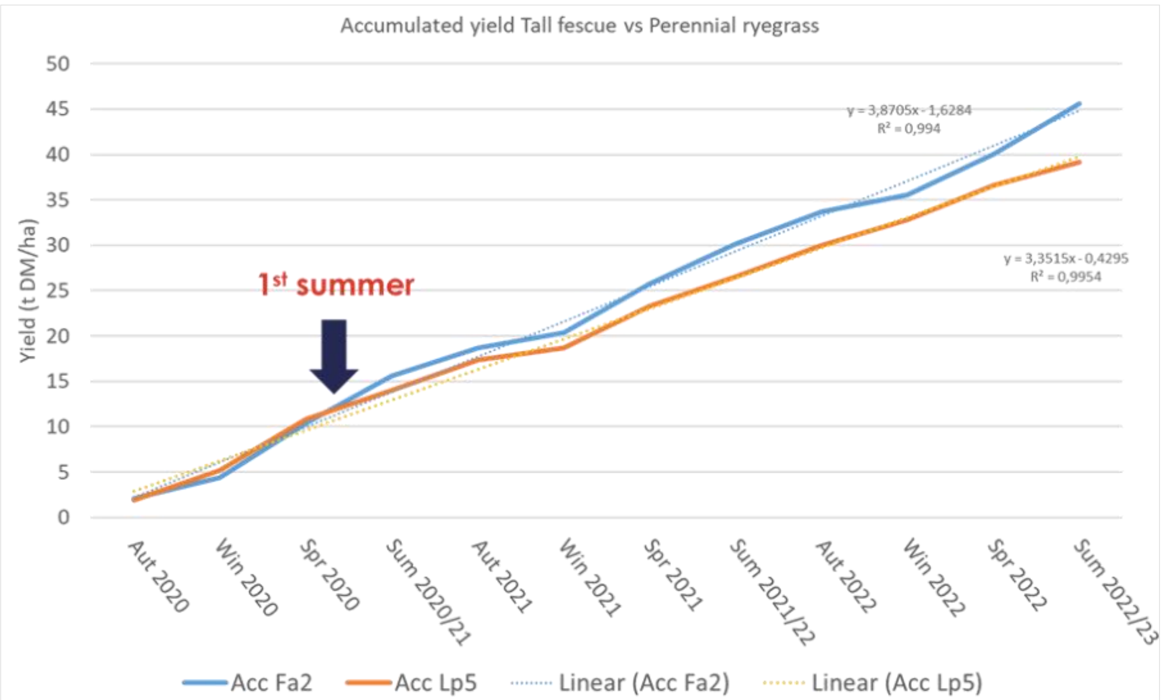


Figure 4. Yield accumulation for the first trial period autumn 2020 to summer 2022/23 with the tall fescue shown with the blue line and the perennial ryegrass with the orange line.

2. Flowering/bolting incidence

The importance of flowering or the plant changing from the vegetative to the reproductive phase is the resulting increased fibre content with the associated increase in NDF%. The higher the flowering incidence is the more advanced the flowering stage is, the higher the NDF will be. NDF is known to be the main determinant of intake.

The NDF values given in this trial data is taken from the entire sample being leaf and stem material. Work done by Chapman et al (2008) showed that the ME value of consumed pasture was higher for that fescue than perennial ryegrass. The likely reason is that in a tall fescue pasture the cows are able to more easily select green leafy material than they can in a perennial ryegrass pasture (Dairy Australia Tall fescue Factsheet).

In Table 1 and 2 the flowering or bolting incidence is shown for tall fescue and perennial ryegrass respectively. During both the first year and second year the flowering window for tall fescue was relatively narrow and especially in the first year the bolting percentages were low. For perennial ryegrass flowering/bolting extended over a much longer time period, especially in the first year from September to January. The extent of flowering percentage is also related to the number of cold days for the specific winter for primary induction in the vernalisation process.

In Table 1 and 2 the flowering or bolting incidence is shown for tall fescue and perennial ryegrass respectively. During both the first year and second year the flowering window for tall fescue was relatively narrow and especially in the first year the bolting percentages were low. For perennial ryegrass flowering/bolting extended over a much longer time period, especially in the first year from September to January. The extent of flowering percentage is also related to the number of cold days for the specific winter for primary induction in the vernalisation process.

Table 1. Tall fescue (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Reproductive tillers/bolting (ratings based)** Individual harvests

Trial is continuing

	Type	Cut 1	Cut 2	Cut 3	Cut 4	Cut 5	Cut 6	Cut 7	Cut 8	Cut 9
Cultivars		**19/5/2020**	**8/7/2020**	**15/9/2020**	**23/10/2020**	**23/11/2020**	**4/1/2021**	**12/2/2021**	**8/4/2021**	**19/5/2021**
Boschhoek	TF-C	0	0	25	21	0	0	0	0	0
Easton	TF-C	0	0	8	13	0	0	0	0	0
Quantico	TF-C	0	0	8	4	8	0	0	0	0
Royal-Q	TF-C/M	0	0	13	17	0	0	0	0	0
Tower	TF-C	0	0	0	25	17	0	0	0	0

	Type	Cut 10	Cut 11	Cut 12	Cut 13	Cut 14	Cut 15	Cut 16	Cut 17
Cultivars		**10/8/2021**	**1/10/2021**	**4/11/2021**	**20/12/2021**	**31/1/2022**	**16/3/2022**	**25/4/2022**	**13/6/2022**
Boschhoek	TF-C	3	**67**	0	0	0	0	0	0
Easton	TF-C	0	13	25	0	0	0	0	0
Quantico	TF-C	0	17	19	0	0	0	0	0
Royal-Q	TF-C/M	0	**50**	13	0	0	0	0	0
Tower	TF-C	0	0	**54**	0	0	0	0	0

Fa = *Festuca arundinacea* (Tall fescue), C = Continental type, M = Mediterranean type, FL = *Festulolium*, L = loloid, F = festucoid

Table 2. Perennial ryegrass (Lolium perenne), Lp 5, Elite Evaluation, Outeniqua Research Farm

Planted: 5 March 2020 **Reproductive tillers/ Bolting % (rating based)** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 1 18/5/2020	Cut 2 24/6/2020	Cut 3 3/8/2020	Cut 4 16/9/2020	Cut 5 21/10/2020	Cut 6 25/11/2020	Cut 7 22/12/2020	Cut 8 18/1/2021	Cut 9 25/2/2021
					Early piping	Piping	Piping + heading	Heading	Heading	
24Seven	D	0	0	0	8	13	25	17	17	0
Base	T	0	0	0	0	29	33	21	17	0
Governor	D	0	0	0	8	21	17	0	13	0
Legion	D	0	0	0	4	13	17	0	0	0
One50	D	0	0	0	13	21	21	17	13	0
Platform	D	0	0	0	0	17	17	4	0	0
Tanker	T	0	0	0	0	33	**63**	29	25	0
Viscount	T	0	0	0	8	33	**46**	4	21	0

Cultivars	Type	Cut 10 30/3/2021	Cut 11 3/5/2021	Cut 12 4/6/2021	Cut 13 7/7/2021	Cut 14 24/8/2021	Cut 15 4/10/2021	Cut 16 4/11/2021	Cut 17 7/12/2021	Cut 18 4/1/2022
								Piping + Late piping	Heading	Heading
Base	T	0	0	0	0	0	0	13	25	4
Governor	D	0	0	0	0	0	0	21	25	0
Legion	D	0	0	0	0	0	0	13	13	0
One50	D	0	0	0	0	0	0	13	25	0
Platform	D	0	0	0	0	0	0	17	21	0
Tanker	T	0	0	0	0	0	0	38	**58**	13
Viscount	T	0	0	0	0	0	0	25	25	5

Forage quality

A very important question in this comparison of the two species is the forage quality. Since NDF% is a major determinant of intake, this parameter was used in the comparison. Figure 5 below shows the NDF % for tall fescue and perennial ryegrass at the various sampling times.

Generally the NDF% of tall fescue is higher than that of perennial ryegrass as would be expected, except in winter.

In order to determine the digestible yield for the two species, a digestibility calculation was done as indicated below according to Mertens (2009).

DMD = dNDF + dNDS – Endogenous loss

NDF = Neutral Detergent Fibre

NDS = Neutral Detergent Solubles (almost completely digestible (0,98) Van Soest 1967)

dNDF = NDF x NDFD30

NDS = 100 – NDF

dNDS = 0,98 x NDS

Endogenous loss = -12,9

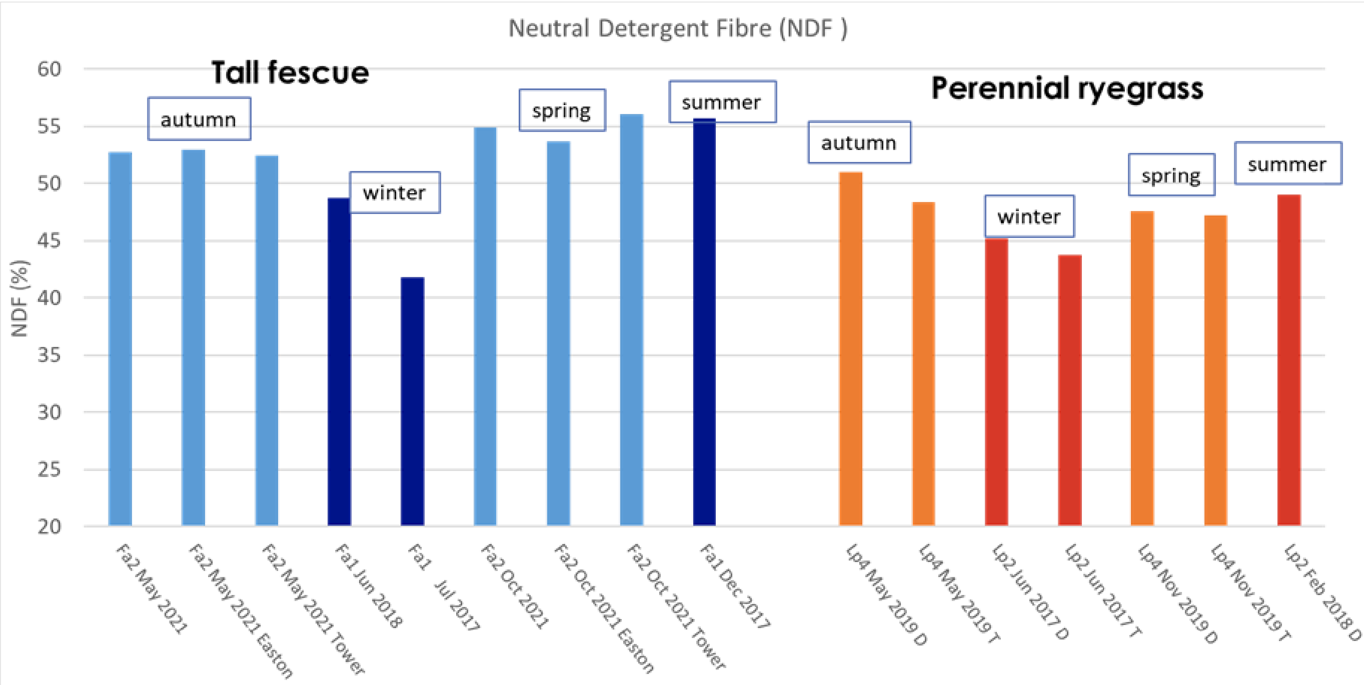


Figure 5. NDF% for the various sampling times for tall fescue (blue bars) and perennial ryegrass (red/orange bars).

In figure 6 the calculated dry matter digestibility per season for tall fescue and perennial ryegrass are shown. The perennial ryegrass has a higher digestibility over all seasons.

The rate of NDF digestibility, also referred to as the kd rate which represents the percentage of NDF digested per hour (%NDF/hr) is given in figure 7. This should preferably be less than 15 hours (Meeske pers comm. 2023), which means a rate of at least 6,7%NDF/hr. The values in figure 7 show that tall fescue is in the required range and perennial ryegrass in spring has a similar value to tall fescue.

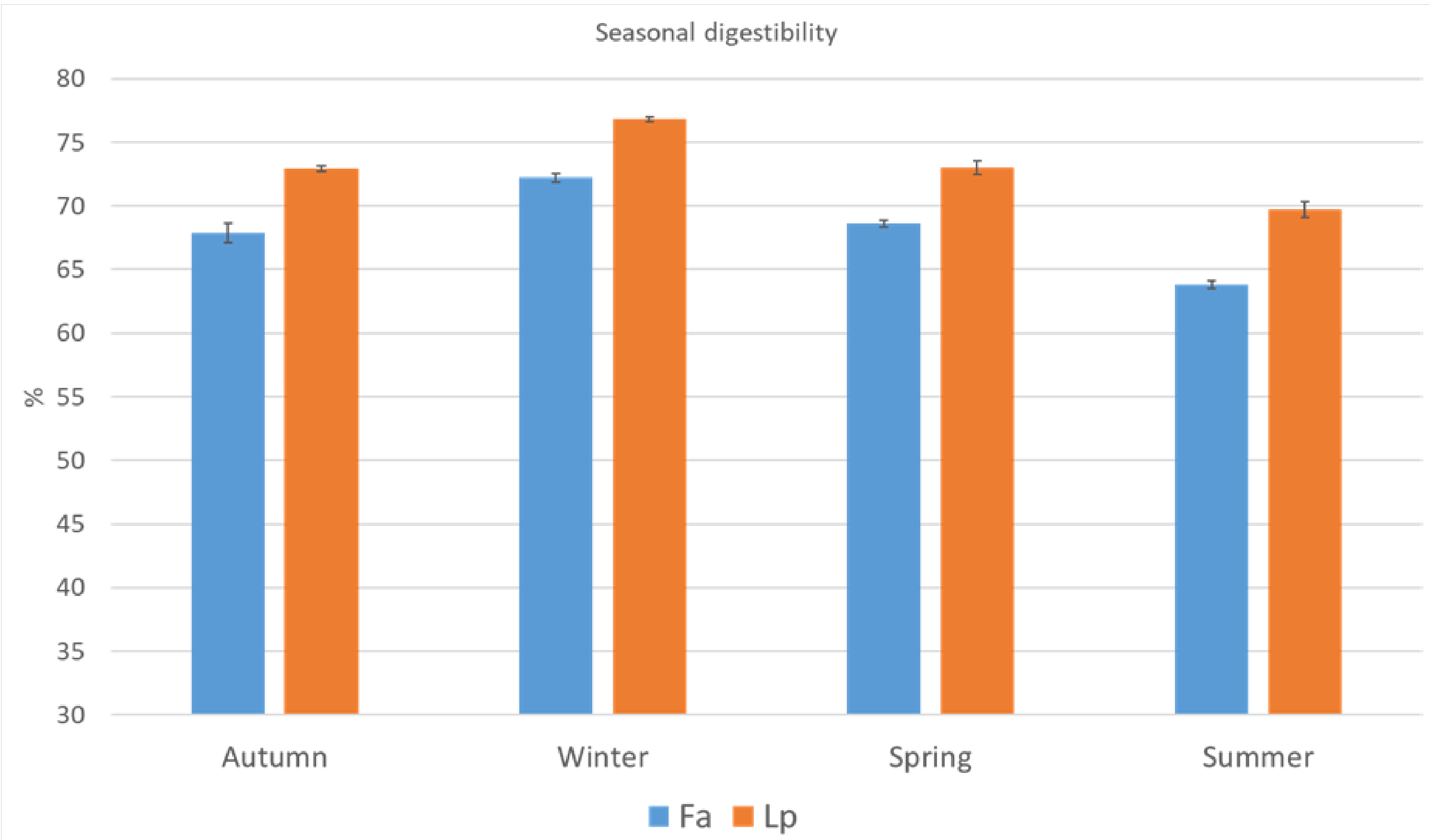


Figure 6. Dry matter digestibility calculated for tall fescue (Fa) and perennial ryegrass (Lp) for the four seasons.

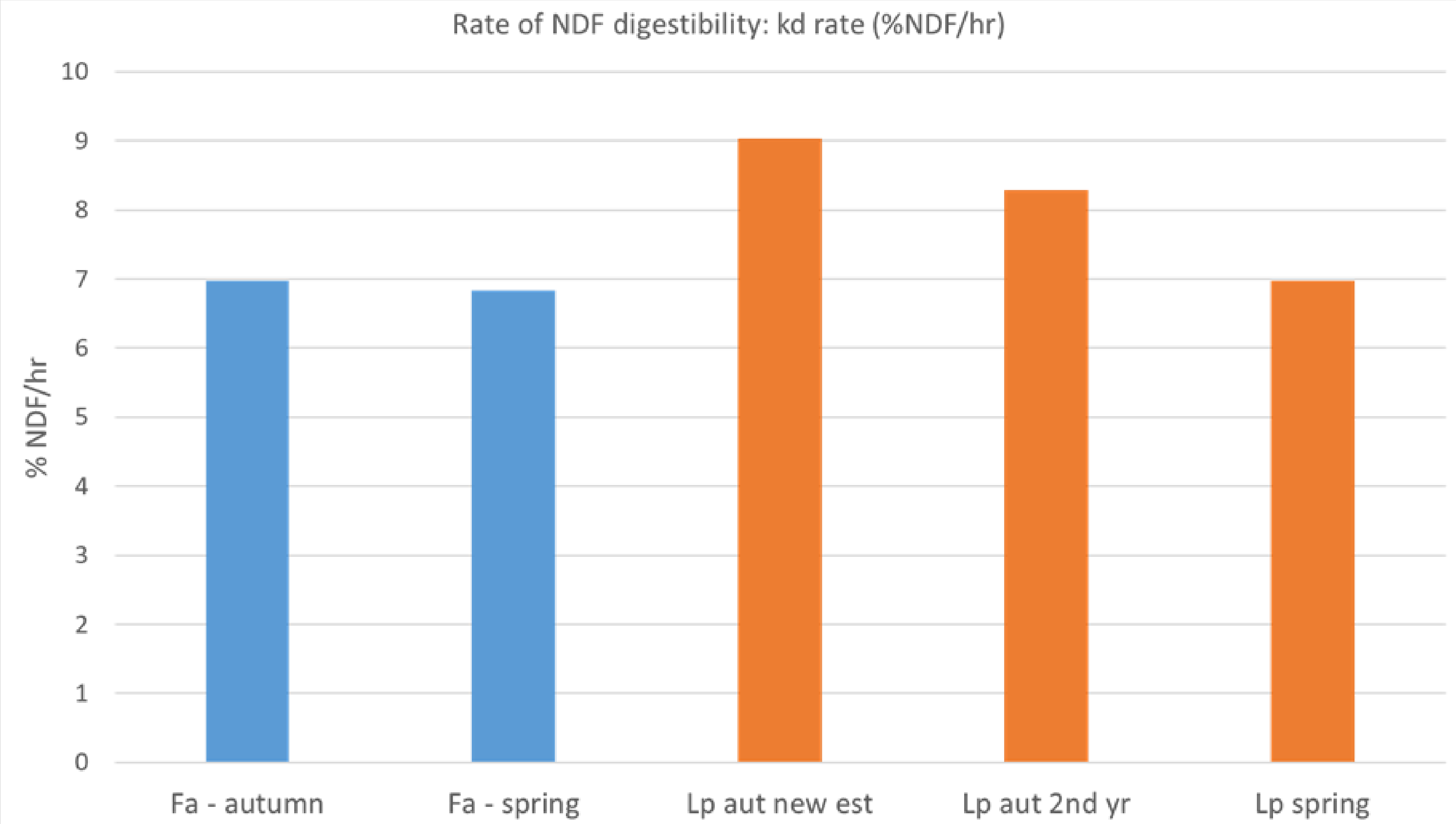


Figure 7. The kd rate as %NDF digested per hour is shown for tall fescue (Fa) and perennial ryegrass (Lp) for autumn and spring.

4. Digestible yield

species is indicated in figure 8 for the first trial period. Tall fescue retained an advantage in digestible yield in the warm seasons but particularly in year two and three . The total digestible yield over three years was similar for the two species with tall fescue at 30,9 t/ha and perennial ryegrass with 30,6 t/ha.

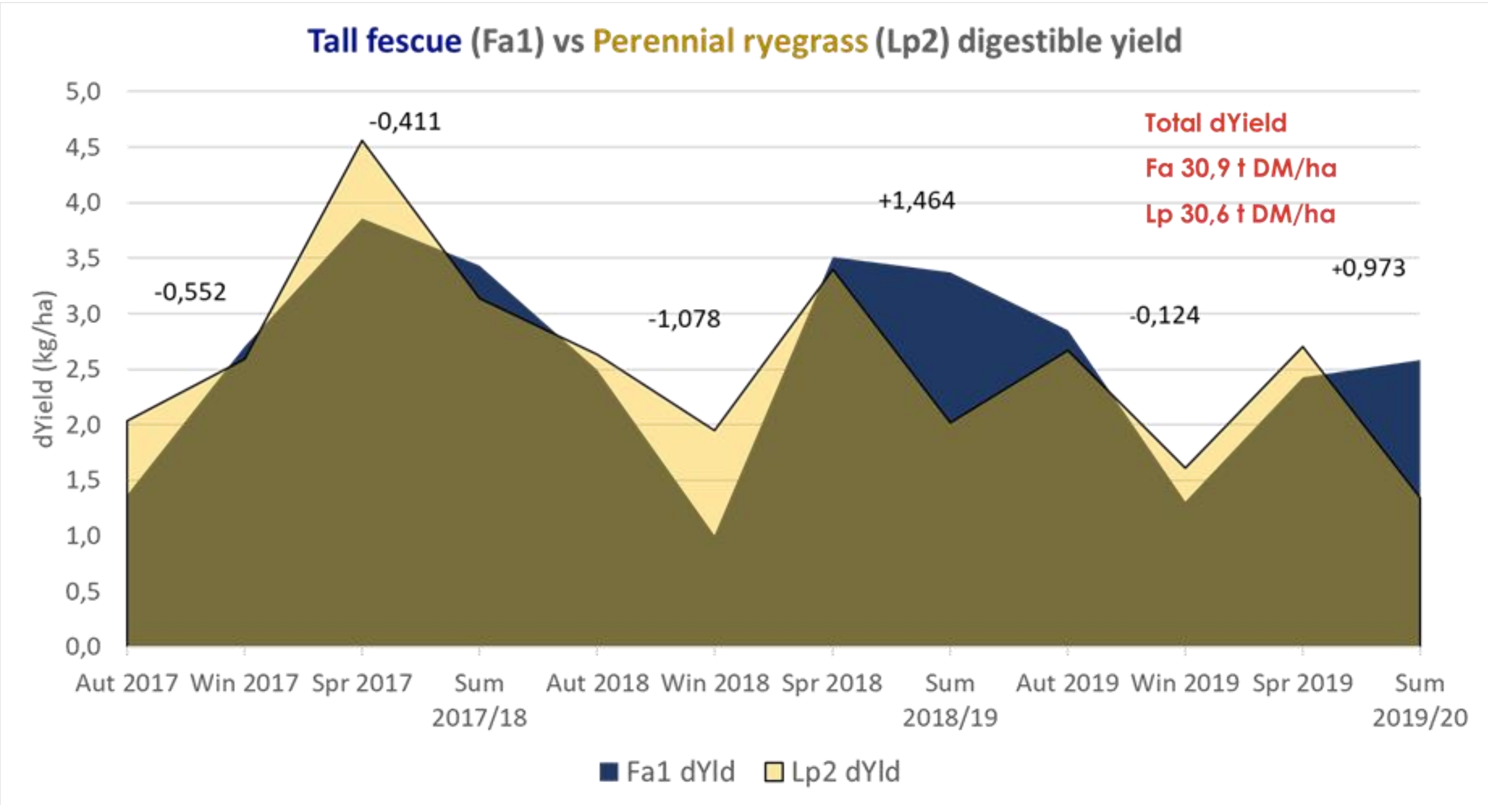


Figure 8. The digestible dry matter yield (dYield) is sown for tall fescue (dark blue) and perennial ryegrass (brown) with seasonal deficits and gains of tall fescue relative to perennial ryegrass indicated by the values above the graph.

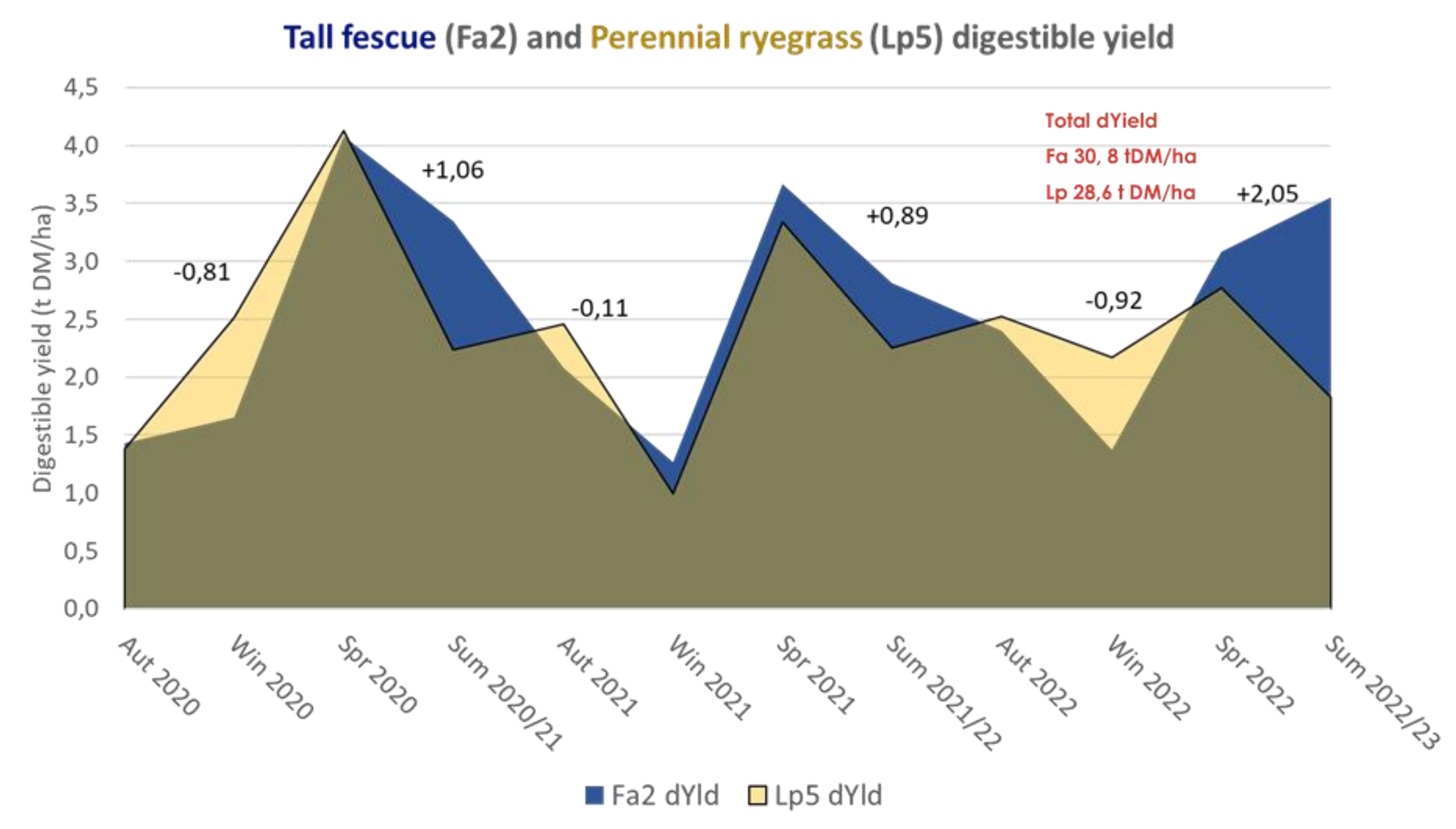


Figure 9. The digestible dry matter yield (dYield) is sown for tall fescue (dark blue) and perennial ryegrass (brown) with seasonal deficits and gains of tall fescue relative to perennial ryegrass indicated by the values above the graph.

The second trial period is shown in figure 9. Tall fescue had a superior digestible yield in the warmer months for all three years. Additionally the dYield of tall fescue remained relatively stable over the three years while that of perennial ryegrass showed a decreasing trend, similar to the first trial period. In the second trial period the tall fescue had a total digestible yield of 30,8 t/ha while perennial ryegrass had 28,6 t/ha.

Digestible yield for various cultivars is sown in figures 10 and 11 for winter and summer for two and three years respectively. During winter 2022 perennial ryegrass had the higher digestible yield but for winter 2021 there was no difference between the two species. For the three summer seasons the two tall fescue cultivars had a higher digestible yield than the two perennial ryegrass cultivars.

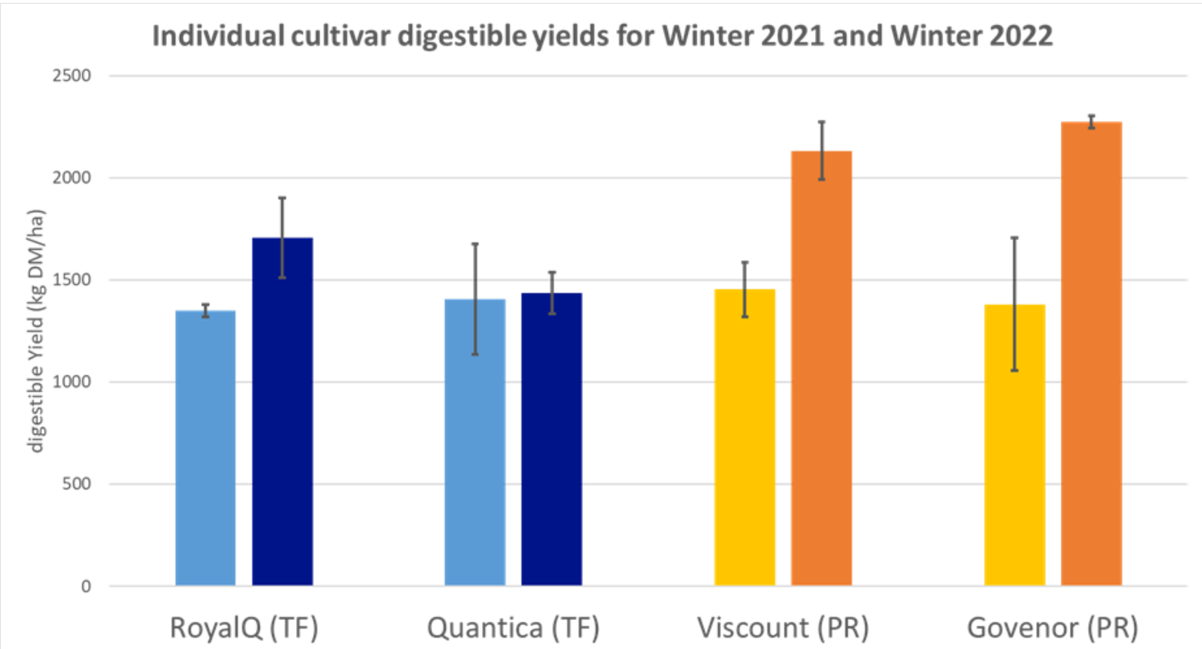


Figure 10. Digestible yield for two winter seasons 2021 and 2022 for tall fescue cultivars Royal Q-100 and Quantica and for the perennial ryegrass cultivars Viscount and Govenor.

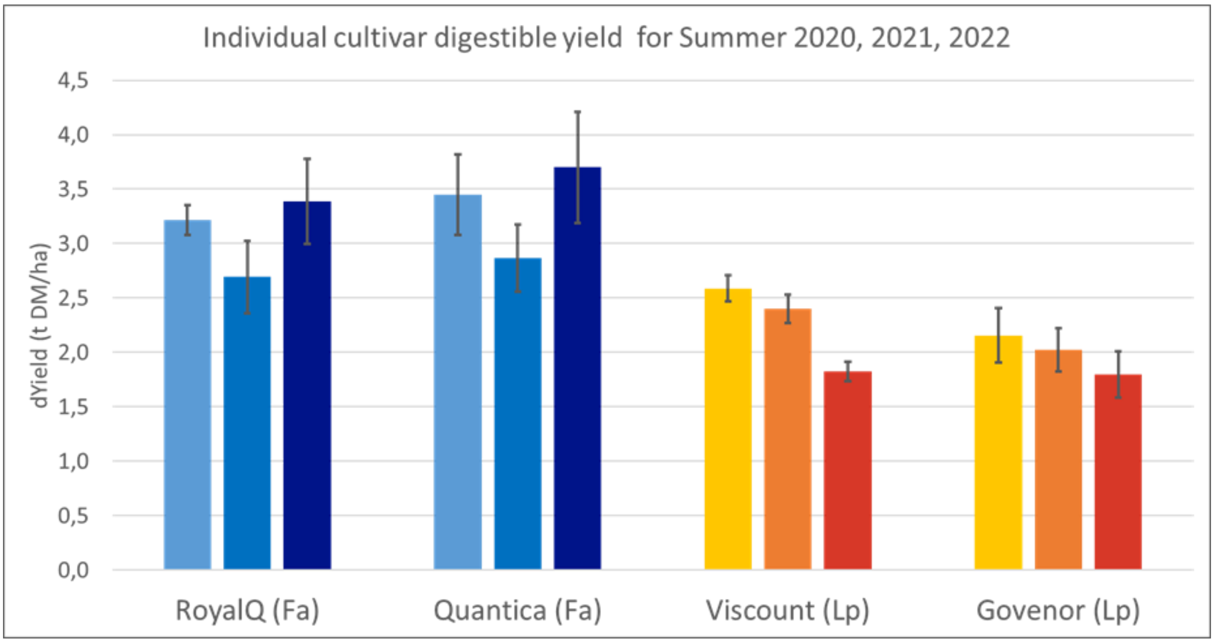


Figure 11. Digestible yield for the three summer seasons 2020, 2021 and 2022 for tall fescue cultivars Royal Q-100 and Quantica and perennial ryegrass cultivars Viscount and Govenor.

Conclusions

Tall fescue has a higher DM yield than perennial ryegrass but with a different seasonal distribution with higher yields in the warmer seasons and generally lower yields in the cooler seasons compared to perennial ryegrass. Tall fescue has yield stability over years while perennial ryegrass has a decreasing yield trend over years. Tall fescue has a higher NDF in most seasons than perennial ryegrass except in winter but tall fescue has a comparable digestible yield to perennial ryegrass. This is not taking into account the added advantage of cows being able to select leafy material in tall fescue due to the structure of the flowering stems in the sward but not in perennial ryegrass. It is very important to choose the correct tall fescue cultivar that has good total production and some cool season growth activity in addition to the warm season growth.

Tall fescue in pasture systems is recommended to be used in combination with low NDF species such as red clover and plantain with an expected further positive effect on digestible yield. The excess high quality yield of such a combination in summer can be ensiled and fed back in the winter months. Tall fescue does not need annual over-sowing which leads to reduced inputs and no disruptions to the grazing cycles, which has a positive effect on the farm fodder flow overall.

References

Ammann Sigrun, Lombard Dalena and Zulu Lethu. 2022. Tall fescue and Festulolium cultivar evaluation results: 2020 to 2022. Outeniqua Information Day Milk Production from Planted Pastures 21 September 2022.

Dairy Australia Tall Fescue Fact sheet. www.dairyaustralian.com.au

Donaghy DJ, Turner LR, Adamczewski KA. 2008. Effect of defoliation management on water-soluble carbohydrate energy reserves, dry matter yields, and herbage quality of tall fescue. Agronomy Journal. 100:122–127

Garwood EA and Sinclair J. 1979. Use of water by six grass species. 2. Root distribution and use of soil water. Journal of Agricultural Science 93: 25-35.

Kaufononga S, Donaghy DJ, Hemdriks SJ, Matthew C, Kemp PD and Cranston LM. 2017. Comparative response of tall fescue and perennial ryegrass swards to variation in defoliation interval and height. NZ Journal of Agricultural Research doi.org/10.1080/00288233.2017.1354893

Mertens DR. 2009. Impact of NDF content and digestibility on dairy cow performance.

Advances in Dairy Technology 21: 191 - 201

Meeske R. pers comm. 2023. Specialist Scientist Dairy Research, Outeniqua Research Farm, Western Cape Department of Agriculture.

White LM. 1973. Carbohydrate reserves of grasses: a review. Journal of Range Management 26: 13 – 18.

Raeside MC, Friend MA, Behrendt R, Lawson AR and Clark SG. 2012. A review of summer-active tall fescue use and management in Australia's high-rainfall zone. New Zealand Journal of Agricultural Research Vol. 55, No. 4, 393-411.

Van Soest, PJ. (1967) Development of a Comprehensive System of Feed Analyses and Its Application to Forages. Journal of Animal Science, 26, 119-128.

Cocksfoot cultivar evaluation results for 2022 to 2023

Dalena Lombard, Sigrun Ammann, Lethu Zulu

Western Cape Department of Agriculture, Research and Technology Development, Directorate Plant Sciences, Outeniqua Research Farm, PO Box 249, George, 6530

Dalena.Lombard@westerncape.gov.za

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.

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 – also sometimes referred to as Mediterranean types
- Intermediate types

Cocksfoot (*Dactylis glomerata*), as an alternative for perennial ryegrass pastures is currently being investigated. 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. Forage quality should also in future be determined, as it is an important factor. By evaluating cocksfoot at Outeniqua we can gather climate specific yield and persistence data, an important decision making factor.

Cultivars evaluated

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

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.

Table 1. Cocksfoot (*Dactylis glomerata*), Dg 1, Outeniqua Research Farm

Planted: 1 March 2022 **Seasonal Yield** (t DM/ha)

Variety	Autumn	Rank	Winter	Rank	Spring	Rank	Summer	Rank	Autumn	Rank	Total Year 1	Rank
Adremo	2.52^{a}	1	3.53^{cdef}	7	8.65^{abc}	6	4.91^{ab}	4	3.41^{ab}	2	19.6^{a}	1
Archibaldi	2.18^{abcde}	6	4.38^{ab}	2	8.55^{abcd}	8	4.38^{bcde}	10	3.52^{a}	1	19.5^{ab}	2
Captur	2.47^{ab}	2	4.18^{abc}	4	8.82^{ab}	3	3.85^{ef}	13	2.88^{bcde}	10	19.3^{abc}	3
Aldebaran	2.22^{abcd}	4	3.33^{def}	9	7.61^{d}	14	4.41^{bcde}	9	2.85^{cde}	11	17.6^{def}	12
Dascada	1.73^{def}	12	2.81^{fg}	12	8.67^{abc}	5	4.82^{ab}	5	2.63^{def}	12	18.0^{cde}	11
Echelon	1.21^{f}	14	3.35^{def}	8	8.62^{abc}	7	5.12^{a}	1	3.31^{abc}	4	18.3^{abcde}	9
Donata	2.09^{abcde}	8	2.26^{g}	13	7.87^{bcd}	12	3.98^{def}	12	2.30^{f}	14	16.2^{f}	14
Savvy	2.16^{abcde}	7	4.20^{abc}	3	8.73^{ab}	4	3.81^{f}	14	3.24^{abc}	6	18.9^{abcd}	5
Bardarus	1.89^{cde}	10	4.59^{a}	1	8.30^{abcd}	10	4.49^{bcd}	7	3.37^{abc}	3	19.3^{abc}	4
Inavale	1.93^{bcde}	9	2.99^{efg}	10	9.05^{a}	1	4.71^{abc}	6	3.30^{abc}	5	18.7^{abcd}	6
Olathe	2.35^{abc}	3	2.23^{g}	14	8.92^{a}	2	5.09^{a}	2	3.15^{abcd}	7	18.6^{abcde}	7
Aurus	2.19^{abcde}	5	3.69^{bcde}	6	8.11^{abcd}	11	4.20^{cdef}	11	3.07^{abcd}	8	18.2^{bcde}	10
Sparta	1.85^{cde}	11	2.85^{fg}	11	7.76^{cd}	13	4.93^{ab}	3	2.39^{ef}	13	17.4^{ef}	13
Oberon	1.66^{ef}	13	3.83^{abcd}	5	8.48^{abcd}	9	4.45^{bcd}	8	3.03^{abcd}	9	18.4^{abcde}	8
LSD (0.05)	0.54		0.77		0.95		0.55		0.53		1.42	
CV%	15.92		13.38		6.73		7.32		10.49		4.61	
SE	0.09		0.20		0.12		0.12		0.10		0.25	

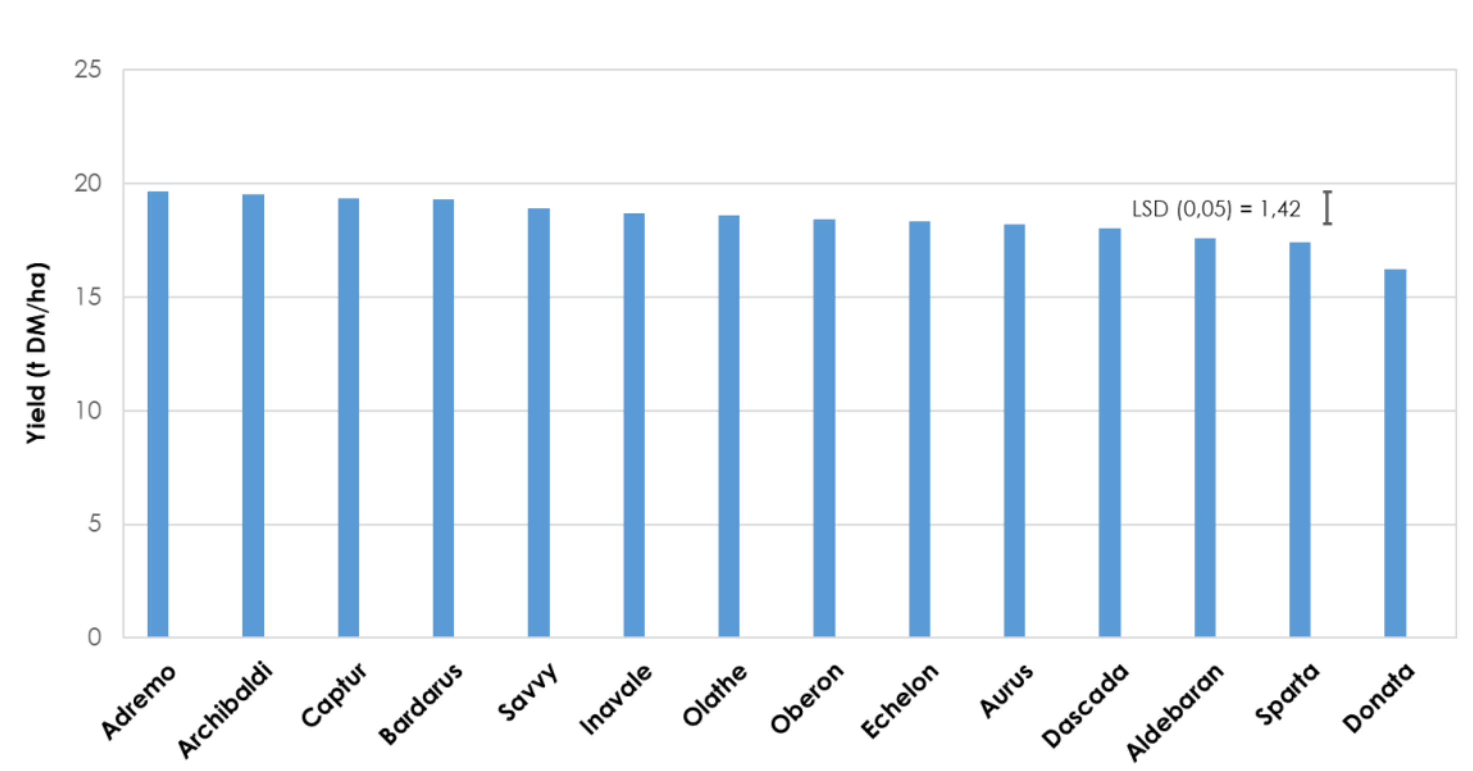


Figure 1. Total year 1 yield (t DM/ha) for cocksfoot

Table 2. Cocksfoot (*Dactylis glomerata*), Dg 1, Outeniqua Research Farm

Planted: 1 March 2022 **Seasonal Growth Rate** (kg DM/ha/day)

Variety	Autumn	Rank	Winter	Rank	Spring	Rank	Summer	Rank	Autumn	Rank	Total Year 1	Rank
Adremo	60.1^{a}	1	38.4^{cdef}	7	95.1^{abc}	6	54.6^{ab}	4	37.1^{ab}	2	62.3^{a}	1
Archibaldi	51.8^{abcde}	6	47.6^{ab}	2	93.9^{abcd}	8	48.7^{bcde}	10	38.3^{a}	1	61.0^{ab}	2
Captur	58.0^{ab}	2	45.5^{abc}	4	96.9^{ab}	3	42.8^{ef}	13	31.3^{bcde}	10	61.3^{abc}	3
Aldebaran	52.74^{abcd}	4	36.2^{def}	9	86.6^{d}	14	49.0^{bcde}	9	31.0^{cde}	11	55.7^{def}	12
Dascada	41.3^{def}	12	30.54^{fg}	12	95.2^{abc}	5	53.6^{ab}	5	28.6^{def}	12	57.3^{cde}	11
Echelon	28.8^{f}	14	36.4^{def}	8	94.7^{abc}	7	56.9^{a}	1	35.9^{abc}	4	58.1^{abcde}	9
Donata	49.8^{abcde}	8	24.6^{g}	13	86.5^{cde}	12	44.6^{def}	12	25.0^{f}	14	51.5^{f}	14
Savvy	51.5^{abcde}	7	45.6^{abc}	3	96.0^{ab}	4	42.3^{f}	14	35.2^{abc}	6	60.0^{abcd}	5
Bardarus	45.1^{cde}	10	49.9^{a}	1	91.2^{abcd}	10	49.9^{bcd}	7	36.7^{abc}	3	61.2^{abc}	4
Inavale	46.0^{bcde}	9	32.5^{efg}	10	99.4^{a}	1	52.4^{abc}	6	35.9^{abc}	5	59.3^{abcde}	6
Olathe	56.0^{abc}	3	24.2^{g}	14	98.1^{a}	2	56.6^{a}	2	34.3^{abcd}	7	59.0^{abcde}	7
Aurus	52.3^{abcde}	5	40.18^{bcde}	6	89.1^{abcd}	11	46.7^{cdef}	11	33.4^{abcd}	8	57.8^{bcde}	10
Sparta	44.0^{cde}	11	31.0^{fg}	11	85.2^{cd}	13	54.8^{ab}	3	26.0^{ef}	13	55.2^{ef}	13
Oberon	39.6^{ef}	13	41.6^{abcd}	5	93.1^{abcd}	9	49.5^{bcd}	8	33.0^{abcd}	9	58.5^{abcde}	8
LSD (0.05)	12.94		8.41		10.47		6.16		5.81		4.52	
CV%	15.92		13.38		6.73		7.32		10.49		4.61	
SE	2.23		2.19		1.21		1.30		1.10		0.79	

Note: treatments with the same letter are similar i.e. not significantly different

Table 3: Cocksfoot (*Dactylis glomerata*), Dg 1, Outeniqua Research Farm

Planted: 1 March 2022 **Leaf rust % (ratings based)**

Variety	Cut 2	Cut 3	Cut 4	Cut 5	Cut 6	Cut 7	Cut 8	Cut 9	Cut 10	Cut 11	Cut 12
Adremo	0	0	0	0	0	0	0	0	0	0	0
Archibaldi	0	0	0	0	0	0	0	0	0	0	0
Captur	0	0	0	0	0	0	0	0	0	0	0
Aldebaran	0	0	0	0	0	0	0	0	8	29	0
Dascada	0	0	4	50	0	0	0	0	4	13	17
Echelon	0	0	0	4	0	0	0	0	0	17	25
Donata	0	0	0	4	0	0	0	0	0	42	4
Savvy	0	0	0	0	0	0	0	0	0	0	0
Bardarus	0	0	0	0	0	0	0	0	0	0	0
Inavale	0	0	0	0	0	0	0	0	0	0	4
Olathe	0	0	4	42	0	0	0	0	0	13	0
Aurus	0	0	0	0	0	0	0	0	0	0	0
Sparta	0	0	75	83	0	0	0	0	71	79	42
Oberon	0	0	0	0	0	0	0	0	0	0	0

Table 4. Cocksfoot (*Dactylis glomerata*), Dg 1, Outeniqua Research Farm

Planted: 1 March 2022 **Reproductive tillers/Bolting % (ratings based)**

Variety	Cut 2	Cut 3	Cut 4	Cut 5	Cut 6	Cut 7	Cut 8	Cut 9	Cut 10	Cut 11	Cut 12
				Piping	Piping + Heading	Heading					
Adremo	0	0	0	13	8	0	0	0	0	0	0
Archibaldi	0	0	0	4	0	0	0	0	0	0	0
Captur	0	0	0	0	0	0	0	0	0	0	0
Aldebaran	0	0	0	0	0	4	0	0	0	0	0
Dascada	0	0	0	0	13	4	0	0	0	0	0
Echelon	0	0	0	8	13	4	0	0	0	0	0
Donata	0	0	0	0	0	4	0	0	0	0	0
Savvy	0	0	0	4	0	0	0	0	0	0	0
Bardarus	0	0	0	4	4	0	0	0	0	0	0
Inavale	0	0	0	13	13	0	0	0	0	0	0
Olathe	0	0	0	17	13	0	0	0	0	0	0
Aurus	0	0	0	13	33	0	0	0	0	0	0
Sparta	0	0	0	0	13	0	0	0	0	0	0
Oberon	0	0	0	0	0	0	0	0	0	0	0

Notes: At the early piping stage (EP), the tillers may survive grazing i.e. growth points are not removed, if the grazing residual is not lower than 5cm. A notable increase in fibre content already occurs at the piping (P) stage. At Late piping (LP) and heading (EH, H) there is significant stem formation with the associated reduction in forage quality.

Table 5. Cocksfoot (*Dactylis glomerata*), Dg 1, Outeniqua Research Farm

Planted: 1 March 2022 **Sward density % (ratings based)**

Variety	Cut 2	Cut 3	Cut 4	Cut 5	Cut 6	Cut 7	Cut 8	Cut 9	Cut 10	Cut 11	Cut 12
Adremo	100	100	100	100	100	100	100	92	100	100	100
Archibaldi	100	100	100	100	100	100	100	79	100	100	100
Captur	100	100	100	100	100	100	100	75	92	96	100
Aldeba-ran	100	100	100	100	100	100	100	100	100	100	100
Dascada	100	100	100	100	100	100	100	100	100	100	96
Echelon	100	100	100	100	100	100	100	88	100	100	100
Donata	100	100	100	100	100	100	100	67	88	100	100
Savvy	100	100	100	100	100	100	100	83	92	100	100
Bardarus	100	100	100	100	100	100	100	92	100	100	100
Inavale	100	100	100	100	100	100	100	96	100	100	100
Olathe	100	100	100	100	100	100	100	96	100	100	100
Aurus	100	100	100	100	100	100	100	88	100	100	100
Sparta	100	100	100	100	100	100	100	100	100	96	92
Oberon	100	100	100	100	100	100	100	100	100	100	100

Parameters reported

- Seasonal dry matter (DM) yield
- Seasonal growth rate
- Disease incidence (mainly rust)
- Flowering behavior
- Sward density (persistence)

In terms of year-round pasture use, the total DM production is important. Secondly, the seasonal yield distribution for winter, summer and early autumn are important considerations.

Seasonal DM production is indicated in **Table 1**. During winter 2022 Bardarus, Archibaldi, Savvy, Captur and Oberon (4.59, 4.38, 4.20, 4.18 and 3.83 t DM/ha respectively), was the most winter active. The top 4 highest producing cultivars in winter had a higher production than the mean (4.02, SE ±0.1) for perennial ryegrass during the same period. The highest producing cocksfoot cultivar during winter, Bardarus, had a higher winter production (4.59 t DM/ha, SE ±0.2) than the highest producing perennial ryegrass (4.44 t DM/ha, SE ±0.1). Cultivars that had a good summer and second autumn production were Adremo, Echelon, Inavale and Olathe. None of the cultivars were able to have a highest, or similar to the highest, production during both winter and summer. All cocksfoot cultivars had a higher total year 1 production than the mean perennial ryegrass production for year 1 (14.81, SE ±0.2). **Figure 1** compares the **total yield** per cultivar of year 1.

Table 2 indicates the **seasonal growth rate** from autumn 2022 to autumn 2023. During winter 2022, the top 4 highest producing cultivars, namely Bardarus, Archibalde, Savvy and Captur (49.86, 51.83, 45.61 and 45.46 kg DM/ha/day respectively) had a higher growth rate than the mean (43.67 kg DM/ha/day, SE ±0.7) for perennial ryegrass during the same period. The highest producing cocksfoot cultivar, Bardarus, had a similar winter growth rate (49.86 kg DM/ha/day, SE ±2.19) than the highest producing perennial ryegrass (48.53 kg DM/ha/day, SE ±0.7).

Percentage of **leaf rust** per cultivar is indicated in **Table 3.** No rust was recorded on Adremo, Archibaldi, Captur, Savvy, Bardarus, Aurus and Oberon for the first 15 months (12 harvests) of the trial.

As indicated in **Table 4**, no **flowering** was recorded for Captur and Oberon during the first 15 months.

Table 5 indicates **sward density** for the first 15 months. Aldebaran, Dascada, Sparta and Oberon retained a 100% sward density during the summer months (harvests 8, 9 and 10). Archibaldi, Captur and Donata had a significantly lower sward density during harvest number 9. Only Aldebaran and Oberon was able to maintain a 100% sward density over the 15 month period.

Conclusion

The interim results of the first year highlighted the following:

- Highest yielding cultivar: Adremo
- Similar to the highest yielding: Archibaldi, Captur, Bardarus, Savvy, Inavale, Olathe, Oberon and Echelon
- Best winter yield: Bardarus
- Similar to highest winter yielding: Archibaldi, Savvy, Captur, Oberon
- Best summer yield: Echelon and Olathe
- Similar to highest summer yielding: Sparta, Adremo, Dascada and Inavale
- Lowest rust incidence: Adremo, Archibaldi, Captur, Savvy, Bardarus, Aurus and Oberon
- Shortest flowering window: Archibaldi, Savvy and Sparta
- Lowest flowering incidence: Captur and Oberon
- Best sward density: Aldebaran and Oberon
- Best overall considering all parameters: Oberon

With the objective of finding cultivars with persistence, resilience and good production, the second and third year's data will be important, as well as the forage quality determinations.

References

Ammann S. 2018. Pasture species suitable for beef production in the southern Cape. Beef Day Booklet. Western Cape Department of Agriculture. Outeniqua Research Farm.

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

Herbage production results for the first year for Italian and Perennial Ryegrass, Plantain and Chicory form evaluation trials established in 2022.

Sigrun Ammann*, Dalena Lombard, Lethu Zulu

Western Cape Department of Agriculture, Research and Technology Development, Directorate Plant Sciences, Outeniqua Research Farm, P.O. Box 24, George 6530

***Sigrun.ammann@westerncape.gov.za**

Multi-year evaluation trials were established for Italian and perennial ryegrass, plantain and chicory in autumn 2022 as follows:

- Forage herbs (Plantain and chicory) (Fh11) planted 4 March 2022
- Italian ryegrass (Lm13) planted 9 March 2022
- Perennial ryegrass (Lp6) planted 22 March 2022

These are the results for yield and growth rate only since these trials are still continuing, the complete results will be reported in the following years for all the parameters for which data is collected in the trials.

Table 1: Forage herbs: *Plantago lanceolata, Cichorium intybus*, Fh 11, Evaluation Outeniqua Research Farm

Planted: 4 March 2022 **Seasonal Yield** (t DM/ha) and **Growth rates (GR)** (kg DM/ha/day)

	Autumn* 2022		Winter 2022		Spring 2022		Summer 2022/23		Autumn 2023		Total Year 1		Total 15 months
	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield
	Narrow-leaved plantain												
Agritonic	1.44 c	16.4 c	**2.64 a**	**28.7 a**	4.32 abc	47.5 abc	9.32 ab	103.5ab	**4.38 a**	**47.6 a**	16.6 bcd	46.1bcd	21.0 b
Captain	1.47 c	16.8 c	**3.04 a**	**33.0 a**	4.07 bc	44.7 bc	**9.40 a**	**104.4 a**	**4.74 a**	**51.4 a**	**18.1 a**	**50.1a**	**23.0 a**
Oracle	1.73 bc	19.6 bc	1.37 b	17.6 b	3.78 c	41.6 c	9.07 ab	100.7abc	3.29 b	35.8 b	15.4 d	42.6 d	19.1 c
	Forage chicory												
Chico	**2.30 a**	**26.2 a**	**3.06 a**	**33.2 a**	**4.72 a**	**51.8 a**	8.46 bcd	94.0 bcd	3.24 b	35.2 b	**18.5 a**	**51.3 a**	21.8 ab
Choice	**2.48 a**	**28.2 a**	**2.81 a**	**30.5 a**	4.29 abc	47.1 abc	7.84 d	87.1 d	3.46 b	37.6 b	17.4 abc	48.2 abc	20.9 bc
Commander	2.13 ab	24.2 ab	**2.72 a**	**29.5 a**	4.59 ab	50.4 ab	8.52 abcd	94.7 abcd	3.61 b	39.2 b	18.0 ab	49.7 ab	21.6 ab
Estero Quality	2.06 ab	23.3 ab	**2.65 a**	**28.8 a**	4.48 ab	49.2 ab	8.20 cd	91.0 cd	3.55 b	38.6 b	17.4 abc	48.1 abc	20.9 b
Puna II	2.09 ab	23.7 ab	**2.80 a**	**30.4 a**	3.87 c	42.5 c	7.81 d	86.8 d	3.59 b	39.1 b	16.6 cd	45.9 cd	20.2 bc
Rocket Fuel	**2.42 a**	**27.5 a**	**2.98 a**	**32.3 a**	4.58 ab	50.3 ab	7.86 d	87.3 d	3.66 b	39.8 b	17.8 abc	49.4 abc	21.5 ab
LSD (0.05)	0.56	6.3	0.45	4.8	0.60	6.6	2.06	10.0	2.06	7.4	1.38	3.8	1.76
CV %	13.5	13.5	11.7	10.2	9.1	9.1	7.2	7.2	12.5	12.5	5.2	5.2	5.5

*includes establishment phase of 6 weeks

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

Table 2. Italian ryegrass (*Lolium multiflorum*), Lm 13, Elite Evaluation, Outeniqua Research Farm

Planted: 9 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		Total 15 months
		Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield
Barcrespo	T	**4.19**^{a}	**50.4**^{a}	**4.85**^{a}	**52.7**^{a}	5.97^{abc}	65.6^{abc}	3.54^{bc}	39.3^{bc}	**3.80**^{a}	**41.2**^{a}	**18.5**^{a}	**52.1**	**22.3**
Barmultra II	T	4.00^{ab}	48.2^{ab}	4.55^{ab}	49.4^{abcd}	**6.34**^{a}	**69.6**^{a}	3.66^{b}	40.6^{b}	3.31^{ab}	36.0^{ab}	**18.5**^{a}	**52.1**	21.9
Bond	D	3.66^{abc}	44.2^{abc}	4.73^{ab}	51.5^{ab}	5.92^{abc}	65.1^{abc}	3.33^{bcd}	37.0^{bcd}	3.35^{ab}	36.4^{ab}	17.7^{bcd}	49.6	21.0
Danergo	T	3.84^{abc}	46.2^{abc}	4.01^{d}	43.6^{e}	5.71^{bcd}	62.8^{bcd}	3.06^{de}	34.0^{de}	3.12^{bc}	33.9^{bc}	16.6^{ef}	46.7	19.7
Elvis	T	3.65^{abc}	43.9^{abc}	4.31^{bcd}	46.8^{bcde}	**6.27**^{a}	**68.9**^{a}	3.55^{bc}	39.5^{bc}	3.10^{bc}	33.7^{bc}	17.8^{abc}	49.9	20.9
Fox	D	3.97^{abc}	47.8^{abc}	4.72^{ab}	51.3^{abc}	**6.28**^{a}	**69.0**^{a}	3.42^{bcd}	38.0^{bcd}	3.25^{abc}	35.3^{abc}	18.4^{ab}	51.7	21.6
Icon	D	3.53^{bc}	42.6^{bc}	3.89^{d}	42.2^{e}	5.93^{abc}	65.2^{abc}	3.46^{bcd}	38.4^{bcd}	3.60^{ab}	39.1^{ab}	16.8^{def}	47.2	20.4
Impact	T	3.57^{bc}	43.0^{bc}	4.22^{cd}	45.8^{de}	**6.35**^{a}	**69.8**^{a}	3.61^{bc}	40.1^{bc}	3.71^{ab}	40.4^{ab}	17.7^{abc}	49.8	21.5
Inducer	D	3.43^{c}	41.4^{c}	4.26^{cd}	46.4^{cde}	6.08^{ab}	66.8^{ab}	3.47^{bcd}	38.6^{bcd}	**3.74**^{a}	**40.6**^{a}	17.3^{cde}	48.5	21.0
Itaka	D	3.73^{abc}	44.9^{abc}	4.49^{abc}	48.8^{abcd}	6.11^{ab}	67.2^{ab}	3.55^{bc}	39.5^{bc}	**3.80**^{a}	**41.2**^{a}	17.9^{abc}	50.2	21.7
Lush	T	3.78^{abc}	45.6^{abc}	4.33^{bcd}	47.1^{bcde}	5.48^{cd}	60.3^{cd}	**4.26**^{a}	**47.3**^{a}	3.65^{ab}	39.7^{ab}	17.9^{abc}	50.1	21.5
Supercruise	D	3.47^{bc}	41.8^{bc}	4.49^{abc}	48.8^{abcd}	5.51^{cd}	60.6^{cd}	3.38^{bcd}	37.6^{bcd}	3.45^{ab}	37.5^{ab}	16.9^{def}	47.3	20.3
Thumpa	T	3.60^{bc}	43.4^{bc}	4.73^{ab}	51.4^{ab}	5.27^{d}	58.0^{d}	2.73^{e}	30.3^{ef}	2.64^{c}	28.7^{c}	16.3^{fg}	45.9	19.0
Turgo	T	3.72^{abc}	44.8^{abc}	4.09^{cd}	44.5^{de}	5.36^{d}	58.8^{d}	2.43^{f}	26.0^{f}	1.76^{d}	19.1^{d}	15.5^{g}	43.6	17.3
Vibe	D	3.61^{bc}	43.5^{bc}	4.53^{abc}	49.2^{abcd}	5.40^{d}	59.3^{d}	3.18^{cde}	35.3^{cde}	3.20^{abc}	34.8^{abc}	16.7^{ef}	47.0	19.9
Yolande	D	3.54^{bc}	42.7^{bc}	**4.81**^{a}	**52.3**^{a}	6.04^{ab}	66.4^{ab}	3.45^{bcd}	38.3^{bcd}	3.40^{ab}	36.9^{ab}	17.8^{abc}	50.1	21.2
LSD (0.05)		0.56	6.80	0.46	4.95	0.49	5.37	0.47	5.24	0.61	6.7	0.87	2.45	1.13
CV %		9.13	9.13	6.16	6.16	5.0	5.0	8.4	8.4	11.2	11.2	3.0	3.0	3.3

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

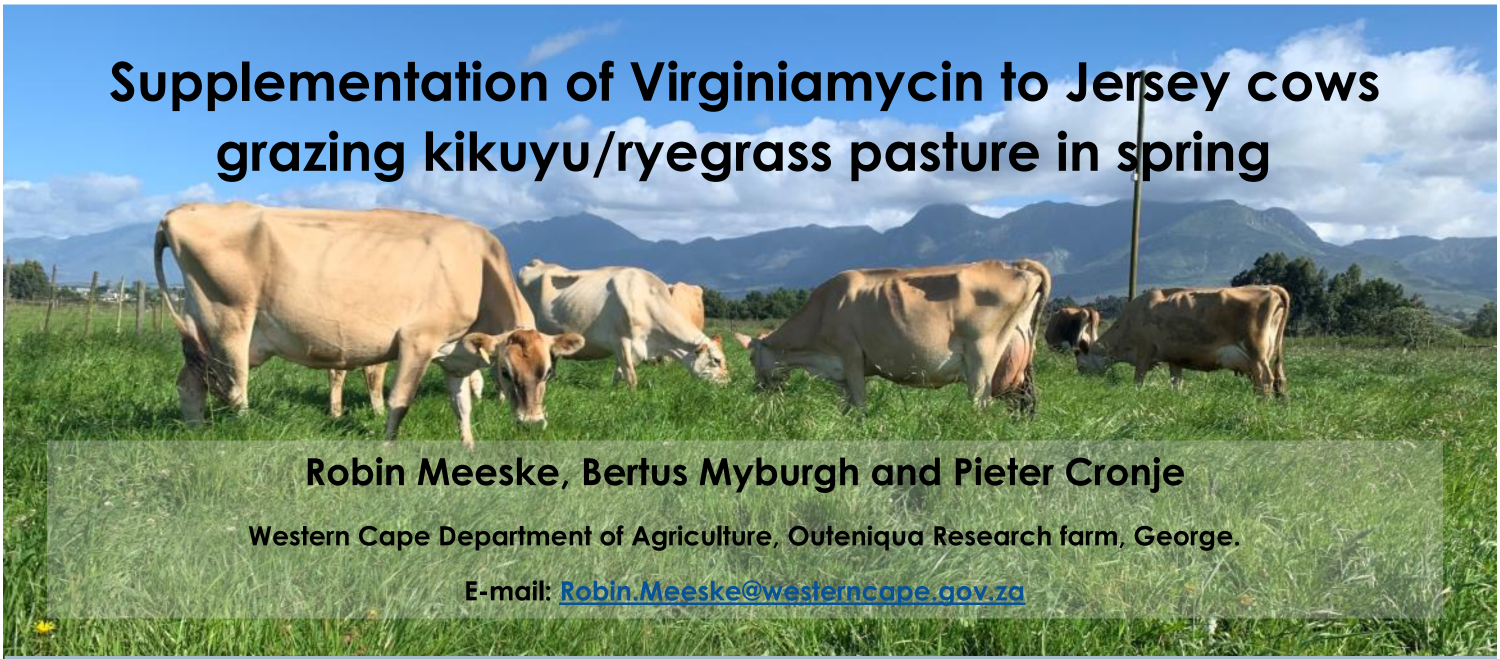
NS = non-significant

Table 3: 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		Total 15 months
		Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield	GR	Yield
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	15.4
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	16.6
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	16.6
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	14.6
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	15.5
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	16.5
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	16.5
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	17.6
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	15.7
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	16.1
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	**18.2**
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	17.3
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	17.5
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	16.4
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**	**18.4**
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	16.7
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	16.5
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	16.0
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	1.35
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	4.91

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



Supplementation of Virginiamycin to Jersey cows grazing kikuyu/ryegrass pasture in spring

Robin Meeske, Bertus Myburgh and Pieter Cronje

Western Cape Department of Agriculture, Outeniqua Research farm, George.

E-mail: Robin.Meeske@westerncape.gov.za

Introduction

Many different feed additives are available to nutritionists and farmers to include in the diet of dairy cows. These come at a cost and inclusion of an additive should be cost effective on farms. Controlled applicable studies are needed to determine the cost effectiveness of feed additives for cows on pasture. Perennial ryegrass pasture under irrigation is commonly used as forage for dairy cows in the southern Cape. Energy intake is the first limiting factor for cows on pasture to produce milk. A dairy concentrate is often supplemented at 4 to 6kg/cow/day and it is estimated that cows ingest 8 to 12 kg dry matter of pasture per day depending on the neutral detergent fibre (NDF) content and the digestibility of pasture. Intake is also affected by milk production and live weight of the cow. When cows graze high quality pasture in spring the rumen pH may get below 5.8 for a few hours per day. This will then negatively affect rumen function, lower fibre digestion and may reduce milk fat content. Virginiamycin is a fermentation product of *Streptomyces virginiae* and has an antimicrobial activity against gram (+) bacteria. This may stabilize rumen pH, improve rumen environment, increase propionate and reduce ruminal acetate and methane production. The question however is if supplementation of virginiamycin will increase milk production and milk fat of Jersey cows grazing perennial ryegrass pasture in spring.

The aim of the study was to determine the effect of virginiamycin on milk production and milk composition of Jersey cows grazing perennial ryegrass pasture in spring.

Materials and methods

The study was conducted during spring 2022 on the Outeniqua Research Farm, situated in the Western Cape province of South Africa (22° 25´ 16´´E and 33˚ 58´ 38´´S). The George area has a temperate climate with a long term mean rainfall of 732 mm per annum. Nine hectare perennial ryegrass pasture with a permanent irrigation system was used. Perennial ryegrasses (*Lolium perenne*) cv. Viscount (15kg/ha) and Platform (10kg/ha) were planted in March 2021 into kikuyu. The study took take place from 9 September to 7 November 2021 and consisted of a 20 day adaptation period followed by a 40 day measurement period. Fertilizer was applied at 33kg N after each grazing (150kg/ha of 1:0:1) containing 22% nitrogen and 22% potassium) Pasture was irrigated according to soil moisture probe readings. A grazing cycle of 21 to 25 days was followed depending on growth rate of pasture. Ryegrass was grazed at the 3 leaf stage. Sixty cows were pre-selected from the Jersey herd of 240 cows in milk and they were managed as one group on pasture. A composite morning and afternoon milk sample was taken from each cow and analysed for milk fat%, milk protein %, milk lactose %, somatic cell count (SSC) and MUN. The milk fat content was used to ensure that cows within blocks were balanced in terms of milk fat% and cows with high SCC were removed. Forty multiparous Jersey cows were selected from the pre-trial group and blocked according to milk production (of the previous three weeks), lactation number and days in milk (DIM). Cows within blocks were randomly allocated to one of two treatments. The average milk production was

21.78 ± 2.03 and 21.64 ± 2.10 kg/cow/day, lactation number 3.65 ±1.42 and 4.45 ± 1.57, DIM 91.5 ± 46.7 and 82.3 ± 46.1 for the control and the virginiamycin (VM) treatments respectively.

Treatments were:

1. Control dairy concentrate fed at 6kg as fed / cow/day.
2. Concentrate containing Virginiamycin fed at 6kg as fed/cow/day. (Stafac supplemented at 0.6g / cow/day = 0.3g virginiamycin/cow/day, 0.01% of concentrate on as is basis).

The composition of concentrates is presented in Table 1. All the concentrates for the study were mixed, pelleted on the same day by Nova feed, George (Saagmeul St., George Industries, P.O. Box 1351, George, 6530) using the same feed ingredients.

Table 1.

Concentrates were placed in different colour coded bags and tagged as Test 1 for control and Test 2 for the VM treatment and supplied to the Outeniqua Experimental farm on a monthly basis. Three kg of concentrate was accurately (± 0.1g) weighed into a plastic bag for each cow and fed in the dairy parlour during each milking. Cows were fitted with colour coded tags attached to the ear tag to distinguish between treatments and separate cows into the different treatment groups before milking. Concentrates were fed (6kg/cow/day) in the dairy parlour during milking, divided between the morning and afternoon milking (3 kg/milking). All cows strip grazed perennial ryegrass pasture as one group and fresh pasture was allocated at 14 kg DM/cow/day with 7kg DM/cow after each milking. Cows were visited 3 hours after they entered the paddock to determine if pasture allocation was sufficient. Pasture yield before and after grazing was estimated by taking 50 pasture height readings on each pasture strip. Pasture yield was calculated using the equation: Y = (103 X H) - 261 where Y= Pasture yield kg DM/ha, H= average RPM height. Cows were milked at 06h00 and 14h30 and grazed 24 hours per day (except for milking times) and clean water was provided (*ad libitum*). Pasture samples were collected weekly during the measurement period on Wednesdays by randomly cutting three circles of 35.4 cm in diameter at a height of 3 cm from the ground on each of the sampling

Table 1. Ingredient and nutrient composition of control and virginiamycin concentrate fed at 6kg/cow/day.

Ingredient	Control treatment	Virginiamycin treatment
	% on as is basis	% on as is basis
Maize	50	50
Hominy Chop	17.65	17.65
Wheat bran	14.51	14.50
Soya oilcake	10	10
Molasses syrup	4	4
Feed lime	2.7	2.7
Salt	0.44	0.44
MgO	0.4	0.4
Premix*	0.3	0.3
Stafac**	0	0.01
Nutrient Specs (As is basis)	%	%
DM %	87.5	87.5
RP %	12	12
ME MJ/kg	10.7	10.7
NDF %	14.25	14.25
Starch %	43.34	43.34
Fat %	3.44	3.44
Ca %	1	1
P %	0.4	0.4
Mg %	0.45	0.45

* Vitamin/mineral premix of Trouw Animal Nutrition, Cape feed and Grain Dairy was used (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)

**Stafac contains 50% Virginiamycin (6 kg concentrate contained 0.6g Stafac resulting in a feeding rate of 0.3g virginiamycin/cow/day) days. Pasture samples were dried at 60°C for 72 hours to determine the DM content and pooled for each week. Concentrate samples were taken on Wednesdays pooled for every two weeks during each measurement period resulting in 5 concentrate samples. All dried samples were milled though a 1mm screen with a Retsch GmbH5657 Laboratory mill (Retch GmbH 5657 Haan, West Germany) and stored pending analysis. The concentrate and pasture samples were analysed for DM, OM, IVOMD, NDF, ADF, CP, EE, Ca, P, Mg, K, Na, Cu, Zn, Mn, and Fe. Cows were weighed and body condition score was determined at the beginning and at the end of the study on two consecutive days before afternoon milking. Body condition score (BCS) of cows was determined according to Wildman et al. (1982) with a scale from 1 to 5, where 1 is thin and 5 is fat. Cows were milked using a 20-Point Waikato/Afikim swing over milking machine with electronic meters. Daily milk production was recorded during each milking with the Afikim milk meter and management system. A morning and afternoon milk sample (06h00 and 14h30) of each cow was collected every week during the measurement period (5 morning and 5 afternoon samples/cow) and preserved with bronopol (Gaillard et al., 2017). The milking machine was fitted with sampling bottles on sampling days. This enabled collection of a representative milk sample during each milking of each cow. The preserved milk samples were analysed for fat, protein, lactose, somatic cell count (SCC) and MUN at the Merieux Nutriscience Pty (Ltd) laboratory using a Milkoscan FT 6000 machine (Foss Electric, Denmark). Milk production of the morning and afternoon milking were recorded separately to allow calculation of the average milk composition.

Statistical analysis

The milk production data was analysed using analysis of variance (ANOVA procedure) for a randomised complete block design on 40 cows in 20 blocks, testing the effects of two treatments. Significance was determined at the 5% level ($P < 0.05$, Freund, Mohr & Wilson, 2010). The statistical software GenStat® (VSN International, 2019) was used for the data analysis. Milk fat % of cows before the study was used as a co-variant.

Results and discussion

Milk production, milk composition, live weight and condition score of cows is shown in Table 2. Cows on the virginiamycin treatment produced significantly (P=0.03) more milk than those on the control treatment. The production of 4% fat corrected milk

Table 2. The effect of Virginiamycin (0.6g Stafac = 0.3 g virginiamycin/cow/day) on production parameters of Jersey cows supplemented with 6kg of concentrate while grazing ryegrass during spring. (n=20)

Parameter	Control	Viginiamycin	SEM	P-value
Milk production kg/cow/day	21.6^{b}	22.3^{a}	0.23	0.03
FCM production kg/cow/day*	24.7	24.6	0.25	0.70
Milk fat %*	5.00^{a}	4.77^{b}	0.073	0.04
Milk protein %	3.90	3.83	0.047	0.27
Milk lactose %	4.84	4.76	0.027	0.06
MUN (mg/dl)	7.8	7.3	0.25	0.16
Somatic cell count (X1000/ml)	114	178	75	0.32
Live weight start (kg)	397	405	5.6	0.32
Live weight end (kg)	416	422	6.47	0.48
Live weight gain (kg)	18.8	17.3	1.46	0.48
Condition score start	2.35	2.35	0.030	1.0
Condition score end	2.35	2.36	0.035	0.80
Condition score change	0	+0.01	0.027	0.75

*FCM= 4% fat corrected milk: FCM= (0.4 X kg milk) + (15 X kg Fat), MUN= Milk urea nitrogen. Milk fat % before study was used as a covariant for milk fat % during the measurement period and 4% fat corrected was determined using the fitted milk fat% values.

however did not differ between treatments. This was caused by the significant lower milk fat % of cows on the virginiamycin treatment compared to the control. The average milk fat (5 test days) of individual cows varied from 3.9% to 6.7%. Care was taken to ensure that milk sampling was representative and accurate. Milk samples were taken from each cow during the morning and afternoon milking on 5 sampling days and analysed separately (10 samples/cow). To establish if allocation of cows to treatments was balanced in terms of milk fat%, the milk fat % of cows over their previous lactation (8 milk recordings of afternoon milk) was compared and was 5.42% and 5.44% for the control and the virginiamycin treatment respectively. The average milk fat % of cows a week before the study started (one composite morning and afternoon sample) was 4.55 ± 0.85% for cows on the control treatment and 4.47 ± 0.74% for cows on the virginiamycin treatment. The average milk fat % before the study was 0.08% higher for cows on the control compared to the virginiamycin treatment and therefore milk fat% before the study was used a co-variant for milk fat% during the study and 4% fat corrected milk production was calculated using the fitted milk fat% values.

Milk fat % is expected to be lower when acetate levels in the rumen are lower. In the present study rumen parameters were not measured. However a study conducted in April of 2021 at Corvallis Research Center – Phibro Animal Health did show lower levels of acetate and a reduced acetate:propionate ratio when virginiamycin was supplemented in an *in vitro* rumen fermentation batch culture system. Coe et al. (1999) also found lower levels of acetate when virginiamycin was supplemented to cattle. Nagaraja et al., (1997) stated that virginiamycin increases propionate at the expense of acetate. This can explain the reduction in milk fat% when virginiamycin was supplemented. Clayton et al. (1999) did not find a significant ($P<0.05$) effect of virginiamycin on milk production, milk fat % or acetate levels in the rumen of cows on pasture.

Milk protein%, MUN content and somatic cell count did not differ between treatments. The milk lactose % of cows on the virginiamycin treatment tended ($P=0.06$) to be lower than that of the control treatment. All cows gained live weight during the study and body condition was stable with no significant differences between treatments.

Table 3. The nutritional composition (% of DM) of concentrates fed at 6kg/cow/day and ryegrass pasture grazed by cows during spring (n=5).

Parameter	Control concentrate	VM concentrate	Pasture
DM%	90.7 ± 0.43	90.6 ± 0.44	17.4 ± 1.72
Ash %	6.77 ± 0.12	6.71 ± 0.15	12.3 ± 2.36
Crude protein %	10.5 ± 0.14	10.4 ± 0.17	17.3 ± 1.68
ME MJ/kg	12.7 ± 0.07	12.7 ± 0.04	10.7 ± 0.18
NDF %	17.5 ± 4.65	22.7 ± 4.00	44.4 ± 2.76
ADF %	5.69 ± 0.90	5.07 ± 0.18	27.6 ± 0.90
Fat %	3.08 ± 0.33	2.89 ± 0.24	5.33 ± 0.25
Ca %	1.23 ± 0.04	1.24 ± 0.07	0.48 ± 0.07
P %	0.43 ± 0.01	0.43 ± 0.01	0.32 ± 0.03
Mg %	0.48 ± 0.01	0.48 ± 0.01	0.30 ± 0.02
K %	1.02 ± 0.32	1.10 ± 0.48	2.82 ± 0.65
Na ppm	1905 ± 98	1916 ± 134	13872 ± 8181
Cu ppm	27.6 ± 0.87	28.3 ± 0.79	5.84 ± 1.07
Zn ppm	166 ± 6.3	166 ± 1.2	38.5 ± 6.77
Mn ppm	153 ± 9.5	155 ± 8.2	29.4 ± 10.9
Fe ppm	211 ± 11.0	210 ± 15.9	209 ± 97.4

VM = Viginiamycin, ME= Metabolisable energy, NDF= Neutral detergent fibre, ADF= Acid detergent fibre

The average rising plate meter (RPM) height before and after grazing was 21.4 ± 2.75 and 9.1 ± 1.66 respectively. Pasture available before grazing was 1945 ± 284kg DM/ha and pasture residue after grazing was 672 ± 177 kg DM/ha. On average cows removed 1273kg DM of pasture per ha during the study. Pasture was well managed and pasture availability was sufficient.

The nutritional composition of concentrates and pasture is presented in Table 3. The control and virginiamycin concentrates were similar as expected. Pasture quality was high as indicated by the 10.7 MJ ME/kg DM, 17.4% crude protein and 44.4% NDF content. The Cu, Zn and Mn content of pasture was lower than the requirement for lactating cows. These minerals were however adequately supplemented in the concentrate. The potassium, sodium and iron content of pasture was higher than the nutrient requirement for dairy cows.

Conclusions

Supplementation of Virginiamycin at 0.3g/cow/day to Jersey cows grazing ryegrass pasture during spring increased milk production but reduced milk fat % significantly. This resulted in no significant (P=0.70) difference in 4% fat corrected milk production between treatments. Live weight and condition score were not affected by supplementing virginiamycin.

References

Cayton, E.H.. Lean, I.J., Rowe, J.B. & Cox J.W., 1999. Effects of feeding Virginiamycin and sodium bicarbonate to grazing dairy cows. J. Dairy Sci., 82, 7, 1545-1554.

Coe, M. L., Nagaraja, T. G., Sun, Y. D., Wallace, N., Towne, E. G., Kemp, K. E, et al., 1999. Effect of virginiamycin on ruminal fermentation in cattle during adaptation to a high concentrate diet and during an induced acidosis. J Anim. Sci. 77 (8):2259-68.

Freund, R., Mohr, D. & Wilson, W. 2010. Statistical Methods 3rd Edition. © Academic Press, Elsevier.

Nagaraja, T. G., C. J. Newbold, C .J. Van Nevel, and D. I. Demeyer, 1997. Manipulation of ruminal fermentation. The Rumen Microbial Ecosystem, 2nd edn, pp. 523–632. Edited by P. N. Hobson. New York: Blackie.

VSN International © 2019. GenStat for Windows 20th Edition. VSN International, Hemel Hempstead, UK. Web page: GenStat.co.uk

Moringa supplementation to Jersey cows grazing perennial ryegrass in spring

Robin Meeske[1], Jordan Smith[2] and Linde du Toit[2]

[1]Western Cape Department of Agriculture, Outeniqua Research Farm, George, [2]University of Pretoria

E-mail: Robin.Meeske@westerncape.gov.za. Cell no: 0829084110

Introduction

The *Moringa oleifera* tree is predominantly found in India and Arabia and has antioxidant and anti-inflammatory properties. Moringa leaves contain anti-oxidants, flavonoids, vitamins and minerals (Atawodi et al., 2010). Most uses of moringa have been for human health purposes with possible effects on blood circulation, blood pressure, blood cholesterol levels, blood glucose levels, prevention of cancer and improved health. In a study done in South Africa, supplementation of 60 g *Moringa oleifera* leaf meal to Jersey cows resulted in increased milk fat content and tended to reduce milk lactose content (Kekana et al., 2019). The total milk solid production increased while dry matter intake and milk production were not affected. In another study *Moringa oleifera* leaves and twigs were included at 0, 3, 6 and 9% of the total diet of lactating Jersey cows (Dong et al. 2019). Intake and milk production were not affected, but adding 6% of *Moringa oleifera* improved milk fat content.

The aim of the study was to determine the effect of supplementing moringa leaves on milk production, milk composition and rumen pH of Jersey cows grazing ryegrass in spring.

Materials and methods

The study started in September 2021 at Outeniqua Research Farm and continued for 60 days. Thirty four cows were blocked according to fat corrected milk production of the previous 3 weeks, days in milk and lactation number. Cows within blocks were randomly allocated to the two treatments resulting in 17 cows per treatment. Cows grazed on 9 ha irrigated perennial ryegrass pasture day and night and were supplemented with 6 kg dairy concentrate/day in the dairy parlour during milking (3kg at each of the two milkings at 5:30 and 14:30). Six rumen fistulated cows were added to enable a rumen study and an *in sacco* digestibility study. The two treatments were control and moringa containing dairy concentrates:

1. Control: Six kg dairy concentrate/cow/day.
2. Moringa: Six kg dairy concentrate/cow/day containing 60g *Moringa oleifera* leaf.

The study consisted of an adaptation period of 14 days, followed by 46 day measurement period. Cows were weighed and condition scored on two consecutive days at the start and the end of the study. Milk production was measured daily at each milking and milk samples will be taken every 14 days (composite morning and afternoon sample for each cow preserved in 30mL bottles with potassium dichromate). Milk was analysed for milk fat, protein, lactose, milk urea nitrogen and somatic cell count at Merieux's laboratory in Jeffrey's bay.

The composition of concentrates is shown in Table 1.

For the rumen study three rumen fistulated cows were allocated to each treatment in a crossover design with two treatments and two periods. Each experimental

Table 1. Composition as mixed and nutritional value of concentrates fed to jersey cows grazing perennial ryegrass pasture in spring.

	kg as is/ton	kg as is/ton
Ingredients	**Control**	**Moringa**
Maize meal	539.2	539.2
Hominy chop	128	128
Wheaten bran	146.5	140.1
Soybean oil cake	111.8	108.2
Molasses	44.2	44.2
Feedlime	22.2	22.2
Salt	4.4	4.4
MgO	2.7	2.7
Premix	1	1
Moringa	0	10
Composition of both concentrates	**% As is basis**	**% on DM basis**
DM	88.5	
ME MJ/kg	10.9	12.3
CP%	12.5	14.1
NDF%	13.9	15.7
Ca %	0.84	0.95
P%	0.41	0.46
Mg%	0.39	0.44

period consisted of an adaptation period of 21 days and a measurement period of 7 days. The rumen pH was monitored for 72 h at 10 minutes intervals using Tru Test data loggers.

Digestion of ryegrass was determined using the *in sacco* technique to determine DM and NDF disappearance.

Cows strip grazed ryegrass pasture with a fresh strip allocated after each milking. Pasture yield was estimated by taking rising plate meter (RPM) readings before and after grazing and using the following regression: Y= 103 X H - 261 where Y = pasture DM yield and H= RPM height. After grazing pasture height of 10 to 12 on the RPM (5 -6cm) was targeted to ensure optimal pasture utilization. Fertilizer was applied at 33kg/ha N after each grazing (150 kg of 1:0:1with S containing 22% N, 22% K and 2-3% S)

Representative samples of concentrates and pasture were taken, dried and analysed for DM, ash, crude protein, neutral detergent fibre, ether extract, Ca, P.

The study was a randomized block design study with two treatments and 17 replicates per treatment. For the different statistical tests, significance of difference between means were declared at $P < 0.05$ and a tendency of difference at $0.05 < P \leq 0.10$, as determined by Fisher's test.

Results

Pasture was well managed with an average DM of 15.9%, ash content 9.63%, crude protein 18.1%, NDF 41.3%, fat content 3.34%, Ca 0.37% and P 0.33% on DM basis. Milk production, milk composition and live weight of cows are presented in Table 2.

Supplementing moringa to cows grazing perennial ryegrass did not affect milk yield, FCM, milk protein, milk lactose or MUN content of milk. The milk fat content was lower on the moringa treatment compared to the control. The rumen pH profile in Figure 1 shows lower rumen pH for cows on the moringa treatment compared to the control treatment. This may partly explain the lower milk fat content on the moringa treatment. This result however does not agree with the study of Kekana et al. (2019) who found increased milk fat% when moringa was supplemented. The MUN levels indicate that protein in the total diet on both treatments was sufficient. The somatic cell count of milk was excellent and did not differ between treatments. Cows on the moringa treatment tended (P=0.07) to gain more weight compared to the control. The rumen pH was at its lowest at 20:00 at night and highest at 5:00 in the morning before milking (Figure 1). The digestion of fibre in the rumen starts to be limited when rumen pH is below 6. The rumen pH was below 6 for 610 and 470 minutes during a 24h period for cows on control and moringa treatment respectively.

The in sacco DM disappearance of perennial ryegrass after 30h incubation in the rumen did not differ between treatments and was 85% for both treatments. The ruminal NDF disappearance of ryegrass after 30h also did not differ (P>0.05) between treatments and was 73 and 74% for cows on the control and moringa treatment respectively.

Table 2. Milk yield, milk composition live weight of Jersey cows fed 6kg concentrate per day with or without Moringa (60g/cow/day) while grazing perennial ryegrass dominant pasture during spring. (n=17)

Parameter[1]	Concentrate treatment		SEM[2]	P-value
	Control	Moringa		
Milk yield (kg/d)	22.2	22.5	0.35	0.47
FCM yield (kg/d)	25.6	24.5	0.47	0.10
Milk fat (%)	4.96[a]	4.67[b]	0.093	0.046
Milk protein (%)	3.89	3.82	0.057	0.40
Milk lactose (%)	4.78	4.71	0.030	0.10
MUN (mg/dL)	11.0	10.8	0.26	0.51
SCC (X 1000)	159	148	52.4	0.89
Live weight before (kg)	372	382	5.8	0.29
Live weight after (kg)	391	406	5.1	0.06
Live weight change (kg)	+19	+24	1.98	0.07

[1] FCM – 4% fat corrected milk; MUN - milk urea nitrogen; SCC – somatic cell count; body condition score

[2] SEM – standard error of mean

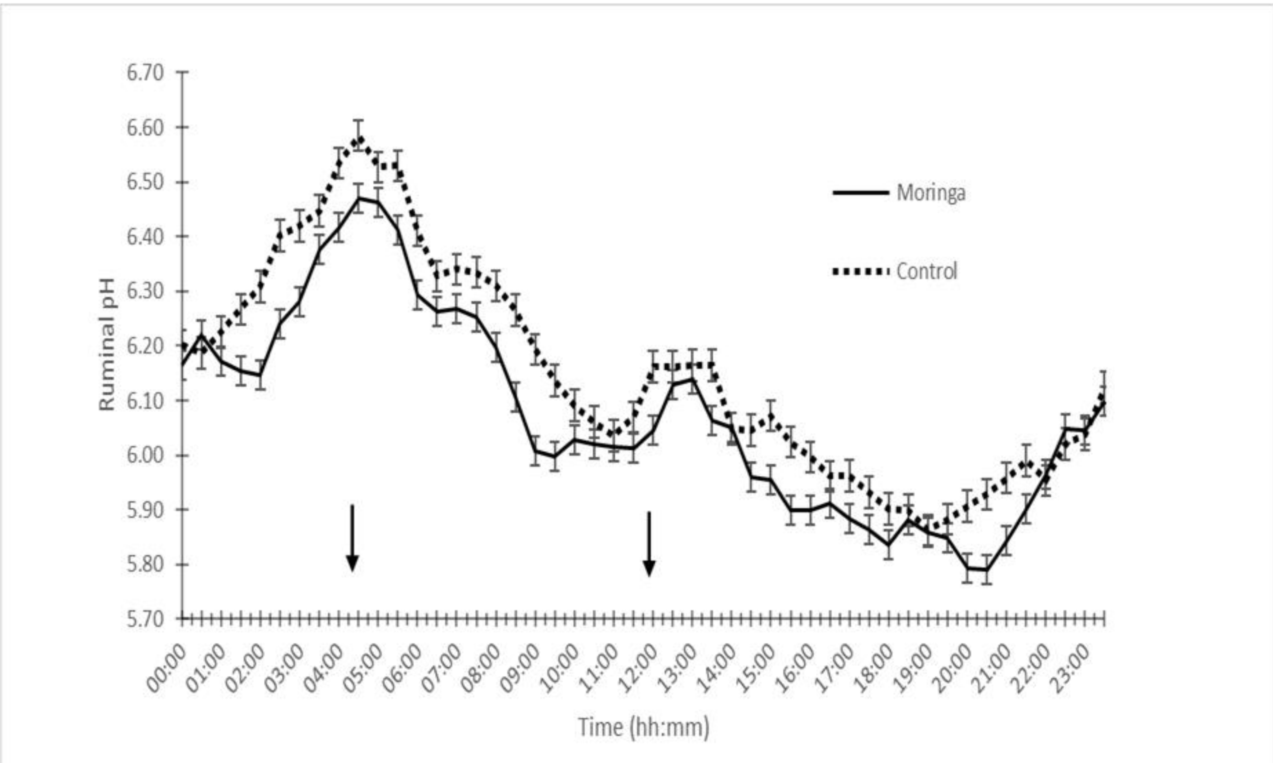


Figure 1. Rumen pH profile of Jersey cows supplemented with 6 kg dairy concentrate (with or without dried Moringa leaves fed at 60g/cow/day) while grazing perennial ryegrass in spring (n=6).

Conclusions

Supplementation of 60g *Moringa oleifera*/cow/day did not improve milk production, 4% fat corrected milk production, milk protein content, SCC or MUN of cows grazing perennial ryegrass in spring. Moringa supplementation significantly reduced milk fat % and tended to increase live weight gain.

References

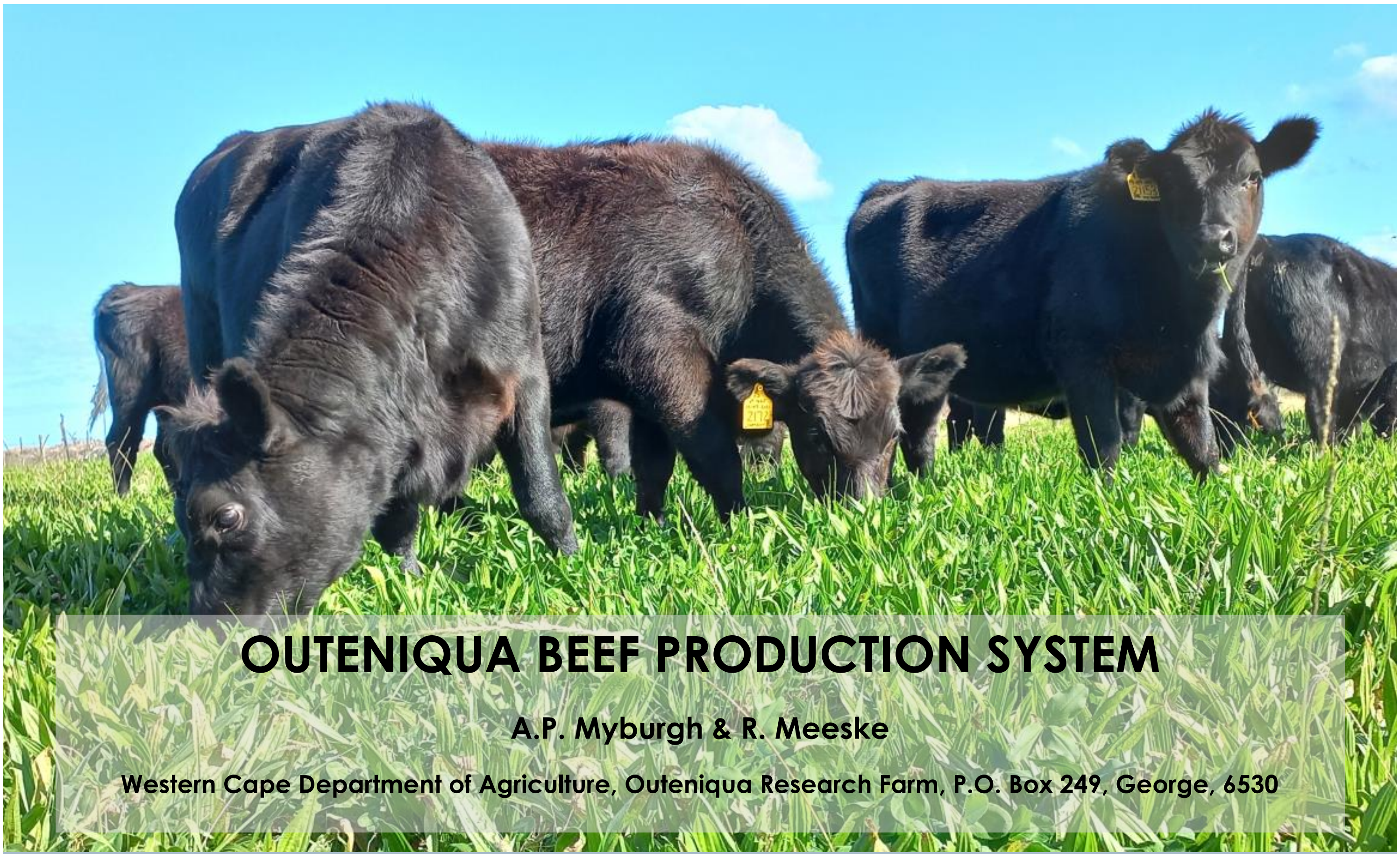
Atawodi S.E., Atawodi J.C., Idakwo G.A., Pfundstein B., Haubner R., Wurtele G., Bartsch H., Owen R.W., 2010. Evaluation of the polyphenol content and antioxidant properties of methanol extracts of the leaves, stem, and root barks of Moringa oleifera. Lam. J. Med. Food. 2010;13:710–716. doi: 10.1089/jmf.2009.0057

Dong, L., Zhang, T & Diao, Q., 2019. Effect of dietary supplementation of Moringa oleifera on the production performance and faecal methanogenic community of lactating dairy cows. Animals, 2019, 9, 262.

Kekana, T.W., Marume, U., Muya, C.M. & Nherera-Chokuda, F.N., 2019. Lactation performance and blood metabolites in lactating dairy cows micro-supplemented with Moringa oleifera leaf meal. SA J. Anim. Sci., 49 no 4, 709-716.

Acknowledgement and comment

The study was financially supported by Nestlé with the focus on reduction of methane emission by supplementing moringa to cows. Final results on methane emission are still pending and await completion of MSc study by J.K Smith under supervision of Dr Linde du Toit of the University of Pretoria.



OUTENIQUA BEEF PRODUCTION SYSTEM

A.P. Myburgh & R. Meeske

Western Cape Department of Agriculture, Outeniqua Research Farm, P.O. Box 249, George, 6530

Introduction

The Outeniqua Research Farm is situated near George in the Western Cape Province. The farm is 204m above sea-level and has a temperate climate with a long-term average rainfall of 725mm per annum. When dairy farmers have extra dryland pasture available and want to add a beef enterprise on their farm, beef animals can be bred out of the dairy herd. Buying in animals can pose many challenges with brucellosis, BVD, EBL and liver fluke to name a few. Bought in animals may also not have resistance against redwater. Breeding the lowest genetic merit dairy cows with beef generates cross calves that can be used to start a beef herd.

The Outeniqua Angus Beef, production system started 10 years ago from calves that were bred out of the Outeniqua Jersey herd. The Outeniqua Jersey herd has been a closed herd for more than 40 years. No animals have been brought onto the farm from outside to maintain biosecurity. The beef herd was started with four F1 Angus x Jersey cows and four Jersey cows. Each cow reared 6 beef cross calves over a 300 day lactation with two calves reared every 3 months resulting in 48 cross calves reared in a year. Calves were kept in a nursing area with access to calf starter pellets and water. Cows grazed on dryland pasture and were brought to the nursing area twice a day to allow calves to suckle. Cows were fitted with a halter and tied in the nursing area. The same two calves would suckle on a cow twice a day. Calves were weaned after 3 months and two new cross calves were allocated to each cow. There were three periods of three months. After 9 months we had an Angus herd of 48 animals, heifers were retained and all the male animals were sold. The F1 Angus x Jersey heifers formed the base of the Outeniqua Angus beef herd. These heifers were bred using artificial insemination with black Angus semen.

Cow herd and weaner calf system

The beef platform on Outeniqua consists of 20ha dryland pasture and 4ha irrigated pasture, all divided into 1ha camps. The cowherd consists of 29 cows grazing on 20ha dryland pasture consisting of kikuyu (*Cenchrus clandestinus*), ryegrass (*Lolium*), Tall fescue (*Festuca arundinacea*), cocksfoot (*Dactylis glomerata*), trefoil (*Lotus corniculatus*), vetch (*Vicia villosa*) and taaipol (*Sporobolus africanis* and *Eragrostis plana*). The beef herd consists of nine F1-generation-, fifteen F2-generation- and seven, F3-generation cows. There are 3 Angus bulls (F3-generation), bred on the farm out of the Angus cows using artificial insemination.

The grazing rotation on the 20ha dryland farm varies between 10-15 weeks per camp. Cows are kept in two groups of 14-15 cows and graze 1-2 weeks per 1 ha camp. Fertilizer is applied at 28N/ha as LAN (100kg/ha) once a year in spring. A protein lick is supplied at strategic times during the year when pasture quality is low and a mineral lick is supplemented to address micro mineral deficiencies. Animals are tested yearly for contagious abortion and vaccinated for Anthrax, Botulism and Black Quarter.

The breeding season is from 1 October to 15 December. The first period from 1 October to 1 November artificial insemination with Angus semen is done where after the F3-generation Angus bulls are put into the herd until 15th of December. Pregnancy test on female animals is done in February, and all animals not pregnant are evaluated and sold. Calving season is from July to September. Cows are dosed for internal parasites just before the breeding season starts. All the calves stay with their mothers for 6 months before they are weaned. Calves are also dosed for internal parasites at weaning.

Heifers are vaccinated against contagious abortion (CA) at 4 months and against Anthrax, Botulism and Black Quarter at 4- and 5 months of age. At 6 months of age, heifers are vaccinated against Lumpy skin disease. Bull calves get the same vaccinations than the heifers except the CA vaccination.

The average live weights for animals in the beef herd at different ages is presented in Figure 1. Heifers at 1 year of age weighed 300kg while mature cows older than 5 years weighed 550-600kg. Some of the older F1 Angus cows weighed up to 600kg.

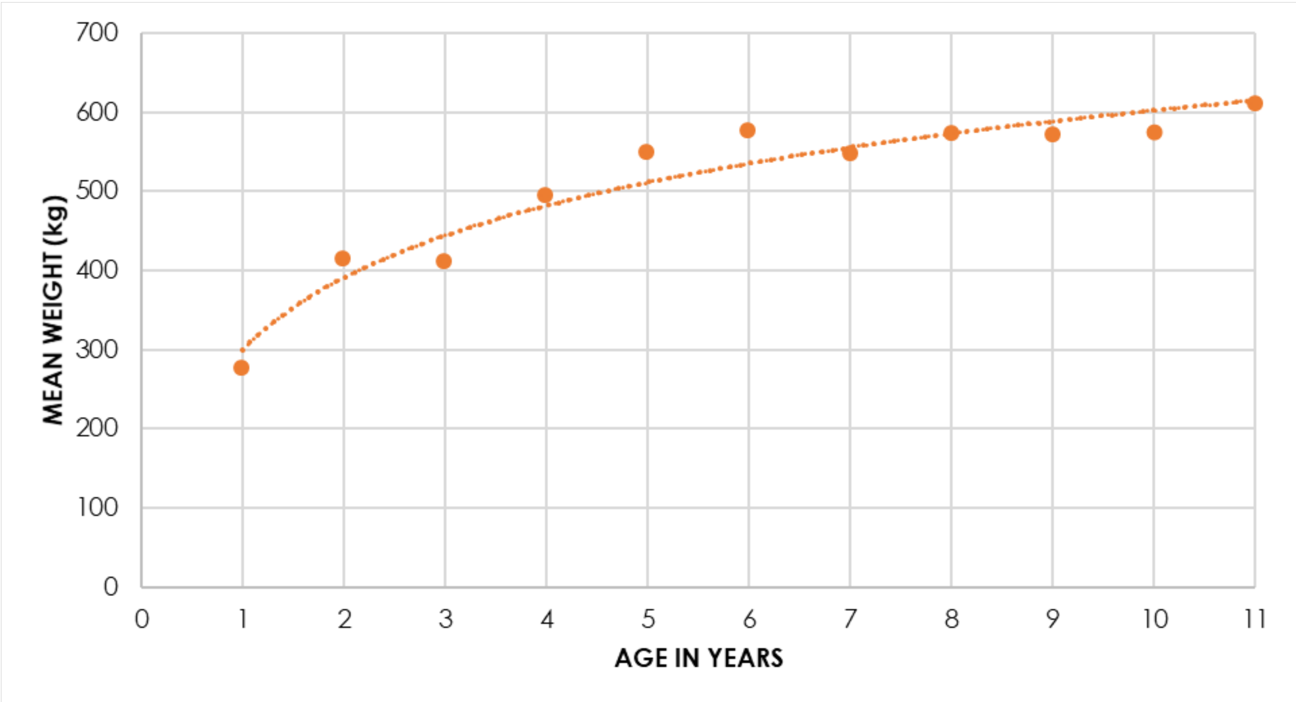


Figure 1. Average live weights of Angus cows at different ages.

Table 1. Birth weights, weaning weights at 6 months of age and average daily gain from birth to weaning of Angus calves allocated to be finished on Lucerne/Plantain/Clover and Plantain/Clover pastures under irrigation.

Pasture	Gender	Birth weight (kg)	Weaning weight (kg)	ADG (kg)
*LC/PL/CL	**Heifers**	33	221	1.01
	Bulls	36.3	235	1.04
AVERAGE		34.9	229	1.03
PL/CL	**Heifers**	33	234	1.05
	Bulls	36.3	238	1.05
AVERAGE		34.9	237	1.05

*LC=Lucerne, PL=Plantain, CL=Red clover

The growth parameters of Angus calves reared on cows and weaned at 6 months of age are presented in Table 1. The average birth weight for heifer calves and bull calves was 33kg and 36.3kg respectively. The average weaning weight at six months was above 220kg and the growth rate from birth to weaning was above 1kg/day. This result was partly due to the milk production potential of F1 Angus x Jersey cows as well as the growth potential of F2 calves (75% Angus).

Finishing calves after weaning

When prices for weaner calves are high in February (R7000-R9000/weaner or 230kg at R30-R40/kg live weight) it is a good option to sell them. When prices are low an alternative is to finish weaners on pasture. At Outeniqua Research farm 4ha pasture under irrigation has been allocated to finish weaner calves. Two ha lucerne/plantain/red clover pasture and 2ha plantain/red clover pasture was established in 2021. Twenty-four calves of 1 year old are currently on the 4ha of irrigated pasture. The grazing rotation on the 4ha of irrigation is 42-45 days. Fertilizer is applied at 28N/ha after each grazing cycle (7 times per year).

In February 2022, a total of 24 calves (10 heifer calves and 14 bull calves at weaning) were randomly allocated to one of two pasture treatments resulting in 12 calves per treatment. One group of 12 calves grazed 2ha of irrigated lucerne/plantain/red clover pasture while the other group of 12 calves grazed 2ha irrigated plantain/red clover pasture.

The animals were weighed every 2 weeks to determine average growth rate. Pastures were measured with a pasture rising plate meter to determine height of pastures before and after grazing and a regression was used to estimate pasture intake. Pasture samples were taken every 2 weeks and dried in an oven for 72 hours, to determine dry matter and pasture quality.

During winter there was a shortage of pasture due to slow pasture growth rate. Animals were supplemented with 2kg per day and per animal, of a 50% maize and 50% bran mix, for 2 months. A mineral lick was supplemented from weaning until finishing at 100g per animal per day. The growth performance of calves from weaning to finishing is presented in Table 2. The average daily gain from weaning to finishing of bull calves was higher than that of heifers. The pasture system used did not affect the average daily gain from weaning to finishing and varied from 0.64 to 0.65kg/day. These growth rates are much lower than growth rates achieved in traditional feedlot systems (1.5-1.8kg ADG).

Table 2. Average live weight at weaning, finishing, average daily gain, average finishing age and average daily gain from birth to finishing of animals on Lucerne/Plantain/Clover mix pasture and Plantain/Clover mix pastures.

Pasture	Gender	Weight at weaning (kg)	Weight at finishing (kg)	ADG weaning to finishing (kg)	Age at finishing (months)	ADG Birth to finishing (kg/day)
*LC/PL/CL	HEIFERS	221	401	0.534	17	0.703
	BULLS	235	428	0.690	16	0.820
AVERAGE		229	410	0.640	16	0.770
PL/CL	HEIFERS	234	419	0.550	17	0.731
	BULLS	238	425	0.690	16.5	0.829
AVERAGE		237	417	0.650	16	0.790

*LC=Lucerne, PL=Plantain, CL=Red clover, ADG=Average daily gain

Table 3. Composition (%of DM) of lucerne/plantain/red clover pasture and plantain/red clover pasture collected from 31 March to 21 November 2022 (n=18).

*Parameter	LUCERNE/PLANTAIN/CLOVER		PLANTAIN/CLOVER	
	Average	STD	Average	STD
DM (%)	12.4	3.39	12.3	2.85
Ash (%)	12.6	1.42	13.5	1.7
CP (%)	23.9	4.63	18.5	3.01
Crude fat (%)	4.68	0.5	4.53	0.47
NDF (%)	32.3	5.05	35.6	4.55
ME (MJ/ kg)	9.74	0.18	9.72	0.15
TDN (%)	72.4	1.4	72.3	1.08
Ca (%)	1.11	0.08	1.32	0.7
P (%)	0.3	0.05	0.26	0.04
Mg (%)	0.29	0.03	0.35	0.03
K (%)	2.28	0.35	2.63	0.46

*CP=Crude protein, NDF=Neutral detergent fibre, ME=Metabolisable energy, TDN=Tolal digestible nutrients, STD=Standard deviation

The growth rate was lower than expected as the pasture quality was high (Table 3). The average daily gain from birth to finishing was similar at 770g/day and 790g/day for calves on the LC/PL/CL and the PL/CL pasture treatment respectively. The nutritional value of Lucerne/Plantain/Clover and Plantain/Clover pasture grazed by calves from weaning to finishing is shown in Table 3. The DM and NDF content was low and the protein content was high of both pasture treatments. The protein content of Lucerne/Plantain/Clover was higher than that of the Plantain/Clover pasture. Protein in the total diet for was not limiting for growth on any of the treatments. The energy content and lack of effective fibre in the diet may have limited growth of weaners

Economic implications

Table 4 shows the potential income on a 20ha dryland beef farm with 30 cows. Every year a potential 5 cows could be sold at an average price of R8000. That could earn a potential income of R40 000. To maintain a herd of 30 cows 5 heifers must be retained to replace the 5 cows that are sold. Any extra animals generated out of the cows could be sold at weaning. The potential total annual income on a 20ha farmlet can be R219 500 or R10 975/ha/year. When expenses were deducted the annual margin over specified cost of R9663/ha or R193269 for a 20ha dryland beef farm was possible.

Table 4. Potential income on a 20ha beef farm carrying 30 cows (1.5 cows/ha) marketing weaner calves at 6 months.

	Number	Sold	Price	Total
Cows	30	5	R8 000,00	R40 000,00
Calves	28			
Heifers	14	9	R7 500,00	R67 500,00
Oxen	14	14	R8 000,00	R112 000,00
Total income				R219 500,00
Income R/ha/year				R10 975,00
Expenses				
Dip				R710,63
Medicine				R5 520,15
Fertilizer				R20 000
Total expenses				R26 230,78
Potential profit/year				R193 269,30
Potential profit/ha/year				R9 663,47

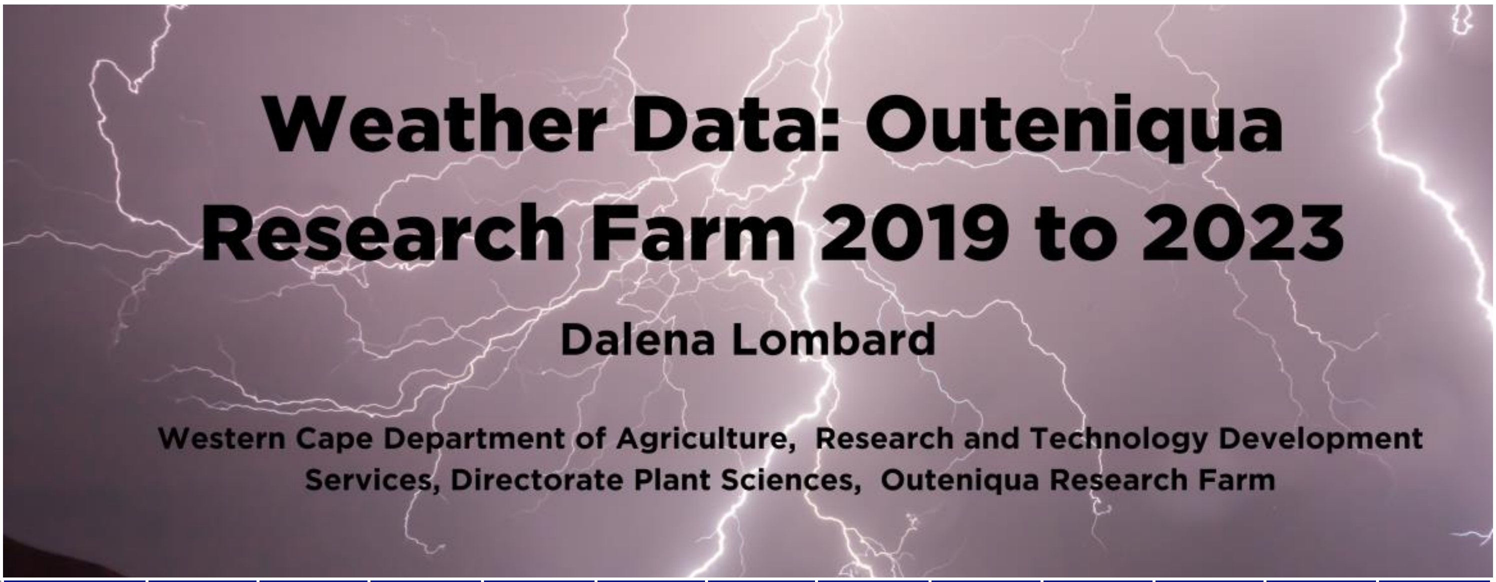
Table 5. Potential income from finishing animals from six months to slaughter on irrigated pasture with only a micro -mineral supplement.

Price weaner calf	**R8 400**
Weaning mass	240 kg
Finish mass	440 kg
Weight gain	200 kg
Carcass	242 kg
Income	**R13 310**
Pasture @R2/kg DM	R4 039
Lick costs	R202.50
Dip	R5.38
Medicine	R117.86
Additional profit/calf	**R545.26**
Profit/ha (6 calves/ha)	R3 271.56

The economics of rearing weaners on pasture based on data collected is presented in Table 5. The price/ value of a weaner at the start, growth rate and pasture cost have a major impact on the profitability of finishing weaners on pasture. When weaner prices are high, pasture cost is high (N fertilizer) and growth rate of weaners is low (700g/day) the profitability of finishing weaners on pasture is very poor. With a profit of R545 per animal finished or R3271/ha per year it is more profitable to have more hectares for cows under dryland than irrigated pasture to finish weaners. The economics will be more promising when weaner prices are low, growth rate of beef animals is above 1kg/day and irrigated pasture has a substantial legume component.

Conclusions

It is possible to have a stocking rate of 1.5 cows/ha in the George area under dryland conditions and normal annual rainfall. It was possible to reach a weaning weight of 240kg at 6 months of age. Selling weaners is a low risk and high profit system. Finishing animals on irrigated pastures can result in high cost and low profit. Profitability can be improved by reducing pasture cost with legumes and increasing average daily gain.



Weather Data: Outeniqua Research Farm 2019 to 2023

Dalena Lombard

Western Cape Department of Agriculture, Research and Technology Development Services, Directorate Plant Sciences, Outeniqua Research Farm

2019	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Min T	15.8	17.2	15.8	13.4	11.7	9.3	7.7	9.6	11.8	11.9	14.6	15.0
Max T	22.7	21.5	22.0	20.1	26.8	23.2	16.9	17.7	28.4	19.2	20.2	21.4
Mean T	19.0	19.8	19.0	16.3	15.7	14.3	13.4	12.9	16.0	15.8	17.3	18.0
RF	24	75	56	36	41	29	30	3	58	35	60	32
2020	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Min T	15.7	16.0	13.3	12.5	8.6	9.8	8.4	7.2	10.1	10.0	13.2	14.3
Max T	24.8	26.8	25.8	26.6	22.5	20.7	21.2	18.3	22.8	20.0	26.4	21.9
Mean T	19.5	20.1	18.4	16.9	15.3	15.1	13.9	12.4	14.4	15.1	17.3	18.9
RF	134	37	33	34	53	18	14	51	68	101	68	31
2021	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Min T	16.9	17.7	15.2	13.8	11.3	9.6	5.9	6.4	8.1	9.8	11.8	13.9
Max T	24.6	25.0	27.0	24.0	22.3	22.0	19.3	19.0	20.0	21.6	21.8	22.4
Mean T	20.3	20.1	19.5	17.6	15.5	15.8	12.6	12.7	14.0	15.7	16.8	18.1
RF	38	30	64	42	85	11	33	147	50	85	66	112
2022	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Min T	16.0	15.8	14.8	10.7	9.3	8.2	7.5	7.3	8.4	12.4	12.1	14.5
Max T	26.8	27.1	26.4	21.6	21.2	22.0	20.1	18.9	20.7	22.7	23.0	24.2
Mean T	21.4	21.3	20.6	16.1	15.5	15.1	13.8	13.1	14.6	17.5	17.6	19.3
RF	18	43	58	59	75	102	42	30	29	55	2	119
2023	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
Min T	15.5	15.5	14.4	11.3	8.9	8.8	6.3	7.8				
Max T	25.7	25.3	25.1	22.9	20.1	18.5	18.1	21.0				
Mean T	20.6	20.4	19.8	17.1	14.5	13.7	12.2	14.4				
RF	56	56	71	57	154	102	60	17				

Min T = Minimum temperature (°C) recorded in specific month

Max T = Maximum temperature (°C) recorded in specific month

Mean T = Mean temperature (°C) of specific month

RF = Total Rainfall (mm) recorded in specific month

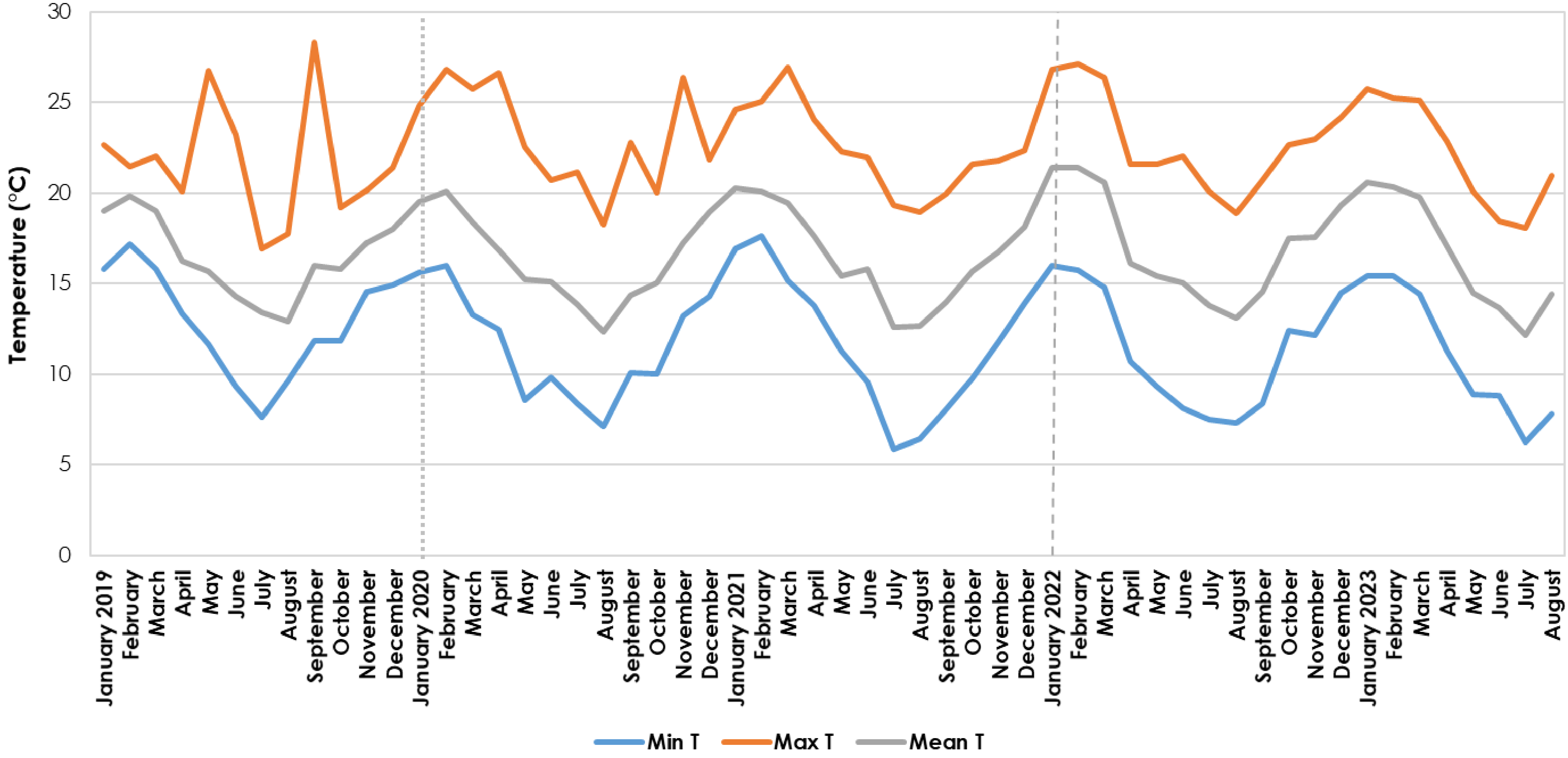


Figure 1. Temperatures recorded on Outeniqua Research Farm for the period January 2019 to August 2023

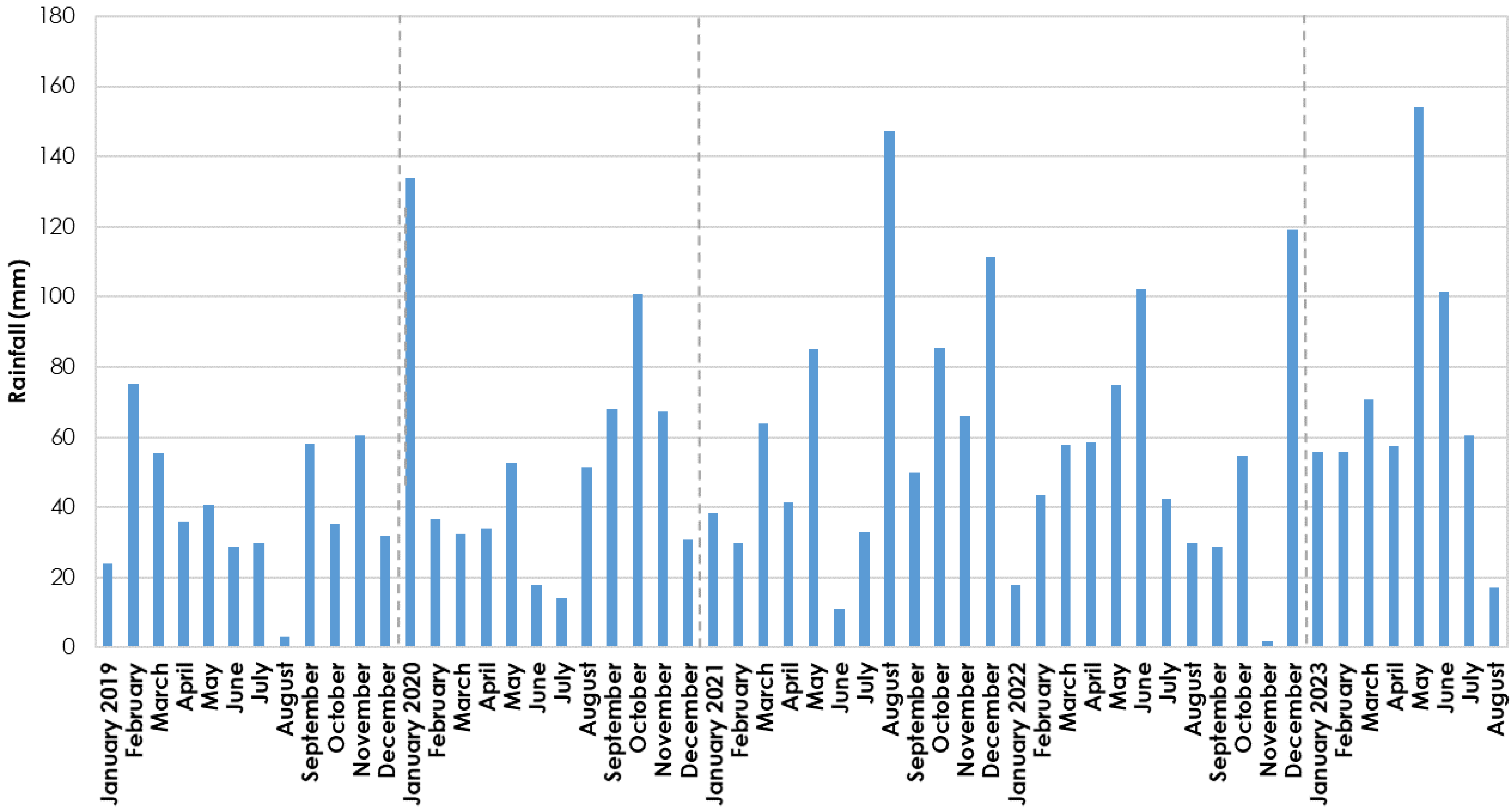


Figure 2. Total monthly rainfall recorded on Outeniqua Research Farm for the period January 2019 to August 2023

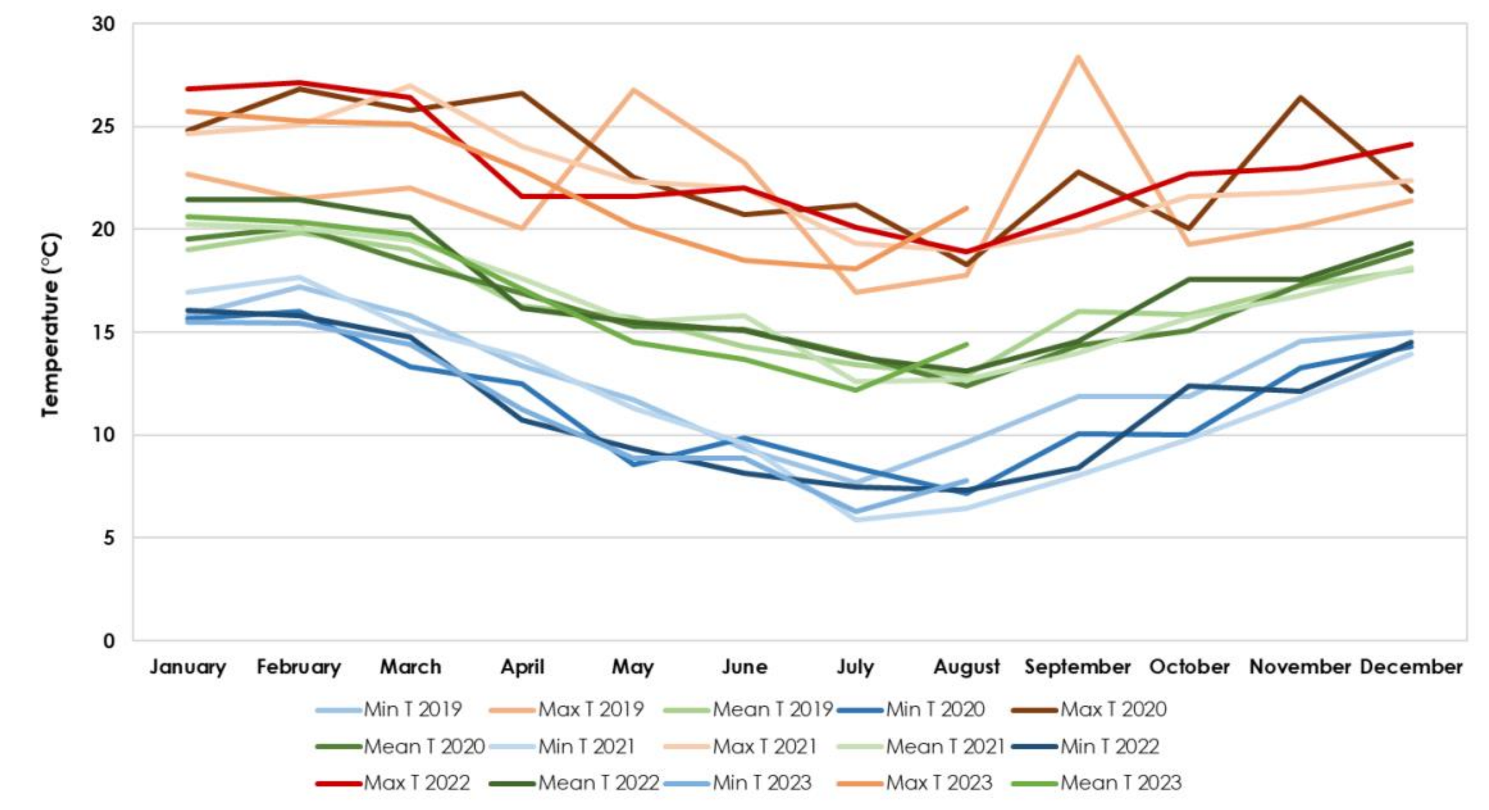


Figure 3. Comparison of monthly temperatures recorded on Outeniqua Research Farm for the period January 2019 to August 2023

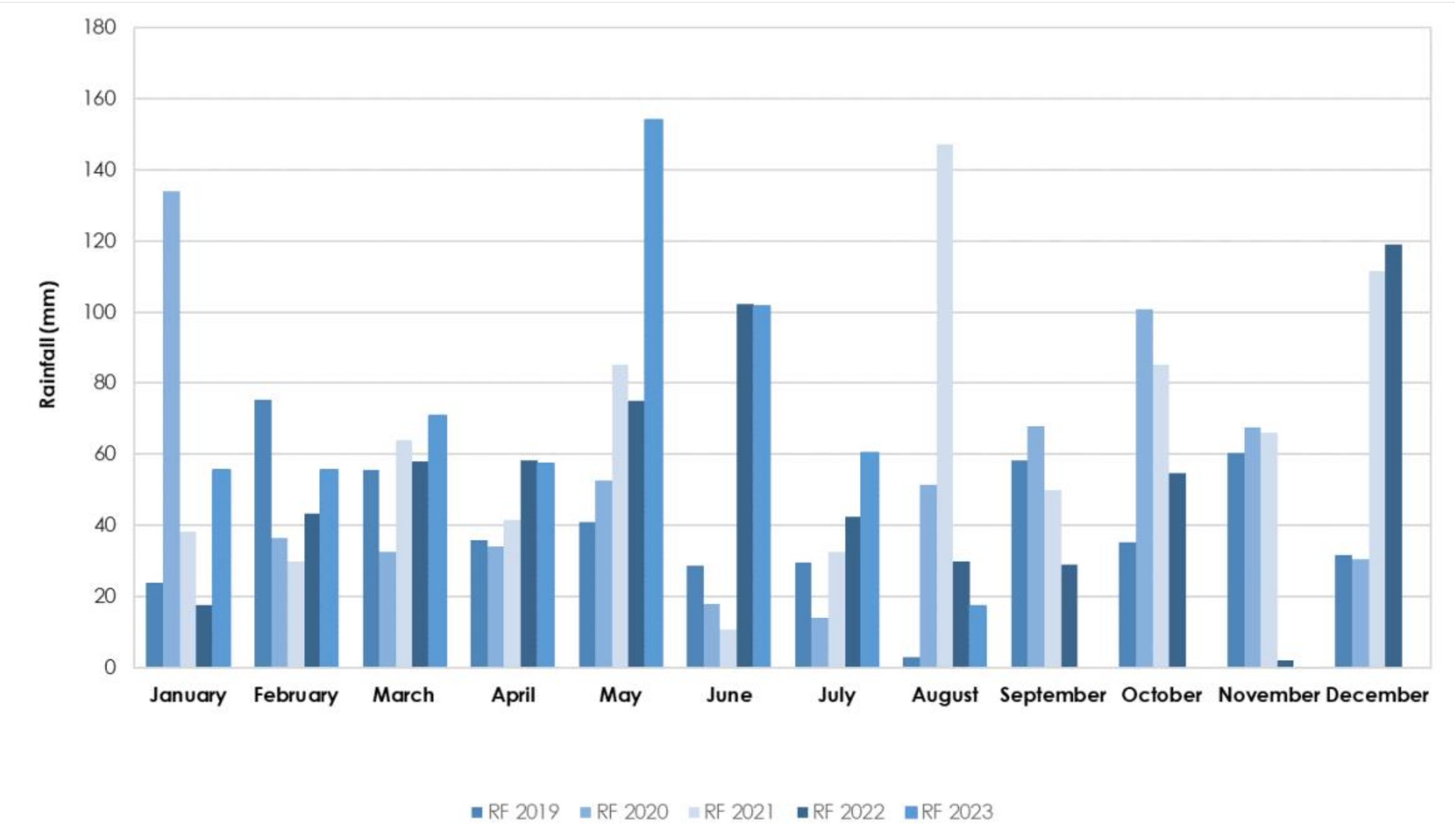


Figure 4. Comparison of total monthly rainfall recorded on Outeniqua Research Farm for the period January 2019 to August 2023