INFORMATION DAY

2022

OUTENIQUA RESEARCH FARM: DIRECTORATES OF PLANT AND ANIMAL SCIENCES

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Contents

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INFORMATION DAY

OUTENIQUA RESEARCH FARM

MILK PRODUCTION FROM PLANTED PASTURE

Wednesday, 21 September 2022

Research Technology and 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**	
09:15-09:50	Incorporating forage herbs into pasture systems: impact on pasture and milk yielding potential	Janke van der Colf
09:50-10:10	Forage quality of grasses and forage herbs in summer/autumn and the opportunities for improvement	Sigrun Ammann
10:10-10:30	Evaluation results of perennial ryegrass and tall fescue cultivars for the two-year period 2020/21	Sigrun Ammann
10:30-10:50	Effect of *Aspergillus oryzae* on milk production and milk composition	Robin Meeske
10:50- 11:00	Questions and discussion?	
11:00–11:30	**Tea**	
11:30-11:50	Prevention of milk fever by feeding a Ca-binder to pre-partum cows grazing pasture	Robin Meeske
11:50-12:00	Concluding remarks	
12:00-13:00	**Visits and exhibits** Visit steam up cows on Tall fescue pasture	Robin Meeske/Janke van Colf
	Visit to cultivar trials	Sigrun Ammann
13:00	**Lunch**	

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Preface

The Outeniqua Information day has been a virtual event for two years following the proclamation of the national state of disaster back in March 2020. It was followed by wide-ranging regulations that imposed a variety of restrictions on our way of experiencing life, not least of all the ability to gather either socially or in the context of work. We are very thankful that things changed during the second quarter of 2022 which has put us in a position to once again meet you all face-to-face at Outeniqua Information Day of 2022!

Following the success of the virtual events where presentations and even the practical research site visits could be accessed on the internet prompted us to have the live event but to also make the material available online again. This can help as refresher material for those who attended or as reference for those who were unable to join us.

Our research efforts continued unabated as our teams gradually returned to a more familiar work routine. "Working from home" was never an option on an operational dairy farm – difficult to milk a cow from home! The Information Day shares new data-based information and results of the research conducted on the research farm.

During the latter part of 2021 and the year to date the agricultural sector faced many challenges. There have been unprecedented increases in the prices of agricultural inputs, and here fertilizer and diesel are central in the farming world, often exacerbated by increasingly unpredictable weather.

So, we are very happy to welcome you all back to Outeniqua Research Farm and I trust you will enjoy the day with us in addition to taking home some useful tidbits of information to assist with keeping farming profitable.

Dr. Chris de Brouwer

Chief Director: Research and Technology Development Services (Acting)

Western Cape Government

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Forage herbs and mixtures: impact of inclusion on pasture system productivity

Janke van der Colf, Sigrun B Ammann and Robin Meeske

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What are the major challenges within our systems?

Until recently pastures for dairy production in the southern Cape were based on predominately grass dominated pastures, most notably ryegrass (*Lolium* spp.) and kikuyu *(Cenchrus clandestinus*), established using minimum till regimes and characterised by relatively high rates of fertilisation and irrigation. **However, the long term sustainability of these pasture systems could be at risk due to a number of factors including:**

- Extended periods of lower than expected rainfall. These are putting an increased strain on the availability and quality of water resources, with the summer/autumn period particularly challenging due to high evaporative demands (Van der Colf 2017).
- The poor persistence of ryegrass, with a decline of as much as 44% reported in even the most productive ryegrass cultivars from year one to year two in the region (Van der Colf et al. 2013). Furthermore, low summer and autumn production often seen for ryegrass in the region, results in lower forage quality of ryegrass based pastures.
- Although kikuyu can support high stocking rates, is high yielding during summer and has resulted in an improvement in soil C levels in the southern Cape, it requires high nitrogen fertilisation rates to remain productive, has low winter yields and low forage quality tends to limit milk yield per animal (Colman and Kaiser 1974, Reeves 1997, Marais 2001).
- Research on kikuyu-ryegrass pastures under more than 15 years of no-till management indicated that pastures often contain in excess of 60% of weedy volunteer grasses such as *Paspalum urvillei*, *Digitaria sanguinalis*, *Eragrostis plana* and *Sporobolus africanus* during summer/autumn (Van der Colf 2017). This could further reduce the forage quality and milk production potential of the pastures in the region.
- Producers are increasingly feeding high rates of concentrates, either in an attempt to maintain milk yield when forage quality is limiting, or to increase stocking rates on their milk platform. However, this often leads to pasture replacement and a low feed conversion ratio.
- Increasing fertiliser costs have resulted in producers reducing fertiliser inputs. The impact of these strategies on the long term pasture yield, persistence of sown pasture species and nutrient use efficiency are, however, often not accounted for (Scott et al. 2013b).

How can forage herbs and tall fescue improve our systems?

The best forage based approach to address issues relating to low resource use efficiency, poor persistence over years and low resilience under adverse climatic conditions of pasture systems in the southern Cape, is to introduce alternative or novel pasture species. **The inclusion of forage herbs, such as Plantain (*Plantago lanceolata*), into pastures has been reported to hold various potential advantages for pasture based producers** including (Moorhead and Piggot 2009, Cave et al. 2013, Totty et al. 2013, Woodward et al. 2013, Lee et al. 2015, Cheng et al. 2015, Box et al. 2016; Minee et al. 2017):

- an improvement or maintenance of milk yield compared to ryegrass during adverse climatic conditions,
- higher kg milk solids production per animal,
- lowered rates of N leaching,
- improved dry matter intake in animals,
- higher forage quality compared to perennial ryegrass-clover pastures,
- higher summer/autumn production than temperate grasses,
- a lower decline in plant population over years compared to ryegrass and
- improved resilience to periods of drought.

In terms of an alternative grass component within dairy systems, Tall Fescue has been noted to be a potential species that can be included due to its improved drought tolerance, the resultant ability to more effectively utilise soil water and rainfall due to their deep root systems (Van Eekeren et al. 2010) and improved persistance over years (Lowe and Bowdler 1995, Nie et al. 2004). **Thus far, research conducted on the Outeniqua Research Farm has shown that plantain yielded 41 t DM ha^{-1} over 20 months and the highest yielding Tall Fescue (*Festuca arundinacea*) cultivar 20 t DM ha^{-1} over 15 months (Ammann et al. 2018a, Ammann et al. 2018b).** This compares favourably with yields of 20 t DM ha^{-1} for perennial ryegrass over a 15 month period (Ammann et al. 2018b) and 18 t DM ha^{-1} for kikuyu-ryegrass pastures on an annual basis (Van der Colf 2011).

What answers do we still need for these systems?

Before pasture systems can be adapted for the inclusion of these alternative pasture species, the following needs to be evaluated and determined relative to current systems:

- The milk yield, pasture yield and forage quality should either be similar or higher than the accepted norm for current pasture systems.
- The effect that alternative species and mixtures will have on the seasonal distribution of dry matter production and the resultant impact on feed budgets, particularly as it relates to the need to buy in feed, needs to be determined.
- The potential of alternative species and pastures to be persistent and maintain yield over years needs to be evaluated.
- The rate of deterioration in pasture composition, indirectly associated with persistence over years, but also related to the rate of weed ingression, needs to be characterised.
- The efficiency with which resources can be utilised by the pasture species and systems, particularly as it relates to water utilisation, nitrogen utilisation and feed conversion ratio should be quantified.
- The appropriate rate of inclusion of alternative pasture species and systems on a farm scale to ensure adequate returns needs to be determined. This includes an evaluation of whether monocultures, mixtures or both should be included in systems.

With this in mind, a farmlet study was conducted on the Outeniqua Research Farm over three years to determine the whole system production potential of four pasture systems based on the traditional system (Kikuyu-ryegrass), monocultures of alternative species (Tall fescue and plantain) and two pasture mixture that included alternative species (Tall fescue, plantain and red clover; ryegrass, Lucerne, chicory and plantain). The following paper will discuss preliminary findings of this study and some important management impacts and challenges identified.

Farmlet Study: Where research and farming meet

Pasture Systems, Establishment and Renovation

The premise behind a farmlet study is to apply systems to a large enough area and in such a manner that it resembles a practical farming unit (Murrison and Scott 2013). This presents a particular challenge when planning and implementing such a study, as the possibility of replication is largely constrained by the availability of both physical and financial resources. As such, this project was based on the principles described by Scott et al. (2013a) for allocating areas to an un-replicated farmlet study, with sub-sampling implemented to over-come problems of estimating experimental error (Grima and Machodo 2013).

The study consisted of four farmlets, each approximately 5 to 5.5 ha in size and with different pasture species or mixtures allocated to each *viz*:

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

The species, varieties and seeding rates of each system are described in Table 1. The MONOC and FESC_PL MIX pastures were established in 2019 by spraying off the existing pasture with a non-selective contact herbicide (200 g/L Glufosinate ammonium applied at 6L ha^{-1}) during February 2019. Approximately 2 weeks after herbicide application, the remaining residue was mulched to ground level to facilitate breakdown and allow weed germination. A week prior to establishment in March 2019, a follow up application of a non-selective contact herbicide (200g/L Paraquat at 4L ha^{-1}) was undertaken. The pastures were then planted using a modified Aitchison no-till seeder with press wheels. A similar methods was used to plant the LUC_HERB MIX in 2020, but planting itself only occurred in May 2020 due to staff shortages resulting from COVID restrictions. The perennial ryegrass on the kikuyu-ryegrass site was established by grazing the area down to a height of 50 mm, mulching the remaining stubble to ground level and planting the perennial ryegrass with a modified Aitchison no-till seeder with press wheels. From year 2 onwards, pastures were evaluated visually and renovation strategies based on the replacement of declining components or the degree of degradation in terms of weed ingression. These practices are listed in Table 2.

Table 1. Species, varieties and seeding rates for pastures during the study

System	Species	Scientific name	Variety*	Seeding rate (kg ha^{-1})
KIKRYE	Kikuyu	*Cenchrus clandestinus*	Existing sward	-
	Perennial ryegrass	*Lolium perenne*	24Seven	25
MONOC	Tall Fescue	*Festuca arundinacea*	Easton	25
	Plantain	*Plantago lanceolata*	Tonic	8
FESC_PL MIX	Tall fescue	*Festuca arundinacea*	Easton	20
	Plantain	*Plantago lanceolata*	Tonic	3
	Red clover	*Trifolium pratense*	Oregon red	3
LUC_HERB MIX	Lucerne	*Medicago sativa*	WL414	6
	Chicory	*Cichorium intybus*	Commandor	2
	Plantain	*Plantago lanceolata*	Agritonic	3
	Hybrid ryegrass	*Lolium*	Shogun	25

Table 2. Renovation interventions for the pasture systems

SYSTEM	YEAR 1					YEAR 2					YEAR 3				
	Species	Area (%)	Action	Month	DTG*	Species	Area (%)	Action	Month	DTG	Species	Area %	Action	Month	DTG
KIKRYE	Ryegrass	100	1. Mulch 2. Plant	Mar 2019	85	Ryegrass	80	1. Mulch 2. Plant	Mar 2020	60	Ryegrass	100	1. Mulch 2. Plant	Mar 2021	60
						Ryegrass	20	1. Herbicide 2. Mulch 3. Plant	Feb 2020	120					
MONOC_FESC	Fescue	100	1.Herbicide 2. Mulch 3. Plant	Feb 2019	125	Plantain	30	1. Herbicide 2. Mulch 3. Plant	Feb 2020	122	Fescue	40	Plant	Feb 2021	35
MONOC_PL	Plantain	100	1. Herbicide 2. Mulch 3. Plant	Oct 2018	88			None			Plantain	40	Plant in 2018 sward	Feb 2021	42
FESC_PL MIX	Full mix	100	1. Herbicide 2. Mulch 3. Plant	Feb 2019	130			None			Fescue	100	Plant	Feb 2019	40
LUC_HERB MIX			N/A			Full mix		1. Herbicide 2. Mulch 3. Plant	Feb 2020	180#	Lucerne Plantain	100	Plant in plantain and Lucerne	Feb 2019	45

* DTG: Days to first grazing after renovation action was initiated

#Area planted later than expected due to staff shortages associated with COVID restrictions

Trial Animals

Each system was allocated its own "mini-herd" of pure bred Jersey cows, selected to maintain days in milk (DIM) at approximately 150 and provide a constant flow of animals into and out of the system, thus mimicking a non-seasonal calving pasture system. Milk yield and milk composition from the previous lactation were used to block animals. Each system was allocated 24 animals in milk and 6 dry animals (25% of herd). As animals in the "milk herd" were dried off, they were replaced by animals from the systems' "dry herd" as they calved. This variability in calving pattern resulted in periods when the pasture area for each system was stocked below or above the 24 animals/ system. The average annual stocking rate ranged between 3.8 and 4.4 cows/ha for all systems over the 3 years.

Cows received 2 kg of dairy concentrate at each milking, equating to a total of 4kg cow/day, in addition pasture.

Fodderflow Management

In order to facilitate ease of management of fodder flow within the respective systems, pasture was measured on a weekly basis for the entire study site using a RPM. Based on dry matter yield on a farmlet scale and the estimated pasture requirement for each mini-herd, it was determined whether pasture availability on the pasture platform was in excess of animal requirements (surplus) or lower than requirements (shortfall) for each system. The following strategies were followed under these circumstances:

- Shortfall in winter of year 1: Animals were supplemented with bought in feed in the form of lucerne hay.
- Shortfall in year 2 and 3: Grass silage produced from system in year 1 fed to cow groups in isolation. Any shortfall beyond silage was met by Lucerne.
- Surplus: Area was cut to make wrapped grass silage. Pure plantain in the MONOC system was not be cut for silage, with allocation rate (% of intake) adjusted upwards as yield increases.

The data collected on the above parameters (silage made, bales fed and feed bought in) will eventually allow for fodderflow dynamics to be determined.

Fertilisation

Based on literature studies and experiences from current small plot cutting trials on Outeniqua with pure forage herb and grass/herb swards, nitrogen was applied at 30 kg N/ha after each grazing to all systems.

Pasture Parameters

To facilitate sub-sampling on each system, grazing strips (average size of 0.18 ha) within the respective paddocks were utilised as measurement units. A varying degree of sampling intensity was applied to strips based on the parameters being measured. For highly intensive measurements (botanical composition determination, forage quality sampling and rising plate meter calibration), paddocks were divided into approximate half hectare (0.50 ha) "blocks", each consisting of three pasture strips, with the centre strip functioning as a monitor strip for sampling purposes. For less intensive sampling (for example daily pasture measurement and allocation), sampling occurred on a grazing strip basis (0.1 ha blocks).

Dry matter production of the pasture treatments was estimated using the rising plate meter (Stockdale 1984, Fulkerson 1997). Calibration equations were developed for each pasture type by cutting samples on monitor strips as per (t'Mannetjie 2000) to a height of 50 mm. Seasonal linear and curvilinear relationships between herbage mass and pasture height were determined and best fit equations used to calculate available herbage mass from pre-grazing height readings per grazing strip. The estimated pre-grazing yield was also used for pasture allocation purposes.

Each system was managed as a self-sustaining, closed system, with pasture allocated to each group following the morning and afternoon milking according to available pasture biomass (kg DM ha^{-1}). Pasture biomass available above 50 mm was determined per sub-plot from RPM readings and calibrations determined during the study for each sward type. Pasture was allocated at a approximate rate of 10 kg DM cow^{-1} day^{-1} (approximately 2% of body weight), with a fresh piece of pasture provided at a aimed rate of 5 kg DM cow^{-1} after each milking. Allocation was at

Table 3. Components into which botanical composition samples were fractioned

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

times adapted to ensure post grazing readings of 10 or below. On the MONOC system, animals were allocated plantain according to the proportional availability of the pasture within a period, with the rest of the intake allocated to Tall Fescue.

Botanical composition was estimated by placing three 0.098 m^2 rings randomly per monitor strip before grazing/cutting and cutting samples to a height of 50 mm above ground during each grazing cycle. The three samples were pooled, thoroughly mixed; a grab sample of approximately 500 g taken and then separated into the relevant fractions for each pasture type as described in Table 3.

Preliminary Results and Discussion

Pasture yield and growth rate

The monthly growth rate of the pasture systems during year 1 to year 3 is shown in Figure 1. The total seasonal and annual pasture yield for year 1 to year 3 is shown in Figure 2.

The higher growth rate of the plantain (which was part of the MONOC system) in winter of year 1 (2019), is a good indicator of the advantage that can be attained from a spring planting of forage herbs. Such a spring planting results in a well-established sward being available for grazing in the following winter. Spring plantings of forage herbs could also alleviate autumn pasture shortages resulting from annual pasture establishment and renovation.

During both year 1 and year 2, the two pasture systems based on alternative species, MONOC and FESC_PL MIX, achieved similar growth rates to the traditional KIKRYE system. This is also reflected in the similar total winter yields of the three systems in year 1 (3.07 to 4.02 t DM/ha) and year 2 (2.85 to 3.43 t DM/ha). The data thus indicates that alternative species such as Fescue and plantain can compete with ryegrass in terms of growth rate during this period. This is even more noteworthy considering that only 25% of the platform was renovated in the MONOC system going into year 2, while for the FESC_PL MIX system none of the platform had to be renovated going into year 2. **Thus, the persistence of alternative species through the summer and autumn of year 1 could improve fodderflow on a farm scale by reducing the need for annual renovation that is required with ryegrass systems in the southern Cape.**

The lower growth rate, and accompanying total seasonal yield, of the LUC_HERB MIX in winter of year 2 (2020) can be attributed to the new establishment of this pasture system during late

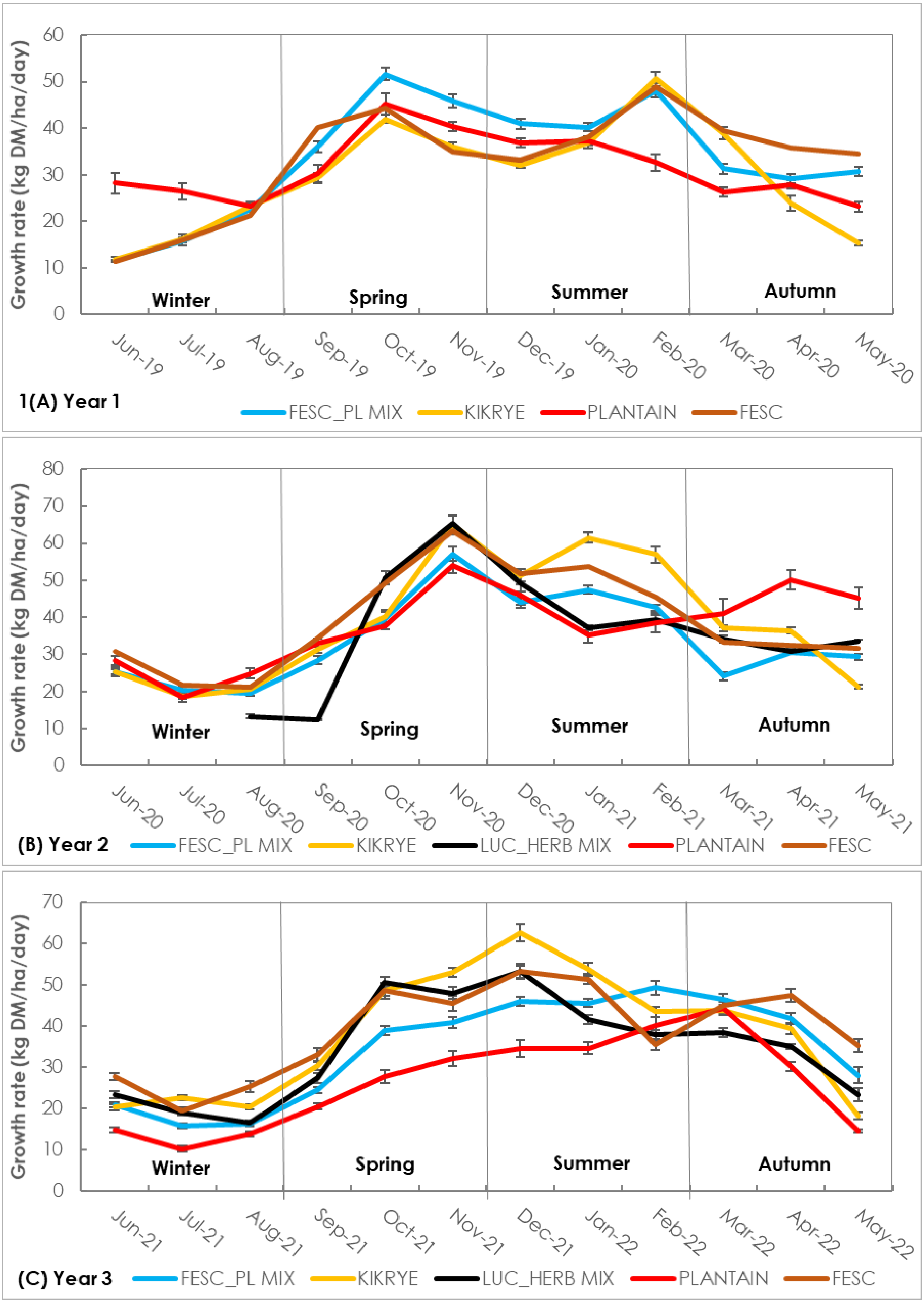

Figure 1. Monthly growth rate of pasture systems during (A) year 1, (B) year 2 and (C) year 3.

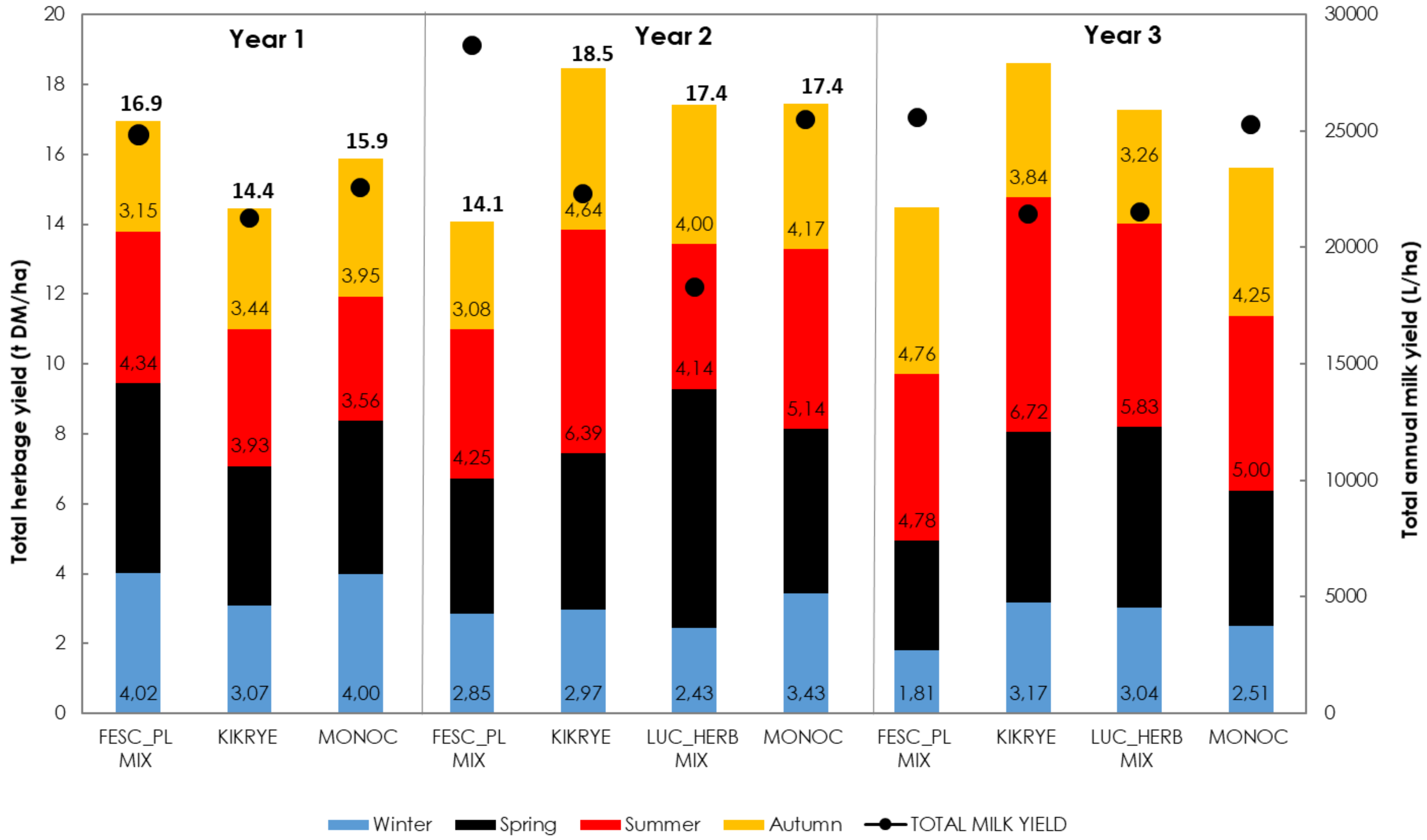

Figure 2. Total seasonal and annual yield (kg DM/ha) of pasture systems during year 1, 2 and 3. * Total annual herbage yield indicated above bars.

autumn (planting in May 2020) and grazing only commencing in August 2020. An earlier establishment date (March, rather than May) could result in a better winter yield in year 1. During the winter of year 3 the growth rate of FESC_PL MIX, as well as the Plantain component of the MONOC system was lower than for other pasture types. This is reflected in the total seasonal winter yield of year 3 for the FESC_PL MIX, but not the MONOC system as a whole. This could indicate that the higher growth rate of the mono-cultured Fescue sward of the MONOC system offset the lower growth rate of the plantain sward on the platform (Figure 1A), but that the fescue component in the FESC_PL MIX was not at an adequate level to achieve the same effect.

The trend in spring growth rates was more variable over years, with different systems achieving the highest growth rates and seasonal yields viz. FESC_PL in year 1 and the LUC_HERB MIX in year 2 and year 3. It was lowest for KIKRYE in year 1 and the FESC_PL MIX in year 2 and year 3. The KIKRYE and MONOC systems had similar spring yields during all three years. The ability of a system to be high yielding during spring is important in the region, as many producers are reliant on excess pasture produced during this period to produce grass silage for winter supplementation. **Thus a proportion of the farm should always be allocated to a system that can achieve high spring growth rates, keeping in mind that the silage should still be of good quality to maintain high milk production in the winter.**

The typical pattern of high summer and autumn growth rates of kikuyu, particularly from December to March, was also evident during this study for the KIKRYE system. However, during year 1 these growth rates were matched by that of Fescue in the MONOC system and the FESC_PL MIX. By late autumn (April/May) the growth rate of the KIKRYE system showed a rapid decline during both year 1 and year 2, likely attributed to the kikuyu component entering its dormancy period.

In terms of total annual DM production (Figure 1) the KIKRYE had the highest yield during year 2 and year 3 (up to summer), but the lowest yield during year 1. The FESC_PL MIX system showed an inverse trend, having the highest yield during year 1, but the lowest yield during year 2 and 3.

The great degree of variability in growth rates and pasture yields over years and systems is most likely attributed to changes in botanical composition and variable climatic conditions. The former, and its impact on management decisions will be discussed in more detail under the botanical composition section.

Botanical composition

Changes in botanical composition over time, particularly in mixed pastures, can be an important driver of various other parameters in a pasture system including growth rate, forage quality and milk yield per cow. Two aspects of particular concern when considering which pasture species or mixture to establish are 1) How to best manage the ingression of pastures by weeds, particularly in no till systems and 2) How botanical composition changes in multi-species mixtures over time and the management thereof.

Persistence of sown species

A large proportion of pastures in the southern Cape were converted to minimum-till systems in the early 2000's, with the most extreme interventions in terms of pasture management limited to mulching the pasture once a year and planting with minimum-till planters since the initial adoption of such systems. Although this has led to appreciable improvements in soil carbon stocks and other soil properties, it has also likely contributed to the increased ingression of weeds over time. **However, the poor persistence of ryegrass could also be a contributing factor to the high proportion of weeds observed in long term kikuyu-ryegrass pastures.** Similar trends for the invasion of pastures by subtropical species have been observed in New-Zealand, with the primary drivers for this trend indicated as enhanced spreading ability of these grasses both vegetatively and through persistent seed banks and high summer temperatures and low soil fertility that may hamper the vigour of sown species (Tozer et al. 2011).

The contribution of sown components to the botanical composition of the five pasture types in the study is shown in Figure 3. During year 1 the contribution of sown components was appreciably higher in the MONOC_PLANTAIN and FESC_PL MIX pastures, indicating that the inclusion of forage herbs, following the treatment of existing pastures with herbicide, can lead to a highly favourable

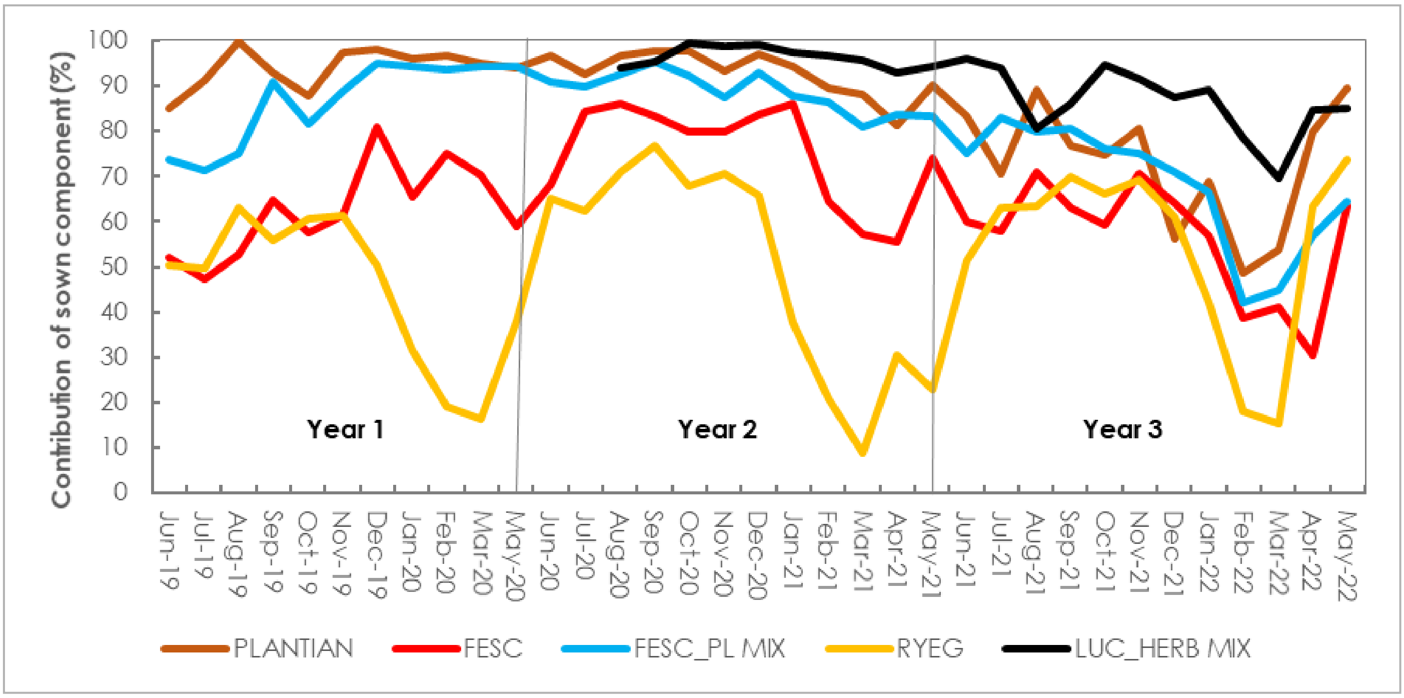

Figure 3. The proportion of temperate sown components in each system over three years.

pasture composition. This trend continues until the summer in year 2 (January 2021), after which a steady decline can be seen. For the LUC_HERB MIX, a similar pattern is observed, with a high sown component during year 1 after establishment (2020/21), which declined gradually during year 2 (2021/22). The rapid decline in the ryegrass component of the KIK_RYE system from approximately November to its lowest just prior to over-sowing in March during all three years is a clear indicator that ryegrass fails to persist adequately over years and supports the common practice of annual over-sowing of ryegrass on an annual basis in kikuyu-ryegrass systems.

The major weed component in pastures in the southern Cape appears to be grasses, rather than broadleaf species. These species include highly vigorous tropical species such as *Paspalum urvillei, Digitaria sanguinalis*, *Eragrostis plana* and *Sporobolus africanus*, winter growing temperate species such as *Bromus catharticus* and kikuyu on areas where it is not being actively cultivated. The contribution of these volunteer grasses to different pasture types is shown in Figure 4. Grass monocultures such as KIKRYE and FESC had a higher proportion volunteer grasses during year 1 and year 2 than MONO_PL and forage herb mixtures (FESC_PL and LUC_HERB MIX). **This indicates that forage herbs can compete to a degree with these species after establishment by use of herbicides.** However, this competitive advantage seems to decline after year 2, resulting in the eventual ingression of weeds during year 3. This fits with the theory of Tozer et al. (2011) that a major driver for the invasion of pastures by weeds is canopy gap formation caused by disturbance of pastures by grazing, trampling, mechanical actions, or poor sown plant persistence due to drought, waterlogging or other abiotic factors. The challenge in terms of management is thus to determine:

- Whether, when and how temperate species can be planted into pastures to fill these gaps
- When weed ingression becomes problematic enough to motivate extreme renovation of alternative pastures (monoculture and mixtures) by spraying out the pasture and re-establishing it.
- Whether forage herb mono-cultures can be utilised to control grasses. Although there are options to control grass weeds by herbicide, it is often ineffective on highly competitive tropical species like E. plana and also cannot be used in grass/herb mixtures.

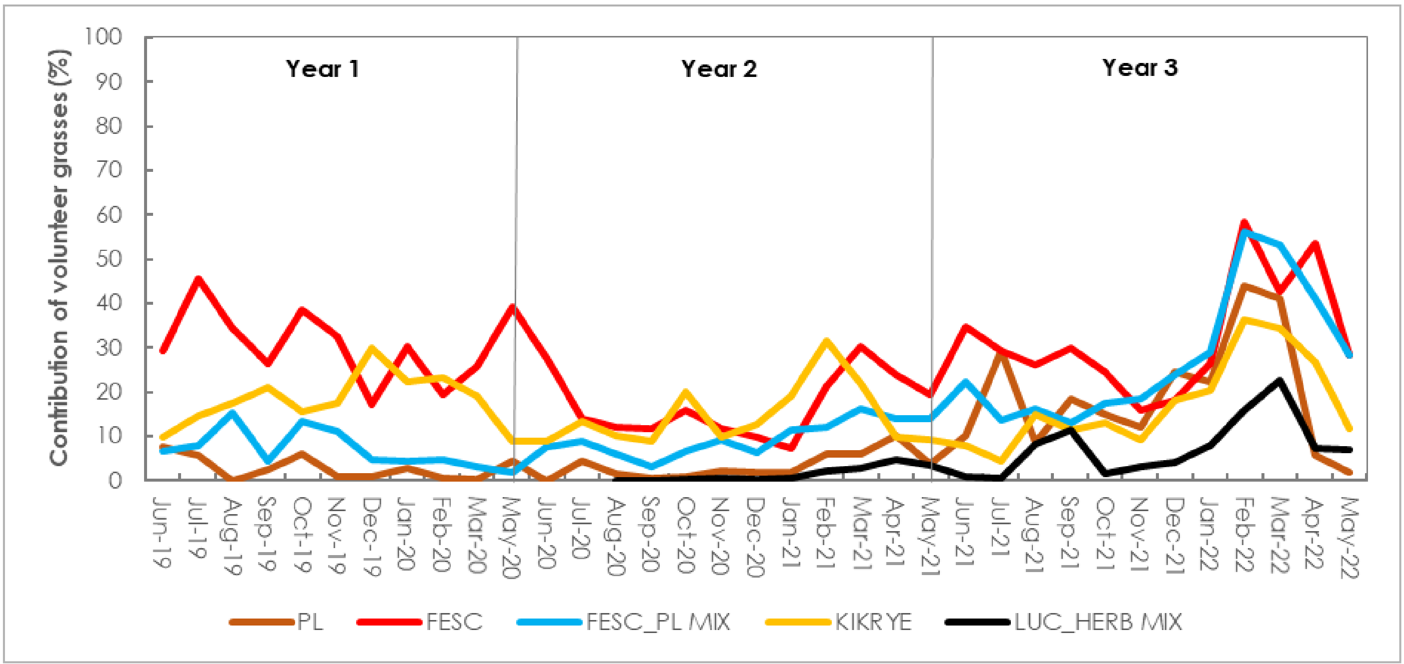

Figure 4. The proportion of volunteer grasses in systems over three years

Changes in contribution of sown species in mixtures

The complexity of pasture mixtures is that the mixture may not behave as expected, since an inclusion rate at planting (in terms of seeding rate), may not translate to contribution in the sward. Furthermore, the contribution of individual species will show changes over seasons and years, with a number of abiotic factors that can effect it. The contribution of different species to the FESC_PL and LUC_HERB MIX pastures is shown in Figure 5 and Figure 6, respectively.

For the FESC_PL mix the major contributor to botanical composition from year 1 to the summer of year 3 was plantain. The high contribution of the plantain in the FESC_PL MIX, and the lower growth rate of the plantain observed in the monoculture of plantain (MONO_PL) during particularly summer and early autumn, could be why this system performed poorly in terms of growth rate and seasonal yield compared to the other systems that had a larger grass (ryegrass, fescue or kikuyu) component during these seasons. The red clover only made a notable contribution during spring and summer of year 1, after which it rapidly declined, indicating that red clover should be viewed as an annual, rather than perennial, component in mixtures. The fescue component, although relatively stable during year 1 and year 2, made a relatively low contribution to sward composition. During year three, the plantain contribution declined rapidly, while the fescue component showed a slight increase. However, this increase was accompanied by a sharp increase in the contribution of "weeds", primarily consisting of kikuyu and other volunteer grasses.

The major component of the LUC_HERB MIX from winter to spring of year 1 was ryegrass, with a relatively low contribution made by the chicory, plantain and Lucerne. During spring and summer, the contribution of chicory increased notably, but declined again during autumn. During year 2, the contribution of ryegrass increased slightly during the winter and spring, but declined to below 10% during the summer, while the contribution of the other components remained relatively stable and equally distributed during this period. The decline in the ryegrass component during the spring of year 2 was strongly associated with an increase in the weed component, once again mainly attributed to volunteer weedy grasses.

A comparison of the changes in botanical composition and total seasonal pasture yield of FESC_PL MIX and LUC_HERB MIX highlights how complex the management decisions in a pasture mixture can be since:

- The inclusion of ryegrass increased the grass component during the first year in the pasture compared to fescue, but resulted in a rapid decline in its contribution in preceding years. However, this higher grass component likely impacted positively on seasonal pasture yield in LUC_HERB MIX compared to FESC_PL MIX.

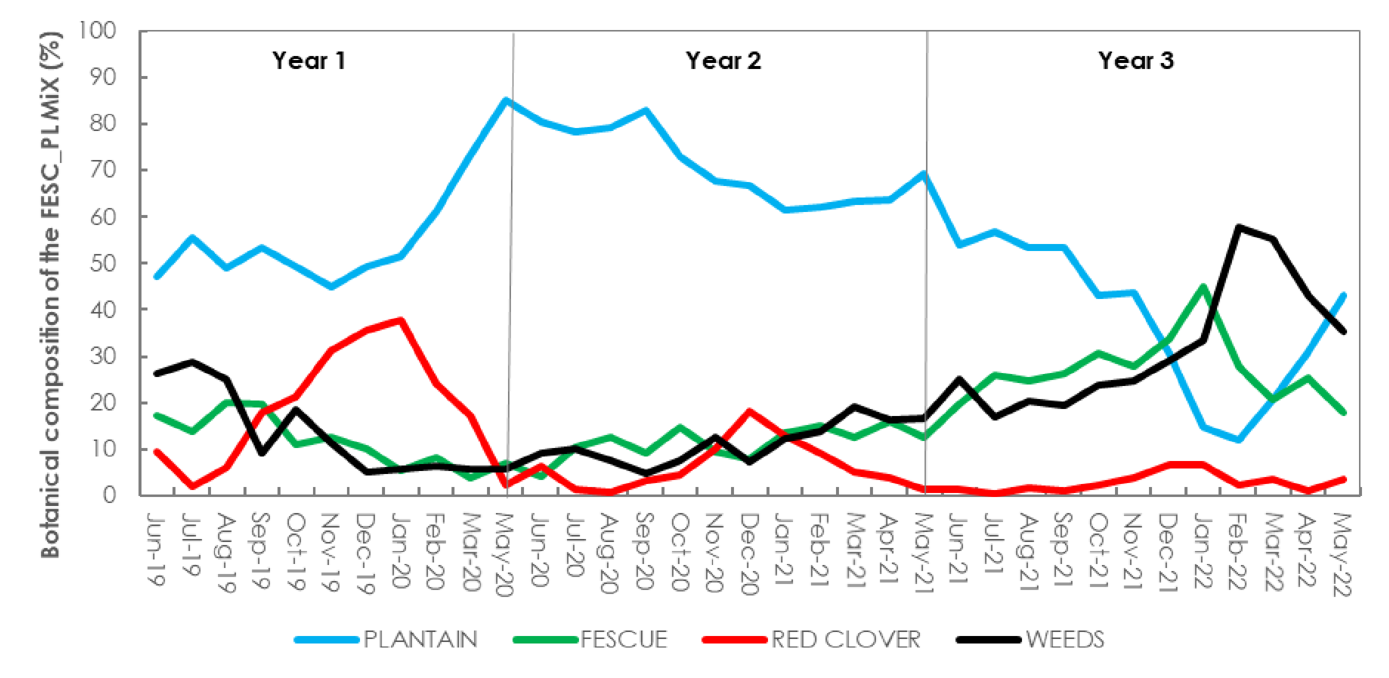

Figure 5. The botanical composition of the FESC_PL MIX system

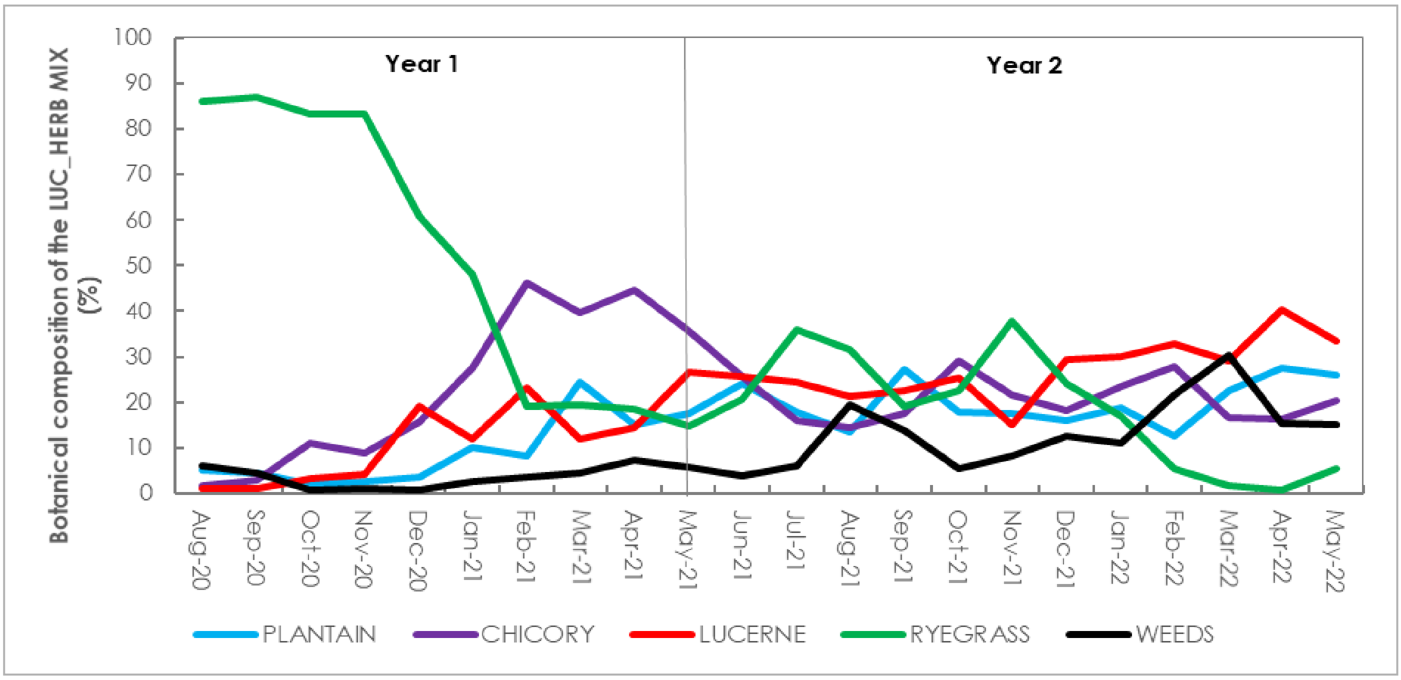

Figure 6. The botanical composition of the LUC_HERB MIX system

- The inclusion of ryegrass rather than fescue in the mixture also resulted in a reduced contribution of forage herbs to the pasture composition. The effect of this on forage quality, and in turn milk yield still needs to be characterised.
- The selection of Lucerne instead of red clover as the legume component resulted in a lower legume component in the year after establishment in the LUC_HERB MIX compared to FESC_PL MIX, but the Lucerne persisted better into the second year. It is however theorised that this may be a effect of the red clover cultivar planted, rather than the species itself.

In both systems the decline of individual components during 2021/2022 (ryegrass in LUC_HERB MIX and plantain in FESC_PL MIX) led to an increase in weeds, rather than a proportional increase in other components. It is thus likely that these components would need to be replaced to fill any physical gaps that may result from loss of individual plants over years.

Grazing capacity

The average monthly grazing capacity of the pasture systems is shown in Figure 7. Grazing capacity showed strong seasonal trends. In terms of winter grazing capacity, all systems tended to show low, but similar grazing capacities, particularly during year 1 and year 2.

During year 1 and 2 all the alternative systems achieved a similar or higher grazing capacity to KIKRYE during spring, however during year 3 the FESC_PL and MONOC systems had lower grazing capacities than the KIKRYE and LUC_HERB MIX systems. This was likely due to the lower growth rate of the plantain components in the FESC_PL and MONOC systems during winter and early spring during year 3 (Figure 1C).

Throughout the study the KIKRYE system tended to have a higher grazing capacity than the other systems from late spring to early autumn.

Irrespective of system differences within season, all systems tended to have a grazing capacity below the stocking rate of 4 cows/ha from Apr/May to September, highlighting the need to ensure that sufficient fodder is conserved as silage during the periods when grazing capacity exceeds stocking rate.

Milk yield

The mean monthly milk yield per cow (L/day) is shown in Figure 8. During year 1, the milk yield per cow was higher for the cows grazing the FESC_PL MIX system from October to May. During year 2, the highest yielding system was more varied over months, but both the FESC_PL MIX and LUC_HERB MIX had a higher milk yield per cow from January to May than the KIKRYE and MONOC systems. Thus, it appears that the inclusion of a legume and forage herb in a pasture mixture could improve milk yield per cow during summer and autumn compared to kikuyu-ryegrass pastures. During year 3, all the systems had a similar milk yield per cow from spring onwards. This was most likely associated with an increase in the volunteer grass component in all systems from spring onwards in year 3, and the likely decline in forage quality.

The total seasonal and annual milk yield per ha (L/ha) of the four pasture systems is given in Table 4 (and on Figure 2). During year 1 the higher seasonal yield of the FESC_PL MIX systems compared to other systems during spring was likely driven by the higher grazing capacity, while during summer and autumn it was the result of a higher milk yield per cow During year 2, the higher seasonal yield of FESC_PL again resulted in it having the highest total annual milk yield, with this trend most likely attributed to higher milk yield per cow per day during the majority of the year 2. Although the FESC_PL achieved high total winter and spring yields in year 3, it should be noted that this group spent a large proportion of the period (from June into September 2021) on Lucerne bales due to a shortage of available pasture (low grazing capacity) and a lack of silage bales cut on the system in the previous year. This highlights the need to consider how milk yield alone can be a poor indicator of performance in pasture based systems.

The KIKRYE system had a lower total seasonal milk yield than FESC_PL MIX and MONOC during summer and autumn during all three years. **This highlights how although kikuyu-ryegrass systems can support high grazing capacities during these seasons, this is offset by a lower milk yield per cow.**

A common concern among producers when including forage herbs in pastures is the potential negative impact on milk solids. The seasonal and annual energy corrected milk yield (kg Milk/ha) for each system is shown in Table 5. Energy corrected milk yield was calculated as ECM = 0.25*kg milk +12.2*kg butterfat +7.7*kg protein (Sjaunja et al. 1990). The pattern in ECM production matched that of milk production in Table 4, indicating that the inclusion of forage herbs did not impact negatively on the yielding potential per ha of the systems in terms on energy corrected milk.

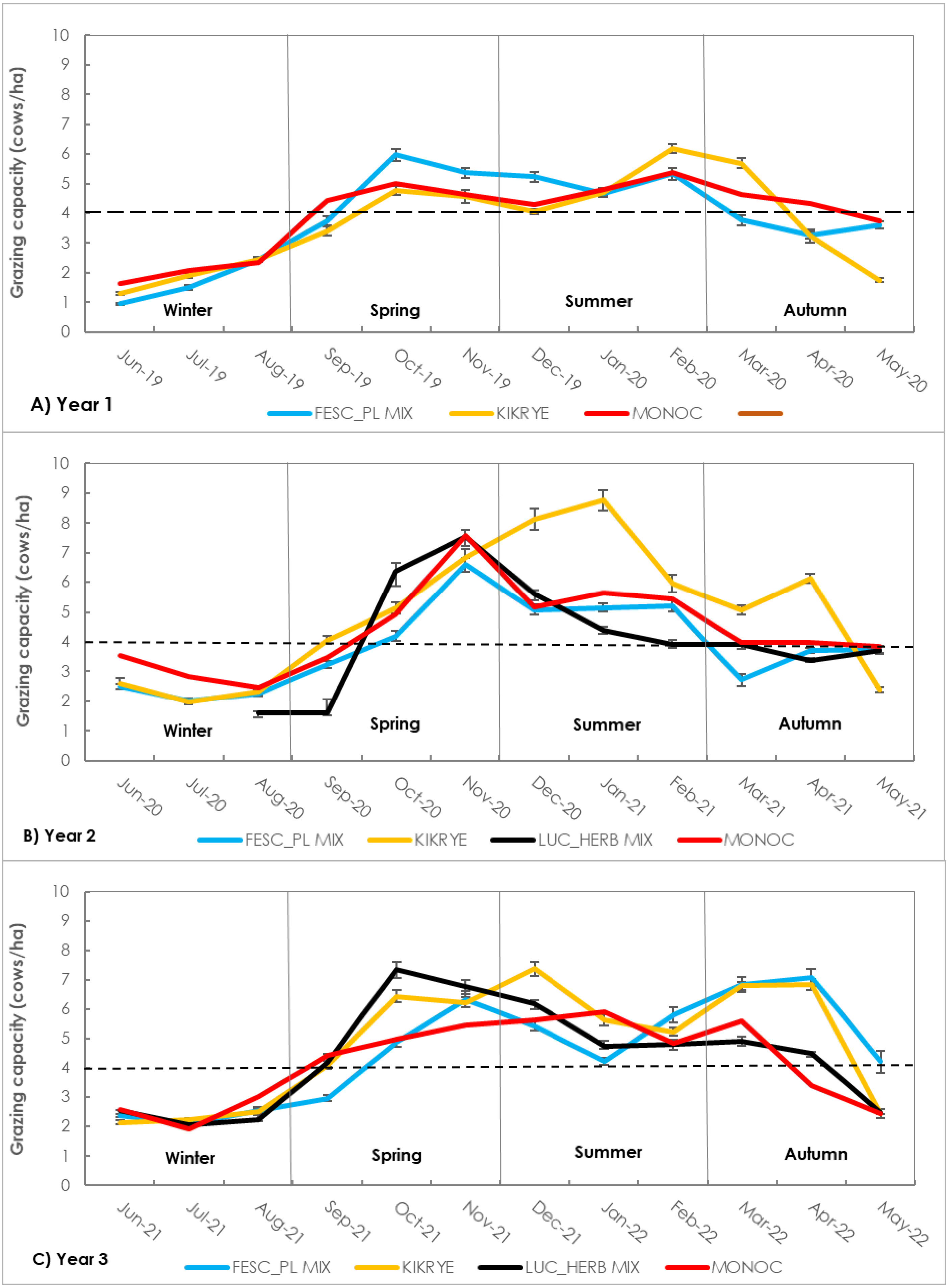

Figure 7. Grazing capacity (cows/ha) of the different pasture systems during year 1 (A), year 2 (B) and year 3 (C). Dashed line indicates a stocking rate of 4 cows/ha.

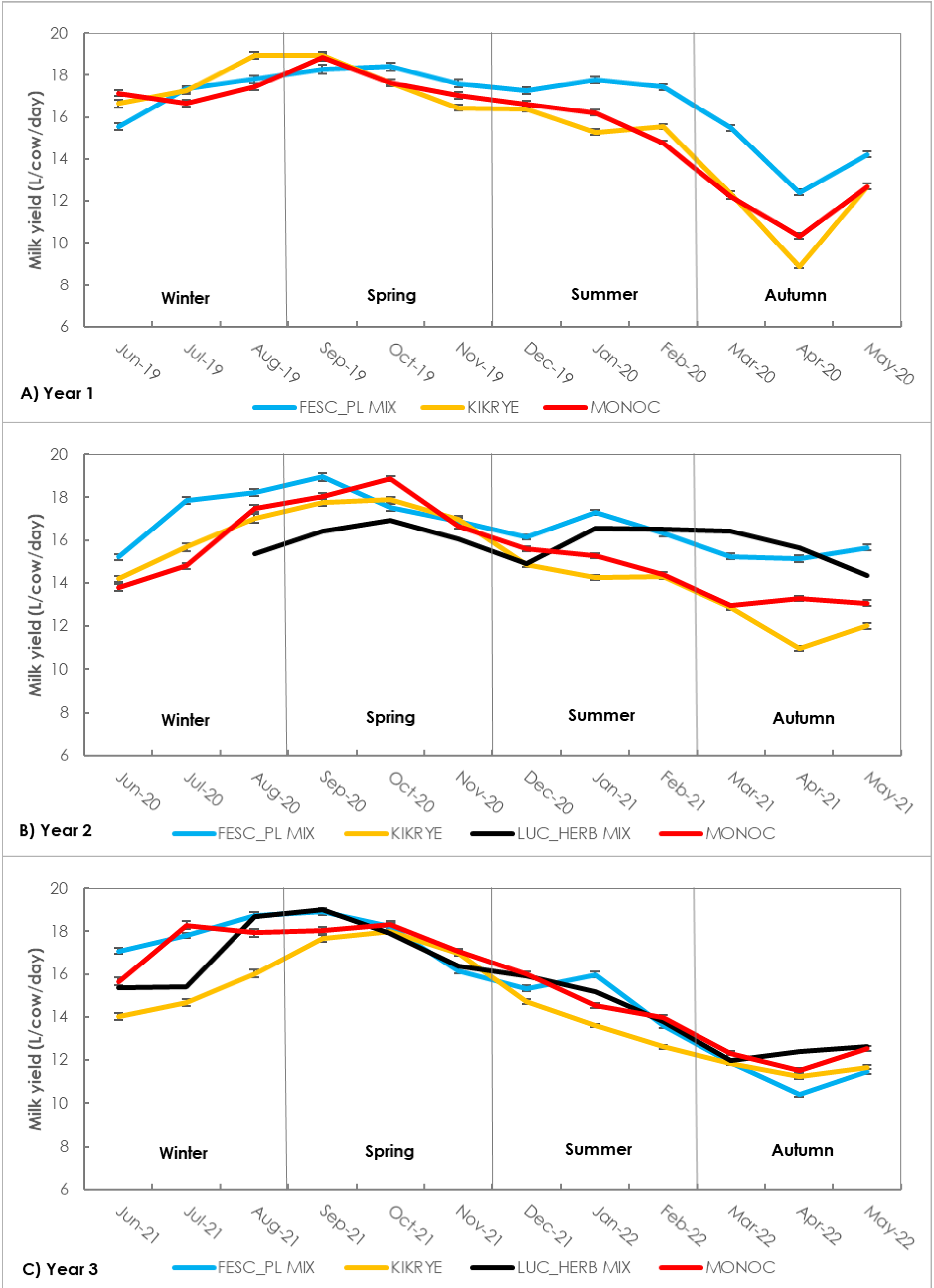

Figure 8. Daily milk yield per cow (L/cow/day) of the different pasture systems during year 1 (A), year 2 (B) and year 3 (C). * Low milk yield in April 2020 due to once a day milking as result of Covid

Table 4. The total seasonal and annual milk yield (L/ha) of different pasture systems

Season		Winter	Spring	Summer	Autumn	Annual
Year 1	MONO	5366*	6409	6444	4862	23081
	FESC_PL MIX	5236	6972*	6749*	5729*	24687*
	KIKRYE	5012	5740	5670	3939	20361
	LUC_HERB MIX					
Year 2	MONO	5599	7495	6793	5717	25603
	FESC_PL MIX	6989*	8061*	7171*	6546*	28767*
	KIKRYE	5305	6480	5947	4705	22438
	LUC_HERB MIX	941#	5722	5892	5492	18047
Year 3	MONO	6750	7466	6152*	4919*	25286
	FESC_PL MIX	7610*	7537*	5564	4868	25579*
	KIKRYE	5050	6732	5275	4386	21443
	LUC_HERB MIX	4667	6698	5578	4572	21514

* Indicates highest yield in season and year.
\# Only milked for one month in the season

Table 5. The total seasonal and annual energy corrected milk yield (kg/ha) of different pasture systems

Season		Winter	Spring	Summer	Autumn	Annual
Year 1	MONO	6759*	7966	8003	6223	28952
	FESC_PL MIX	6400	8189*	8106*	7139*	29834*
	KIKRYE	6105	7127	6867	4907	25006
	LUC_HERB MIX					
Year 2	MONO	7193	9313	8435	7374	32315
	FESC_PL MIX	8898*	9831*	8516*	8267*	35512*
	KIKRYE	6597	7976	7039	5947	27559
	LUC_HERB MIX	1173#	7108	7201	6927	22410
Year 3	MONO	8736	9270*	7477*	6171*	31654*
	FESC_PL MIX	9728*	9218	6693	5923	31563
	KIKRYE	6461	8100	6114	5363	26039
	LUC_HERB MIX	5918	8164	6430	5555	26067

* Indicates highest yield in season and year.
\# Only milked for one month in the season

Conclusions

Results reported in this paper are still very preliminary, but do indicate that the inclusion of plantain, chicory, lucerne and Tall Fescue, whether in a mixture or as a monoculture, holds the potential to yield similar or even higher pasture and milk per ha when compared to kikuyu-ryegrass. **The inclusion of forage herbs and legumes in pasture mixtures, in particular, could improve milk yield per cow from spring to autumn.**

The establishment of alternative pasture species and mixes could also be an effective method to manage weed ingression in minimum till pasture systems in the southern cape. **The inclusion of herbs, following eradication of the existing sward by herbicides, can reduce the weedy grass component in pastures.** Another strategy would be to utilise herb monocultures on areas where weedy grasses are problematic, as it can allow the use of grass-specific herbicides. The competitive yielding ability of Tall fescue pasture in the MONOC system, particularly during summer and autumn, illustrates that it, rather than a ryegrass monoculture, could also be established in areas where broadleaf weeds need to be controlled.

However, a major challenge to the adoption of mixtures into pasture systems, is the management of botanical composition due to the complexities in determining what species and/or mixture to plant and when renovation or re-establishment is required. This will require further and more detailed research to allow for more effective recommendations to be made. Here the major determinants will be firstly the properties of the area to be planted in terms of climate, soil properties and available resources (for example irrigation water supply). The second will be the motivation for the inclusion of a specific component for example: rapid establishment (ryegrass and clovers), versus persistence (fescue and Lucerne). Lastly interspecies competition and complementarity, particularly during establishment, needs to be taken into consideration. For example, including a highly competitive component like ryegrass at a high rate may reduce the contribution of a more persistent and environmentally resilient species like plantain. As stated by Sanderson et al. (2007), however, in all likelihood the continued sustainability of pasture systems will not be met my simply combining a myriad of species together, but rather by a multi-scale approach where different forages and combination of forage species are distributed across a farm according to site suitability and goals of the producer.

References:

Ammann SB, Lombard D, Zulu L. 2018a. Chicory and plantain production results 2018. Outeniqua Research Farm Information Day 2018 Booklet. Western Cape Department of Agriculture. 18-24.

Ammann SB, Lombard D, Zulu L. 2018a. Elite cultivar evaluation: Lolium and Tall Fescue. Outeniqua Research Farm Information Day 2018 Booklet. Western Cape Department of Agriculture. 25-33.

Box LA, Edwards GR, Bryant RH. 2016. Milk production and urinary nitrogen excretion of dairy cows grazing perennial ryegrass-white clover and pure plantain pastures. Proceedings of the New Zealand Society of Animal Production 76: 18-21.

Cave LM, Kemp PD, Kenyon PR, Morris ST. Plantain (*Plantago lanceolata*) and chicory (Cichorium intybus) under moisture stress in glasshouse. Proceedings of the 22nd International Grassland Congress. pp.139-140.

Cheng L, McCormick, Hussein AN, Fraslin C, Moonsan Y, Logan C, Grabot J, Edwards GR. 2015. Urinary nitrogen excretion, grazing and urination behaviour of dairy heifers grazing pasture, chicory and plantain in autumn. Proceedings of the New Zealand Society of Animal Production 75: 70-73.

Colman RL, Kaiser AG. 1974. The effect of stocking rate on milk production from kikuyu grass pastures fertilised with nitrogen. Australian Journal of Experimental Agriculture and Animal Husbandry 14: 155-160.

Fulkerson WJ. 1997. Use of the rising plate meter to allocate pasture. Research to Farm. NSW Agriculture, Wollongbar Agricultural Institute, May 1997.

Lee JM, Hemmingson NR, Minee EMK, Clark CEF. 2015. Management strategies for chicory (Chicorium intybus) and plantain (Plantago lanceolata): impact on dry matter yield, nutritive characteristics and plant density. Crop and Pasture Science 66:168 – 183.

Marais JP. 2001. Factors affecting the nutritive value of kikuyu grass (Pennisetum clandestinum) -a review. Tropical Grasslands 35: 65-84.

Mineé EMK, Waghorn GC, Lee JM, Clark CEF. 2017. Including Chicory and plantain in perennial ryegrass/white clover-based diet of dairy cattle in late lactation: Feed intake, milk production and rumen digestion. Animal Feed Science and Technology 227: 52-61.

Moorhead AJE, Piggot GJ. 2009. The performance of pasture mixes containing "Ceres Tonic" plantain in Northland.. Proceedings of the New Zealand Grassland Association 71: 195-199.

Nie Z, Miller S, Moore G, Hackney B, Boschma S, Reed KFM, Mitchell M, Albertsen TO, Clark S, Craig AD, Kearney G, Li GD, Dear BS. 2008. Field evaluation of perennial grasses and herbs in southern Australia 2. Persistence, root characteristics and summer activity. Australian Journal of Experimental Agriculture, 48:424-435.

Reeves M. 1997. Milk production from kikuyu. PhD Thesis, University of Sydney, Australia.

Scott JM, Munro M, Rollings N, Browne W, Vickery PJ, Macgregor C, Donald GE, Sutherland H. 2013a. Planning for whole farm systems research at a credible scale: subdividing land into farmlets with equivelant initial conditions. Animal Production Science 53: 618-627.

Scott JM, Behrendt K, Colvin A, Scott F, Shakhane LM, Guppy C, Hoad J, Gaden CA, Edwards C, Hinch GN, Cacho OJ, Donald GE, Cottle D, Coventry T, Williams G, Mackay DF. 2013b. Integrated overview of result from a farmlet experiment which compared the effects of pasture inputs and grazing management on profitability and sustainability. Animal Production Science 53: 841-855.

Stockdale CR. 1984. Evaluation of techniques for estimating the yield of irrigated pastures intensively grazed by dairy cows. II. The rising plate meter. Australian Journal of Experimental Agriculture and Animal Husbandry 24: 305-311.

`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.

Totty VK, Greenwood SL, Bryant RH, Edwards GR. 2013. Nitrogen partitioning and milk production of dairy cows grazing simple and diverse pastures. Journal of Dairy Science 96:141-149.

Tozer KN, Bourdot GW, Edwards GR. 2011. What factors lead to poor pasture persistence and weed ingress? Grassland Research and Practice Series 15: 196-138.

Van der Colf 2011. The production potential of Kikuyu (Pennisetum clandestinum) pastures over-sown with ryegrass (Lolium spp.). MSc Dissertation: University of Pretoria, South Africa.

Van der Colf J, Botha PR, Lombard MM. 2013. The production potential of perennial ryegrass and ryegrass hybrid cultivars over a three year evaluation period. Research Article Compilation Outeniqua Research Farm 2008-2013. Western Cape Department of Agriculture. Elsenburg. pp19 - 28.

Van der Colf J. 2017. Outeniqua Research Farm Climatic and Soil Data: 2015 to 2017; and the potential to improve resilience to drought in pasture based systems. Outeniqua Research Farm Day 2017 Booklet. 15-32.

Van Eekeren N, Bos M, De Wit J, Kiedel H, Bloem J. 2010. Effect of individual grass species and grass species mixtures on soil quality as related to root biomass and grass yield. Applied Soil Ecology 45: 2715-283.

Woodward SL, Waugh CD, Roch CG, Fynn D, Phillips J. 2013. Are diverse species mixtures better pastures for dairy farming. Proceedings of the New Zealand Grassland Association.

Perennial ryegrass cultivar evaluation results for 2020 to 2022

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Introduction

The perennial ryegrass (*Lolium perenne*) elite cultivar evaluation trial (Lp5) was planted on 5 March 2020 at the Outeniqua Research Farm. The aim of the trial is to evaluate the recent perennial ryegrass cultivars being used for intensive dairy pastures or ones that are about to enter the market together with cultivars that have shown promising results in the previous evaluation trial. This trial provides local data to assist farmers with choosing cultivars best adapted to the coastal region. Since all perennial ryegrass cultivars are imported, this data provides insight into the genetic potential and adaption for the southern Cape region. This data is specific for autumn 2020 (March) to May 2022 but the best cultivars are evaluated in successive trials, which means some have also been in previous trials. For previous data refer to the Outeniqua Information Day booklets for 2018, 2019, 2020 and 2021. The current trial, Lp5, of which the first two years data are reported here, is continuing to determine productivity for a third year provided the sward density remains at an acceptable level.

Cultivars evaluated

The trial consists of 16 cultivars of which 11 are diploid and five are tetraploid types.

- **Diploid cultivars**: 24Seven, 50Fifty, Boyne, Governor, Kimbuko, Kingsgate, Legion, Nui, One50, Platform, Tugela
- **Tetraploid cultivars**: Base, Evans, Portique, Tanker, Viscount

Parameters reported in this article

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

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

The harvest cycle is determined according to physiological stage being 3-leaf or in spring canopy closure. As the first cultivars reach these stages, the trial is harvested. Since leaf emergence rate is mainly driven by temperature, as well as radiation intensity, water and nutrient availability (Chapman 2016), most cultivars reach the 3-leaf stage at a similar time.

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

Seasonal yield data **(Table 1 and 2)** is of value for optimising fodder flow requirements especially for the more challenging seasons which are generally winter and summer/beginning of autumn. The question is whether there are cultivars with both good winter and summer yield. Alternatively it is advisable to plant paddocks to different cultivars to take advantage of different seasonal yield distributions and to spread risk. Alternatively other species like forage herbs can be used to boost summer production. A high yielding spring cultivar can for instance be considered for silage making of the surplus production. Other options are mixed swards.

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

Individual harvest yields and ***growth rates*** are given in **Table 3 and 4.**

Dry matter (DM) content **(Table 5)** is a consideration especially early in the season when the DM content is generally low, since DM content in ryegrass can negatively influence voluntary intake if it is very low (Cabrera Estrada et al 2004, John & Ulyatt 1987, Leaver 1985, Minson 1990. The

work by Vértité & Journet 1970 is also widely referenced where they investigated reduced intake with decreasing DM content. This can also be relevant when combined with other species in mixed pastures that also have a very low DM content such as forage herbs. However DM content on its own is not the only influence. If the rate of passage is fast and alters the grazing behaviour meaning that the cows graze again after a short interval the influence of low DM content will be less.

***Rust incidence* (Table 6)** refers mainly to crown rust (Puccinia coronata). According to Clarke & Eagling (1994) crown rust causes yield loss as well as negative effects on root weight, tiller numbers and leaf area. Potter (2007) reported not only reduced yield but also reduced water-soluble carbohydrates and reduced digestibility. Hence there are advantages to cultivars which are resistant or have a low incidence only.

***Flowering or reproductive behaviour* (Table 7)** is important since it results in a higher stem component which implies a higher fibre content and thus lower nutritive value, but also increased bulk and sward height. The percentage of the sward that is reproductive varies significantly between cultivars as does the duration of reproductive tillers in the sward. Generally perennial ryegrass has a lower flowering incidence in the local climate than Italian ryegrass which is linked to its higher vernalization requirements. Cultivars that do have a high bolting percentage could for instance be used in mixed pastures. 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.

***Sward density* (Table 8)** and plant population counts **(Table 9)** gives an indication of persistence especially after the summer when a decrease in plant population often occurs from late February onwards. The cultivars that retain good sward density or plant population after the challenging summer conditions are desirable.

Leaf emergence rate for this trial up to July 2021 is given in **Table 10**.

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 driven by 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 when there is rapid growth and some reproductive tillers, the first criterion for defoliation should be canopy closure since a lack of light penetration into the base of the sward can reduce tillering which is important for persistence.

Leaf emergence rate can be used to give an approximate indication of grazing rotation length i.e. when the pasture will be ready for the next grazing, by counting the leaf number regularly as the pasture regrows and calculating the number of days it takes to grow a leaf. Since the process is driven mainly by temperature and soil moisture, one needs to also take weather predictions into account whether the growth rate will either increase or decrease during the regrowth cycle.

Table 1: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm

Planted: 5 March 2020 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2020	Rank	Winter 2020	Rank	Spring 2020	Rank	Summer 2020/21	Rank	Year 1 2020/21	Rank
24Seven	D	**2.01** ^{a}	4	2.88 ^{de}	10	**5.01** ^{abc}	13	2.68 ^{bc}	11	12.6 ^{bc}	10
50Fifty	D	**2.08** ^{a}	2	2.93 ^{cde}	8	**5.45** ^{abc}	4	**3.02** ^{abc}	4	**13.5** ^{abc}	4
Base	T	**1.64** ^{abc}	14	**3.37** ^{abc}	4	**5.21** ^{abc}	9	**3.05** ^{ab}	3	**13.3** ^{abc}	5
Boyne	D	**1.72** ^{ab}	12	2.73 ^{efg}	12	**5.59** ^{abc}	3	2.50 ^{bc}	14	12.6 ^{bc}	11
Evans	T	1.31 ^{bc}	15	2.66 ^{efg}	13	**5.20** ^{abc}	11	2.87 ^{bc}	7	12.0 ^{cd}	13
Governor	D	**1.78** ^{ab}	11	3.10 ^{bcde}	6	**5.81** ^{ab}	2	**3.09** ^{ab}	2	**13.8** ^{ab}	3
Kimbuko	D	**2.07** ^{a}	3	2.41 ^{fg}	14	**5.20** ^{abc}	10	2.74 ^{bc}	10	12.4 ^{bc}	12
Kingsgate	D	**1.82** ^{a}	8	2.81 ^{ef}	11	5.84 ^{c}	15	2.40 ^{bc}	15	11.9 ^{cd}	15
Legion	D	**1.88** ^{a}	5	**3.58** ^{a}	2	4.93 ^{bc}	14	2.67 ^{bc}	12	**13.1** ^{abc}	6
Nui (cont)	D	**1.69** ^{ab}	13	**3.32** ^{abcd}	5	**5.23** ^{abc}	8	2.82 ^{bc}	8	**13.0** ^{abc}	7
One50	D	**1.86** ^{a}	6	**3.45** ^{ab}	3	**5.25** ^{abc}	7	2.31 ^{c}	16	**12.8** ^{abc}	9
Platform	D	**2.09** ^{a}	1	**3.66** ^{a}	1	**5.29** ^{abc}	5	2.82 ^{bc}	9	**13.9** ^{ab}	2
Portique	T	1.18 ^{c}	16	1.78 ^{h}	16	4.82 ^{c}	16	2.93 ^{bc}	5	10.7 ^{d}	16
Tanker	T	**1.80** ^{ab}	10	2.91 ^{de}	9	**5.25** ^{abc}	6	2.93 ^{bc}	6	**12.9** ^{abc}	8
Tugela	D	**1.86** ^{a}	7	2.34 ^{g}	15	**5.15** ^{abc}	12	2.53 ^{bc}	13	11.9 ^{cd}	14
Viscount	T	**1.80** ^{ab}	9	3.07 ^{bcde}	7	**5.84** ^{a}	1	**3.71** ^{a}	1	**14.4** ^{a}	1
LSD (0.05)		0.50		0.46		0.90		0.77		1.68	
CV %		16.9		9.3		10.3		16.4		7.86	

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

Table 1 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2021	Rank	Winter 2021	Rank	Spring 2021	Rank	Summer 2021/22	Rank	Year 2 2021/22	Rank
24Seven	D	**2.78** abc	7	1.02 bcd	14	4.36 bcde	12	2.43 bcd	11	9.78 bcde	11
50Fifty	D	**2.97** ab	5	**1.24** abcd	8	**4.80** abcd	3	2.52 bcd	10	**10.69** abcde	6
Base	T	**2.75** abc	8	**1.19** abcd	11	**4.63** abcde	6	**2.85** abcd	8	**10.47** abcde	8
Boyne	D	2.37 bc	14	**1.25** abcd	7	**5.30** a	1	**3.37** abc	3	10.05 bcde	10
Evans	T	2.16 c	16	**1.26** abcd	6	**4.55** abcde	8	2.14 d	15	8.68 de	15
Governor	D	**3.40** a	2	**1.32** abcd	5	**4.57** abcde	7	**2.90** abcd	6	**12.19** ab	2
Kimbuko	D	2.39 bc	13	**1.07** abcd	13	**5.06** ab	2	2.15 d	14	**10.67** abcde	7
Kingsgate	D	**2.74** abc	9	**1.22** abcd	9	4.23 cde	13	2.19 cd	13	8.92 cde	14
Legion	D	**3.43** a	1	**1.39** ab	2	3.89 e	16	**3.76** a	1	**11.21** abcd	5
Nui (cont)	D	2.25 bc	15	**1.40** a	1	4.48 bcde	10	0		8.13 e	16
One50	D	2.44 bc	11	**1.34** abc	4	4.01 de	15	2.31 bcd	12	10.09 bcde	9
Platform	D	**3.35** a	4	**1.19** abcd	10	4.17 cde	14	**3.36** abc	4	**12.08** ab	3
Portique	T	2.56 bc	10	0.98 cd	15	**4.54** abcde	9	**2.79** abcd	9	9.01 cde	12
Tanker	T	2.43 bc	12	**1.07** abcd	12	4.47 bcde	11	**3.03** abcd	5	8.98 cde	13
Tugela	D	**2.95** ab	6	0.96 d	16	**4.67** abcde	5	**2.85** abcd	7	**11.43** abc	4
Viscount	T	**3.36** a	3	**1.37** ab	3	**4.98** ab	3	**3.44** ab	2	**13.15** a	1
LSD (0.05)		0.72		0.38		0.81		1.67		2.74	
CV %		15.7		18.7		10.7		17.9		15.9	

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

Table 1 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation,
Outeniqua Research Farm
Planted: 5 March 2020 **Seasonal Yield** (t DM/ha)
D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2022	Rank	Year 1 + 2 2020 - 22	Rank
24Seven	D	**2.66** abcde	10	22.37 bcd	11
50Fifty	D	**2.73** abcde	9	**24.16** abc	5
Base	T	**2.90** abcd	7	23.73 bc	6
Boyne	D	**3.02** abcd	6	22.59 bcd	10
Evans	T	1.85 e	15	20.72 cd	15
Governor	D	**3.32** abc	4	**25.98** ab	2
Kimbuko	D	2.16 de	13	23.09 bcd	8
Kingsgate	D	2.13 de	14	20.79 cd	14
Legion	D	**3.40** abc	3	**24.27** abc	4
Nui (cont)	D	0		21.18 cd	13
One50	D	2.47 cde	12	22.95 bcd	9
Platform	D	**3.50** ab	2	**25.93** ab	3
Portique	T	**2.77** abcde	8	19.73 d	16
Tanker	T	2.57 bcde	11	21.86 cd	12
Tugela	D	**3.23** abc	5	23.30 bcd	7
Viscount	T	**3.58** a	1	**27.59** a	1
LSD (0.05)		1.67		3.71	
CV %		13.7		9.6	

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

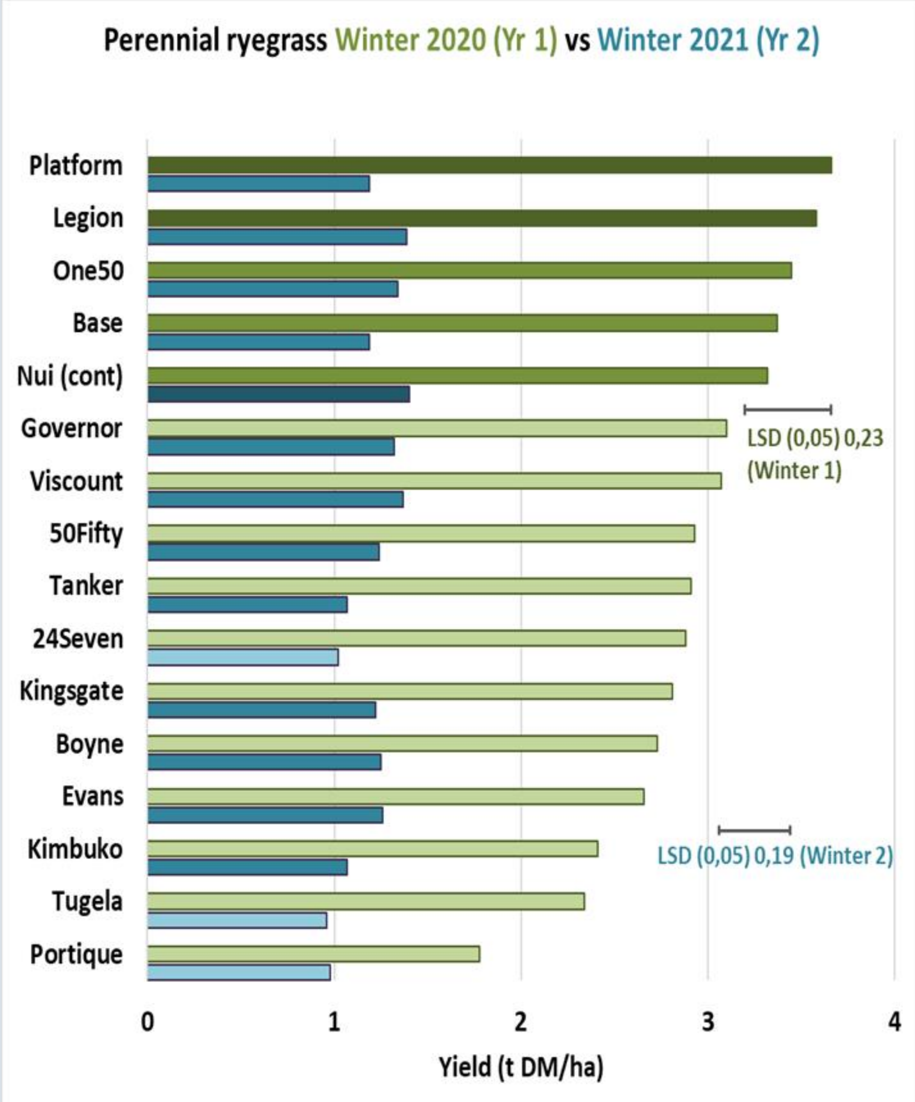


Figure 1: Yield (t DM/ha) for winter year 1 (2020) and winter year 2 (2021) showing the low yield of the second winter.

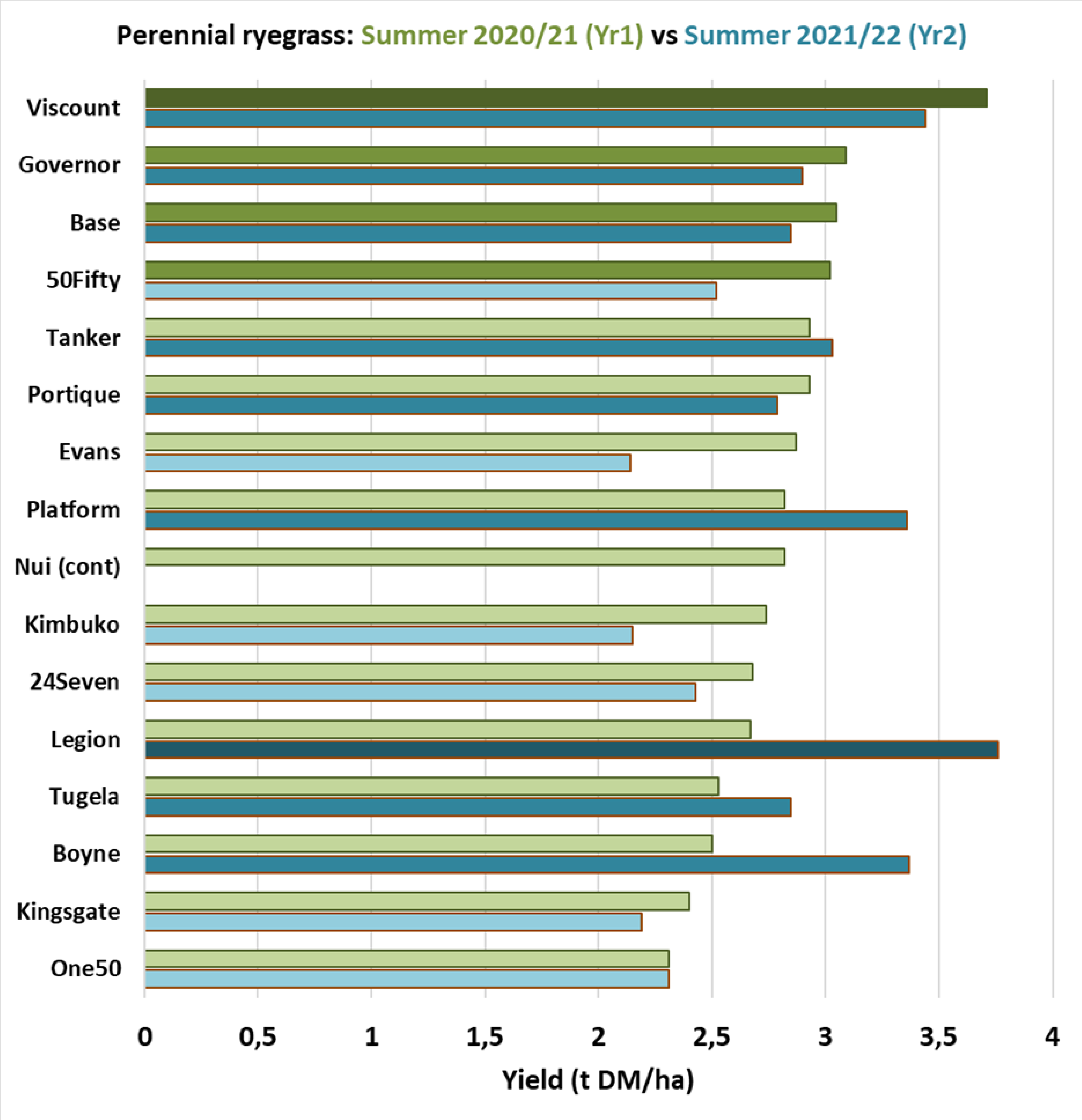


Figure 2: Yield (t DM/ha) for summer year 1 (2020/21) and summer year 2 (2021/22) showing variable responses for the different cultivars in the second summer.

The highest yielding cultivars for the second summer were not all amongst the best yielding group for annual yield. The cultivars Viscount, Platform, Governor, Base and Legion were amongst the high yielding group for the second summer and for annual yield. However Legion had a significantly lower yield in the first summer as well as spring of both years.

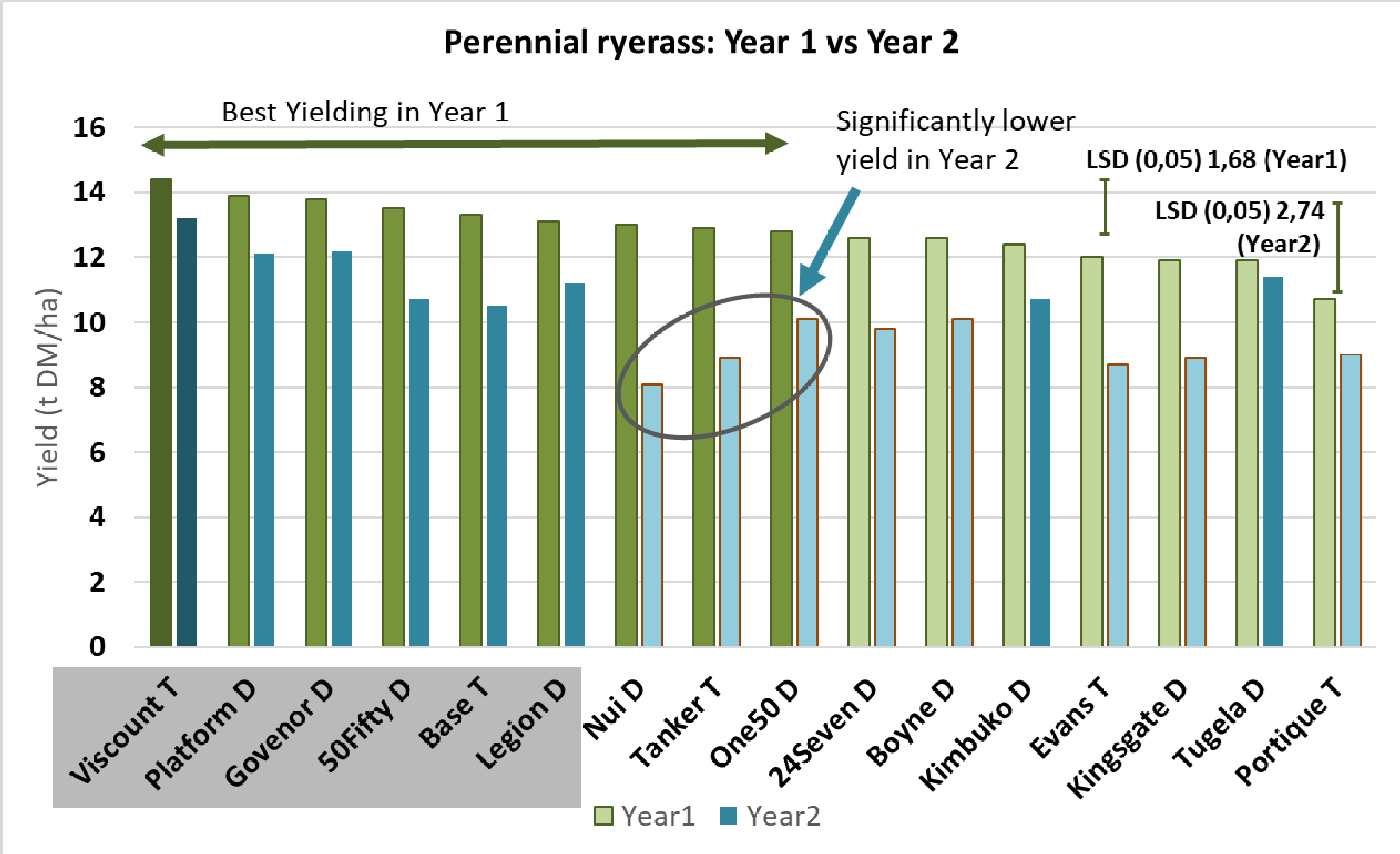
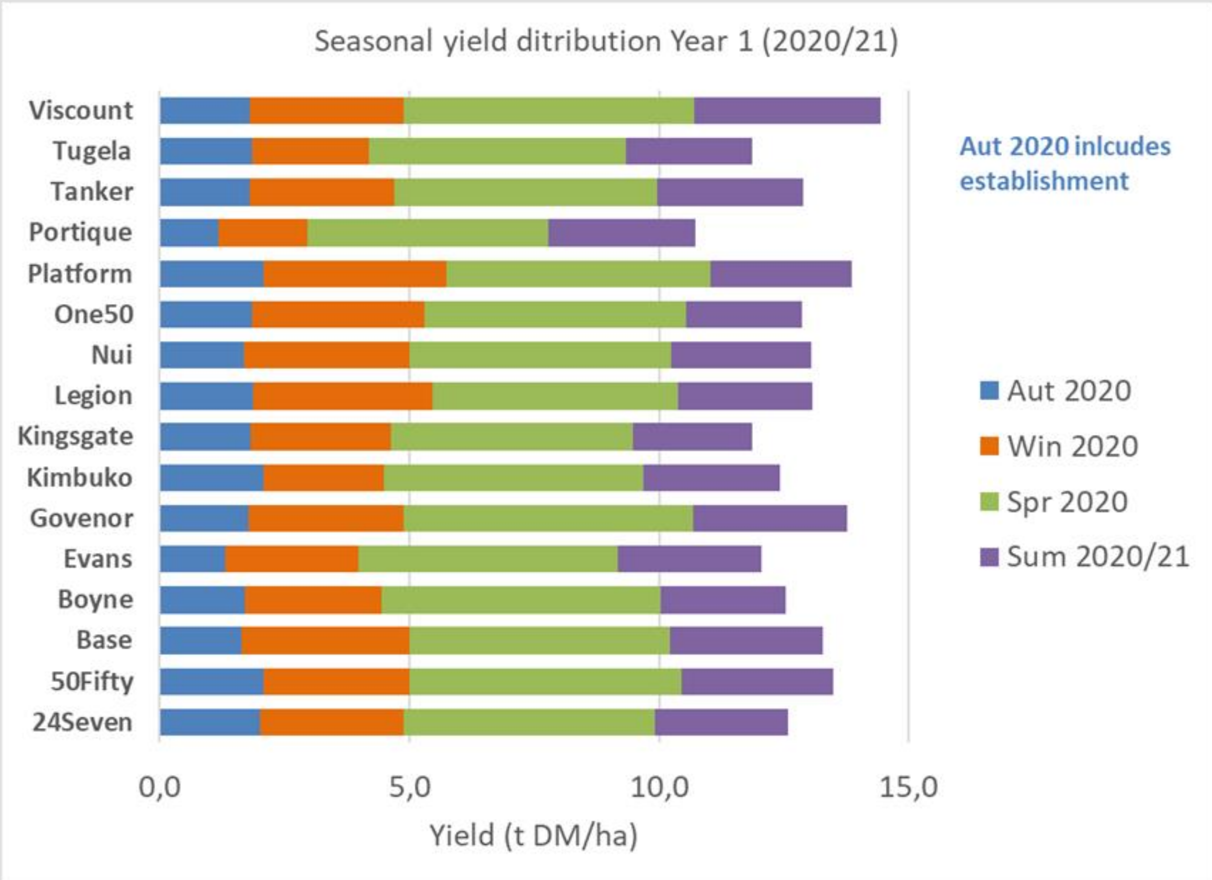


Figure 3: Perennial ryegrass cultivar yield (t DM/ha) comparing year 1 (2020/21) with year 2 (2021/22). All cultivars had a lower yield in the second year. For the highest yielding cultivars from the first year (nine cultivars) only six cultivars were also amongst the highest yielding in year 2, shown in the green block. Three of the cultivars marked by the circle showed a significantly lower yield in the year 2.



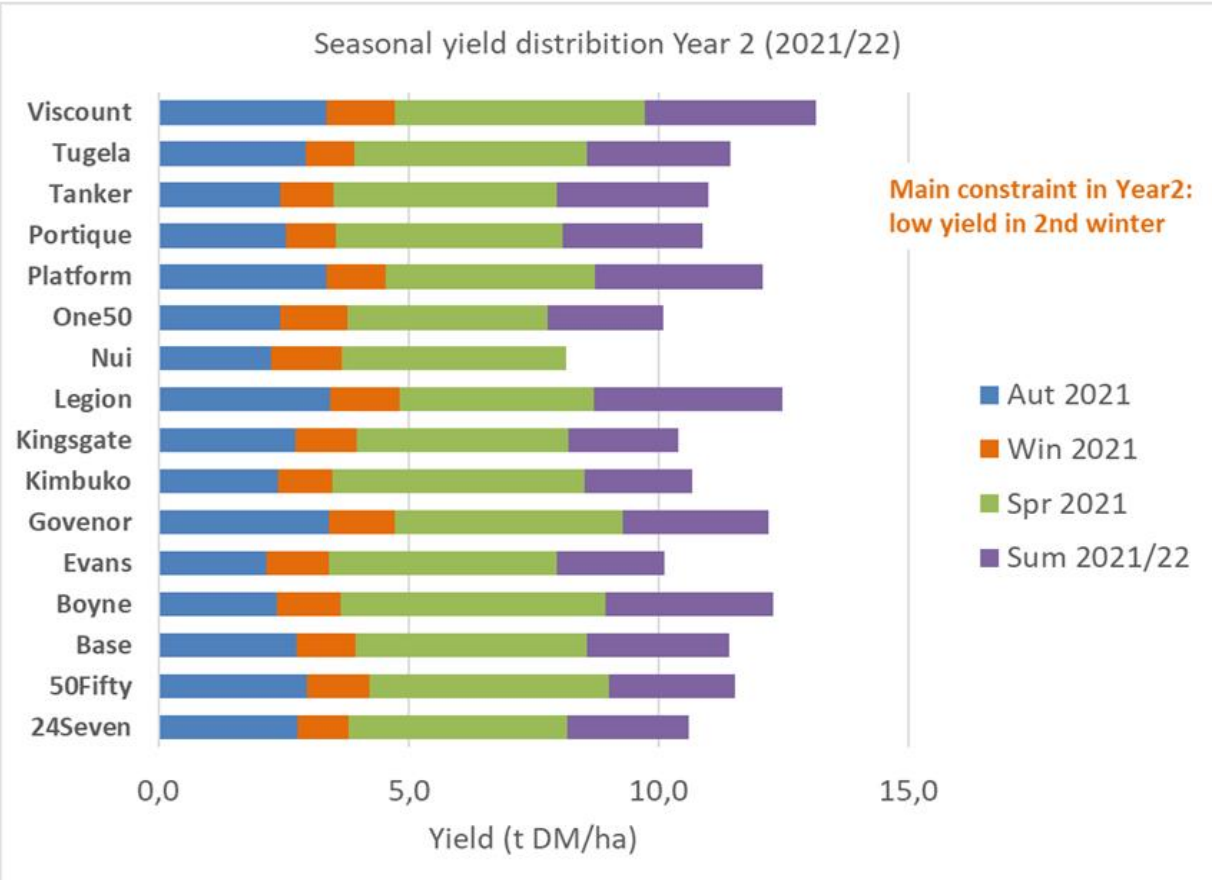


Figure 4: Seasonal yield distribution (t DM/ha) for autumn, winter spring and summer for year and in the upper graph and year 2 in the lower graph showing the significant decline in winter yield (orange) in the second year and the variations between cultivars for the second summer (purple). The autumn yield (blue) in the first year is lower since it includes the establishment phase.

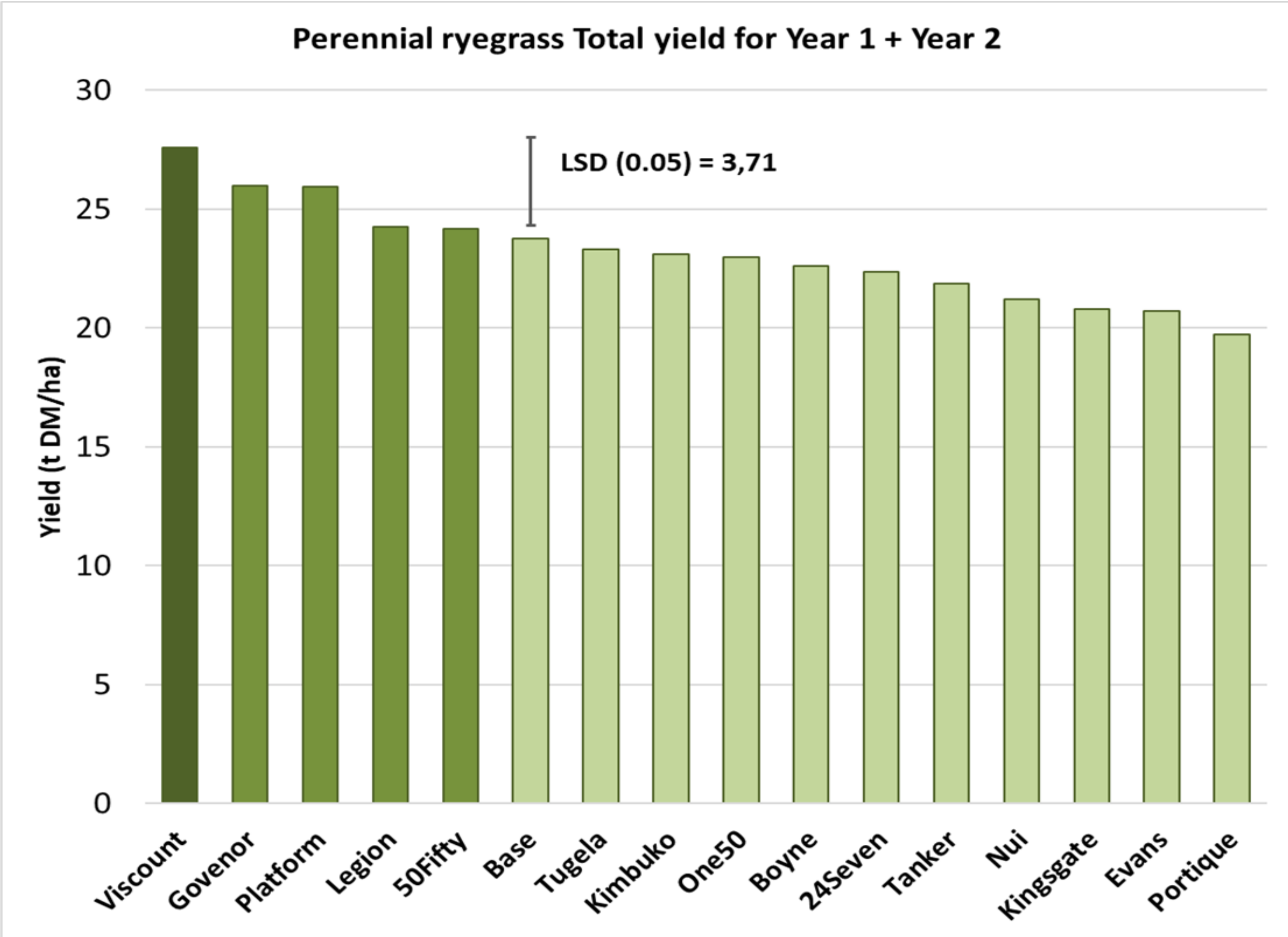


Figure 5: Total yield (t DM/ha) for perennial ryegrass cultivars over two years from March 2020 to end of February 2022.

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

Planted: 5 March 2020 **Mean seasonal growth rate over 3 months** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2020	Rank	Winter 2020	Rank	Spring 2020	Rank	Summer 2020/21	Rank	Autumn 2021	Rank
24Seven	D	**21.8 a**	4	31.3 de	10	**55.1 abc**	13	29.8 bc	11	**30.2 abc**	7
50Fifty	D	**22.6 a**	2	31.9 cde	8	**59.8 abc**	4	**33.6 abc**	4	**32.3 ab**	5
Base	T	**17.8 abc**	14	**36.6 abc**	4	**57.3 abc**	9	**33.9 ab**	3	**29.9 abc**	8
Boyne	D	**18.7 ab**	12	29.7 efg	12	**61.5 abc**	3	27.8 bc	14	25.8 bc	14
Evans	T	14.3 bc	15	29.0 efg	13	**57.1 abc**	11	31.9 bc	7	23.5 c	16
Governor	D	**19.3 ab**	11	33.8 bcde	6	**63.8 ab**	2	**34.3 ab**	2	**36.9 a**	2
Kimbuko	D	**22.5 a**	3	26.2 fg	14	**57.1 abc**	10	30.4 bc	10	26.0 bc	13
Kingsgate	D	**19.9 a**	8	30.6 ef	11	53.1 c	15	26.6 bc	15	**29.8 abc**	9
Legion	D	**20.4 a**	5	**38.9 a**	2	54.2 bc	14	29.7 bc	12	**37.3 a**	1
Nui (cont)	D	**18.4 ab**	13	**36.1 abcd**	5	**57.4 abc**	8	31.3 bc	8	24.5 bc	15
One50	D	**20.2 a**	6	**37.5 ab**	3	**57.7 abc**	7	25.6 c	16	26.4 bc	11
Platform	D	**22.7 a**	1	**39.8 a**	1	**58.1 abc**	5	31.3 bc	9	**36.4 a**	4
Portique	T	12.8 c	16	19.4 h	16	53.0 c	16	32.6 bc	5	27.8 bc	10
Tanker	T	**19.5 ab**	10	31.6 de	9	**57.7 abc**	6	32.6 bc	6	26.4 bc	12
Tugela	D	**20.2 a**	7	25.4 g	15	**56.6 abc**	12	28.2 bc	13	**32.1 ab**	6
Viscount	T	**19.6 ab**	9	33.4 bcde	7	**64.2 a**	1	**41.3 a**	1	**36.5 a**	3
LSD (0.05)		5.46		4.96		9.85		8.58		7.87	
CV %		16.9		9.3		10.3		16.4		15.7	

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

Table 2 cont: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Mean seasonal growth rate over 3 months** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Winter 2021	Rank	Spring 2021	Rank	Summer 2021/22	Rank	Autumn 2022	Rank
24Seven	D	11.1 bcd	14	48.0 bcde	12	27.0 bcd	11	**28.9 abcde**	10
50Fifty	D	**13.5 abcd**	8	**52.7 abcd**	4	27.9 bcd	10	**29.7 abcde**	9
Base	T	**12.9 abcd**	11	**50.9 abcde**	6	**31.6 abcd**	8	**31.5 abcd**	7
Boyne	D	**13.6 abcd**	7	**58.2 a**	1	**37.4 abc**	3	**32.8 abcd**	6
Evans	T	**13.7 abcd**	6	**50.0 abcde**	8	23.8 d	15	20.1 e	15
Governor	D	**14.4 abcd**	5	**50.3 abcde**	7	**32.2 abcd**	6	**36.1 abc**	4
Kimbuko	D	**11.7 abcd**	12	**55.6 ab**	2	23.9 d	14	23.5 de	13
Kingsgate	D	**13.2 abcd**	9	46.5 cde	13	24.3 cd	13	23.2 de	14
Legion	D	**15.0 ab**	2	42.8 e	16	**41.8 a**	1	**37.0 abc**	3
Nui (cont)	D	**15.2 a**	1	49.2 bcde	10	0		0	
One50	D	**14.6 abc**	4	44.0 de	15	25.7 bcd	12	26.8 cde	12
Platform	D	**13.0 abcd**	10	45.9 cde	14	**37.3 abc**	4	**38.0 ab**	2
Portique	T	10.7 cd	15	**49.9 abcde**	9	**31.0 abcd**	9	**30.1 abcde**	8
Tanker	T	**11.6 abcd**	13	49.1 bcde	11	**33.7 abcd**	5	28.0 bcde	11
Tugela	D	10.4 d	16	**51.3 abcde**	5	**31.7 abcd**	7	**35.0 abc**	5
Viscount	T	**14.9 ab**	3	**54.7 abc**	3	**38.3 ab**	2	38.9 a	1
LSD (0.05)		4.07		8.94		13.2		10.2	
CV %		18.6		10.7		17.9		13.6	

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. Refer to Table 4 for growth rates on individual harvests for more detail for specific months of the year.**

Table 3: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Yield: Individual harvests** (t DM/ha) 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
24Seven	D	**1.53** a	**1.37** abc	0.97 de	**1.61** abc	2.10	**2.00** ab	1.47 cde
50Fifty	D	**1.63** a	1.27 bcd	1.06 cd	**1.65** abc	2.29	**2.12** ab	1.49 cde
Base	T	**1.18** abc	1.31 bc	**1.33** abc	**1.87** a	2.14	**2.04** ab	**1.55** abcde
Boyne	D	**1.23** abc	**1.39** abc	0.93 de	1.42 bc	2.33	**2.41** ab	1.49 cde
Evans	T	0.97 bc	0.97 ef	1.01 d	**1.60** abc	2.34	1.96 b	1.42 e
Governor	D	**1.31** abc	1.32 bc	1.18 bcd	**1.69** ab	2.45	**2.34** ab	**1.76** a
Kimbuko	D	**1.61** a	1.32 bc	0.89 de	1.04 de	2.12	**2.32** ab	**1.65** abcd
Kingsgate	D	**1.36** ab	1.32 bc	1.10 bcd	1.34 cd	1.99	**2.06** ab	1.32 e
Legion	D	**1.36** ab	**1.46** ab	**1.48** a	**1.81** a	2.03	1.91 b	1.45 de
Nui (cont)	D	**1.20** abc	**1.38** abc	**1.34** abc	**1.69** ab	2.12	**2.14** ab	1.53 bcde
One50	D	**1.38** ab	**1.37** abc	**1.37** ab	**1.87** a	2.07	**2.17** ab	1.44 de
Platform	D	**1.54** a	**1.57** a	**1.59** a	**1.64** abc	1.98	**2.38** ab	1.46 de
Portique	T	0.86 c	0.90 f	0.57 f	0.99 e	1.98	**2.10** ab	**1.68** abc
Tanker	T	**1.34** abc	1.30 bcd	1.03 d	**1.64** abc	2.10	**2.23** ab	1.47 cde
Tugela	D	**1.47** a	1.11 de	0.73 ef	1.40 bc	2.34	**1.99** ab	1.40 e
Viscount	T	**1.37** ab	1.24 cd	1.16 bcd	**1.73** ab	2.35	**2.47** a	**1.73** ab
LSD (0.05)		0.49	0.20	0.28	0.34	NS	0.51	0.22
CV %		22.1	9.54	15.3	13.0	13.5	14.0	8.85

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 3 cont: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Yield: Individual harvests** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 8 18/1/2021	Cut 9 25/2/2021	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
24Seven	D	0.88 bcde	**0.59 abcd**	0.89 bcde	**1.21 abc**	**0.77 abcd**	0.70 cd	0.72 bc
50Fifty	D	1.00 bcde	**0.81 ab**	**1.01 abcd**	**1.16 abc**	**0.92 ab**	**0.86 abc**	**0.88 abc**
Base	T	**1.15 ab**	**0.64 abcd**	0.88 bcde	**1.24 abc**	0.72 bcd	**0.95 ab**	**0.87 abc**
Boyne	D	0.93 bcde	0.36 cd	0.70 de	0.91 c	**0.87 abcd**	**0.75 abcd**	**0.86 abc**
Evans	T	**1.12 ab**	**0.60 abcd**	0.58 e	0.96 c	0.69 d	**0.82 abcd**	**0.95 abc**
Governor	D	0.95 bcde	**0.71 abc**	**1.13 abc**	**1.43 a**	**0.96 a**	**0.82 abcd**	**0.98 ab**
Kimbuko	D	0.81 cde	**0.59 abcd**	0.82 cde	0.98 c	0.68 d	0.74 bcd	0.69 bc
Kingsgate	D	0.71 e	**0.61 abcd**	**0.97 abcd**	**1.09 abc**	**0.77 abcd**	**0.80 abcd**	**0.91 abc**
Legion	D	0.86 bcde	**0.63 abcd**	**1.30 a**	**1.37 a**	**0.87 abcd**	**0.96 a**	**1.08 a**
Nui (cont)	D	**1.11 abc**	0.46 bcd	0.72 de	0.91 c	0.70 cd	**0.75 abcd**	**1.07 a**
One50	D	0.89 bcde	0.24 d	0.79 cde	**1.07 abc**	0.67 d	**0.77 abcd**	**1.06 a**
Platform	D	0.95 bcde	**0.68 abc**	**1.26 a**	**1.37 ab**	**0.83 abcd**	**0.76 abcd**	**0.88 abc**
Portique	T	0.95 bcde	**0.61 abcd**	0.71 de	**1.11 abc**	**0.85 abcd**	0.72 cd	0.64 c
Tanker	T	**1.05 abcd**	**0.68 abc**	0.81 cde	1.01 bc	0.70 cd	0.69 cd	**0.80 abc**
Tugela	D	0.79 de	**0.60 abcd**	**1.01 abcd**	**1.24 abc**	**0.80 abcd**	0.63 d	0.65 c
Viscount	T	**1.31 a**	**0.98 a**	**1.20 ab**	**1.36 ab**	**0.90 abc**	**0.89 abc**	**1.00 ab**
LSD (0.05)		0.30	0.44	0.35	0.36	0.20	0.21	0.33
CV %		18.8	42.7	22.7	18.9	15.4	29.8	22.4

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 3 cont: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Yield: Individual harvests** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 15 4/10/2021	Cut 16 4/11/2021	Cut 17 7/12/2021	Cut 18 4/1/2022	Cut19 7/2/2022	Cut 20 15/3/2022	Cut 21 12/4/2022	Cut 22 16/5/2022
24Seven	D	1.51 c	1.60 bcde	**1.86 ab**	**1.27 abcde**	**0.48 ab**	**0.52 ab**	0.52 def	1.34 bcde
50Fifty	D	**1.78 abc**	**1.69 abc**	**2.00 ab**	**1.40 abcd**	0.32 b	0.36 b	0.46 ef	**1.58 ab**
Base	T	**1.61 abc**	**1.69 abc**	**1.97 ab**	**1.38 abcd**	**0.48 ab**	**0.61 ab**	0.63 cdef	1.40 bcd
Boyne	D	**2.05 ab**	**1.80 ab**	**2.20 a**	**1.35 abcd**	**0.51 ab**	**0.60 ab**	**1.09 a**	1.04 e
Evans	T	1.57 bc	**1.75 abc**	**1.85 ab**	**1.49 a**	0.31 b	0.20 b	0.34 f	1.13 de
Governor	D	1.56 bc	**1.67 abcd**	**1.98 ab**	1.24 bcde	**0.74 ab**	**0.86 ab**	**0.81 abcd**	**1.64 ab**
Kimbuko	D	**2.12 a**	**1.87 a**	1.72 b	1.16 de	**0.46 ab**	0.29 b	0.43 ef	1.22 de
Kingsgate	D	1.50 c	1.54 cdef	**1.78 ab**	**1.33 abcd**	**0.49 ab**	0.35 b	0.42 ef	1.25 cde
Legion	D	1.40 c	1.35 f	1.70 b	**1.51 a**	**0.95 a**	**1.13 a**	0.69 bcde	**1.53 abc**
Nui (cont)	D	**1.72 abc**	1.56 bcdef	**1.81 ab**	1.23 cde	**0.43 ab**	0	0.32 f	1.16 de
One50	D	1.37 c	1.43 def	**1.77 ab**	1.16 de	**0.62 ab**	0.27 b	0.53 def	1.42 bcd
Platform	D	1.47 c	1.41 ef	**1.90 ab**	**1.48 ab**	**0.81 ab**	1.15 a	**0.92 abc**	**1.61 ab**
Portique	T	**1.65 abc**	**1.64 abcde**	**1.87 ab**	1.05 e	**0.51 ab**	**0.47 ab**	0.46 ef	1.25 cde
Tanker	T	1.31 c	**1.65 abcde**	**2.15 ab**	**1.32 abcd**	**0.52 ab**	**0.55 ab**	0.51 def	1.34 bcde
Tugela	D	1.51 c	**1.79 abc**	**2.01 ab**	**1.34 abcd**	**0.70 ab**	**0.66 ab**	**0.81 abcd**	**1.73 a**
Viscount	T	**1.82 abc**	**1.75 abc**	**2.11 ab**	**1.41 abc**	**0.93 a**	1.12 a	**1.01 ab**	**1.62 ab**
LSD (0.05)		0.53	0.25	0.46	0.24	0.56	0.74	0.32	0.31
CV %		19.4	9.1	14.4	11.0	56.3	47.5	25.2	12.9

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 4: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Growth rate: Individual harvests** (kg DM/ha/day) 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
24Seven	D	**33.2 a**	**37.0 abc**	24.2 de	**36.6 abc**	59.8	**57.2 ab**	54.5 cde
50Fifty	D	**35.4 a**	34.3 bcd	26.6 cd	**37.5 abc**	65.3	**63.5 ab**	55.2 cde
Base	T	**25.6 abc**	35.5 bc	**33.2 abc**	**42.5 a**	61.2	**58.4 ab**	**57.3 abcde**
Boyne	D	**26.7 abc**	**37.6 abc**	23.3 de	32.2 bc	66.4	**68.9 ab**	55.2 cde
Evans	T	21.1 bc	26.2 ef	25.4 d	**36.3 abc**	66.7	55.8 b	52.5 e
Governor	D	**28.5 abc**	35.7 bc	29.4 bcd	**38.4 ab**	70.0	**66.9 ab**	**65.0 a**
Kimbuko	D	**35.0 a**	35.6 bc	22.3 de	23.6 de	60.8	**66.3 ab**	**61.0 abcd**
Kingsgate	D	**29.6 ab**	35.6 bc	27.6 bcd	30.4 cd	57.0	**58.8 ab**	48.9 e
Legion	D	**29.6 ab**	**39.4 ab**	**37.1 a**	**41.0 a**	58.1	54.7 b	53.5 de
Nui (cont)	D	**26.1 abc**	**37.4 abc**	**33.6 abc**	**38.5 ab**	60.6	**61.2 ab**	56.5 bcde
One50	D	**29.9 ab**	**37.0 abc**	**34.2 ab**	**42.5 a**	59.2	**62.0 ab**	53.4 de
Platform	D	**33.4 a**	**42.4 a**	**39.8 a**	**37.3 abc**	56.6	**68.1 ab**	53.8 de
Portique	T	18.8 c	24.3 f	14.2 f	22.6 e	56.5	**60.0 ab**	**62.4 abc**
Tanker	T	**29.1 abc**	35.0 bcd	25.6 d	**37.1 abc**	59.9	**63.7 ab**	54.6 cde
Tugela	D	**31.9 a**	29.9 de	18.2 ef	31.9 bc	66.7	**56.6 ab**	51.9 e
Viscount	T	**29.8 ab**	33.5 cd	29.1 bcd	**39.3 ab**	67.1	**70.6 a**	**64.2 ab**
LSD (0.05)		10.6	5.51	7.10	7.66	NS	14.5	8.32
CV %		22.1	9.54	15.3	13.0	13.5	14.0	8.85

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 4 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Growth rate: Individual harvests** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 8 18/1/2021	Cut 9 25/2/2021	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
24Seven	D	32.9 bcde	**15.6 abcd**	27.1 bcde	**34.7 abc**	**23.9 abcd**	21.2 cd	14.9 bc
50Fifty	D	37.1 bcde	**21.2 ab**	**30.5 abcd**	**33.1 abc**	**28.7 ab**	**26.2 abc**	**18.3 abc**
Base	T	**42.5 ab**	**16.9 abcd**	26.7 bcde	**35.3 abc**	22.5 bcd	**28.9 ab**	**18.1 abc**
Boyne	D	34.4 bcde	9.4 cd	21.7 de	26.0 c	**27.4 abcd**	**22.6 abcd**	**17.8 abc**
Evans	T	**41.3 ab**	**15.8 abcd**	17.8 e	27.6 c	21.7 d	**24.7 abcd**	**19.8 abc**
Governor	D	35.3 bcde	**18.6 abc**	**34.2 abc**	**40.8 a**	**30.0 a**	**24.7 abcd**	**20.4 ab**
Kimbuko	D	30.1 cde	**15.4 abcd**	24.8 cde	27.9 c	21.4 d	22.4 bcd	14.4 bc
Kingsgate	D	26.3 e	**16.0 abcd**	**29.4 abcd**	**31.3 abc**	**24.2 abcd**	**24.1 abcd**	**18.9 abc**
Legion	D	31.9 bcde	**16.6 abcd**	**39.3 a**	**39.1 a**	**27.3 abcd**	**29.0 a**	**22.5 a**
Nui (cont)	D	**41.1 abc**	12.2 bcd	22.0 de	26.1 c	22.0 cd	**22.7 abcd**	**22.3 a**
One50	D	33.0 bcde	6.3 d	23.7 cde	**30.5 abc**	20.9 d	**23.3 abcd**	**22.1 a**
Platform	D	35.2 bcde	**18.0 abc**	**38.2 a**	**39.1 ab**	**25.8 abcd**	**23.0 abcd**	**18.4 abc**
Portique	T	35.2 bcde	**16.2 abcd**	21.6 de	**31.6 abc**	**26.4 abcd**	21.9 cd	13.4 c
Tanker	T	**38.9 abcd**	**17.9 abc**	24.5 cde	28.8 bc	22.0 cd	20.8 cd	**16.7 abc**
Tugela	D	29.3 de	**15.9 abcd**	**30.6 abcd**	**35.4 abc**	**25.0 abcd**	19.0 d	13.5 c
Viscount	T	**48.6 a**	**26.0 a**	**36.5 ab**	**38.9 ab**	**28.2 abc**	**27.0 abc**	**20.9 ab**
LSD (0.05)		11.2	11.5	10.6	10.4	6.4	6.4	6.8
CV %		18.8	42.7	22.7	18.9	15.5	29.8	22.4

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 4 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Growth rate: Individual harvests** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 15 4/10/2021	Cut 16 4/11/2021	Cut 17 7/12/2021	Cut 18 4/1/2022	Cut19 7/2/2022	Cut 20 15/3/2022	Cut 21 12/4/2022	Cut 22 16/5/2022
24Seven	D	36.9 ^{c}	51.7 ^{bcde}	**56.2** ^{ab}	**45.2** ^{abcde}	**14.2** ^{ab}	**14.5** ^{ab}	18.4 ^{def}	39.2 ^{bcde}
50Fifty	D	**43.6** ^{abc}	**54.4** ^{abc}	**60.7** ^{ab}	**49.8** ^{abcd}	9.5 ^{b}	10.1 ^{b}	16.3 ^{ef}	**46.5** ^{ab}
Base	T	**39.3** ^{abc}	**54.6** ^{abc}	**59.7** ^{ab}	**49.3** ^{abcd}	**14.2** ^{ab}	**16.8** ^{ab}	22.3 ^{cdef}	41.2 ^{bcd}
Boyne	D	**50.2** ^{ab}	**58.0** ^{ab}	**66.7** ^{a}	**48.2** ^{abcd}	**14.9** ^{ab}	**16.8** ^{ab}	**38.9** ^{a}	30.5 ^{e}
Evans	T	38.2 ^{bc}	**56.4** ^{abc}	**55.9** ^{ab}	**53.2** ^{a}	9.0 ^{b}	5.5 ^{b}	12.0 ^{f}	33.4 ^{de}
Governor	D	38.1 ^{bc}	**54.0** ^{abcd}	**59.9** ^{ab}	44.5 ^{bcde}	**21.6** ^{ab}	**24.1** ^{ab}	**28.9** ^{abcd}	**48.2** ^{ab}
Kimbuko	D	**51.8** ^{a}	**60.5** ^{a}	52.2 ^{b}	41.2 ^{de}	**13.6** ^{ab}	7.9 ^{b}	15.3 ^{ef}	35.8 ^{de}
Kingsgate	D	36.5 ^{c}	49.8 ^{cdef}	**54.0** ^{ab}	**47.5** ^{abcd}	**14.5** ^{ab}	9.8 ^{b}	14.9 ^{ef}	37.0 ^{cde}
Legion	D	34.1 ^{c}	43.5 ^{f}	51.6 ^{b}	**53.7** ^{a}	**28.1** ^{a}	**31.3** ^{a}	24.7 ^{bcde}	**44.9** ^{abc}
Nui (cont)	D	**42.1** ^{abc}	50.4 ^{bcdef}	**55.0** ^{ab}	43.8 ^{cde}	**12.5** ^{ab}	0	11.3 ^{f}	34.1 ^{de}
One50	D	33.4 ^{c}	46.2 ^{def}	**53.6** ^{ab}	41.4 ^{de}	**18.2** ^{ab}	7.5 ^{b}	18.8 ^{def}	41.7 ^{bcd}
Platform	D	35.9 ^{c}	45.4 ^{ef}	**57.6** ^{ab}	**52.9** ^{ab}	**23.8** ^{ab}	**31.9** ^{a}	**32.8** ^{abc}	**47.4** ^{ab}
Portique	T	**40.3** ^{abc}	**53.1** ^{abcde}	**56.6** ^{ab}	37.6 ^{e}	**14.9** ^{ab}	**12.9** ^{ab}	16.2 ^{ef}	36.6 ^{cde}
Tanker	T	32.0 ^{c}	**53.1** ^{abcde}	**65.1** ^{ab}	**47.1** ^{abcd}	**15.3** ^{ab}	**15.4** ^{ab}	18.2 ^{def}	39.4 ^{bcde}
Tugela	D	36.7 ^{c}	**57.6** ^{abc}	**60.9** ^{ab}	**47.7** ^{abcd}	**20.6** ^{ab}	**18.4** ^{ab}	**29.1** ^{abcd}	**50.8** ^{a}
Viscount	T	**44.5** ^{abc}	**56.5** ^{abc}	**64.0** ^{ab}	**50.5** ^{abc}	**27.2** ^{a}	**31.2** ^{a}	**36.0** ^{ab}	**47.6** ^{ab}
LSD (0.05)		12,8	7.95	13.9	8.6	16.4	20.4	11.4	9.1
CV %		19,4	9.0	14.4	11.0	56.1	47.4	25.3	13.0

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 5: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Dry matter content (%)** 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
24Seven	D	**15.8 ab**	**15.7 abc**	**18.2 abc**	**18.5 abc**	**23.2 a**	**21.5 abc**	**20.5 abc**
50Fifty	D	14.3 bcd	**16.4 ab**	**18.3 abc**	**20.0 a**	**23.2 a**	**21.8 ab**	**20.7 abc**
Base	T	13.1 d	14.0 de	15.4 fg	17.1 cd	20.6 cd	19.2 cdef	18.3 de
Boyne	D	14.5 abcd	**16.9 a**	19.4 a	20.1 a	**21.7 abc**	**22.2 ab**	**21.3 ab**
Evans	T	13.3 cd	15.2 bcde	15.8 fg	16.2 d	19.0 d	18.9 def	17.6 e
Governor	D	14.0 bcd	15.4 abcde	17.5 bcde	**18.5 abc**	**21.5 abc**	**21.3 abcd**	**20.0 abcd**
Kimbuko	D	13.1 d	15.0 bcde	**19.5 a**	**19.5 ab**	**22.7 ab**	20.8 bcde	**21.0 abc**
Kingsgate	D	13.7 cd	**15.6 abcd**	**18.1 abc**	**20.0 a**	**23.1 a**	**22.6 ab**	**21.2 ab**
Legion	D	14.1 bcd	14.4 cde	16.9 cdef	**18.6 abc**	20.6 bcd	**21.4 abc**	19.6 bcd
Nui (cont)	D	13.8 bcd	**15.6 abcd**	17.5 bcde	**19.4 ab**	**21.9 abc**	**22.1 ab**	19.8 bcd
One50	D	**16.4 a**	14.9 bcde	17.8 bcd	**18.9 ab**	**23.1 a**	**21.8 ab**	**21.9 a**
Platform	D	13.1 d	13.9 e	16.2 ef	**19.0 ab**	**22.0 abc**	**21.9 ab**	19.2 cde
Portique	T	13.2 cd	**16.3 ab**	18.6 ab	**19.5 ab**	20.5 cd	19.3 cdef	18.5 de
Tanker	T	12.6 d	14.0 de	16.4 def	17.9 bc	18.8 d	18.1 f	18.3 de
Tugela	D	**15.1 abc**	**16.5 ab**	**18.8 ab**	**19.9 a**	**22.4 abc**	**23.4 a**	**20.8 abc**
Viscount	T	14.4 bcd	14.0 de	14.5 g	17.0 cd	18.8 d	18.6 ef	17.3 e
LSD (0.05)		1.98	1.66	1.56	1.67	2.07	2.43	1.92
CV %		8.47	6.53	5.37	5.34	5.79	6.97	5.84

BOLD = Highest and similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 5 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Dry matter content (%)** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 8 18/1/2021	Cut 9 25/2/2021	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
24Seven	D	**23.1 ab**	**23.6 abcd**	**21.6 abcd**	**18.5 abc**	**15.0 abc**	**16.5 abcd**	**20.3 ab**
50Fifty	D	**23.0 abc**	**22.6 abcde**	**21.9 abcd**	**18.3 abc**	**15.3 abc**	**17.6 ab**	19.4 bc
Base	T	21.5 bcd	**24.1 abc**	20.8 cd	16.1 e	13.9 c	15.7 cd	19.5 bc
Boyne	D	**23.2 ab**	20.4 e	23.8 ab	19.7 a	**16.0 a**	**17.9 a**	**20.3 ab**
Evans	T	20.5 d	22.0 bcde	21.0 cd	15.9 e	14.1 c	15.5 d	18.1c
Governor	D	**24.2 a**	**24.2 abc**	21.3 bcd	17.9 bcd	**16.2 a**	16.1 bcd	19.5 bc
Kimbuko	D	**24.2 a**	21.2 de	**23.9 a**	**19.2 abc**	**15.7 ab**	**16.7 abcd**	19.1 bc
Kingsgate	D	**24.2 a**	**22.6 abcde**	**22.7 abc**	17.9 bcd	**15.0 abc**	15.8 cd	18.8 bc
Legion	D	**24.5 a**	**25.2 a**	**22.2 abcd**	17.7 cd	**14.6 abc**	15.7 cd	**20.3 ab**
Nui (cont)	D	**23.6 a**	22.3 bcde	**23.8 ab**	**18.6 abc**	**15.5 abc**	**16.5 abcd**	19.7 bc
One50	D	**23.3 ab**	**22.8 abcde**	**22.6 abc**	**19.3 ab**	**15.2 abc**	16.1 bcd	20.1 b
Platform	D	**23.9 a**	**23.5 abcd**	**21.7 abcd**	**18.8 abc**	**14.7 abc**	16.1 bcd	19.2 bc
Portique	T	21.1 cd	21.6 cde	20.9 cd	17.9 bcd	**15.1 abc**	16.0 bcd	20.3 b
Tanker	T	20.1 d	21.8 cde	20.5 cd	16.5 de	**14.9 abc**	15.1 de	18.6 bc
Tugela	D	**24.8 a**	**24.7 ab**	**22.0 abcd**	**19.6 a**	**16.1 a**	**17.2 abc**	**22.1 a**
Viscount	T	20.1 d	21.7 cde	19.7 d	16.6 de	14.1 bc	13.6 e	18.8 bc
LSD (0.05)		1.96	2.75	2.53	1.55	1.65	1.78	1.82
CV %		5.15	7.23	6.92	5.16	6.56	6.62	5.57

BOLD = Highest and similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 5 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Dry matter content (%)** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 15 4/10/2021	Cut 16 4/11/2021	Cut 17 7/12/2021	Cut 18 4/1/2022	Cut19 7/2/2022	Cut 20 15/3/2022	Cut 21 12/4/2022	Cut 22 16/5/2022
24Seven	D	**19.3 abcd**	19.0 fghi	18.1 bcdef	20.0 bc	**20.5 a**	**26.0 a**	16.6 cdef	14.7 defg
50Fifty	D	**19.8 abcd**	**20.4 abcde**	17.9 bcdef	**20.8 ab**	**20.6 a**	**22.7 ab**	17.6 bc	15.6 bcd
Base	T	**19.3 abcd**	18.8 ghij	18.0 bcdef	19.7 bcd	**19.1 ab**	20.6 b	15.9 defg	14.1 fgh
Boyne	D	**19.4 abcd**	**20.8 abc**	**20.2 a**	**21.9 a**	**20.3 ab**	**23.7 ab**	**20.6 a**	**16.6 a**
Evans	T	17.9 d	17.3 k	16.6 ef	18.0 e	**19.7 ab**	20.6 b	15.1 gf	13.9 gh
Governor	D	**20.7 a**	19.2 efgh	18.1 bcdef	**20.6 ab**	**20.4 ab**	21.4 b	16.1 cdef	15.0 cdef
Kimbuko	D	18.4 bcd	20.1 cdef	**18.5 abcde**	**22.0 a**	**20.5 a**	**23.2 ab**	17.3 bcd	15.5 bcd
Kingsgate	D	**19.0 abcd**	**20.9 abc**	17.9 bcdef	**21.8 a**	**20.8 a**	**22.7 ab**	17.1 cde	14.9 cdef
Legion	D	**19.2 abcd**	20.2 bcde	**19.0 abc**	**21.0 ab**	**19.7 ab**	20.8 b	17.1 cde	15.2 cde
Nui (cont)	D	**20.2 abc**	**21.5 a**	**18.9 abc**	**20.9 ab**	**20.6 a**	-	18.8 b	**16.4 ab**
One50	D	**20.6 ab**	**21.4 ab**	**19.5 abc**	**21.6 a**	**19.6 ab**	**23.0 ab**	17.2 cd	15.2 cde
Platform	D	**19.6 abcd**	19.4 defg	17.7 cdef	20.0 bc	**19.9 ab**	**22.5 ab**	16.4 cdef	14.8 cdefg
Portique	T	18.3 cd	18.2 hijk	**18.7 abcd**	20.0 bc	**19.9 ab**	**22.2 ab**	16.3 cdef	14.4 efgh
Tanker	T	18.3 cd	17.6 kj	16.2 f	18.2 de	**19.6 ab**	20.8 b	15.6 efg	13.7 h
Tugela	D	**19.7 abcd**	**20.6 abcd**	**19.7 ab**	**22.0 a**	**20.8 a**	22.1 b	17.1 cde	**15.7 abc**
Viscount	T	**19.5 abcd**	18.0 ijk	16.9 def	18.7 cde	18.6 b	20.3 b	14.5 g	13.6 h
LSD (0.05)		2.20	1.23	1.93	1.52	2.91	3.78	1.55	0.95
CV %		6.83	3.77	6.34	11.0	5.51	7.50	4.60	3.76

BOLD = Highest and similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments**

Table 6: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Leaf rust %** (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	Cut 10 30/3/2021	Cut 11 3/5/2021
24Seven	D	4	0	4	12.5	12.5	33	12.5	17	21	8	12.5
50Fifty	D	4	0	4	8	33	33	8	4	25	4	4
Base	T	8	0	4	17	50	50	12.5	17	**62.5**	12.5	12.5
Boyne	D	0	0	4	8	21	21	17	25	46	4	37.5
Evans	T	0	0	8	12.5	25	**54**	21	42	**75**	4	29
Governor	D	0	0	0	0	8	12.5	4	0	0	0	0
Kimbuko	D	0	0	0	0	0	4	0	0	4	4	0
Kingsgate	D	0	0	0	12.5	21	46	21	25	21	0	8
Legion	D	0	0	0	0	0	17	12.5	4	8	0	0
Nui (cont)	D	0	0	4	12.5	**58**	**79**	25	46	**54**	21	25
One50	D	0	0	8	8	17	33	4	8	33	8	21
Platform	D	0	0	0	0	8	21	12.5	0	4	0	0
Portique	T	0	0	0	0	0	17	4	8	42	4	21
Tanker	T	4	0	0	12.5	33	33	8	4	29	17	12.5
Tugela	D	4	0	12,5	8	42	42	12.5	33	12.5	4	8
Viscount	T	0	0	0	0	4	17	8	8	21	12.5	8

Table 6 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Leaf rust %** (rating based) D = Diploid, T = Tetraploid

Cultivars	Type	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	Cut19 7/2/2022	Cut 20 15/3/2022	Cut 21 12/4/2022	Cut 22 16/5/2022
24Seven	D	0	0	0	0	0	37.5	37.5	17	37.5	0	0
50Fifty	D	0	0	0	0	0	25	25	12.5	37.5	0	0
Base	T	0	0	0	0	12.5	50	29.2	37.5	37.5	0	19
Boyne	D	0	0	0	0	0	37.5	75	50	46	0	0
Evans	T	0	0	0	12.5	12.5	67	42	62.5	33	0	0
Governor	D	0	0	0	0	0	17	12.5	17	21	0	0
Kimbuko	D	0	0	0	0	12.5	17	37.5	0	25	0	0
Kingsgate	D	0	0	0	0	0	37.5	29	12.5	19	0	0
Legion	D	0	0	0	0	0	19	25	37.5	25	0	0
Nui (cont)	D	0	4	0	16.7	20.8	75	58	58	58	0	25
One50	D	0	4	0	12.5	0	58	54	25	12.5	0	0
Platform	D	0	0	0	0	0	12.5	12.5	19	19	0	0
Portique	T	0	0	0	0	0	75	54	25	46	0	0
Tanker	T	0	0	0	12.5	0	25	37.5	37.5	17	0	0
Tugela	D	0	4	0	0	0	37.5	58	25	33	0	12.5
Viscount	T	0	0	0	0	0	21	21	17	33	0	0

Table 7: 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 10** 30/3/2021	**Cut 11** 3/5/2021	**Cut 9** 25/2/2021
					Early piping	Piping	Piping + heading	Heading	Heading			
24Seven	D	0	0	0	8	13	25	17	17	0	0	0
50Fifty	D	0	0	0	0	17	21	8	13	0	0	0
Base	T	0	0	0	0	29	33	21	17	0	0	0
Boyne	D	0	0	0	0	17	17	4	0	0	0	0
Evans	T	0	0	0	13	**54**	**50**	21	13	0	0	0
Governor	D	0	0	0	8	21	17	0	13	0	0	0
Kimbuko	D	0	0	0	0	0	0	0	0	0	0	0
Kingsgate	D	0	0	0	0	25	25	4	0	0	0	0
Legion	D	0	0	0	4	13	17	0	0	0	0	0
Nui (cont)	D	0	0	0	0	25	25	13	4	0	0	0
One50	D	0	0	0	13	21	21	17	13	0	0	0
Platform	D	0	0	0	0	17	17	4	0	0	0	0
Portique	T	0	0	0	0	0	0	0	0	0	0	0
Tanker	T	0	0	0	0	33	**63**	29	25	0	0	0
Tugela	D	0	0	0	0	13	13	8	8	0	0	0
Viscount	T	0	0	0	8	33	**46**	4	21	0	0	0

Table 7 cont.: 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 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	Cut19 7/2/2022	Cut 20 15/3/2022	Cut 21 12/4/2022	Cut 22 16/5/2022	Cut 18 4/1/2022
						Piping + Late piping	Heading					Heading
24Seven	D	0	0	0	0	25	29	0	0	0	0	4
50Fifty	D	0	0	0	0	21	29	0	0	0	0	0
Base	T	0	0	0	0	13	25	0	0	0	0	4
Boyne	D	0	0	0	0	29	17	0	0	0	0	0
Evans	T	0	0	0	0	25	33	0	0	0	0	4
Governor	D	0	0	0	0	21	25	0	0	0	0	0
Kimbuko	D	0	0	0	0	0	0	0	0	0	0	0
Kingsgate	D	0	0	0	0	21	13	0	0	0	0	0
Legion	D	0	0	0	0	13	13	0	0	0	0	0
Nui (cont)	D	0	0	0	0	21	13	0	0	0	0	0
One50	D	0	0	0	0	13	25	0	0	0	0	0
Platform	D	0	0	0	0	17	21	0	0	0	0	0
Portique	T	0	0	0	0	0	0	0	0	0	0	0
Tanker	T	0	0	0	0	38	**58**	0	0	0	0	13
Tugela	D	0	0	0	0	13	17	0	0	0	0	4
Viscount	T	0	0	0	0	25	25	0	0	0	0	5

Table 8: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Sward density %** (ratings based) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 8 18/1/2021	Cut 9 25/2/2021	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
24Seven	D	100	83	88	100	100	100	100
50Fifty	D	100	83	88	100	100	100	100
Base	T	100	83	83	100	100	100	100
Boyne	D	100	46	67	83	92	92	96
Evans	T	100	63	58	96	92	92	96
Governor	D	100	96	96	100	100	100	100
Kimbuko	D	100	75	79	96	96	96	100
Kingsgate	D	100	79	88	100	96	100	96
Legion	D	100	96	100	100	100	100	100
Nui (cont)	D	100	67	71	92	88	92	87.5
One50	D	100	46	79	100	100	100	100
Platform	D	100	100	100	100	100	100	100
Portique	T	100	79	79	100	96	100	100
Tanker	T	100	83	83	100	96	100	100
Tugela	D	100	92	96	100	100	100	100
Viscount	T	100	96	100	100	100	100	100

Table 8 cont.: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Sward density %** (ratings based) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 15 4/10/2021	Cut 16 4/11/2021	Cut 17 7/12/2021	Cut 18 4/1/2022	Cut19 7/2/2022	Cut 20 15/3/2022	Cut 21 12/4/2022	Cut 22 16/5/2022
24Seven	D	100	100	100	100	58	50	67	83
50Fifty	D	100	100	100	96	38	38	63	92
Base	T	100	100	100	100	50	38	58	92
Boyne	D	100	100	100	100	38	25	42	58
Evans	T	100	100	92	100	38	25	50	83
Governor	D	100	100	100	100	79	63	83	100
Kimbuko	D	100	100	100	100	46	25	58	75
Kingsgate	D	100	100	100	100	63	13	54	75
Legion	D	100	100	100	100	79	63	79	96
Nui (cont)	D	100	92	92	92	38	17	46	63
One50	D	100	100	100	100	42	33	75	88
Platform	D	100	100	100	100	88	79	88	100
Portique	T	100	100	100	100	54	29	54	83
Tanker	T	100	100	100	100	29	21	46	79
Tugela	D	100	100	100	100	79	71	88	92
Viscount	T	100	100	100	100	83	83	96	100

Table 9: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **Plant counts** (4x10-point, within row) D = Diploid, T = Tetraploid

Cultivars	Type	1st count Aug 2020 (%)	2nd count Apr 2021 (%)	Apr 2021 vs Aug 2020 (%)	Row width Apr 2021 (cm)	3rd count Mar 2022 (%)	Mar 2022 vs Apr 2021 (%)	Mar 2022 vs Aug 2020 (% of 1st count)
24Seven	D	90	79	**88**	10	60	**76**	**67**
50Fifty	D	80	80	**100**	10	58	**72**	**72**
Base	T	81	83	**102**	5	53	**64**	**65**
Boyne	D	84	75	**89**	10	46	**61**	**54**
Evans	T	79	67	**84**	5	46	**69**	**58**
Governor	D	87	78	**89**	8	58	**74**	**66**
Kimbuko	D	82	70	**86**	10	48	**68**	**58**
Kingsgate	D	86	73	**85**	10	51	**69**	**59**
Legion	D	84	78	**93**	7	61	**78**	**72**
Nui (cont)	D	74	62	**83**	5	47	**76**	**63**
One50	D	78	71	**91**	10	58	**82**	**75**
Platform	D	88	90	**103**	10	78	**87**	**90**
Portique	T	82	74	**91**	10	49	**66**	**60**
Tanker	T	79	68	**85**	5	41	**60**	**52**
Tugela	D	84	90	**107**	10	59	**66**	**70**
Viscount	T	68	75	**110**	5	63	**83**	**91**

Leaf emergence rate

Table 10: Perennial ryegrass (*Lolium perenne*), Lp 5, Elite Evaluation, Outeniqua Research Farm
Planted: 5 March 2020 **No. of days per leaf and projected harvest rotation based on 3-leaf stage**

	5 Mar to 18 May 2020	18 May to 24 Jun 2020	24 Jun to 3 Aug 2020	3 Aug to 16 Sep 2020	16 Sep to 21 Oct 2020	21 Oct to 25 Nov 2020	25 Nov to 22 Dec 2020	22 Dec 2020 to 18 Jan 2021
No. of days	13.1	13.5	16	13.5	11.7	11.7	12	12
Projected time to 3-leaf	39	41	48	41	35	35	36	36
2.75-leaf Shortest cycle	36	37	44	37	32	32	33	33

	18 Jan to 25 Feb 2021	25 Feb to 30 Mar 2021	30 Mar to 3 May 2021	3 May to 4 Jun 2021	4 Jun to 7 Jul 2021	7 Jul to 24 Aug 2021	24 Aug to 4 Oct 2021	4 Oct to 4 Nov 2021
No. of days	9.8	10.2	10	11.6	12	16	12.6	9.5
Projected time to 3-leaf	29	31	30	35	36	48	38	29
2.75-leaf Shortest cycle	27	28	28	32	33	44	35	26

	4 Nov to 7 Dec 2021	7 Dec to 4 Jan 2022	4 Jan to 7 Feb 2022	7 Feb to 15 Mar 2022	15 Mar to 12 Apr 2022	12 Apr to 16 May 2022	
No. of days	10.2	8	12	11	9.3	9.7	
Projected time to 3-leaf	31	25	36	33	28	29	
2.75-leaf Shortest cycle	28	22	33	30	26	27	

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.

Summary (trial results for first two years; the trial is continuing)

Total yield for the first year (Year 1)

- Highest yielding cultivar: Viscount
- Similar to the highest yielding: Platform, Governor, 50Fifty, Base, Legion, Nui, Tanker, One50

Total yield for the second year (Year 2)

- Highest yielding cultivar: Viscount
- Similar to the highest yielding: Governor, Platform, Tugela, Legion, 50Fifty, Kimbuko, Base

Total yield over two years (Year 1 + 2)

- Highest yielding cultivar: Viscount
- Similar yield: Governor, Platform, Legion, 50Fifty
- This shows which cultivars continued strongly beyond the first summer into the second autumn: Legion, Governor, Viscount, Platform.

Establishment and autumn 2020

- Only two cultivars were significantly slower than the rest as reflected in the first autumn yield (Evans, Portique). All other cultivars had a similar yield.

Winter yield 2020

- Highest yielding: Platform, Legion
- Similar yield: One50, Base, Nui

Spring 2020

- As expected in spring, most cultivars produce well and is the season of least concern.

Summer yield 2020/21

- Highest yielding: Viscount
- Similar yield: Governor, Base, 50Fifty

Second autumn (2021)

- Highest yielding: Legion, Governor, Viscount, Platform
- Similar yield: 50Fifty, Tugela, 24Seven, Base, Kingsgate

Second winter (2021)

- This is a significant constraint with the yield of the second winter on average only 0.4 times that of the first winter (1.20 t DM/ha vs 2.94 (mean over 16 cultivars)).

Second spring (2021)

- Although it was the highest yielding season of the second year, one average yields were 15% lower than in the first spring.

Second summer (2021/22)

- Unexpectedly some cultivars had higher yields in the second summer than they had in the first summer: Legion, Boyne, Platform, Tugela, Tanker.
- The cultivars Viscount, Platform, Governor, Base and Legion were amongst the high yielding group for the second summer and for annual yield. However Legion had a significantly lower yield in the first summer as well as spring of both years.

Lowest rust incidence (mainly October to February but some cultivars September to May)

17% or less during Year 1:

- Kimbuko, Governor, Legion

33% or less during Year 1:

- Platform, Viscount, 24Seven, 50Fifty, One50, Tanker

17% or less during Year 2:

- Governor

33% or less during Year 2:

- Platform, Viscount

Reproductive tillers/bolting

- No bolting: Kimbuko, Portique
- Highest bolting incidence: Evans, Tanker, Viscount

Followed by: Base, Kingsgate, Nui.

Table 7 also shows the length of the flowering window.

- Low bolting and relatively short flowering window in Year 1: Boyne, Legion, Platform
- Generally lower bolting incidence in Year2 and shorter window.

Sward density after the first summer Feb 2021: lowest values recorded in February with density increasing again as conditions become more favourable.

- 100%: Platform
- 90-100%: Governor, Legion, Viscount, Tugela
- 80 – 89% : 24Seven, 50Fifty, Base, Tanker
- 75 – 79%: Kimbuko, Kingsgate, Portique

Sward density after second summer Mar 2022:

- 100%: none
- 90-100%: none
- 80-89%: Viscount
- 75-79%: Platform
- 65-74%: Tugela
- Govenor and Legion were at 63%
- All other below 50%

All cultivars increased sward density again by May 2022 to varying degrees with only Governor, Platform and Viscount recovering fully.

***Plant counts* comparing April 2021 to August 2020** using the 10-point/m x4 method :

- Increased count (increased sward density): Viscount, Tugela, Platform, Base
- Unchanged: 50Fifty

Plant counts comparing Mar 2022 to August 2020

All cultivars have a reduced count compared to the first winter.

- Viscount 91%, Platform 90%
- 70-75%: One50, 50Fifty, Legion, Tugela

References:

Cabrera Estrada JI, Delagarde R, Faverdin RP, Peyraud JL. 2004. Dry matter intake and eating rate of grass by dairy cows is restricted by internal, but not external water. Animal Feed Science and Technology 114: 59- 74.

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

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.

John A and Ulyatt MJ. 1987. Importance of dry matter content to voluntary intake of fresh grass forages. Proceedings of the New Zealand Society of Animal Production 47: 13 – 16.

Leaver JD 1985. Milk production from grazed temperate grassland. Journal of Dairy Research 52: 313-344

Minson DJ. 1990. Forages in ruminant nutrition. Animal feeding and nutrition. A Series of Monographs and Treatises (Cunha TJ, Ed.)

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

Verite R and Journet M. 1970. Effect of the Water Content of Grass and Dehydration at Low Temperature upon Its Feeding Value for Dairy Cows. Annales de Zootechnie, 19, 255-268.

Tall Fescue and Festulolium cultivar evaluation results: 2020 to 2022

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Introduction

The Elite evaluation trials are aimed at evaluating agronomic traits such as DM yield, disease tolerance and forage quality, and also provide data on interaction traits (seasonal yield distribution, flowering, growth form, persistence) for what can be mostly considered recent and high-end varieties or varieties with unique characteristics that may have a beneficial application for local pasture systems. This information provides local data for choice of pasture cultivars. The interaction traits can be used to assist in selecting varieties for pasture mixes. It is important to determine the genetic potential of varieties and in that way evaluate all varieties on equal terms in an unbiased way.

- Evaluate high-end varieties with modern genetics and special traits
- Characterize into types
- Determine agronomic and interaction traits to assist with choosing varieties for mixtures aiming at complementarity within the mixture

Parameters measured/assessed:

- DM yield (harvested according to leaf-stage)
- Seasonal yield patterns
- Dry matter (DM) content
- Disease incidence (mainly rust)
- Flowering behaviour (reproductive tillers)
- Persistence/ plant population (not applicable in the current report)
- Forage quality (not in the current report, refer to the 2019 booklet)
- General growth form (will be reported at the end of the trial)

Festuca species evaluated

The following Festuca species are evaluated

- *Festuca arundinacea* (tall fescue) – Continental (11 cultivars) and Mediterranean types (1 cultivar)
- *Festulolium* – tall fescue types: 6 cultivars
- The trial also contains one treatment which is a mixture of tall fescue and cocksfoot. However the cocksfoot component has been completely dominant with not much tall fescue evident in the plots.

Tall fescue (*Festuca arundinacea*) characteristics that are of interest:

- Perennial grass with deep root system with good persistence
- Relatively good forage quality, especially recent varieties that have softer leaves (lower tensile strength) and also related to appropriate grazing management (Donaghy et al 2008)
- Tolerates waterlogging
- Tolerates higher temperatures than ryegrass
- Tolerates low pH soils and salinity
- Has a high responsiveness to irrigation or rainfall and responds more quickly than perennial ryegrass (Lowe & Bondler 1995, Nie et al 2008, Raeside et al 2012)
- Has a better water use efficiency than perennial ryegrass (Minnee et al 2010).

- *Continental types*
    - Summer active growth
    - "intermediate types" with some winter growth activity
- *Mediterranean types*
    - Winter active (summer dormant)

- Soil temperature at sowing should consistently be >12°C for rapid germination and consequently successful establishment (Dairy NZ 2010). Hence establishment should be done in early autumn or even late summer depending on the climate.

The aim of the cultivar evaluation trials is to determine the genetic potential for the various parameters. The *Festuca* trial is harvested when the first continental cultivars reach the 2 to 2.5 leaf stage or in spring at canopy closure if necessary. According to Chapman et al (2014), tall fescue carbohydrate reserves are replenished between the 2 and 4 leaf stage and maximum growth rate is achieved at the 2.5 leaf stage. Leaf appearance rate is determined mainly by temperature and hence most varieties reach the required leaf stage at a similar time. This harvest interval is used even though tall fescue is known to be a four-leaf plant, however with the larger root system, root growth recommencing almost immediately after defoliation and greater tolerance of higher temperatures, the plants tend to have sufficient storage carbohydrates to be harvested before the maximum leaf number is reached. Previous trials have shown no apparent adverse effects in terms of persistence when swards are harvested at the 2-leaf stage. There could however be an advantage in having a slightly longer defoliation interval at certain times of the year to allow for additional carbohydrate reserve accumulation. The advantage of tall fescue in terms of leaf stage is that there is greater flexibility than is the case of ryegrass since the sward can be grazed between the 2 and 4-leaf stage without leaf death. According to Donaghy et al (2008) forage quality is highest at the 2-leaf stage and lowest at the 4-leaf stage. Hence the compromise is sensible to graze between the two and three leaf stage.

Results are given below the trial named Fa2, which was planted on 3 March 2020 at the Outeniqua Research Farm. These are interim results for the first 15 months of the trial, which is expected to continue to a maximum of five years.

Total and seasonal yield (Table 1) gives an important overview of what to expect from different cultivars. This is especially important for tall fescue and festulolium since there are distinct types in terms of summer and winter active growth and fewer cultivars on the market as is the case for the ryegrasses. More recently there are continental types with improved winter growth activity. Tall fescue, more than the ryegrasses has more pronounced seasonal growth patterns which are important to quantify so that the species can be combined with other species either in a monoculture or mixtures for more optimal fodder flow or excess forage conserved as silage for feeding out in the lower producing season, typically winter. **Mean seasonal growth rates** are given in **Table 2.**

Individual harvests data is given in **Table 3** with **growth rates** in **Table 4** and shows the data for the first nine harvests of this trial up to May 2021. The trial is continuing.

Table 5 shows the **dry matter content** while **rust** and **flowering incidence** are given in **Tables 6 and 7**.

Leaf emergence rate is given in **Table 8.**

Table 1: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Seasonal Yield** (t DM/ha) TF-C = Continental, TF-M = Mediterranean, FL-Fa = Festulolium tall fescue type

Cultivars	Type	Autumn 2020	Rank	Winter 2020	Rank	Spring 2020	Rank	Summer 2020/21	Rank	Total Year 1 2020/21	Rank
Bariane	TF-C	1.19 ^{jghij}	14	1.31 ^{ghijk}	16	2.96 ^{k}	20	4.40 ^{efgh}	15	10.9 ^{h}	18
Baroptima	TF-C	0.76 ^{ij}	19	1.08 ^{jk}	19	4.28 ^{jk}	19	4.66 ^{defg}	13	10.8 ^{h}	19
Boschhoek	TF-C	**1.86 ^{abcde}**	7	1.91 ^{cde}	7	5.58 ^{bcde}	5	4.50 ^{efgh}	14	13.9 ^{bcde}	7
Duramax	TF-C	**2.03 ^{abc}**	3	1.69 ^{defg}	8	5.42 ^{cdef}	6	4.79 ^{bcdefg}	9	13.9 ^{bcd}	6
Easton	TF-C	1.52 ^{cdefgh}	10	2.04 ^{bcd}	5	5.27 ^{defg}	8	4.97 ^{bcdef}	8	13.8 ^{bcde}	8
Felina	FL-Fa	0.89 ^{ij}	18	1.02 ^{k}	20	4.60 ^{hij}	17	5.15 ^{bcd}	6	11.6 ^{gh}	16
Fojtan	FL-Fa	1.16 ^{ghij}	15	1.12 ^{ijk}	18	4.42 ^{ijk}	18	3.94 ^{h}	20	10.6 ^{h}	20
Hipast	FL-Fa	1.29 ^{efghi}	12	1.55 ^{fghi}	12	4.66 ^{hij}	16	4.28 ^{gh}	18	11.8 ^{fgh}	15
Honak	FL-Fa	1.28 ^{efghi}	13	1.66 ^{defgh}	9	4.76 ^{ghij}	15	4.30 ^{gh}	17	12.0 ^{fgh}	13
Hummer	TF-C	1.69 ^{bcdefg}	9	1.56 ^{fgh}	11	4.85 ^{fghij}	12	1.73 ^{cdefg}	11	12.8 ^{defg}	11
Hykor	FL-Fa	1.10 ^{ghij}	16	1.36 ^{ghijk}	15	4.99 ^{efghi}	10	4.79 ^{bcdefg}	10	12.2 ^{efgh}	12
Jesup	TF-C	1.07 ^{hij}	17	1.24 ^{hijk}	17	4.97 ^{fghi}	11	4.35 ^{fgh}	16	11.6 ^{gh}	17
Kora	TF-C	**1.79 ^{abcdef}**	8	1.59 ^{efgh}	10	4.83 ^{fghij}	13	5.15 ^{bcd}	5	13.4 ^{cdef}	9
Mahulena	FL-Fa	0.63 ^{j}	20	1.37 ^{ghijk}	14	5.11 ^{efgh}	9	4.69 ^{cdefg}	12	11.8 ^{fgh}	14
Paolo	TF-C	1.35 ^{defghi}	11	1.50 ^{fghij}	13	4.77 ^{ghij}	14	**5.34 ^{abc}**	3	12.9 ^{defg}	10
Quantico	TF-C	**1.99 ^{abc}**	4	2.19 ^{bc}	4	**5.72 ^{abcd}**	4	**5.40 ^{ab}**	2	**15.3 ^{ab}**	4
Royal-Q	TF-C/M	**2.38 ^{a}**	1	2.46 ^{b}	2	**6.20 ^{a}**	1	5.04 ^{bcde}	7	**16.1 ^{a}**	1
Temora	TF-M	**2.13 ^{ab}**	2	**3.15 ^{a}**	1	5.35 ^{cdefg}	7	3.98 ^{h}	19	**14.6 ^{abc}**	5
Tower	TF-C	**1.95 ^{abcd}**	5	2.22 ^{bc}	3	**5.93 ^{abc}**	3	**5.27 ^{abcd}**	4	**15.4 ^{ab}**	3
UltraSoft *	Mix	**1.94 ^{abcd}**	6	2.00 ^{cde}	6	**6.14 ^{ab}**	2	**5.84 ^{a}**	1	**15.9 ^{a}**	2
LSD (0.05)		0.61		0.43		0.60		0.65		1.63	
CV %		24.4		15.4		7.14		8.25		7.57	

Shaded = highest yielding, **Light shaded** = similar to highest**. Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments** *dominated by cocksfoot component

Table 1: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Seasonal Yield** (t DM/ha) TF-C = Continental, TF-M = Mediterranean, FL-Fa = Festulolium tall fescue type

Cultivars	Type	Autumn 2021	Rank	Winter 2021	Rank	Spring 2021	Rank	Summer 2021/22	Rank	Total Year 2 2021/22	Rank	Autumn 2022	Rank	Total Year 1 + 2	Rank
Bariane	TF-C	2.77 cde	11	1.05 cdefg	13	4.30 fgh	17	3.49 efg	17	11.6 ijk	17	2.85 efg	15	22.5 gh	19
Baroptima	TF-C	2.96 bcd	5	1.05 cdefg	14	4.48 efgh	15	3.38 fg	18	11.9 hijk	16	2.84 efg	16	22.7 gh	17
Boschhoek	TF-C	3.05 bc	3	1.96 b	3	4.92 bcdef	8	3.89 bcdefg	13	13.8 bcde	6	3.15 cde	9	27.7 bcd	6
Duramax	TF-C	2.58 cde	15	1.12 cdefg	12	**5.09 abcde**	5	**4.52 ab**	2	13.3 cdefg	8	3.30 cde	6	27.2 cde	8
Easton	TF-C	2.85 cde	8	1.39 c	6	4.48 bcdefg	11	**4.42 abc**	5	13.4 cdef	7	3.10 cde	12	27.2 cde	7
Felina	FL-Fa	2.81 cde	10	0.87 fg	17	4.84 bcdefg	10	3.96 bcdefg	12	12.5 fghi	14	2.94 defg	14	24.1 fg	15
Fojtan	FL-Fa	2.31 e	20	0.83 g	20	4.38 fgh	16	3.33 g	20	10.9 jk	19	2.59 fg	18	21.5 h	20
Hipast	FL-Fa	2.45 de	17	0.86 fg	18	3.99 h	20	3.55 efg	16	10.9 jk	18	2.60 fg	17	22.6 gh	18
Honak	FL-Fa	2.38 de	19	0.99 defg	15	4.04 h	19	3.38 fg	19	10.8 k	20	2.49 g	20	22.8 gh	16
Hummer	TF-C	2.82 cde	9	1.30 cde	9	4.57 cdefgh	13	3.82 cdefg	14	12.5 fghi	12	3.15 cde	10	25.4 def	11
Hykor	FL-Fa	2.66 cde	14	0.91 efg	16	4.89 bcdefg	9	**4.03 abcdef**	11	12.5 fghi	13	3.33 bcde	5	24.7 efg	13
Jesup	TF-C	2.41 de	18	1.34 cd	7	4.93 bcdef	7	**4.07 abcde**	10	12.8 efghi	11	2.52 g	19	24.4 fg	14
Kora	TF-C	2.67 cde	13	0.85 g	19	4.23 gh	18	**4.33 abc**	6	12.1 ghij	15	3.24 cde	7	25.5 def	10
Mahulena	FL-Fa	2.52 cde	16	1.26 cdef	10	**5.18 abcd**	4	**4.07 abcde**	9	13.0 defgh	10	3.05 def	13	24.8 efg	12
Paolo	TF-C	2.87 cde	7	1.22 cdefg	11	4.53 defgh	14	**4.63 a**	1	13.3 cdefg	9	3.59 bc	3	26.2 def	9
Quantico	TF-C	**3.53 ab**	2	*2.02 b*	2	**4.98 abcdef**	6	**4.48 ab**	4	15.0 ab	2	**4.10 a**	1	**30.3 a**	2
Royal-Q	TF-C/M	2.98 bcd	4	*1.91 b*	4	**5.40 ab**	2	**4.22 abcd**	8	14.5 abc	3	3.12 cde	11	**30.6 a**	1
Temora	TF-M	**3.68 a**	1	**3.30 a**	1	4.63 cdefgh	12	**3.63 defg**	15	**15.2 a**	1	**3.81 ab**	2	**29.9 ab**	4
Tower	TF-C	2.68 cde	12	1.33 cd	8	**5.64 a**	1	**4.51 ab**	3	14.2 abcd	5	3.40 bcd	4	**29.5 abc**	5
UltraSoft *	Mix	2.89 cde	6	*1.88 b*	5	**5.22 abc**	3	**4.24 abcd**	7	14.2 abcd	4	3.23 cde	8	**30.2 ab**	3
LSD (0.05)		0.60		0.40		0.68		0.68		1.28		0.51		2.55	
CV %		13.0		17.6		8.62		9.97		5.97		9.80		5.95	

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different. NS = non-significant, no difference between treatments** *dominated by cocksfoot component

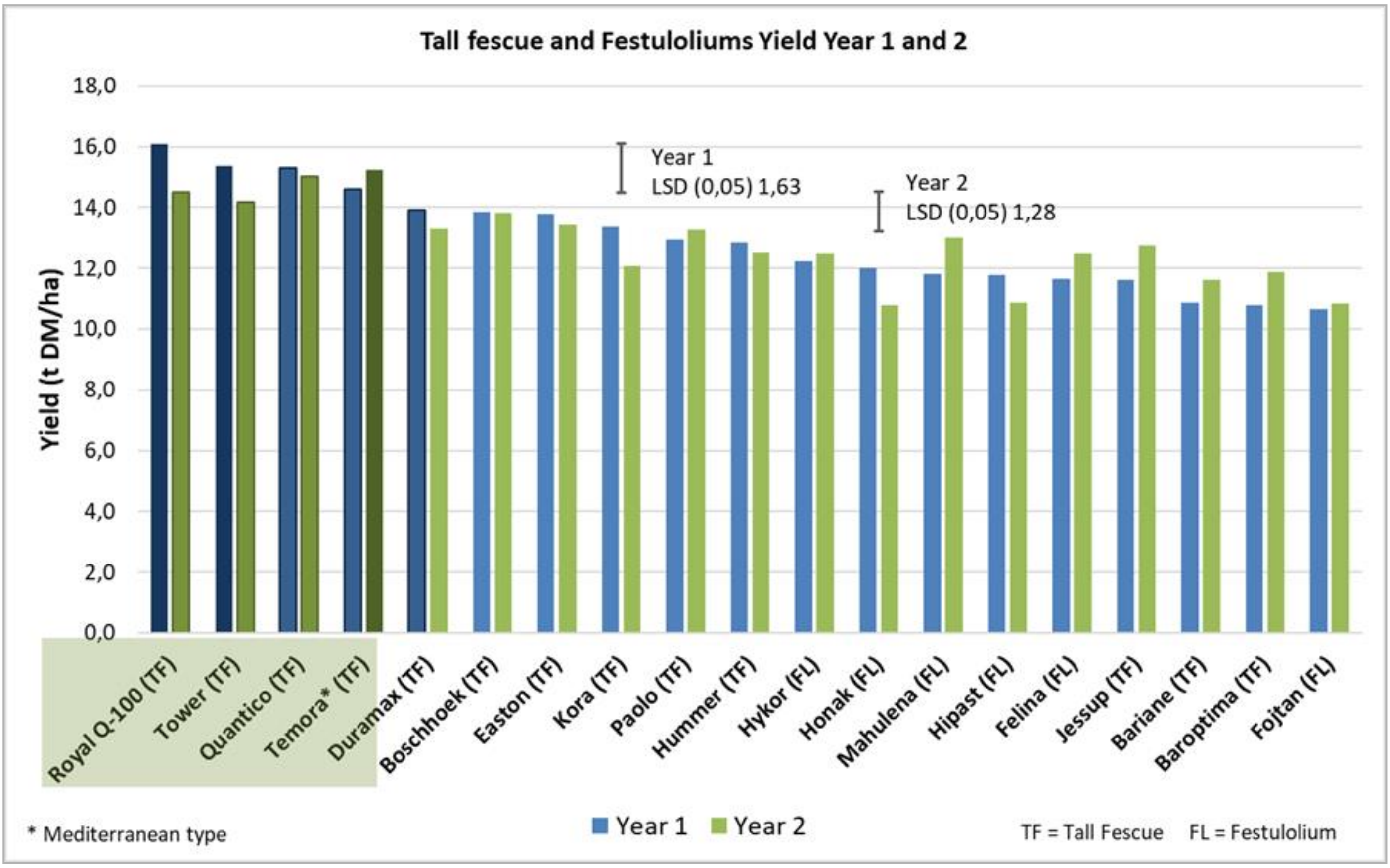

Figure 1: Tall fescue and Festulolium total yield (t DM/ha) for year 1 and year 2.

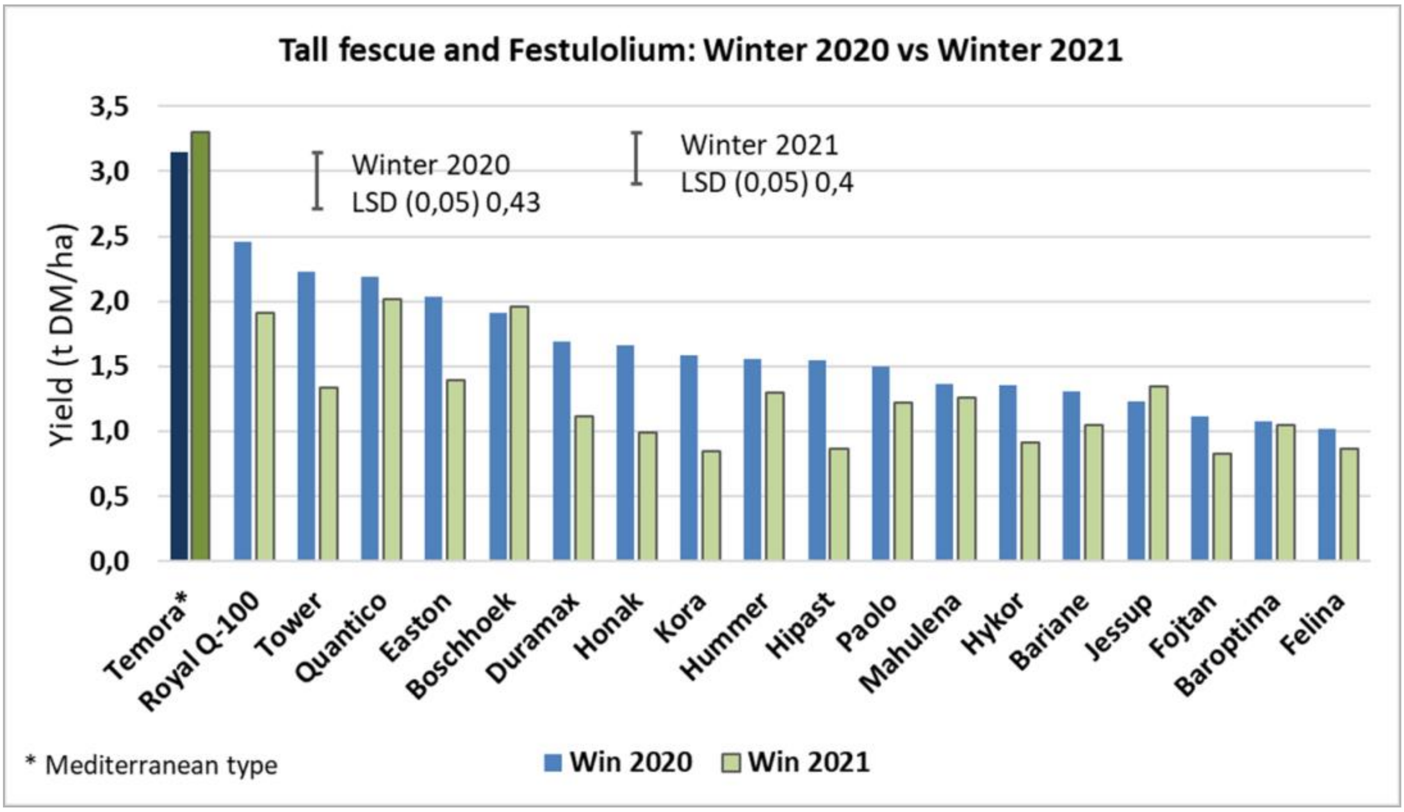

Figure 2: Tall fescue and Festulolium yield (t DM/ha) for winter 2020 and winter 2021.

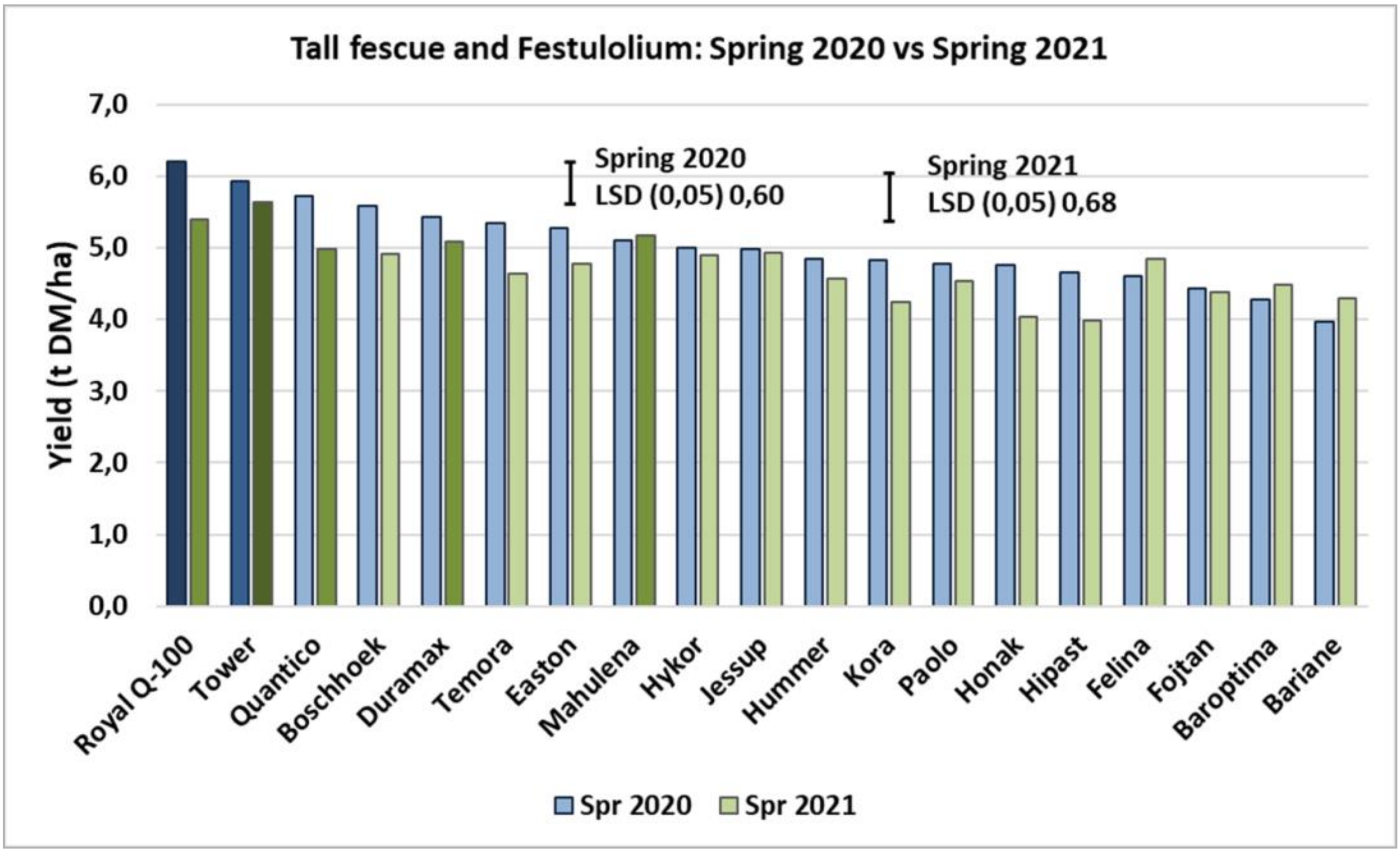

Figure 3: Tall fescue and Festulolium yield for spring 2020 and spring 2021.

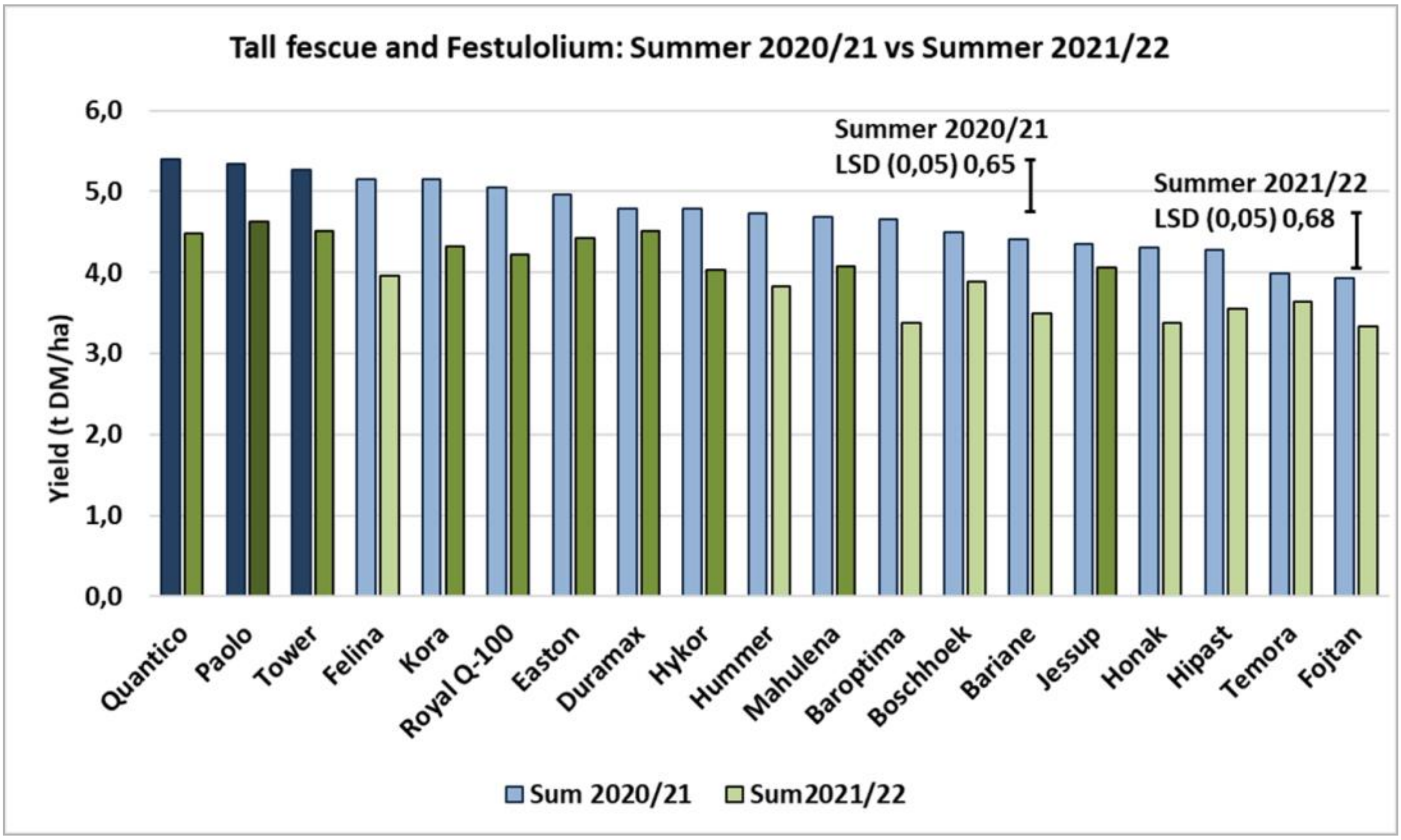

Figure 4: Tall fescue and Festulolium yield for Summer 2020/21 and Summer 2021/22

Table 2: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Mean seasonal growth rates** (kg DM/ha/day)

Cultivars	Type	Autumn 2020	Rank	Winter 2020	Rank	Spring 2020	Rank	Summer 2020/21	Rank
Bariane	TF-C	13.2 ^{efgh}	14	14.2 ^{ghijk}	16	43.5 ^{k}	20	48.9 ^{fghi}	15
Baroptima	TF-C	8.4 ^{gh}	19	11.7 ^{jk}	19	47.1 ^{jk}	19	51.7 ^{defgh}	13
Boschhoek	TF-C	**20.7** ^{abcd}	7	20.8 ^{defg}	7	61.3 ^{bcde}	5	50.0 ^{defgh}	14
Duramax	TF-C	**22.5** ^{ab}	3	18.4 ^{defg}	8	59.6 ^{cdef}	6	53.2 ^{bcdefgh}	9
Easton	TF-C	17.0 ^{bcdef}	10	22.2 ^{bcd}	5	58.0 ^{defg}	8	55.2 ^{bcdefg}	8
Felina	FL-Fa	9.8 ^{gh}	18	11.1 ^{k}	20	50.6 ^{hij}	17	57.2 ^{bcde}	6
Fojtan	FL-Fa	12.8 ^{efgh}	15	12.2 ^{ijk}	18	48.6 ^{ijk}	18	43.7 ^{i}	20
Hipast	FL-Fa	14.3 ^{defg}	12	16.8 ^{fghi}	12	51.2 ^{hij}	16	47.6 ^{hi}	18
Honak	FL-Fa	14.2 ^{defg}	13	18.1 ^{defgh}	9	52.3 ^{ghij}	15	47.8 ^{hi}	17
Hummer	TF-C	18.9 ^{bcde}	9	17.0 ^{fgh}	11	53.3 ^{fghij}	12	52.6 ^{cdefgh}	11
Hykor	FL-Fa	12.2 ^{efgh}	16	14.8 ^{ghijk}	15	54.9 ^{efghi}	10	53.2 ^{bcdefgh}	10
Jesup	TF-C	12.0 ^{fgh}	17	13.4 ^{hijk}	17	54.6 ^{fghi}	11	48.4 ^{ghi}	16
Kora	TF-C	**20.2** ^{abcd}	8	17.3 ^{efgh}	10	53.1 ^{fghij}	13	57.2 ^{bcde}	5
Mahulena	FL-Fa	7.0 ^{h}	20	14.9 ^{ghijk}	14	56.2 ^{efgh}	9	52.1 ^{cdefgh}	12
Paolo	TF-C	15.0 ^{cdefg}	11	16.3 ^{fghij}	13	52.5 ^{ghij}	14	**59.3** ^{abc}	3
Quantico	TF-C	**22.1** ^{ab}	4	23.8 ^{bc}	4	**62.8** ^{abcd}	4	**59.9** ^{ab}	2
Royal-Q	TF-C/M	**26.5** ^{a}	1	26.6 ^{b}	2	**68.1** ^{a}	1	56.0 ^{bcdef}	7
Temora	TF-M	**23.6** ^{ab}	2	**34.2** ^{a}	1	58.8 ^{cdefg}	7	44.2 ^{i}	19
Tower	TF-C	**21.7** ^{ab}	5	24.2 ^{bc}	3	**65.2** ^{abc}	3	**58.6** ^{abcd}	4
UltraSoft *	Mix	**21.6** ^{abc}	6	21.8 ^{cde}	6	**67.4** ^{ab}	2	**64.8** ^{a}	1
LSD (0.05)		6.73		4.71		6.62		7.24	
CV %		24.4		15.4		7.16		8.25	

Shaded = highest yielding, **Light shaded** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant *dominated by cocksfoot component TF-C = Continental, TF-M = Mediterranean, FL-Fa = Festulolium tall fescue type

Table 2 cont: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Mean seasonal growth rates** (kg DM/ha/day)

Cultivars	Type	Autumn 2021	Rank	Winter 2021	Rank	Spring 2021	Rank	Summer 2021/22	Rank	Autumn 2022	Rank
Bariane	TF-C	30.8 ^{cdef}	11	11.4 ^{cdef}	14	47.3 ^{fgh}	17	38.8 ^{efg}	17	31.7 ^{efg}	15
Baroptima	TF-C	32.9 ^{bcde}	5	11.4 ^{cdef}	13	49.3 ^{efgh}	15	37.6 ^{fg}	18	31.6 ^{efg}	16
Boschhoek	TF-C	33.9 ^{bc}	3	21.2 ^{b}	3	54.1 ^{bcdef}	8	43.2 ^{bcdefg}	13	35.0 ^{cde}	9
Duramax	TF-C	28.6 ^{cdef}	15	12.2 ^{cdef}	12	**55.9** ^{abcde}	5	**50.2** ^{ab}	2	36.7 ^{cde}	6
Easton	TF-C	31.7 ^{cdef}	8	15.1 ^{c}	6	52.5 ^{bcdefg}	11	**49.1** ^{abc}	5	34.5 ^{cde}	12
Felina	FL-Fa	31.2 ^{cdef}	10	9.5 ^{ef}	17	53.2 ^{bcdefg}	10	44.0 ^{bcdefg}	12	32.7 ^{defg}	14
Fojtan	FL-Fa	25.7 ^{f}	20	9.0 ^{f}	20	48.1 ^{fgh}	16	37.0 ^{g}	20	28.7 ^{fg}	18
Hipast	FL-Fa	27.2 ^{def}	17	9.4 ^{ef}	18	43.9 ^{h}	20	39.5 ^{efg}	16	28.9 ^{fg}	17
Honak	FL-Fa	26.4 ^{ef}	19	10.8 ^{cdef}	15	44.4 ^{h}	19	37.5 ^{fg}	19	27.6 ^{g}	20
Hummer	TF-C	31.4 ^{cdef}	9	14.1 ^{cd}	9	50.3 ^{cdefgh}	13	42.5 ^{cdefg}	14	35.0 ^{cde}	10
Hykor	FL-Fa	29.5 ^{cdef}	14	9.9 ^{def}	16	53.7 ^{bcdefg}	9	**44.8** ^{abcdef}	11	37.1 ^{bcde}	5
Jesup	TF-C	26.8 ^{def}	18	14.6 ^{c}	7	54.2 ^{bcdef}	7	**45.2** ^{abcde}	10	28.0 ^{g}	19
Kora	TF-C	29.6 ^{cdef}	13	9.3 ^{f}	19	46.5 ^{gh}	18	**48.1** ^{abc}	6	36.0 ^{cde}	7
Mahulena	FL-Fa	28.0 ^{cdef}	16	13.7 ^{cde}	10	**56.8** ^{abcd}	4	**45.3** ^{abcde}	9	33.9 ^{def}	13
Paolo	TF-C	31.9 ^{cdef}	7	13.3 ^{cdef}	11	49.8 ^{defgh}	14	**51.4** ^{a}	1	39.9 ^{bc}	3
Quantico	TF-C	**39.1** ^{ab}	2	21.9 ^{b}	2	**54.6** ^{abcdef}	6	**49.9** ^{ab}	4	**45.6** ^{a}	1
Royal-Q	TF-C/M	33.1 ^{bcd}	4	20.8 ^{b}	4	**59.4** ^{ab}	2	**46.9** ^{abcd}	8	34.7 ^{cde}	11
Temora	TF-M	**40.9** ^{a}	1	**35.9** ^{a}	1	50.9 ^{cdefgh}	12	40.4 ^{defg}	15	**42.3** ^{ab}	2
Tower	TF-C	29.8 ^{cdef}	12	14.5 ^{c}	8	**62.0** ^{a}	1	**50.1** ^{ab}	3	37.8 ^{bcd}	4
UltraSoft *	Mix	32.1 ^{cdef}	6	20.4 ^{b}	5	**57.4** ^{abc}	3	**47.1** ^{abcd}	7	35.9 ^{cde}	8
LSD (0.05)		6.66		4.34		7.43		7.31		5.61	
CV %		13.0		17.6		8.61		9.96		9.79	

Shaded = highest yielding, **Light shaded** = similar to highest**. Note: treatments with the same letter are similar i.e. not significantly different**
NS = non-significant *dominated by cocksfoot component TF-C = Continental, TF-M = Mediterranean, FL-Fa = Festulolium tall fescue type

Table 3: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Yield (t DM/ha)** **Individual harvests** Trial is continuing

Cultivars	Type	Cut 1 19/5/2020	Cut 2 8/7/2020	Cut 3 15/9/2020	Cut 4 23/10/2020	Cut 5 23/11/2020	Cut 6 4/1/2021	Cut 7 12/2/2021	Cut 8 8/4/2021	Cut 9 19/5/2021
Bariane	TF-C	0.91 efghi	1.19 cde	0.68 hij	1.55 g	2.14 def	2.14 ef	1.70 cde	**1.93 ab**	1.40 cdef
Baroptima	TF-C	0.53 hi	0.95 efg	0.59 ij	1.75 fg	2.30 cdef	2.22 cdef	1.80 bcde	**2.17 ab**	1.43 cdef
Boschhoek	TF-C	**1.57 abcd**	1.21 bcde	1.65 c	**2.65 ab**	2.28 cdef	2.19 def	1.71 cde	**2.08 ab**	1.58 bcd
Duramax	TF-C	**1.73 ab**	1.25 bcde	1.22 defg	2.52 bc	2.42 bcde	2.34 cdef	**1.89 abcd**	**1.91 ab**	1.23 fg
Easton	TF-C	1.17 bcdefg	**1.46 abc**	1.53 cd	2.44 bcd	2.34 cdef	2.43 bcde	**1.92 abcd**	**2.13 ab**	1.34 defg
Felina	FL-Fa	0.70 ghi	0.81g	0.67 hij	2.09 def	2.24 cdef	2.60 bcde	**1.94 abc**	**2.09 ab**	1.33 defg
Fojtan	FL-Fa	0.91 efghi	1.02 defg	0.57 j	1.99 ef	2.21 cdef	1.89 f	1.57 ef	1.66 b	1.13 g
Hipast	FL-Fa	1.01 defgh	1.16 cdef	1.10 fg	2.16 cdef	2.07 f	2.12 ef	1.65 cde	1.74 b	1.22 fg
Honak	FL-Fa	0.97 efghi	1.30 bcd	1.11 efg	2.09 def	2.24 cdef	2.10 ef	1.69 cde	1.76 b	1.13 g
Hummer	TF-C	1.39 bcdef	1.26 bcde	1.00 fghj	2.19 cde	2.26 cdef	2.51 bcde	1.65 cde	**1.95 ab**	1.44 cdef
Hykor	FL-Fa	0.84 fghi	1.10 defg	0.87 ghij	2.30 bcde	2.34 cdef	2.47 bcde	1.79 bcde	1.83 b	1.36 cdefg
Jesup	TF-C	0.88 efghi	0.83 fg	1.00 fghi	2.48 bcd	2.10 ef	2.22 cdef	1.62 de	1.73 b	1.18 fg
Kora	TF-C	**1.48 abcde**	1.32 bcd	0.97 fghij	2.00 ef	2.45 bcd	**2.73 abc**	**1.86 abcde**	**1.93 ab**	1.30 efg
Mahulena	FL-Fa	0.40 i	0.95 efg	1.07 fgh	2.54 bc	2.15 def	2.39 cdef	1.76 bcde	1.84 b	1.21 fg
Paolo	TF-C	1.09 cdefgh	1.08 defg	1.12 defg	1.98 ef	2.35 cdef	**2.71 abc**	**2.06 ab**	**1.95 ab**	1.49 cde
Quantico	TF-C	**1.63 abc**	**1.49 abc**	1.76 c	2.49 bcd	2.54 bc	**2.66 abcd**	**2.02 ab**	**2.48 a**	1.76 b
Royal-Q	TF-C/M	**2.03 a**	**1.49 abc**	2.18 b	**3.00 a**	2.34 cdef	2.34 cdef	**2.07 ab**	**2.18 ab**	1.43 cdef
Temora	TF-M	**1.71 ab**	**1.73 a**	**3.02 a**	2.14 cdef	2.01 f	2.11 ef	1.26 f	**2.12 ab**	**2.18 a**
Tower	TF-C	**1.54 abcd**	**1.71 a**	1.53 cde	**2.63 ab**	**2.70 ab**	**2.92 ab**	1.82 bcde	1.82 b	1.39 cdefg
UltraSoft *	Mix	**1.57 abcd**	**1.54 ab**	1.38 cdef	**2.66 ab**	**2.94 a**	**3.16 a**	**2.15 a**	1.81	1.61 bc
LSD (0.05)		0.57	0.34	0.42	0.42	0.34	0.52	0.30	0.60	0.26
CV %		28.7	16.6	20.2	11.0	9.01	12.9	10.2	18.6	11.2

Fa = *Festuca arundinacea* (Tall fescue), C = Continental type, M = Mediterranean type, FL = *Festulolium*, L = loloid, F = festucoid
Shaded = highest yielding, **Lighter shade** = similar to highest**. Note: treatments with the same letter are similar i.e. not significantly different**

Table 3 cont.: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Yield (t DM/ha)** **Individual harvests** Trial is continuing

Cultivars	Type	Cut 10 10/8/2021	Cut 11 1/10/2021	Cut 12 4/11/2021	Cut 13 20/12/2021	Cut 14 31/1/2022	Cut 15 16/3/2022	Cut 16 25/4/2022	Cut 17 13/6/2022
Bariane	TF-C	0.77 cde	1.06 fg	2.25 bcd	2.47 def	1.42 d	1.61 cde	1.66 cdef	0.82 efg
Baroptima	TF-C	0.73 cdef	1.15 efg	2.34 bcd	2.54 cdef	1.51 cd	1.24 e	1.71 bcdef	0.93 def
Boschhoek	TF-C	0.95 c	**2.81 a**	1.77 fg	2.56 cdef	**1.74 abcd**	1.66 bcde	1.80 bcde	1.01 cde
Duramax	TF-C	0.49 ef	1.91 bc	2.34 bcd	**2.80 abcde**	**2.06 a**	2.00 ab	1.95 bc	0.83 efg
Easton	TF-C	0.98 c	1.34 efg	2.25 bcd	**3.01 abc**	**2.07 a**	1.68 bcde	1.70 bcdef	1.07 cd
Felina	FL-Fa	0.44 f	1.43 def	2.43 bc	2.73 bcdef	**1.77 abcd**	1.61 cde	1.71 bcdef	0.88 defg
Fojtan	FL-Fa	0.50 ef	1.19 efg	2.36 bcd	2.28 f	1.42 d	1.47 de	1.52 ef	0.72 fg
Hipast	FL-Fa	0.50 ef	1.26 efg	1.85 ef	2.42 ef	1.60 bcd	1.45 de	1.56 def	0.69 g
Honak	FL-Fa	0.58 def	1.34 efg	1.88 ef	2.38 ef	1.46 d	1.42 de	1.48 f	0.66 g
Hummer	TF-C	0.70 cdef	1.79 cd	2.04 def	2.54 cdef	**1.73 abcd**	1.59 cde	1.86 bcd	0.96 de
Hykor	FL-Fa	0.51 ef	1.36 efg	2.48 b	**2.79 abcde**	**1.73 abcd**	**1.75 abcd**	1.94 bc	1.02 cde
Jesup	TF-C	0.60 def	2.20 b	2.12 cdef	2.62 bcdef	**1.93 ab**	1.60 cde	1.46 f	0.66 g
Kora	TF-C	0.57 def	1.04 g	1.88 ef	**3.02 abc**	**1.93 ab**	**1.74 abcd**	1.84 bcd	1.03 cde
Mahulena	FL-Fa	0.51 ef	2.21 b	2.25 bcd	**2.79 abcde**	**1.73 abcd**	**1.81 abcd**	1.78 bcde	0.82 efg
Paolo	TF-C	0.84 cd	1.26 efg	2.06 def	**2.99 abc**	**2.08 a**	**1.99 abc**	1.99 b	1.19 bc
Quantico	TF-C	1.35 b	1.95 bc	2.17 bcde	**2.86 abcde**	**1.94 ab**	**2.08 ab**	**2.32 a**	1.38 b
Royal-Q	TF-C/M	0.95 c	**2.70 a**	2.10 cdef	**2.94 abcd**	**1.84 abc**	**1.77 abcd**	1.73 bcdef	1.02 cde
Temora	TF-M	**2.38 a**	**2.60 a**	1.47 g	**2.81 abcde**	1.44 d	1.58 cde	1.99 b	**1.69 a**
Tower	TF-C	0.93 c	1.35 efg	**3.06 a**	**3.08 ab**	**1.84 abc**	**2.15 a**	1.90 bc	0.97 cde
UltraSoft *	Mix	1.39 b	1.50 de	2.47 b	**3.22 a**	**1.89 ab**	1.53 de	1.66 cdef	1.37 b
LSD (0.05)		0.31	0.37	0.35	0.49	0.37	0.44	0.30	0.22
CV %		22.6	13.5	9.84	10.8	12.7	15.9	10.3	13.8

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

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

Table 4: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Growth rates (kg DM/ha/day)** **Individual harvests** Trial is continuing

Cultivars	Type	Cut 1 19/5/2020	Cut 2 8/7/2020	Cut 3 15/9/2020	Cut 4 23/10/2020	Cut 5 23/11/2020	Cut 6 4/1/2021	Cut 7 12/2/2021	Cut 8 8/4/2021	Cut 9 19/5/2021
Bariane	TF-C	19.3 fghi	23.8 cde	17.8 hij	40.7 g	69.2 def	51.0 ef	43.6 cde	**35.1 ab**	34.2 cdef
Baroptima	TF-C	11.3 hi	19.0 efg	15.5 ij	46.0 fg	74.3 cdef	52.8 cdef	46.3 bcde	**39.4 ab**	34.8 cdef
Boschhoek	TF-C	**33.4 abcd**	24.1 bcde	43.2 c	**69.7 ab**	73.6 cdef	52.0 def	43.8 cde	**37.8 ab**	38.4 bcd
Duramax	TF-C	**36.7 ab**	25.0 bcde	32.2 defg	66.4 bc	78.0 bcde	55.8 cdef	**48.6 abcd**	**34.6 ab**	29.9 fg
Easton	TF-C	25.0 bcdefg	**29.2 abc**	40.3 cde	64.1 bcd	72.1 cdef	57.8 bcde	**49.1 abcd**	**38.8 ab**	32.6 defg
Felina	FL-Fa	14.7 ghi	16.1 g	17.8 hij	55.0 def	72.4 cdef	61.9 bcde	**49.8 abc**	**38.0 ab**	32.5 defg
Fojtan	FL-Fa	19.4 efghi	20.4 defg	15.1 j	52.4 ef	71.2 cdef	44.9 f	40.1 ef	30.2 b	27.7 g
Hipast	FL-Fa	21.5 defgh	23.2 cdef	29.0 fg	56.9 cdef	66.6 f	50.6 ef	42.3 cde	31.6 b	30.0 fg
Honak	FL-Fa	20.5 efghi	26.0 bcd	29.3 efg	54.9 def	72.1 cdef	49.9 ef	43.4 cde	32.0 b	27.6 g
Hummer	TF-C	29.6 bcdef	25.1 bcde	26.3 fghj	57.6 cde	72.9 cdef	59.8 bcde	42.4 cde	**35.4 ab**	35.1 cdef
Hykor	FL-Fa	17.8 fghi	21.9 defg	23.0 ghij	60.6 bcde	75.6 cdef	58.9 bcde	45.8 bcde	33.2 b	33.1 cdefg
Jesup	TF-C	18.6 efghi	16.6 fg	26.3 fghi	65.2 bcd	67.7 ef	52.9 cdef	41.6 de	31.5 b	28.8 fg
Kora	TF-C	**31.5 abcde**	26.4 bcd	25.5 fghij	52.7 ef	79.0 bcd	**64.9 abc**	**47.8 abcde**	**35.1 ab**	31.8 efg
Mahulena	FL-Fa	8.6 i	19.0 efg	28.1 fgh	66.8 bc	69.3 def	56.9 cdef	45.3 bcde	33.5 b	29.6 fg
Paolo	TF-C	23.1 cdefgh	21.6 defg	29.4 defg	52.1 ef	75.9 cdef	**64.6 abc**	**52.7 ab**	**35.4 ab**	36.4 cde
Quantico	TF-C	**34.7 abc**	**29.7 abc**	46.3 c	65.4 bcd	81.9 bc	**63.2 abcd**	**51.8 ab**	**45.1 a**	43.0 b
Royal-Q	TF-C/M	**43.1 a**	**29.8 abc**	57.4 b	**79.0 a**	75.4 cdef	55.7 cdef	**53.1 ab**	**39.7 ab**	34.8 cdef
Temora	TF-M	**36.4 ab**	**34.6 a**	**79.5 a**	56.4 cdef	65.0 f	50.1 ef	32.4 f	**38.5 ab**	**53.0 a**
Tower	TF-C	**1.54 abcd**	**34.2 a**	40.2 cde	**69.0 ab**	**87.2 ab**	**69.5 ab**	46.7 bcde	33.1 b	33.9 cdefg
UltraSoft *	Mix	**1.57 abcd**	**30.7 ab**	36.3 cdef	**69.9 ab**	**94.8 a**	**75.2 a**	**55.1 a**	32.8	39.3 bc
LSD (0.05)		12.1	6.81	11.0	10.9	11.2	12.2	7.82	10.9	6.35
CV %		28.7	16.6	20.3	11.0	9.04	12.9	10.3	18.6	11.2

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

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

Table 4 cont: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Growth rates (kg DM/ha/day)** **Individual harvests** Trial is continuing

Cultivars	Type	Cut 10 10/8/2021	Cut 11 1/10/2021	Cut 12 4/11/2021	Cut 13 20/12/2021	Cut 14 31/1/2022	Cut 15 16/3/2022	Cut 16 25/4/2022	Cut 17 13/6/2022
Bariane	TF-C	7.5 cde	20.5 fg	66.1 bcd	53.6 def	33.7 d	36.6 cde	41.5 cdef	16.7 fg
Baroptima	TF-C	7.1 cdef	22.1 efg	68.7 bcd	55.3 cdef	36.0 cd	28.1 e	42.7 bcdef	19.0 def
Boschhoek	TF-C	9.9 c	**53.9 a**	52.2 fg	55.7 cdef	**41.5 abcd**	37.6 bcde	45.2 bcde	20.6 cde
Duramax	TF-C	4.2 ef	36.8 bc	68.8 bcd	**60.8 abcde**	**48.9 a**	**45.4 abc**	48.9 bc	17.0 efg
Easton	TF-C	10.2 c	25.7 efg	66.2 bcd	**65.4 abc**	**49.3 a**	38.1 bcde	42.4 bcdef	22.0 cd
Felina	FL-Fa	3.5 f	27.5 def	71.3 cd	59.3 bcdef	**42.2 abcd**	36.5 cde	42.6 bcdef	17.9 defg
Fojtan	FL-Fa	4.2 ef	22.9 efg	69.3 bcd	49.7 f	33.9 d	33.4 de	38.0 ef	14.6 g
Hipast	FL-Fa	4.4 ef	24.1 efg	54.5 ef	52.6 ef	38.2 bcd	33.0 de	38.9 def	14.1 g
Honak	FL-Fa	5.4 def	25.7 efg	55.2 ef	51.8 f	34.7 d	32.4 de	37.0 f	13.5 g
Hummer	TF-C	6.9 cdef	34.4 cd	60.1 def	55.3 cdef	**41.2 abcd**	36.1 cde	46.5 bc	19.6 de
Hykor	FL-Fa	4.4 ef	26.1 efg	72.8 b	**60.6 abcde**	**41.1 abcd**	**39.9 abcd**	48.6 bc	20.7 cde
Jesup	TF-C	5.5 def	42.3 b	62.2 cdef	57.0 bcdef	**46.0 ab**	36.3 cde	36.4 f	13.5 g
Kora	TF-C	5.2 def	19.9 g	55.4 ef	**65.6 abc**	**46.1 ab**	**39.5 abcd**	46.0 bcd	21.1 cde
Mahulena	FL-Fa	4.4 ef	42.5 b	66.3 bcd	**60.7 abcde**	**41.3 abcd**	**41.1 abcd**	44.6 bcde	16.7 efg
Paolo	TF-C	8.6 cd	24.3 efg	60.7 def	**65.0 abc**	**49.7 a**	**45.3 abc**	49.7 b	24.3 bc
Quantico	TF-C	14.8 b	37.5 bc	63.8 bcde	**62.1 abcde**	**46.3 ab**	**47.4 ab**	**58.2 a**	28.1 b
Royal-Q	TF-C/M	9.9 c	**51.8 a**	61.9 cdef	**63.9 abcd**	**43.9 abc**	**40.1 abcd**	43.2 bcdef	20.8 cde
Temora	TF-M	**27.1 a**	**49.9 a**	43.3 g	**61.0 abcde**	34.2 d	35.9 cde	49.7 b	**34.4 a**
Tower	TF-C	9.5 c	26.1 efg	**90.1 a**	**66.9 ab**	**43.7 abc**	**48.8 a**	47.5 bc	19.8 cde
UltraSoft *	Mix	15.3 b	28.9 de	72.8 b	**70.2 a**	**45.1 ab**	34.7 de	41.5 cdef	27.9 b
LSD (0.05)		3.81	7.13	10.4	10.7	8.82	10.1	7.55	4.57
CV %		27.4	13.4	9.85	10.8	12.7	15.9	10.3	13.7

Fa = *Festuca arundinacea* (Tall fescue), C = Continental type, M = Mediterranean type, FL = *Festulolium*, L = loloid, F = festucoid
Shaded = highest yielding, **Lighter shade** = similar to highest. **Note: treatments with the same letter are similar i.e. not significantly different**

Table 5: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Dry matter content (DM%)Individual harvests** Trial is continuing

Cultivars	Type	Cut 1 19/5/2020	Cut 2 8/7/2020	Cut 3 15/9/2020	Cut 4 23/10/2020	Cut 5 23/11/2020	Cut 6 4/1/2021	Cut 7 12/2/2021	Cut 8 8/4/2021	Cut 9 19/5/2021
Bariane	TF-C	15.2 bc	16.9 cdefg	24.8 abcd	20.1 bcde	19.7 cde	22.7 c	18.3 e	24.2 abcd	17.8 defg
Baroptima	TF-C	16.1 abc	18.1 abc	25.7 ab	20.8 abcd	20.1 bcd	22.3 cd	20.0 cd	23.6 abcd	18.8 bcde
Boschhoek	TF-C	15.3 bc	17.5 abcde	22.7 defgh	21.0 abcd	20.0 bcd	22.9 c	20.1 cd	23.6 abcd	18.0 defg
Duramax	TF-C	18.1 a	17.7 abcde	23.9 bcdefg	21.1 abcd	22.0 a	23.0 c	21.4 abc	25.1 ab	19.6 ab
Easton	TF-C	14.3 bc	17.0 cdefgh	23.7 bcdefg	20.5 abcde	20.4 bc	23.4 bc	20.6 bcd	24.9 abc	18.7 bcdef
Felina	FL-Fa	14.3 bc	17.2 bcdef	25.6 ab	21.0 abc	19.7 cde	22.7 c	20.5 bcd	24.2 abcd	18.8 bcde
Fojtan	FL-Fa	15.4 bc	17.9 abcd	27.0 a	21.6 a	21.5 ab	26.1 a	21.9 ab	25.4 a	20.2 a
Hipast	FL-Fa	15.9 abc	18.4 ab	25.1 abc	20.7 abcd	20.1 bcd	22.5 c	19.6 de	24.9 abc	18.4 cdefg
Honak	FL-Fa	15.4 bc	17.2 bcdefg	24.0 bcdef	20.3 abcde	19.1 cde	22.3 cd	19.5 de	24.2 abcd	19.0 bcd
Hummer	TF-C	15.3 bc	16.6 efgh	24.7 bcde	19.9 bcde	18.7 de	23.2 c	20.6 bcd	23.0 cd	17.2 g
Hykor	FL-Fa	14.9 bc	17.5 abcdef	23.7 bcdefg	20.5 abcde	19.4 cde	23.4 bc	20.7 abcd	24.2 abcd	18.6 bcdef
Jesup	TF-C	16.2 ab	18.1 abc	23.2 cdefg	21.8 a	20.3 bc	23.2 c	21.3 abc	24.1 abcd	19.4 abc
Kora	TF-C	14.7 bc	17.7 abcde	25.9 ab	21.1 abc	19.3 cde	23.5 bc	19.1 de	23.6 abcd	18.0 defg
Mahulena	FL-Fa	15.1 bc	18.5 a	25.6 ab	20.6 abcd	20.0 bcd	25.3 ab	20.2 cd	25.6 a	19.4 abc
Paolo	TF-C	15.1 bc	16.7 defgh	23.9 bcde	20.1 abcd	19.1 cde	20.4 de	18.2 e	23.6 abcd	17.5 fg
Quantico	TF-C	14.9 bc	16.3 fghi	21.7 gh	19.2 e	18.2 e	22.3 cd	20.2 cd	23.8 abcd	17.7 efg
Royal-Q	TF-C/M	14.9 bc	15.8 hi	22.2 fgh	19.7 cde	19.3 cde	22.5 c	20.0 cd	23.2 bcd	18.7 bcdef
Temora	TF-M	13.6 c	14.2 j	22.5 efgh	21.3 ab	21.4 ab	25.6 a	22.2 a	22.5 d	17.7 efg
Tower	TF-C	14.2 bc	15.9 ghi	21.4 h	19.9 bcde	20.1 bcd	22.6 c	20.7 abcd	23.7 abcd	18.8 bcde
UltraSoft *	Mix	15.0 bc	15.0 ij	22.1 fgh	19.6 de	16.7 f	19.6 e	18.3 e	23.0 cd	17.2 g
LSD (0.05)		2.56	1.26	2.21	1.46	1.53	1.96	1.62	1.97	1.23
CV %		10.2	4.47	5.56	4.30	4.69	5.17	4.85	4.96	4.03

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

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

Table 5 cont: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Dry matter content (DM%)Individual harvests** Trial is continuing

Cultivars	Type	Cut 10 10/8/2021	Cut 11 1/10/2021	Cut 12 4/11/2021	Cut 13 20/12/2021	Cut 14 31/1/2022	Cut 15 16/3/2022	Cut 16 25/4/2022	Cut 17 13/6/2022
Bariane	TF-C	25.3 efg	17.4 de	19.5 cdef	22.6 bcde	21.9 efg	20.0 fg	16.0 efg	19.4 fg
Baroptima	TF-C	26.2 defg	18.1 abcd	19.1 def	22.4 cde	22.6 cdefg	22.3 abc	16.9 bcdef	19.8 cdef
Boschhoek	TF-C	24.8 efgh	17.9 abcde	19.7 bcde	23.0 abc	23.5 bcde	21.4 abcdef	16.8 cdef	19.7 def
Duramax	TF-C	28.3 abcd	18.1 abcd	20.8 ab	22.9 abcd	23.1 bcdef	21.7 abcd	18.0 abc	21.3 ab
Easton	TF-C	24.8 efgh	18.7 ab	19.4 cdef	22.3 cdef	23.3 bcde	20.9 cdefg	16.5 def	19.3 fg
Felina	FL-Fa	28.2 abcd	17.8 bcde	19.4 cdef	22.0 defg	23.5 bcde	21.0 cdefg	17.5 abcd	20.4 bcde
Fojtan	FL-Fa	29.4 a	18.6 abc	20.6 abc	23.2 ab	23.8 bcd	22.2 abc	18.3 a	21.6 a
Hipast	FL-Fa	27.9 abcd	18.0 abcde	18.9 ef	22.4 cde	22.7 bcdef	20.9 cdefg	17.4 abcd	21.1 ab
Honak	FL-Fa	29.1 a	17.9 bcde	19.6 bcde	23.1 abc	23.1 bcdef	20.9 cdefg	18.1 ab	20.7 abc
Hummer	TF-C	26.3 cdef	17.2 de	18.7 ef	23.6 a	25.5 a	22.7 ab	16.6 def	19.6 ef
Hykor	FL-Fa	30.1 a	17.9 abcde	19.7 bcde	22.9 abcd	24.4 ab	20.8 cdefg	16.7 def	20.5 bcde
Jesup	TF-C	27.1 bcde	18.1 abcd	21.0 a	22.6 cde	23.9 abcd	22.8 a	18.5 a	21.0 ab
Kora	TF-C	28.7 abc	17.7 bcde	19.7 bcde	22.5 cde	22.5 defg	20.8 cdefg	16.3 def	20.6 bcde
Mahulena	FL-Fa	30.0 a	17.9 abcde	20.3 abcd	23.6 ab	24.3 abc	21.9 abcd	15.0 g	20.6 bcd
Paolo	TF-C	25.9 defg	18.0 abcde	19.5 cdef	21.3 fg	20.9 g	19.9 g	17.0 bcde	19.0 gh
Quantico	TF-C	23.9 fgh	17.8 bcde	19.3 cdef	22.3 cdef	24.0 abcd	20.6 defg	15.8 g	18.7 h
Royal-Q	TF-C/M	23.8 h	17.5 cde	18.7 ef	22.3 cde	22.8 bcdef	21.5 abcde	16.4 def	19.1 fgh
Temora	TF-M	22.4 hi	19.0 a	18.8 ef	23.7 a	23.4 bcde	21.1 bcdefg	16.9 bcdef	18.4 h
Tower	TF-C	24.9 efg	18.0 abcde	18.9 ef	21.2 g	21.4 fg	19.6 g	17.3 abcd	19.7 def
UltraSoft *	Mix	21.0 i	16.9 e	18.3 f	21.7 efg	22.3 defg	20.7 cdefg	14.8 g	19.3 fgh
LSD (0.05)		2.45	1.13	1.28	1.00	1.76	1.58	1.25	0.96
CV %		5.60	3.83	3.97	2.67	4.59	4.52	4.49	2.92

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

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

Table 6: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Leaf rust** (ratings based) **Individual harvests** Trial is continuing

Cultivars	Type	Cut 1 19/5/2020	Cut 2 8/7/2020	Cut 3 15/9/2020	Cut 4 23/10/2020	Cut 5 23/11/2020	Cut 6 4/1/2021	Cut 7 12/2/2021	Cut 8 8/4/2021	Cut 9 19/5/2021
Bariane	TF-C	13	67	33	42	4	75	63	71	0
Baroptima	TF-C	8	33	29	21	17	63	54	63	4
Boschhoek	TF-C	13	50	17	13	8	79	63	71	0
Duramax	TF-C	8	42	17	4	8	63	67	54	0
Easton	TF-C	0	8	0	4	0	33	17	17	0
Felina	FL-Fa	8	79	33	21	8	67	46	67	4
Fojtan	FL-Fa	0	50	25	17	13	50	33	25	4
Hipast	FL-Fa	4	63	21	17	0	50	42	29	4
Honak	FL-Fa	0	46	17	13	8	58	50	54	13
Hummer	TF-C	13	75	25	29	17	83	79	79	8
Hykor	FL-Fa	17	67	42	29	4	71	46	58	8
Jesup	TF-C	4	67	13	17	13	67	54	58	4
Kora	TF-C	0	63	50	38	8	67	33	58	0
Mahulena	FL-Fa	4	75	29	21	17	88	71	79	17
Paolo	TF-C	8	8	8	0	0	29	25	46	4
Quantico	TF-C	0	0	4	0	0	75	83	58	0
Royal-Q	TF-C/M	0	0	4	0	0	58	17	29	0
Temora	TF-M	0	0	0	0	0	4	0	0	0
Tower	TF-C	0	13	17	4	0	33	17	25	0
UltraSoft *	Mix	0	0	0	0	0	0	0	0	0

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

Table 6 cont.: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

Planted: 3 March 2020 **Leaf rust** (ratings based) **Individual harvests** Trial is continuing

Cultivars	Type	Cut 10 10/8/2021	Cut 11 1/10/2021	Cut 12 4/11/2021	Cut 13 20/12/2021	Cut 14 31/1/2022	Cut 15 16/3/2022	Cut 16 25/4/2022	Cut 17 13/6/2022
Bariane	TF-C	75	50	13	63	25	50	33	0
Baroptima	TF-C	58	25	13	38	17	42	17	0
Boschhoek	TF-C	42	0	0	75	46	46	33	0
Duramax	TF-C	58	0	0	46	38	38	13	0
Easton	TF-C	13	13	0	13	13	13	0	0
Felina	FL-Fa	79	25	0	58	25	63	29	0
Fojtan	FL-Fa	54	13	0	29	13	21	21	0
Hipast	FL-Fa	67	13	0	58	25	21	25	0
Honak	FL-Fa	71	21	0	63	38	38	13	0
Hummer	TF-C	71	31	13	75	54	50	58	0
Hykor	FL-Fa	63	25	0	63	38	33	25	0
Jesup	TF-C	42	13	0	42	33	29	17	0
Kora	TF-C	79	38	0	33	17	29	25	0
Mahulena	FL-Fa	63	19	0	88	63	67	48	0
Paolo	TF-C	42	13	0	13	13	13	13	0
Quantico	TF-C	54	31	0	75	29	25	13	0
Royal-Q	TF-C/M	13	0	0	21	17	13	13	0
Temora	TF-M	0	0	0	0	0	0	0	0
Tower	TF-C	42	13	0	13	13	13	0	0
UltraSoft *	Mix	0	0	0	0	0	0	0	0

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

Table 7: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

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

Cultivars	Type	Cut 1 19/5/2020	Cut 2 8/7/2020	Cut 3 15/9/2020	Cut 4 23/10/2020	Cut 5 23/11/2020	Cut 6 4/1/2021	Cut 7 12/2/2021	Cut 8 8/4/2021	Cut 9 19/5/2021
Bariane	TF-C	0	0	0	13	17	0	0	0	0
Baroptima	TF-C	0	0	0	13	25	0	0	0	0
Boschhoek	TF-C	0	0	25	21	0	0	0	0	0
Duramax	TF-C	0	0	13	50	13	0	0	0	0
Easton	TF-C	0	0	8	13	0	0	0	0	0
Felina	FL-Fa	0	0	8	25	17	0	0	0	0
Fojtan	FL-Fa	0	0	0	25	33	0	0	0	0
Hipast	FL-Fa	0	0	0	4	8	0	0	0	0
Honak	FL-Fa	0	0	0	0	4	0	0	0	0
Hummer	TF-C	0	0	8	21	8	0	0	0	0
Hykor	FL-Fa	0	0	8	21	13	0	0	0	0
Jesup	TF-C	0	0	13	**58**	8	0	0	0	0
Kora	TF-C	0	0	0	8	13	0	0	0	0
Mahulena	FL-Fa	0	0	13	50	13	0	0	0	0
Paolo	TF-C	0	0	0	8	13	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
Temora	TF-M	0	0	**88**	8	4	0	0	0	0
Tower	TF-C	0	0	0	25	17	0	0	0	0
UltraSoft *	Mix	0	0	0	13	**67**	0	0	0	0

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

Table 7 cont.: Tall fescue and Festulolium (*Festuca arundinaea*), Fa 2, Elite Evaluation, Outeniqua Research Farm

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

Cultivars	Type	Cut 10 10/8/2021	Cut 11 1/10/2021	Cut 12 4/11/2021	Cut 13 20/12/2021	Cut 14 31/1/2022	Cut 15 16/3/2022	Cut 16 25/4/2022	Cut 17 13/6/2022
Bariane	TF-C	0	0	33	13	0	0	0	0
Baroptima	TF-C	0	13	48	13	0	0	0	0
Boschhoek	TF-C	3	**67**	0	0	0	0	0	0
Duramax	TF-C	0	17	42	0	0	0	0	0
Easton	TF-C	0	13	25	0	0	0	0	0
Felina	FL-Fa	0	13	**54**	0	0	0	0	0
Fojtan	FL-Fa	0	13	**67**	13	0	0	0	0
Hipast	FL-Fa	0	0	17	0	0	0	0	0
Honak	FL-Fa	0	0	13	0	0	0	0	0
Hummer	TF-C	0	13	21	0	0	0	0	0
Hykor	FL-Fa	0	13	**50**	0	0	0	0	0
Jesup	TF-C	0	33	46	0	0	0	0	0
Kora	TF-C	0	13	21	13	0	0	0	0
Mahulena	FL-Fa	0	33	46	0	0	0	0	0
Paolo	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
Temora	TF-M	29	**75**	0	0	0	0	0	0
Tower	TF-C	0	0	**54**	0	0	0	0	0
UltraSoft *	Mix	0	0	17	13	0	0	0	0

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

Table 8: Tall fescue (*Festuca arundinaea*) **and Festulolium**, Fa 2, Elite Evaluation, Outeniqua Research Farm
Planted: 3 March 2020 **Mean no. of days per leaf and projected harvest rotation based on 2 or 2.5-leaf stage**

	3 Mar 2020 to 19 May	19 May 2020 to 8 Jul	8 Jul 2020 to 15 Sep	15 Sep 2020 to 23 Oct	23 Oct 2020 to 23 Nov	23 Nov 2020 to 4 Jan 2021	4 Jan 2021 to 12 Feb
No. of days/ leaf	12	22	13	19	18	17	18
Projected time to 2-leaf	24	44	26	38	36	34	36
2.5 leaf est.	30	55	33	48	45	43	45
	12 Feb 2021 to 8 Apr	**8 Apr 2021 to 19 May**	**19 May 2021 to 10 Aug**	**10 Aug 2021 to 1 Oct**	**1 Oct 2021 to 4 Nov**	**4 Nov 2021 to 20 Dec 2021**	**20 Dec 2021 to 31 Jan**
No. of days/ leaf	22	21	25.5	23	15	20	21
Projected time to 2-leaf	44	42	51	46	30	40	42
2.5 leaf est.	55	53	64	58	38	45	53
	12 Feb 2021 to 8 Apr	**8 Apr 2021 to 19 May**	**19 May 2021 to 10 Aug**				
No. of days/ leaf	22	21	25.5				
Projected time to 2-leaf	44	42	51				
2.5 leaf est.	55	53	64				

The mean leaf stage at harvest for the first 9 harvests of this trial was 2.4 leaves.

According to Donaghy et al 2008, the minimum defoliation interval for tall fescue is at the 2-leaf stage although the maximum leaf number is 4 leaves and the plant will accumulate additional carbohydrate reserves if left to grow to the 4-leaf stage thus enabling greater persistence and regrowth potential in subsequent growth cycles. However at the 4-leaf stage the forage quality is lower than at the 2-leaf stage. Hence Donaghy et al (2008) suggest a compromise at around the 3-leaf stage. Alternatively one could consider allowing the pasture a recovery period for carbohydrate reserves by allowing a longer grazing cycle at certain times of the year if generally the 2-leaf stage is used for defoliation interval.

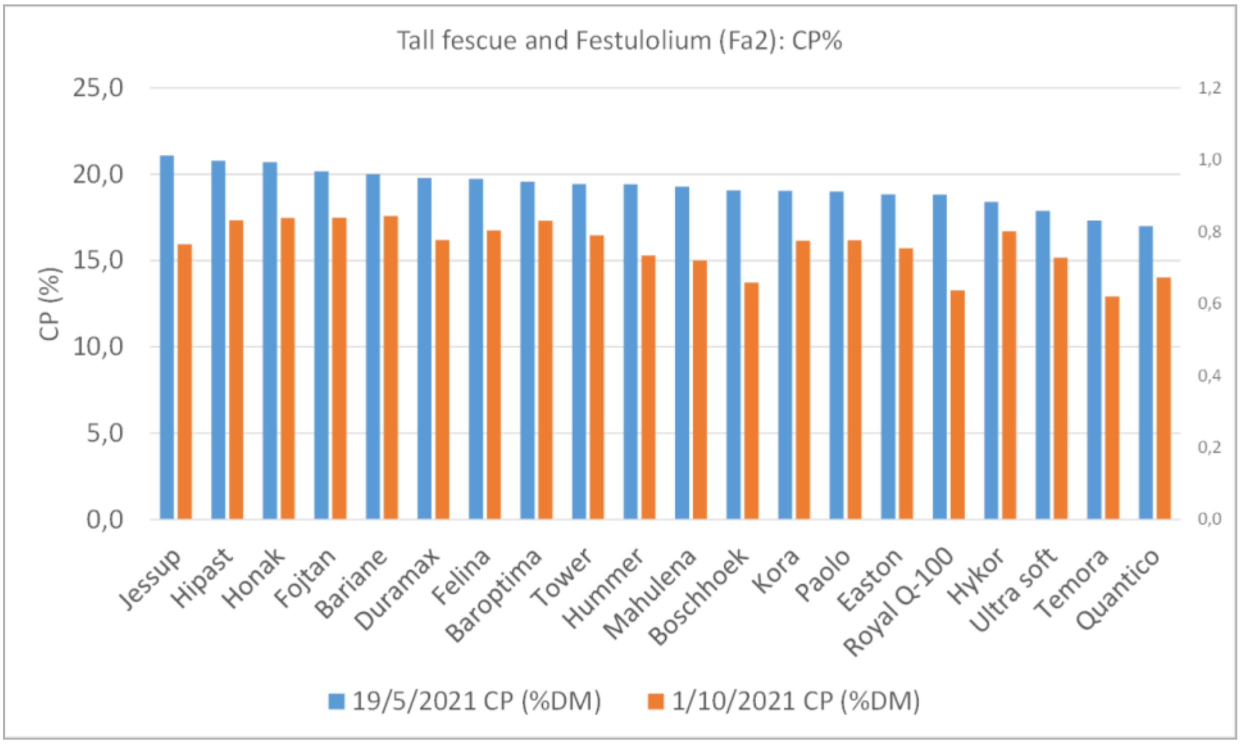

Figure 5: Crude protein (CP%) for the tall fescue and Festulolium cultivars for autumn and spring.

As a comparison these are means for CP% of **perennial ryegrass** cultivars over three trials for autumn and spring.

	Mean CP% of all cultivars	Mean minimum CP%	Mean maximum CP%
Autumn	24.2	21.1	28.7
Spring	16.0	14.2	18.5

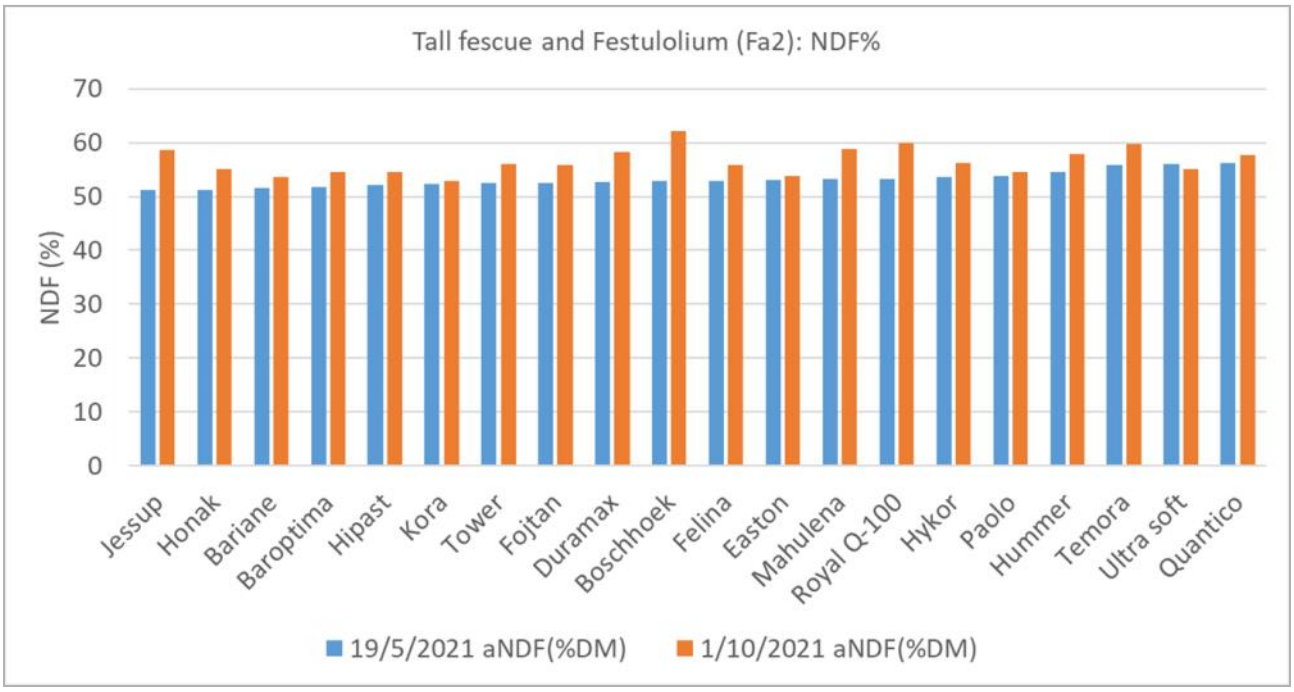

Figure 6: Neutral Detergent Fibre (NDF%) for the tall fescue and Festulolium cultivars for autumn and spring.

As a comparison these are means for NDF% of **perennial ryegrass** cultivars over three trials for autumn and spring.

	Mean NDF% of all cultivars	Mean minimum NDF%	Mean maximum NDF%
Autumn	46.3	40.0	50.4
Spring	47.5	42.9	50.6

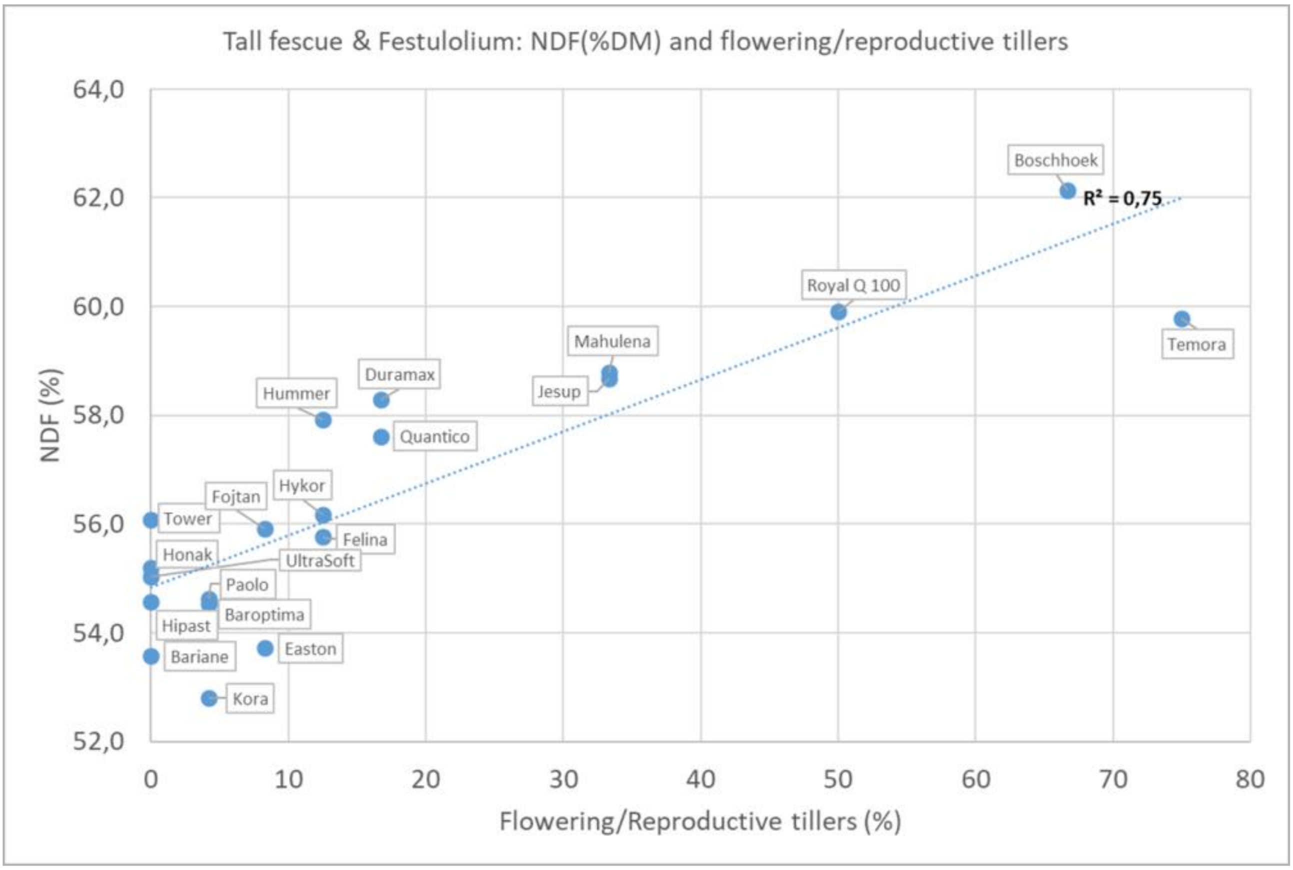

Figure 7: Relationship between reproductive tiller and NDF% for tall fescue and Festulolium cultivars.

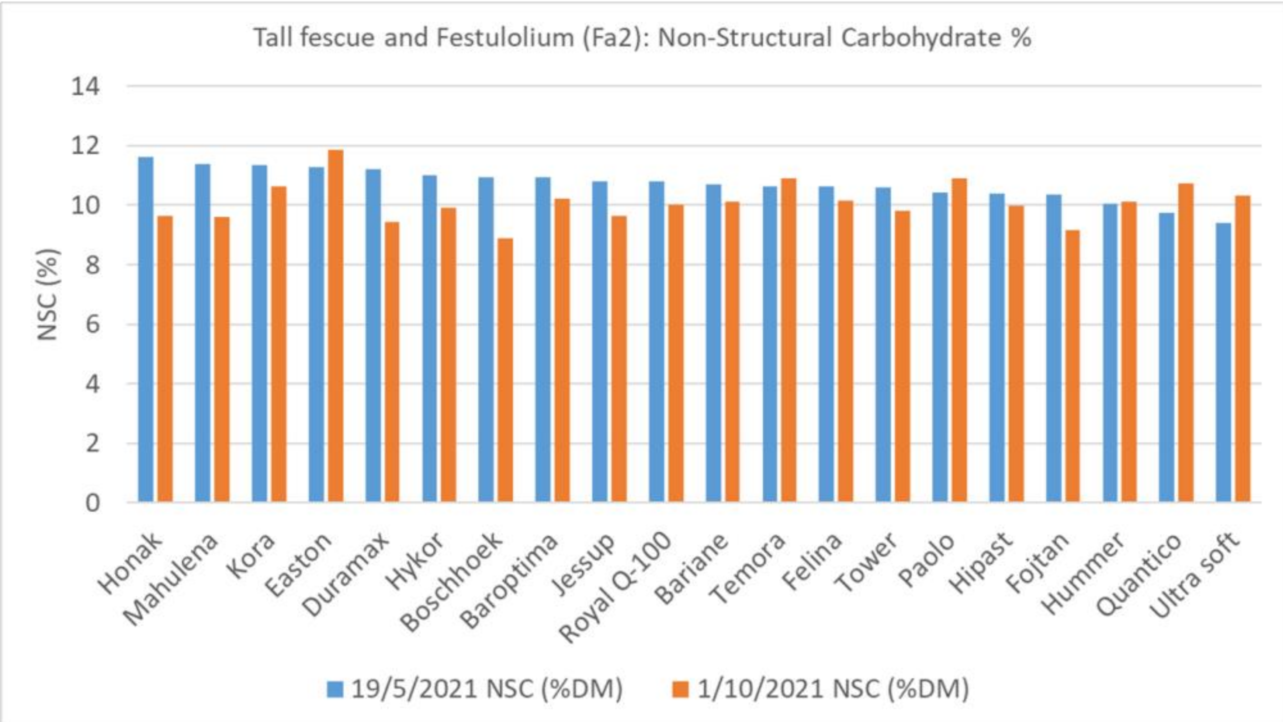

Figure 8: Non-structural carbohydrates (NSC%) for the tall fescue and Festulolium cultivars for autumn and spring.

As a comparison these are means for NSC% of **perennial ryegrass** cultivars over three trials for autumn and spring.

	Mean NSC% of all cultivars	Mean minimum NSC%	Mean maximum NSC%
Autumn	11.6	9.4	15.3
Spring	17.4	13.8	20.6

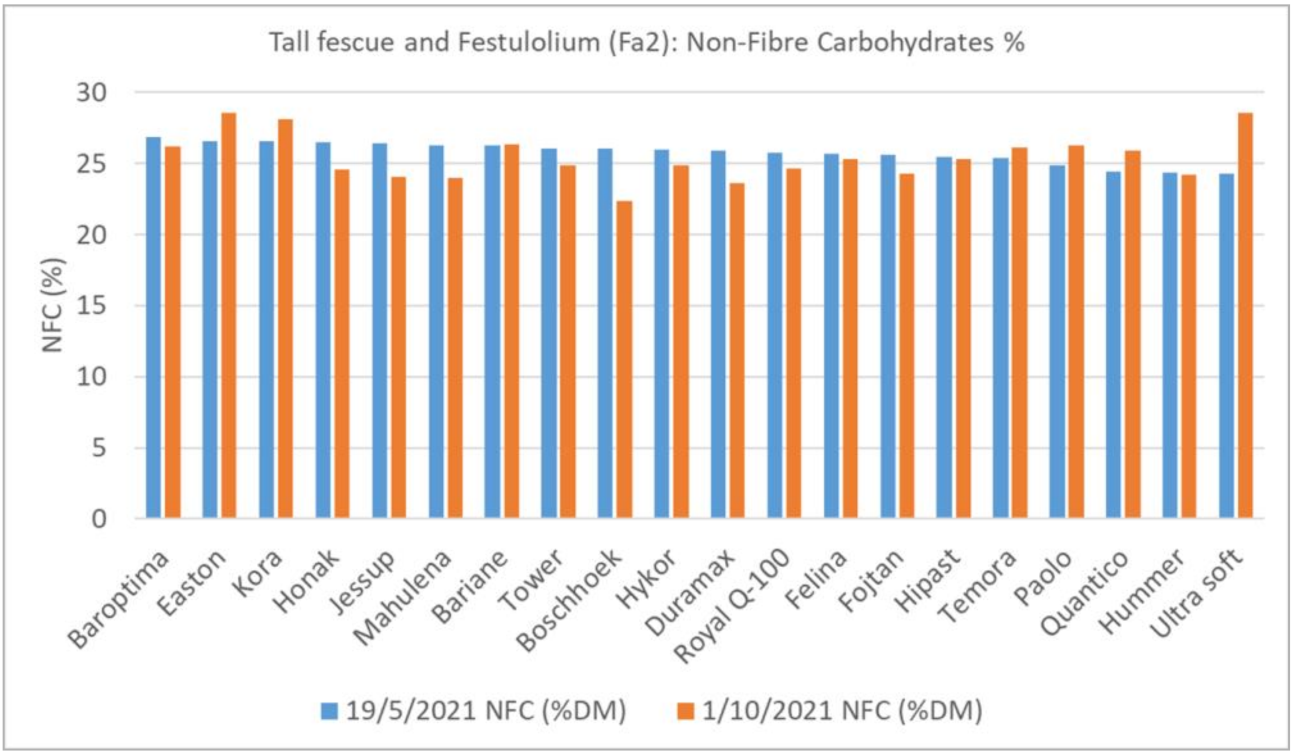

Figure 7: Relationship between reproductive tiller and NDF% for tall fescue and Festulolium cultivars.

As a comparison these are means for NFC% of **perennial ryegrass** cultivars over three trials for autumn and spring.

	Mean NFC% of all cultivars	Mean minimum NFC%	Mean maximum NFC%
Autumn	24.8	18.9	29.4
Spring	29.1	23.3	33.5

Summary of results for the two-year period (2020 to 2022) since establishment in March 2020

These results are for the first two years of the trial and the trial is still in progress. Amongst the continental tall fescue cultivars, there are some cultivars with potential improved winter yield which make them more suitable for our dairy pasture systems. The winter yield could also be affected to some extent by leaf stage at cutting which for this trail is generally 2.25 leaves to ensure a reasonable grazing cycle. This will be investigated in a future trial.

Total yield over the two-year period since establishment:

- Highest yielding over two years: Royal Q100 (30.6 t DM/ha), Quantico (30.3 t DM/ha)
- Similar yield: Tower (29.5 t DM/ha), Temora (Mediterranean type) (29.9 t DM/ha).

In comparison the best perennial ryegrass for the same time period was Viscount with 27.6 t DM/ha. It is important to note that the seasonal yield distribution differs between tall fescue and perennial ryegrass.

Total year 1 yield:

- Highest yielding: Royal Q100 (16.1 t DM/ha)
- Similar yield: Tower, Quantico, Temora

The best perennial ryegrass for the same period was Viscount with 14.4 t DM/ha

Total year 2 yield:

- Highest yielding: Temora (Mediterranean type) (15.2 t DM/ha)
- Similar yield: Quantico (15.0 t DM/ha), Royal-Q (14.5 t DM/ha), Tower (14.2 t DM/ha)

For comparison purposes the best perennial ryegrass cultivar over the same period also in the second year of production was Viscount with 13.2 t DM/ha.

Winter yield year 1:

- Highest: Temora (Mediterranean type) with 3.15 t DM/ha
- Best continental type: Royal Q100 (2.46 t DM/ha), similar yield: Tower, Quantico, Easton. The typical winter dormant continental types generally yielded less than 1.5 t DM/ha. This data, at least for the first year, clearly shows that there are continental types with competitive winter yield even though it is still less than perennial ryegrass.

For perennial ryegrass the best yield was Platform 3.66 t DM/ha and Legion 3.58 t DM/ha

Winter yield year 2:

- Highest yielding: Temora (Mediterranean type) with 3.30 t DM/ha
- Best continental types: Quantico (2.02 t DM/ha), Boschhoek (1.96 t DM/ha), Royal-Q (1.91 t DM/ha). This was lower than the first winter.

Spring yield in the first and second year for both tall fescue and perennial ryegrass were very similar and generally a season were excess forage can be conserved.

Summer yield year 1:

- Highest yielding: Quantico (5.40 t DM/ha)
- Similar yield: Paolo (5.34 t DM/ha), Tower (5.27 t DM/ha)

In contrast the best perennial ryegrass cultivar in summer was Viscount with 3.71 t DM/ha.

Summer yield year 2:

- Highest yielding:Paola (4.63 t DM/ha)
- Similar yield: Duramax, Tower, Quantico, Easton, Kora, Royal-Q, Mahulena, Jesup, Hykor (4.52 to 4.03 t DM/ha)

Best perennial ryegrass cultivars in the second summer were Legion (3.76 t DM/ha) and Viscount (3.44 t DM/ha).

Tall fescue thus provides an advantage in the summer months and may provide further opportunity to conserve excess forage as silage.

Second autumn yield:

Highest yielding: Temora (M type) 3.68 t DM/ha, with similar yield from the continental type cultivar Quantico with 3.53 t DM/ha.

Perennial ryegrass cultivars that did best in the second autumn were Legion, Governor, Viscount and Platform with yields of 3.43 to 3.35 t DM/ha.

Third autumn yield:

Highest yielding: Quantico (4.10 t DM/ha), similar to Temora (3.81 t DM/ha)

The best perennial ryegrass cultivar during the same period was Viscount with 3.58 t DM/ha with similar yields from 3.50 to 2.66 t DM/ha.

This data shows that tall fescue can have a roll in dairy pasture systems but it is important to understand the limitations and the differences in seasonal production compared to ryegrass as well as which combinations with other species will be most suitable in mixtures or pure stands. The deeper root system of tall fescue is a definite advantage over perennial ryegrass in water stressed environments as well as its higher temperature tolerances, the better water use efficiency and good response to rainfall and irrigation. (Reed 1996, Boschma et al 2003, Nie et al 2008).

For pastures with tall fescue as the grass component it is of utmost importance to choose continental cultivars that also have some yielding capacity during the winter months. In addition it will be important to take advantage of the excess forage produced in spring and summer for silage to feed out in winter.

The tall fescue cultivars that show some winter activity also seem to have a more upright growth habit which could be an advantage in combination with other species such as forage herbs and lucerne.

It will be important to see how the yielding capacity of these cultivars continues into the second and third year. From the current two years of data, a decrease or increase in total annual yield seems to be cultivar specific.

Leaf rust incidence was generally high but some cultivars did have a lower rust incidence:

- Lowest rust: Temora (Mediterranean type)
- Lowest rust in continental types: Easton, followed by Royal Q100, Tower, Paolo.

Bolting incidence was generally low, especially compared to ryegrass with only the Mediterranean type cv. Temora having a typically high incidence of reproductive tillers at the end of winter/early spring.

For the continental types the highest flowering incidence was recorded for Jesup, followed by Fojtan, Mahulena, Duramax, Felina and Boschhoek.

Forage quality data is given above in figures 5 to 9 for CP%, NDF%, NDF% in relation to flowering, NSC% and NFC%. For comparison purposes some mean values are given in the tables below for perennial ryegrass although for different years. Tall fescue does generally have a shorter flowering window than the ryegrasses especially shorter than Italian ryegrass. Tall fescue strongly goes back into leaf after flowering since it is a strongly perennial plant.

There are individual tall fescue and festulolium cultivars that have CP% values similar to the mean of perennial ryegrass. There are also some that have lower values than perennial ryegrass for this particular trial.

The NDF values in tend to be higher than those for perennial ryegrass but still within a reasonable range, also considering that tall fescue will generally be used in a mixed system with forage herbs which have a very low NDF%. The values for spring should be considered together with the flowering data given in Table 7 and Figure 7.

NSC% for tall fescue and Festulolium cultivars in autumn are comparable to perennial ryegrass while the NFC% is slightly higher.

References

Boschma SP, Hill MJ, Scott JM, Rapp GG. 2003. The response to moisture and defoliation stresses, and traits for resilience of perennial grasses on the Northern Tablelands of New South Wales, Australia. Australian Journal of Agricultural Research 54: 903 - 916

Chapman DF, Lee JM and Waghorn GC. 2014. Interaction between plant physiology and pasture feeding value: a review. Crop and Pasture Science 65: 721 – 734

DairyNZ (2010). Tall fescue establishment and management. DairyNZ Farmfact 1-28.

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.

Lowe KF and Bowdler TM. 1995. Growth, persistence, and rust sensitivity of irrigated perennial temperate grasses in the Queensland subtropics. Australian Journal of Experimental Agriculture, 35: 571–578.

Minneé EMK, Knight TL, Sutherland BL, Vlaming JB, Fletcher LR and Clark DA. 2010. Herbage production from perennial ryegrass and tall fescue pastures under irrigation in the Canterbury and Waikato regions of New Zealand. Proceedings of the New Zealand Grassland Association 72: 185 – 190.

Nie ZN, Miller S, Moore GA, Hackney BF, Boschma SP, Reed KFM, Mitchell M, Albertsen TO, Clark S, Craig AD, Kearney G, Li GD, Dear BS. 2008. Field evaluation of perennial grasses and herbs in southern Australia. 2. Persistence, root characteristics and summer activity. Australian Journal of Experimental Agriculture 48: 424 – 435.

Raeside MC, Friend MA, Behrendt R, Lawson AR, Clarke SG. 2012. A review of summer-active tall fescue use and management in Australia's high-rainfall zone. New Zealand Journal of Agricultural Research 55: 393 – 411.

Reed KFM 1996. Improving the adaptation of perennial ryegrass, tall fescue, phalaris and cocksfoot for Australia. New Zealand Journal of Agricultural Research 39: 457 – 464.

Italian ryegrass cultivar evaluation results for 2020 to 2022

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Introduction

The Italian ryegrass (*Lolium multiflorum*) elite cultivar evaluation trial, Lm11, was planted on 10 March 2021 at the Outeniqua Research Farm. The aim of the trial is to evaluate the recent Italian ryegrass cultivars being used for intensive dairy pastures or ones that are about to enter the market. This trial provides local data to assist farmers with choosing cultivars best suited to the region and to their specific use of pastures. Preferably the cultivars evaluated in this trial should be ones that persist for at least a 12-month period, preferably 15 months which we call long duration Italian ryegrass cultivars. There is however also a use for the shorter duration cultivars in combination with other species or cultivars to fill certain gaps.

Since most ryegrass cultivars are imported, this data provides insight into the genetic potential and adaption for the southern Cape coastal region. This data is specific for March 2020 to June 2022 which covers the full duration of the trial. The potential best cultivars are evaluated in successive trials. For previous data refer to the Outeniqua Information Day booklets for 2018, 2019, 2020 and 2021, which will give an indication of how cultivars perform in different years of establishment.

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

The diploids were sown at 25 kg/ha while the tetraploids were sown at 30kg/ha. The evaluation was done in small plot trials 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.

***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.

***Dry matter (DM) content* (Table 2)** is a consideration especially early in the season when the DM content is generally low, since DM content in ryegrass can negatively influence voluntary intake if it is very low (Cabrera Estrada et al 2004, John & Ulyatt 1987, Leaver 1985, Minson 1990. The work by Vértité & Journet 1970 is widely referenced where they investigated reduced intake with decreasing DM content. In mixtures with other species that have a very low DM content this can be taken into account. However if the rate of passage through the rumen is fast enough the DM content is less of a consideration.

***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).

***Sward density* (Table 4)** 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.

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. For these results refer to the 2020 booklet and Table 5.

***Flowering behaviour* (Table 6)** 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 wndow). 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 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 cultivars, AgriBoost.

Plant counts **(Table 7)** were done twice, in March 2021 after successful establishment of the trial and again at the end of the trial in July 2022. The 10-point method was used for these counts. It consists of 10 pins on a wooden bar that are spaced 10cm apart. The bar is placed randomly within four rows within the plot and the number of strikes are counted i.e. how many spikes are in contact with a plant. Thus the number of strikes out of 40 are then used to calculate a percentage. The table gives the percentage decrease in plant numbers over the 10 month period giving an indication of persistence. A rating for survival was done at the end of January 2022 after a hot spell.

Leaf emergence rate **(Table 8)** 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 1: Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm

Planted: 10 March 2021 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2021	Rank	Winter 2021	Rank	Spring 2021	Rank	Summer 2021/22	Rank	Autumn 2022	Rank	Total Year 1	Rank	Total Cuts 1-13	Rank
AgriBoost	D	2.79 a	1	3.17 bcde	16	3.80 h	20	0.10 e	20	0		9.86 f	20	9.86 e	20
Asset	D	1.55 b	18	3.32 bcde	10	4.90 fg	18	1.85 cd	15	0.70 bc	13	11.62 e	18	12.57 cd	18
Barcrespo	T	2.30 ab	4	3.31 bcde	11	5.73 abcde	6	2.11 bc	5	0.75 bc	11	13.44 abc	4	14.35 abcd	5
Barmultra II	T	1.89 b	10	3.18 bcde	15	5.59 abcdef	7	2.30 ab	2	0.56 bc	15	12.97 abcde	8	13.75 abcd	9
Bond	D	1.91 ab	9	3.64 abc	4	5.77 abcde	5	2.02 bc	8	0.75 bc	10	13.34 abcd	6	14.34 abcd	6
Elvis	T	1.86 b	13	3.44 bcde	6	6.07 ab	2	1.97 bcd	10	0		13.34 abcd	5	13.34 bcd	13
Fox	D	2.33 ab	3	3.34 bcde	9	6.15 a	1	1.93 bcd	12	0.07 c	18	13.77 ab	2	13.89 abcd	7
Icon	D	1.52 b	19	2.68 e	20	5.17 cdefg	15	1.97 bcd	11	1.07 b	3	11.34 ef	19	12.74 cd	15
Impact/Udine	T	2.34 ab	2	3.36 bcde	8	5.87 abc	3	2.06 bc	7	1.07 b	2	13.63 ab	3	15.05 ab	3
Inducer	T	1.49 b	20	3.49 abcd	5	5.33 cdefg	13	1.93 bcd	13	0.88 bc	8	12.24 bcde	12	13.4 bcd	12
Jackpot	D	2.24 ab	5	3.42 bcde	7	5.19 cdefg	14	2.00 bcd	9	0.61 bc	14	12.85 abcde	11	13.68 abcd	10
Jeanne	T	2.08 ab	6	2.84 de	18	5.47 abcdefg	9	1.64 d	19	0.48 bc	16	12.03 cde	14	12.65 cd	17
Knight	D	1.87 b	12	3.21 bcde	14	4.80 g	19	1.77 cd	18	0.76 bc	9	11.65 e	17	12.65 cd	16
Lush	T	1.89 b	11	3.30 bcde	12	5.15 defg	16	2.60 a	1	2.18 a	1	12.94 abcde	9	15.51 a	1
Sukari	D	1.80 b	14	4.22 a	1	5.83 abcd	4	2.14 bc	4	1.06 b	4	13.99 a	1	15.32 ab	2
Supercruise	D	2.01 ab	7	3.85 ab	2	5.38 bcdefg	11	1.92 cd	14	1.06 b	5	13.16 abcd	7	14.61 abc	4
Tabu +	D	1.61 b	16	3.66 abc	3	5.51 abcdef	8	2.14 bc	3	0.74 bc	12	12.92 abcde	10	13.86 abcd	8
Teanna	T	1.97 ab	8	2.77 de	19	5.37 bcdefg	12	1.81 cd	17	0.46 bc	17	11.92 cde	15	12.56 d	19
Thumpa	T	1.58 b	17	3.29 bcde	13	5.07 efg	17	1.81 cd	16	0.89 bc	7	11.75 de	16	12.90 cd	14
Yolande	D	1.70 b	15	3.00 cde	17	5.42 abcdefg	10	2.07 bc	6	1.01 b	6	12.19 bcde	13	13.61 abcd	11
LSD (0.05)		0.88		0.77		0.70		0.37		0.89		1.65		2.04	
CV %		27.6		14.1		7.94		11.6		71.5		7.98		9.14	

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*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2021 **Leaf rust** (%) (rating based) **Individual harvests** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 1 23/4/2021	Cut 2 20/5/2021	Cut 3 22/6/2021	Cut 4 16/8/2021	Cut 5 22/9/2021	Cut 6 13/10/2021	Cut 7 10/11/2021
AgriBoost	D	0	0	0	0	0	0	0
Asset	D	0	0	0	0	4	0	0
Barcrespo	T	0	0	0	0	4	0	0
Barmultra II	T	0	0	0	4	33	0	0
Bond	D	0	0	0	0	0	0	0
Elvis	T	0	0	0	0	8	0	0
Fox	D	0	0	0	0	4	0	0
Icon	D	0	0	0	0	0	0	0
Impact/Udine	T	0	0	0	0	0	0	0
Inducer	T	0	0	0	0	0	0	0
Jackpot	D	0	0	0	0	4	0	0
Jeanne	T	0	0	0	23	**83**	0	0
Knight	D	0	0	0	0	0	0	0
Lush	T	0	0	0	0	4	0	0
Sukari	D	0	0	0	0	0	0	0
Supercruise	D	0	0	0	0	4	0	0
Tabu +	D	0	0	0	0	13	0	0
Teanna	T	0	0	0	8	**67**	0	0
Thumpa	T	0	0	0	0	8	0	0
Yolande	D	0	0	0	0	0	0	0

Table 2. Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2021 **Leaf rust** (%) (rating based) **Individual harvests** D = Diploid, T = Tetraploid

Cultivars	Type	Cut 8 9/12/2021	Cut 9 10/1/2022	Cut 10 18/2/2022	Cut 11 30/3/2022	Cut 12 5/5/2022	Cut 13 22/6/2022
AgriBoost	D	0	-	-	-	-	-
Asset	D	0	8	8	19	0	0
Barcrespo	T	0	21	4	38	0	0
Barmultra II	T	0	17	29	50	0	0
Bond	D	0	30	21	25	0	0
Elvis	T	13	33	**63**	-	-	0
Fox	D	4	28	29	38	-	0
Icon	D	0	4	4	8	0	0
Impact/Udine	T	0	17	17	48	0	0
Inducer	T	0	0	8	25	0	0
Jackpot	D	0	30	32	6	0	0
Jeanne	T	25	**67**	50	**63**	0	0
Knight	D	4	19	29	31	0	0
Lush	T	4	13	8	50	0	0
Sukari	D	8	0	0	0	0	0
Supercruise	D	8	29	17	21	4	0
Tabu +	D	8	21	13	13	0	0
Teanna	T	4	50	**63**	**75**	0	0
Thumpa	T	0	30	21	38	4	0
Yolande	D	0	8	4	13	0	0

Table 3 Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2021 **Sward density** (%) (rating based) **Individual harvests** D = Diploid, T = Tetraploid,

Cultivars	Type	Cut 1 23/4/2021	Cut 2 20/5/2021	Cut 3 22/6/2021	Cut 4 16/8/2021	Cut 5 22/9/2021	Cut 6 13/10/2021	Cut 7 10/11/2021
AgriBoost	D	100	100	100	100	100	100	100
Asset	D	100	100	100	100	100	100	100
Barcrespo	T	100	100	100	100	100	100	100
Barmultra II	T	100	100	100	100	100	100	100
Bond	D	100	100	100	100	100	100	100
Elvis	T	100	100	100	100	100	100	100
Fox	D	100	100	100	100	100	100	100
Icon	D	100	100	100	100	100	100	100
Impact/Udine	T	100	100	100	100	100	100	100
Inducer	T	100	100	100	100	100	100	100
Jackpot	D	100	100	100	100	100	100	100
Jeanne	T	100	100	100	100	100	100	100
Knight	D	100	100	100	100	100	100	100
Lush	T	100	100	100	100	100	100	100
Sukari	D	100	100	100	100	100	100	100
Supercruise	D	100	100	100	100	100	100	100
Tabu +	D	100	100	100	100	100	100	100
Teanna	T	100	100	100	100	100	100	100
Thumpa	T	100	100	100	100	100	100	100
Yolande	D	100	100	100	100	100	100	100

Table 3 Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2021 **Sward density** (%) (rating based) **Individual harvests** D = Diploid, T = Tetraploid,

Cultivars	Type	Cut 8 9/12/2021	Cut 9 10/1/2022	Cut 10 18/2/2022	Cut 11 30/3/2022	Cut 12 5/5/2022	Survival After hot spell 27/1/2022
AgriBoost	D	13	0	0	0	0	0 d
Asset	D	100	100	50	25	42	70.8 abc
Barcrespo	T	100	100	63	25	33	66.7 bc
Barmultra II	T	100	100	75	17	50	79.2 abc
Bond	D	100	100	79	29	38	79.2 abc
Elvis	T	100	100	54	0	8	66.7 bc
Fox	D	100	100	54	13	13	79.2 abc
Icon	D	100	100	79	21	67	75.0 abc
Impact/Udine	T	88	100	63	17	63	83.3 ab
Inducer	T	100	100	54	29	42	75.0 abc
Jackpot	D	100	100	46	13	38	79.2 abc
Jeanne	T	100	100	38	4	29	58.3 c
Knight	D	100	100	50	25	46	58.3 c
Lush	T	100	100	92	96	100	95.8 a
Sukari	D	100	96	42	25	46	70.8 abc
Supercruise	D	100	96	67	38	63	62.5 c
Tabu +	D	100	100	58	29	42	70.8 abc
Teanna	T	100	100	46	8	29	70.8 abc
Thumpa	T	96	100	46	25	54	58.3 c
Yolande	D	100	100	71	29	54	83.3 ab

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

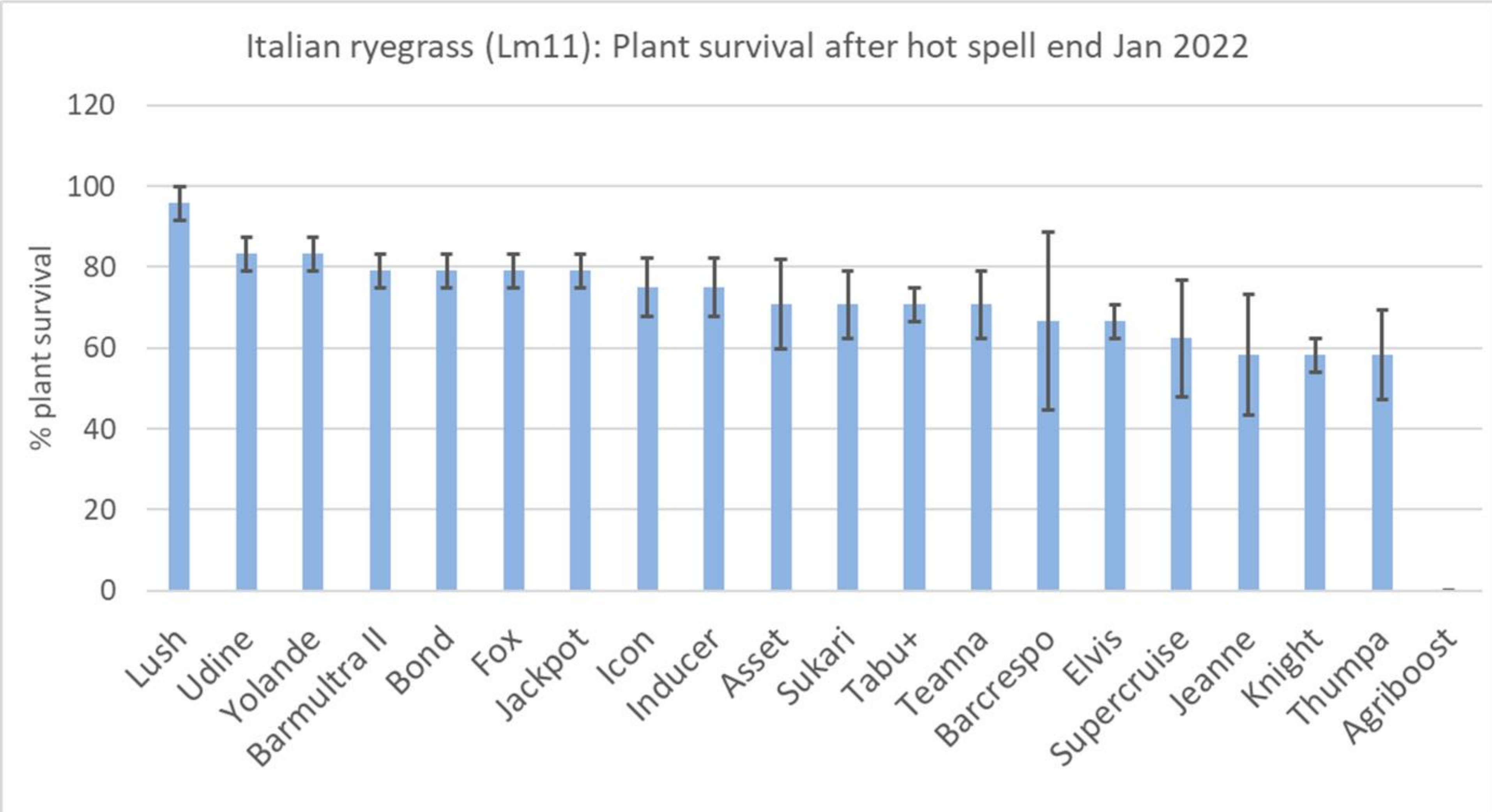


Figure 1: Plant survival as assessed on a ratings basis (27/1/2022) after a hot spell in January 2022

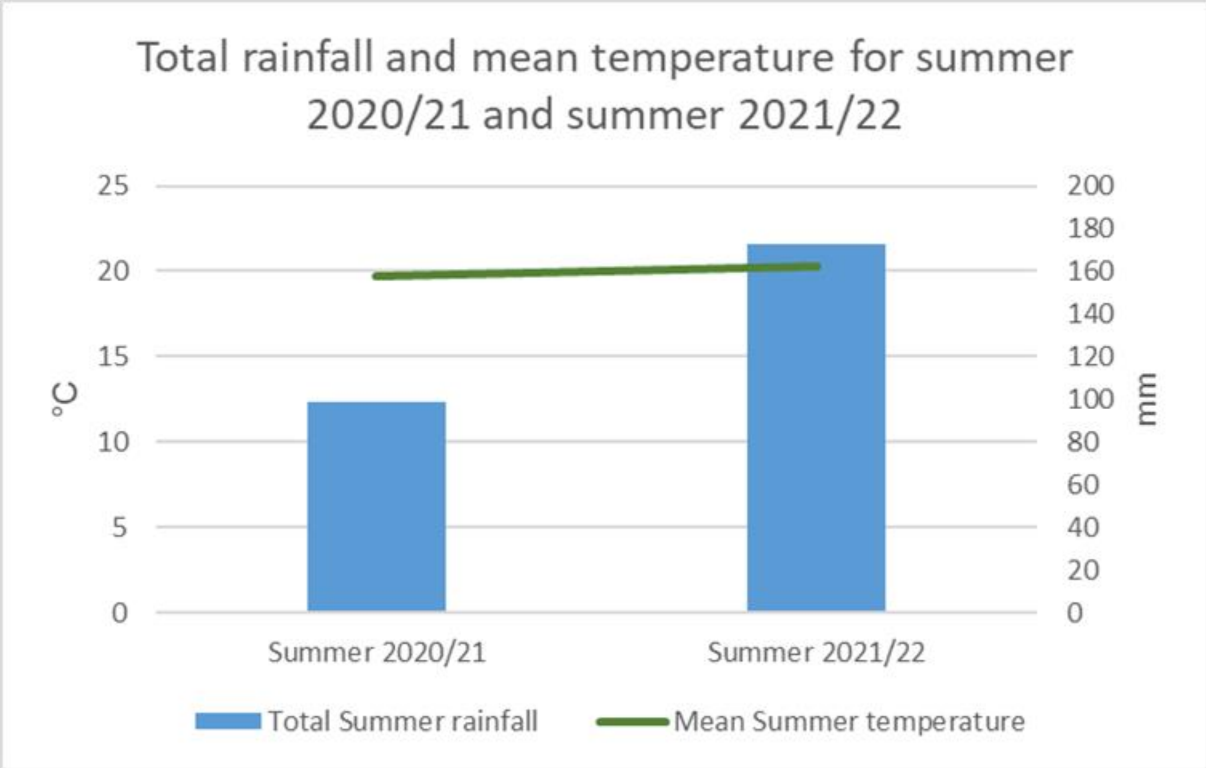


Figure 1: Plant survival as assessed on a ratings basis (27/1/2022) after a hot spell in January 2022

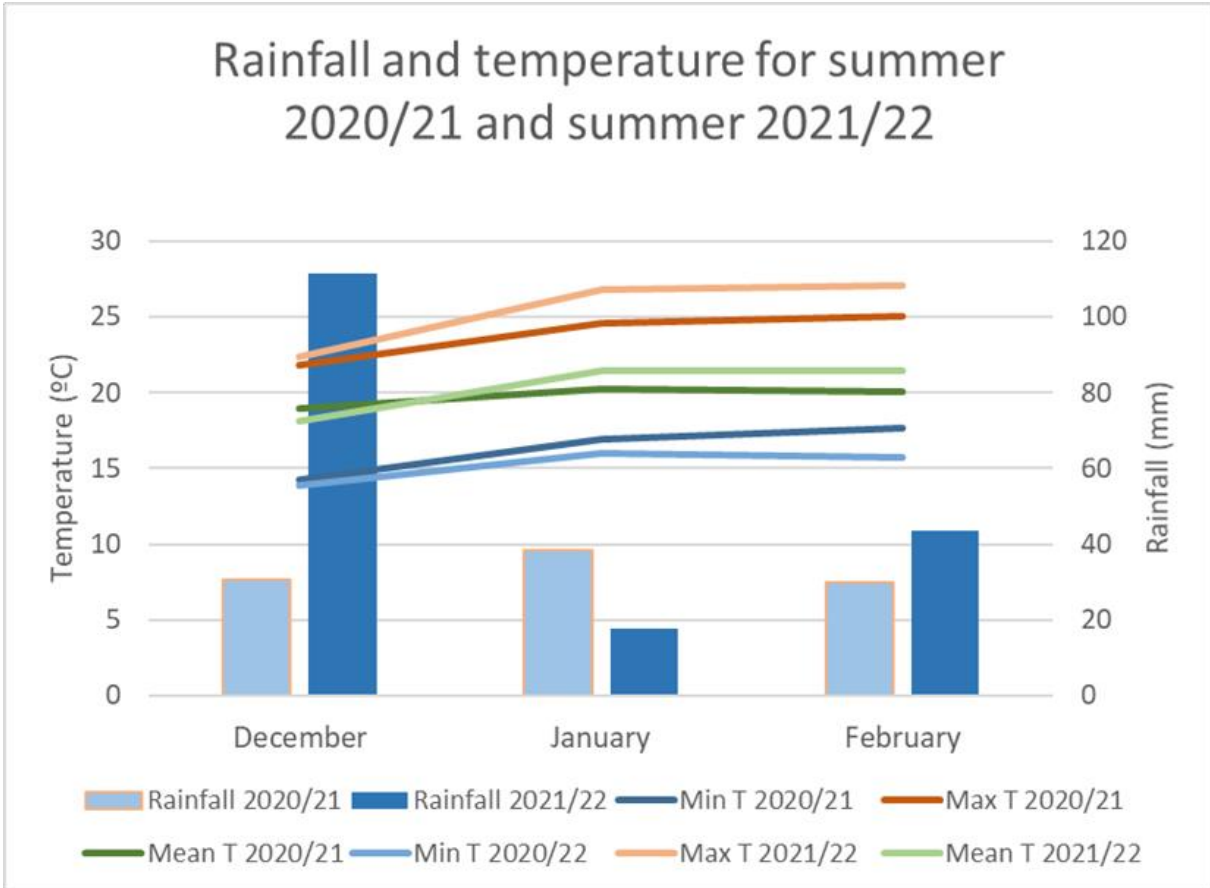


Figure 3: Rainfall and mean, mean minimum and mean maximum temperature for the individual summer months 2020/21 vs 2021/22

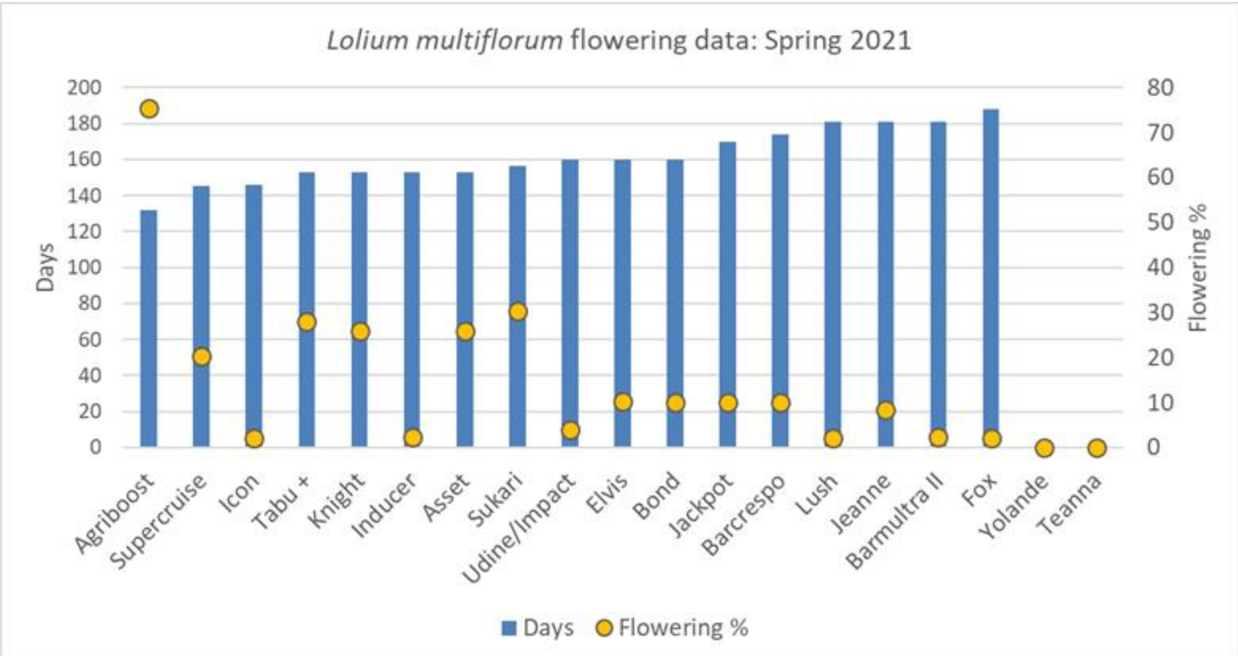
Even though the overall summer rainfall was higher for the summer of 2021/22 than the summer of 2020/21, the main difference between the two summer seasons was the lower rainfall and higher temperatures in January 2022.

Table 4 Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2021 **Reproductive tillers/bolting** (%) (rating based) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 5 22/9/2021	Cut 6 13/10/2021	Cut 7 10/11/2021	Cut 8 9/12/2021	Cut 9 10/1/2022	Cut 10 18/2/2022
AgriBoost	D	88	83	96	100	-	-
Asset	D	42	13	17	38	21	8
Barcrespo	T	79	50	79	42	25	4
Barmultra II	T	50	79	83	67	25	0
Bond	D	79	75	67	31	17	4
Elvis	T	50	83	83	79	38	17
Fox	D	50	67	71	50	21	4
Icon	D	46	38	54	46	17	4
Impact/Udine	T	63	75	75	75	17	0
Inducer	T	75	79	63	38	13	0
Jackpot	D	63	50	46	29	38	17
Jeanne	T	17	71	83	75	25	0
Knight	D	63	13	42	67	29	0
Lush	T	25	71	46	38	17	4
Sukari	D	88	83	88	88	54	21
Supercruise	D	71	46	54	46	33	21
Tabu +	D	83	63	83	75	63	21
Teanna	T	33	75	83	67	21	4
Thumpa	T	83	29	83	71	42	4
Yolande	D	38	58	58	33	13	0

Table 5: Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2021 **Days to 50% flowering and Flowering % from a spring planting** D = Diploid, T = Tetraploid

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



For spring-planting a low flowering % is best

(Spring yield data will be available in 2023)

Table 6: Italian ryegrass (*Lolium multiflorum*), Lm 11, Elite Evaluation, Outeniqua Research Farm
Planted: 10 March 2022 **No. of days per leaf and projected harvest rotation based on 3-leaf stage**

	10 Mar 2021 To 23 Apr	23 Apr 2021 To 20 May	20 May 2021 To 22 Jun	22 Jun 2021 To 16 Aug	16 Aug 2021 To 22 Sep	22 Sep 2021 To 13 Oct	13 Oct 2021 To 10 Nov
No. of days/leaf	11	10	12	15	11	11	8.5
Projected time to 3-leaf	33	30	36	44	33	33	26
2.75-leaf Shortest cycle	30	28	33	40	30	30	24

	10 Nov 2021 To 9 Dec	9 Dec 2021 To 10 Jan 2022	10 Jan 2022 To 18 Feb	18 Feb 2022 To 30 Mar	30 Mar 2022 To 5 May	5 May 2022 To 22 Jun
No. of days/leaf	9.5	8.5	12	11.5	11	15
Projected time to 3-leaf	29	26	36	35	33	44
2.75-leaf Shortest cycle	27	24	33	31	30	41

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. 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.

Summary

Total year 1

- Highest yielding cultivar: Sukari
- Cultivars similar to the highest yielding: Fox, Impact, Barcrespo, Elvis, Bond, Supercruise, BArmutra II, Lush, Tabu+, Jackpot

Total yield over 13 harvests (Mar 2021 to Jun 2022)

Highest yielding: Lush

- Similar: Sukari, Impact, Supercruise, Barcrespo, Bond, Fox, Tabu+, Barmultra II, Jackpot, Yolande

Winter yield

- Highest yielding cultivar: Sukari
- Similar: Supercruise, Tabu+, Bond

Summer yield

- Highest yielding cultivars: Lush
- Similar yielding: Barmultra II
- Unfortunately these were not also in the best group of cultivars for winter yield.

Second autumn yield

- Highest yielding: Lush
- Generally production was poor after the challenging weather conditions of Jan 2022.

Prolific flowering during summer with higher stem component for an extended period with the lowest flowering incidence for Asset, Icon and Yolande.

Best sward density through summer: Lush

Rust incidence: Rust occurred during September and again December to March.
Lowest rust incidence: AgriBoost, Assest, Icon, Inducer, Sukari, Tabu+, Yolande.

References:

Cabrera Estrada JI, Delagarde R, Faverdin RP, Peyraud JL. 2004. Dry matter intake and eating rate of grass by dairy cows is restricted by internal, but not external water. Animal Feed Science and Technology 114: 59- 74.

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.

John A and Ulyatt MJ. 1987. Importance of dry matter content to voluntary intake of fresh grass forages. Proceedings of the New Zealand Society of Animal Production 47: 13 – 16.

Leaver JD 1985. Milk production from grazed temperate grassland. Journal of Dairy Research 52: 313-344

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.

Minson DJ. 1990. Forages in ruminant nutrition. Animal feeding and nutrition. A Series of Monographs and Treatises (Cunha TJ, Ed.)

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.

Verite R and Journet M. 1970. Effect of the Water Content of Grass and Dehydration at Low Temperature upon Its Feeding Value for Dairy Cows. Annales de Zootechnie, 19, 255-268.

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.

Feeding a Ca-binder to pre-partum cows grazing pasture does prevent milk fever

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Introduction

Milk fever or hypocalcemia in dairy cows around calving is a health disorder that can be fatal. The cow's Ca requirement drastically increases when milk synthesis starts at calving resulting in low blood Ca levels. At calving the production of 10 litres of colostrum will result in a loss of 23 g of calcium in a single milking (Horst et al. 1997). The cow will extract Ca from the blood and then start to mobilize Ca from her bones but this takes time. When the blood Ca level falls below 1.4 mmol Ca/litre the cow has clinical milk fever and is paralysed. She then urgently must be treated with intravenous calcium to save her. If the cow has clinical milk fever before calving, the birth process is compromised often resulting in death of the calf. Subclinical milk fever is when blood Ca levels are from 2.0 to 1.4 mmol total Ca/litre and this increases risk of dystocia, retained placenta, mastitis and displaced abomasum. According to Lean et al. (2006), Jersey cows are at 2.25 higher risk of milk fever than Holstein cows. Clinical and subclinical milk fever impairs health and reproduction in cows.

On many farms anionic salts are fed to cows during the 3 week steam-up period before calving. The

Anionic salts and low K roughage

aim is to acidify the blood to activate Ca mobilization. The dietary cation anion difference (DCAD) calculation proposed by Ender et al. (1962), DCAD mEq/kg = (mEq Na^+ + mEq K^+) – (mEq Cl^- + mEq S^{2-}) is most commonly used. The (DCAD) of -100 to -200 mEq/kg is targeted. High levels of sodium and potassium should be avoided and therefore sodium bicarbonate should not be included in prepartum diets. This approach can only be successful if the potash (K) level in the total diet is 1.5 to 2%. Pasture often contains 3 to 6% K and therefore cows are taken off pasture and are fed roughages like maize silage, triticale silage, oat silage or poor quality hay supplemented with a pre-partum concentrate containing anionic salts.

Change of system using a Ca binder

Intensive feeding maize silage, oat hay or other low K roughages to cows in small paddocks create a dirty environment for cows to calve in and is labour intensive. The risk of mastitis increases and calf health may be compromised. Cows will graze pasture after calving and it therefore makes a lot of sense to also have them on pasture before calving.

An alternative approach is to cause a Ca deficiency in cows 14 days before calving to activate Ca mobilization from bones. The intake of Ca should be limited to 20g/cow/day or less. This is however not possible as most feedstuffs contain 0.3 to 0.4% of Ca or more. Cows grazing kikuyu/ ryegrass pasture containing 0.4% Ca will have a daily Ca intake of 40 to 50g. The calcium available to the cow can be reduced by feeding a Ca-binder in the pre-partum concentrate. The cow will then have a shortage of calcium in the blood and start mobilizing Ca from her bones before calving. When the cow calves her intake drops but she does not depend on dietary Ca to maintain blood Ca levels. Increasing the magnesium (Mg) content of the diet from 0.3-0.4% is expected to reduce the risk for milk fever by 62%. This can be explained as Mg is critical in the release of parathyroid hormone and in the synthesis of 1,25-dihydroxycholecalciferol involved in Ca mobilization. Pasture often has low levels (0.2%) of Mg resulting in grass staggers.

Outeniqua Jersey herd

At the Outeniqua Research Farm a pre-partum concentrate containing anionic salts has been fed to cows before calving for many years and oat hay was used as roughage source. We had to buy in 120 ton of oat hay in December every year to feed steam-up cows. Steam-up cows were kept in a paddock and fed chopped oat hay using a mixer wagon on a daily basis. Two kg pre-partum concentrate containing anionic salts was fed to each cow per day in the dairy parlour. The system worked reasonably well but was labour intensive and cows calved in a dirty environment. We still had 2-5% of cows going down with clinical milk fever.

In September 2020 we changed the feeding system for the pre-partum cows. Cows were moved to irrigated kikuyu/ryegrass pasture close to the dairy at 21 days before calving and were fed 3 kg of a commercial pre-partum concentrate containing 400g of a Ca binder (X-Zelit, a synthetic zeolite). Concentrate was fed individually in the dairy parlour. The level of Ca-binder needed depends on the Ca content of the total diet and 100g of X-Zelit binds 10g of dietary Ca. Pasture should not contain legumes as this will increase the Ca content of the diet. The incidence of milk fever in multiparous cows has been low at 1.8% over 600 calvings over the past two years. Most cases of milk fever occurred during June and July when cows grazed high quality ryegrass with a high K content and a low Mg content. It is recommended not to graze recently fertilized paddocks with high potassium levels (K>4.5%). Dietary Mg content should be 0.4% and Ca content less than 0.5%. Kikuyu contains lower levels of available Ca and therefor suits this system well. Plantain contains high levels of Ca (1.2-1.5%) and should not be grazed during the pre-partum period when Ca-binders are fed to prevent milk fever. The dietary phosphorus should be kept between 0.25 and 0.45% .

The cost of the pre-partum concentrate containing X-Zelit may be up to 3 X higher than conventional pre-partum concentrates with ionic salts. Costs of pasture is however lower (R1.50/kg DM) than that of oat hay (R2.50/kg DM) that we previously had to buy in. The nutritional quality of irrigated pasture is higher than that of oat hay resulting in a better start of the next lactation. The greatest benefit is that we can keep cows on pasture before calving and still have a low incidence of milk fever.

Conclusions

Milk fever was well controlled when cows were kept on pasture during the steam-up period and a pre-partum concentrate containing an effective Ca binder was fed.

Cows calved in a clean environment on pasture and were well adapted to high quality pasture after calving.

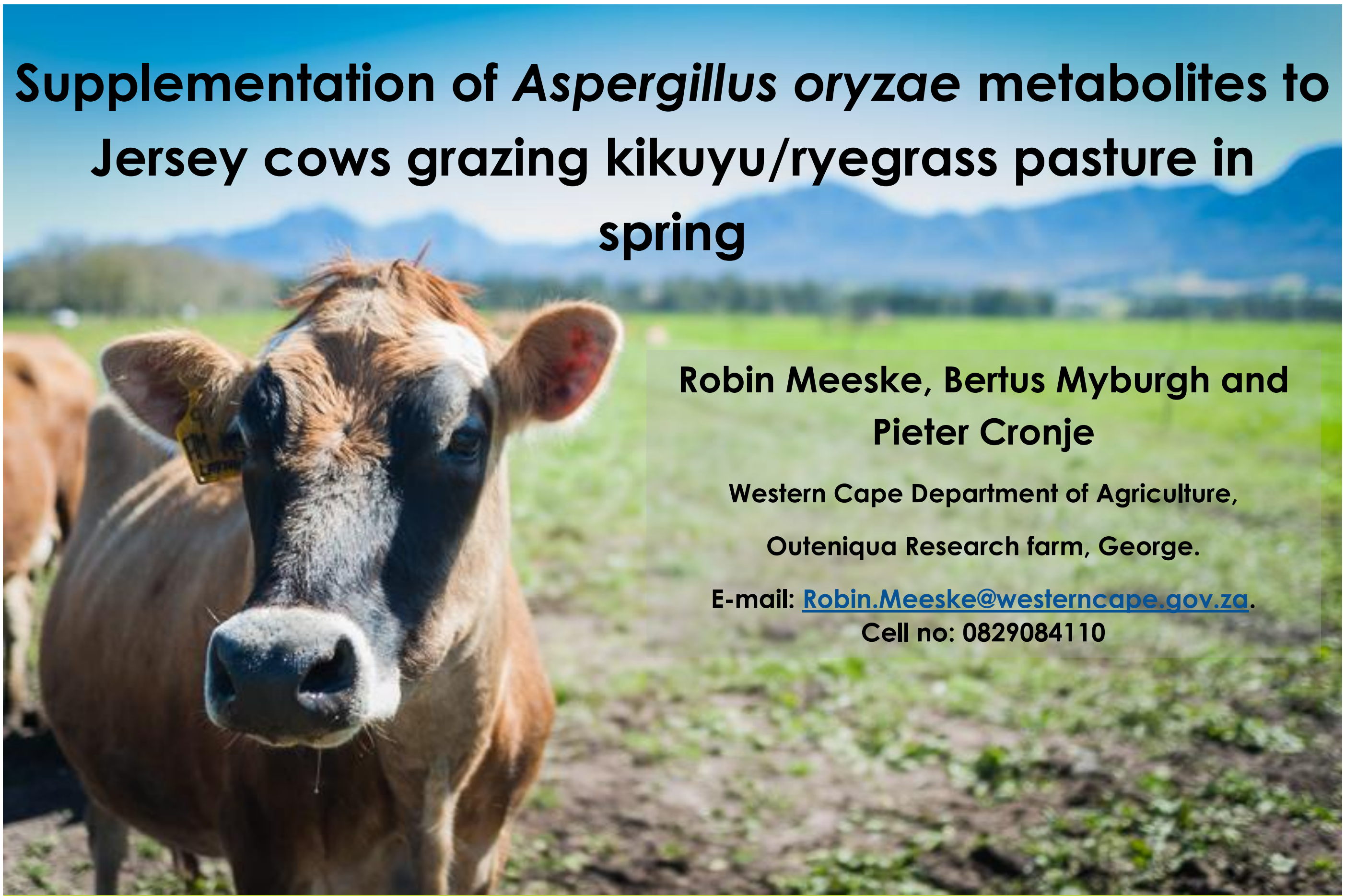
Keeping cows on pasture pre-partum was less labour intensive.

Make sure Mg is at 0.4% of the total diet and avoid extreme high K levels in pasture.

References

R.L. Horst, R.L., Goff, J.P., Reinhardt, T.A. & Buxton, D.R.,1997. Strategies for Preventing Milk Fever in Dairy Cattle, J. Dairy Sci., 80, 1269-1280.

Lean, I.J., DeGaris, P.J., McNeil, D.M., Block, E., 2006. Hypocalcemia in dairy cows: meta analysis and dietary cation anion difference theory revisited. Journal of Dairy Science 89, 669–684.



Supplementation of *Aspergillus oryzae* metabolites to Jersey cows grazing kikuyu/ryegrass pasture in spring

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Introduction

Profitability of milk production is under pressure due to increasing input costs. Many different feed additives are available to nutritionists and farmers to include in the diet of dairy cows. Controlled applicable studies are needed to determine the cost effectiveness of feed additives for cows on pasture. Kikuyu/ryegrass pasture under irrigation is commonly used as forage for dairy cows in the southern Cape. It is well documented that the first limiting factor for cows on pasture to produce milk, is energy intake. In a typical situation, cows are supplemented with 6kg/day of a maize based concentrate and will take in 8 to 10 kg dry matter of pasture. Fibre content (Neutral detergent fibre, NDF) and digestibility of fibre (NDFd) determines intake of pasture. Dry matter intake is limited by the cow's rumen capacity as well as rate of digestion. Fungi have the capability to break lignin-hemicellulose bonds and improve fibre digestion.

Fungi are essential for normal rumen function, especially in converting fibre to usable products for ruminants (Gordon & Phillips, 1993). Fungi help break the lignin-hemicellulose bond physically, whereas the fungal enzymes play an integral role in breaking the hemicellulose and cellulose bonds (Akin & Borneman, 1990; Li & Galza, 1991). The diet's starch and protein fraction can also be broken down into smaller particles by fungi, primarily using the enzymes produced by the fungi (Schmidt et al., 2004; Gomez-Alarcon et al., 1991). Fungi help to break down the feed particles into smaller particles enlarging the feed surface area, increasing the surface for bacteria to attach. According to Akin & Rigsby (1987), fungi degraded the sclerenchyma of a leaf blade four-fold. The fungal degradation and the cattle chewing their cut will help break down the feed particles in the diet, making the nutrients available to the rumen bacteria.

Fibre plays an important role as part of the dairy cow's diet. However, digestion of fibre in the rumen is influenced by factors like the maturity of the fibre, the digesta flow rate in the rumen and the rumen microbiome. Supplementing *Aspergillus oryzae* metabolites (AOM_ will increase both the fungal numbers in the rumen and increase the fungi's growth rate. According to Chang et al.

(1999), fungal stem surface area was increased by 15%, branch surface area was increased by 348%, and the branch number increased by 281% when AOM were supplemented. Increasing the fungi in the rumen may lead to an increase in nutrients available for rumen bacteria. According to Frumholtz et al.,1989 and Wiedmeier et al., 1987, AOM supplementation increased bacterial numbers by 79% and 14%, respectively. An increase in bacteria may increase volatile fatty acid (Arambiel et al., 1987; Sun et al., 2017) and microbial protein (Gomez-Alarcon et al.,1990; Caton et al., 1993) production in the rumen.

The effect of supplementing AOM to dairy cows in a total mixed ration (TMR), has been well researched. In a meta-analysis including 18 dairy cow studies, Cantet et al. (2019) showed that dry matter intake and fat corrected milk production was increased significantly ($P<0.05$) by 0.390kg and 1.028kg respectively due to supplementation of AOM. All these studies were however done with TMR diets.

The effect of AOM on dairy cows grazing pasture has not been well established. More than 70% of dairy cows in South Africa are pasture-based. A study was therefore needed to determine the effect of supplementing AOM to cows grazing kikuyu/ryegrass pasture on milk production. The aim of the study was to determine the effect of AOM on milk production and milk composition of Jersey cows grazing kikuyu/ryegrass pasture in spring.

Materials and methods

The study was conducted during spring 2021 on the Outeniqua Research Farm, situated in the Western Cape province of South Africa (22º 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 kikuyu/ ryegrass pasture with a permanent irrigation system was used. Perennial ryegrass (*Lolium multiflorum*) cv. 24 Seven was planted at 20kg/ha in March 2021into kikuyu. The study took place from 9 September to 9 November 2021. 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. Forty Jersey cows from the Outeniqua Research Farm were used in a randomized block design with two treatments. The cows were blocked according to milk production (of the previous three weeks), lactation number and days in milk (DIM) and randomly allocated to one of two treatments within each block. Cows were adapted to treatments for 21 days followed by a measurement period of 40 days.

Treatments were:

1. Control dairy concentrate fed at 6kg as fed / cow/day.
2. Concentrate containing AOM fed at 6kg as fed/cow/day. (AOM supplemented at 3g Amaferm/cow/day, 500g AOM/ton of concentrate)

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. Concentrates were placed in different colour coded bags and tagged as Test 3 for control and Test 4 for the AOM 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 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 kikuyu/ryegrass pasture as one group and fresh pasture was allocated at 6 kg DM/cow after each milking. Cows were milked at 06h00 and 14h30 and grazed 24 hours per day (except for milking times) and clean water was provided (ad libitum). Cows were marked with a coloured tag attached to the ear tag indicating the specific treatment.

Pasture samples were collected weekly during the measurement period on Wednesday's 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 days. Pasture samples were dried at 60°C for 72 hours to determine the DM content and pooled for each week. Concentrate

Table 1. Ingredient and nutrient composition of concentrates on DM basis and as mixed per ton on as is basis.

Ingredient	% of DM	Kg /ton as mixed Control	Kg /ton as mixed AOM
Maize	50.0	500.2	500.2
Hominy chop	19.0	196.36	196.36
Wheat bran	8.0	79.2	78.7
Soybean hulls	8.0	77.4	77.4
Soybean oilcake	7.0	68.6	68.6
Molasses	4.0	43.0	43.0
Feed lime	2.45	21.5	21.5
MCP	0.2	1.76	1.76
Salt	0.5	4.39	4.39
MgO	0.25	2.20	2.20
Ureum	0.5	4.39	4.39
AOM*		0	0.50
Premix	0.1	1	1
Nutrient composition	% on DM basis	% on as is basis	% on as is basis
DM (%)	87.4		
CP (%)	13.9	12.1	12.1
ME (MJ/kg)	12.1	10.5	10.5
NDF (%)	18.4	16.0	16.0
Starch (%)	46.0	40.2	40.2
Ca (%)	1.0	0.88	0.88
P (%)	0.41	0.36	0.36
Mg (%)	0.40	0.35	0.35

*AOM= *Aspergillus oryzae* metabolites derived supplement, Amaferm supplemented at 3g/cow/day

samples were taken on Wednesday's 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.

The pasture height before and after grazing was determined by using the rising plate meter (RPM) (Filip's folding plate pasture meter, Jenquip, Rd 5, Fielding, New Zealand). A total of 100 disk meter readings were taken in each pasture strip. Available pasture before grazing was estimated by Y= (103XH)-261 (Y=pasture available kg DM/ha, H= Average pasture height on the RPM). The RPM height should be 20-25 before grazing and 10-12 after grazing. Pasture was allocated at 6-7kg DM/ cow for each grazing. Cows were visited 3 hours after they entered the paddock to determine if pasture allocation was sufficient.

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. Milking systems and management conforms to standard dairy principles and practises. Daily milk production was recorded during each milking with the Afikim milk meter and management system. A composite milk sample (Ratio 8 ml: 16 ml, afternoon: morning milking) (06h00 and 14h30) of each cow was collected every week during the measurement period (4 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).

Results and discussion

Milk production, milk composition, live weight and condition score of cows is shown in Table 2. The 4% fat corrected milk production, milk fat % and milk protein% of cows supplemented with AOM was significantly higher ($P<0.05$) than that of the control. All cows gained live weight during the study and body condition improved. The MUN levels indicate that protein level in the total diet was sufficient.

Milk fat content increased by 0.32%, milk protein by 0.14% and 4% fat corrected milk increased by 1.7 kg/cow/day due to supplementation of AOM.

The average RPM height before and after grazing was 23.7 ± 2.85 and 10.2 ± 1.26 respectively. Pasture available before grazing was 2181kg DM/ha and pasture residue after grazing was 791 kg DM/ha. On average cows removed 1390kg DM of pasture per ha during the study.

The composition of concentrates and pasture is shown in Table 3. The control and AOM concentrates were similar as expected. Pasture quality was high as indicated by the 10.6 MJ ME/kg DM, 18.5% crude protein and 40% 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.

Table 2. The effect of *Aspergillus oryzae* metabolites supplementation (3 g Amaferm/cow/day) on production parameters of Jersey cows supplemented with 6kg of concentrate while grazing ryegrass during spring. (n=20)

Parameter	Control	AOM	SEM	P-value
Milk production kg/cow/day	20.0	20.7	0.36	0.20
FCM production kg/cow/day	22.3^{b}	24.0^{a}	0.42	0.01
Milk fat %	4.77^{b}	5.09^{a}	0.089	0.02
Milk protein %	3.98^{b}	4.12^{a}	0.046	0.04
Milk lactose %	4.65	4.70	0.030	0.20
MUN (mg/dl)	8.12	8.40	0.314	0.53
Somatic cell count (X1000/ml)	169	162	120	0.36
Live weight start (kg)	401	395	6.45	0.50
Live weight end (kg)	424	422	6.54	0.76
Live weight gain (kg)	23.3	26.8	1.68	0.16
Condition score start	2.30	2.38	0.04	0.19
Condition score end	2.48	2.45	0.050	0.73
Condition score change	$+0.18^{a}$	$+0.08^{b}$	0.032	0.04

FCM= 4% fat corrected milk, MUN= Milk urea nitrogen, AOM= *Aspergillus oryzae* metabolites derived supplement fed at 3g Amaferm/cow/day

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	AOM concentrate	Pasture
DM%	91.2 ± 0.41	91.3 ± 0.43	13.0 ± 1.88
Ash %	7.08 ± 0.116	7.17 ± 0.158	12.3 ± 0.84
Crude protein %	11.6 ± 0.27	11.1 ± 0.26	18.5 ± 2.48
ME MJ/kg	12.5 ± 0.04	12.5 ± 0.03	10.6 ± 0.18
NDF %	11.2 ± 0.86	10.9 ± 0.91	40.0 ± 1.80
ADF %	4.86 ± 0.221	4.88 ± 0.163	27.3 ± 2.00
Fat %	2.48 ± 0.074	2.25 ± 0.046	4.38 ± 0.315
Ca %	1.43 ± 0.044	1.54 ± 0.012	0.42 ± 0.017
P %	0.48 ± 0.004	0.45 ± 0.006	0.38 ± 0.050
Mg %	0.41 ± 0.010	0.43 ± 0.009	0.31 ± 0.005
K %	0.94 ± 0.018	0.88 ± 0.014	3.91 ± 0.254
Na ppm	2155 ± 93.0	2162 ± 127.7	4115 ± 1096
Cu ppm	26.2 ± 2.80	27.4 ± 2.34	6.42 ± 1.52
Zn ppm	159 ± 9.4	179 ± 9.7	32.2 ± 5.40
Mn ppm	102 ± 5.3	107 ± 5.4	40.6 ± 12.85
Fe ppm	139 ± 5.3	165 ± 6.5	162 ± 31.3

AOM = *Aspergillus oryzae* metabolites derived supplement, ME= Metabolisable energy, NDF= Neutral detergent fibre, ADF= Acid detergent fibre

The potassium, sodium and iron content of pasture was higher than the nutrient requirement for dairy cows.

Conclusions

Supplementation of *Aspergillus oryzae* metabolite product at 3g Amaferm/cow/day to Jersey cows grazing ryegrass pasture during spring increased 4% fat corrected milk production, milk fat % and milk protein % significantly. Pasture provided inadequate amounts of Cu, Zn and Mn and therefor these micro-minerals were supplemented in the concentrate.

References

Akin, D.E & Borneman, W.S., 1990. Role of Rumen Fungi in Fiber Degradation. Journal Dairy Science, 73:3023-3032.

Akin, D.E. and Rigsby, L.L., 1987. Mixed fungal populations and lignocellulosic tissue degradation in the bovine rumen. Applied and Environmental Microbiology, 53(9).

Arambiel, M.J., Wiedmeier, R.D. and Walters, J.L., 1987. Influence of donor animal adaptation to added yeast culture and/or *Aspergillus oryzae* fermentation extract on in vitro rumen fermentation. Nutrition reports international, 35 (3),433-437.

Cantet, J. M., Palladino, R. A., Ocasio, C., Bargo, F., Ipharraguerre, I. R. 2019. A meta-analysis of the impact of the *Aspergillus oryzae* fermentation product on dairy cow performance. International Symposium on Ruminant physiology, Leizig, Germany. 3-6 Sept 2019.

Caton, J.S., Erickson, D.O., Carey, D.A. and Ulmer, D.L., 1993. Influence of *Aspergillus oryzae* fermentation extract on forage intake, site of digestion, in situ degradability, and duodenal amino acid flow in steers grazing cool-season pasture. Journal of Animal Science, 71(3), 779-787.

Chang, J.S., Harper, E.M. and Calza, R.E., 1999. Fermentation extract effects on the morphology and metabolism of the rumen fungus

Neocallimastix frontalis EB188. Journal of Applied Microbiology, 86(3) 389-398.

Frumholtz, P.P., Newbold, C.J. and Wallace, R.J., 1989. Influence of *Aspergillus oryzae* fermentation extract on the fermentation of a basal ration in the rumen simulation technique (Rusitec). The Journal of Agricultural Science, 113(2),169-172.

Gomez-Alarcon, R.A., Dudas, C. and Huber, J.T., 1990. Influence of cultures of *Aspergillus oryzae* on rumen and total tract digestibility of dietary components. Journal of Dairy Science, 73(3), 703-710.

Gomez-Alarcon, R.A., Huber, J.T., Higginbotham, G.E., Wiersma, F., Ammon, D. and Taylor, B., 1991. Influence of feeding *Aspergillus oryzae* fermentation extract on the milk yields, eating patterns, and body

Weather data: Outeniqua Research Farm 2019 to 2022

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	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	Jun	Jul	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
Min T	16.0	15.8	14.8	10.7	9.3
Max T	26.8	27.1	26.4	21.6	21.2
Mean T	21.4	21.3	20.6	16.1	15.5
RF	18	43	58	59	75

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

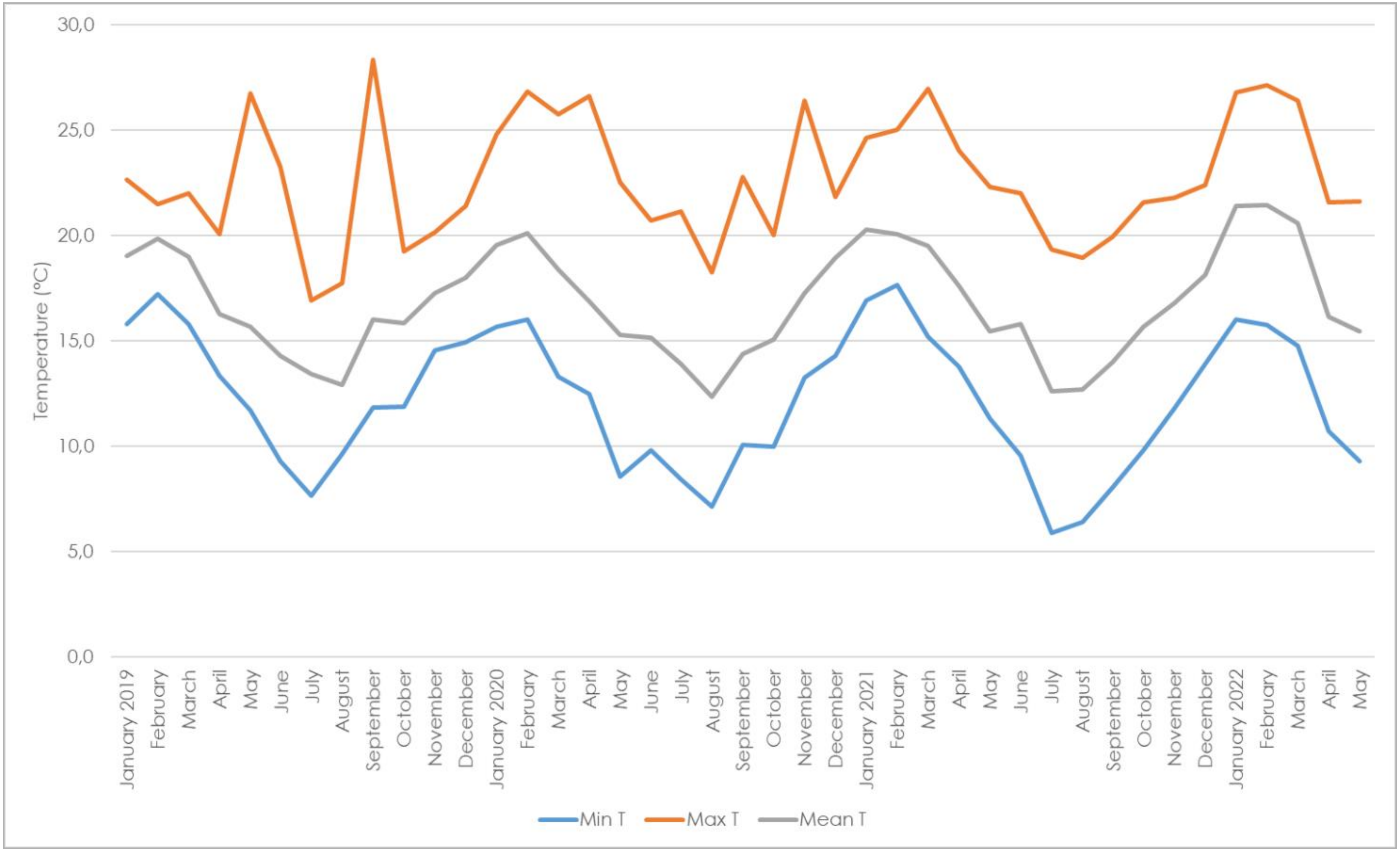

Figure 1. Temperatures recorded on Outeniqua Research Farm for the period January 2019 to May 2022

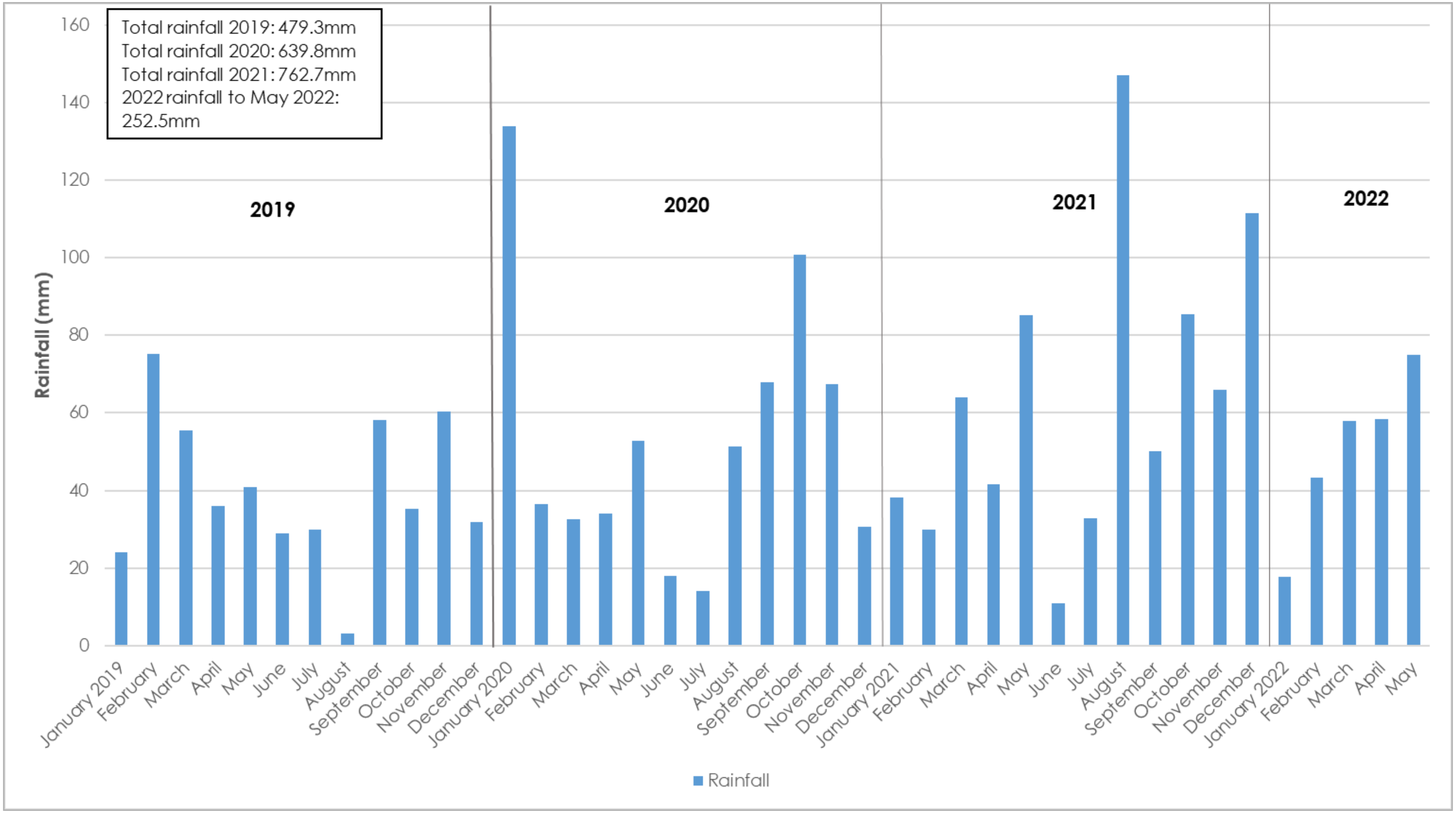

Figure 2. Total monthly rainfall recorded on Outeniqua Research Farm for the period January 2019 to May 2022

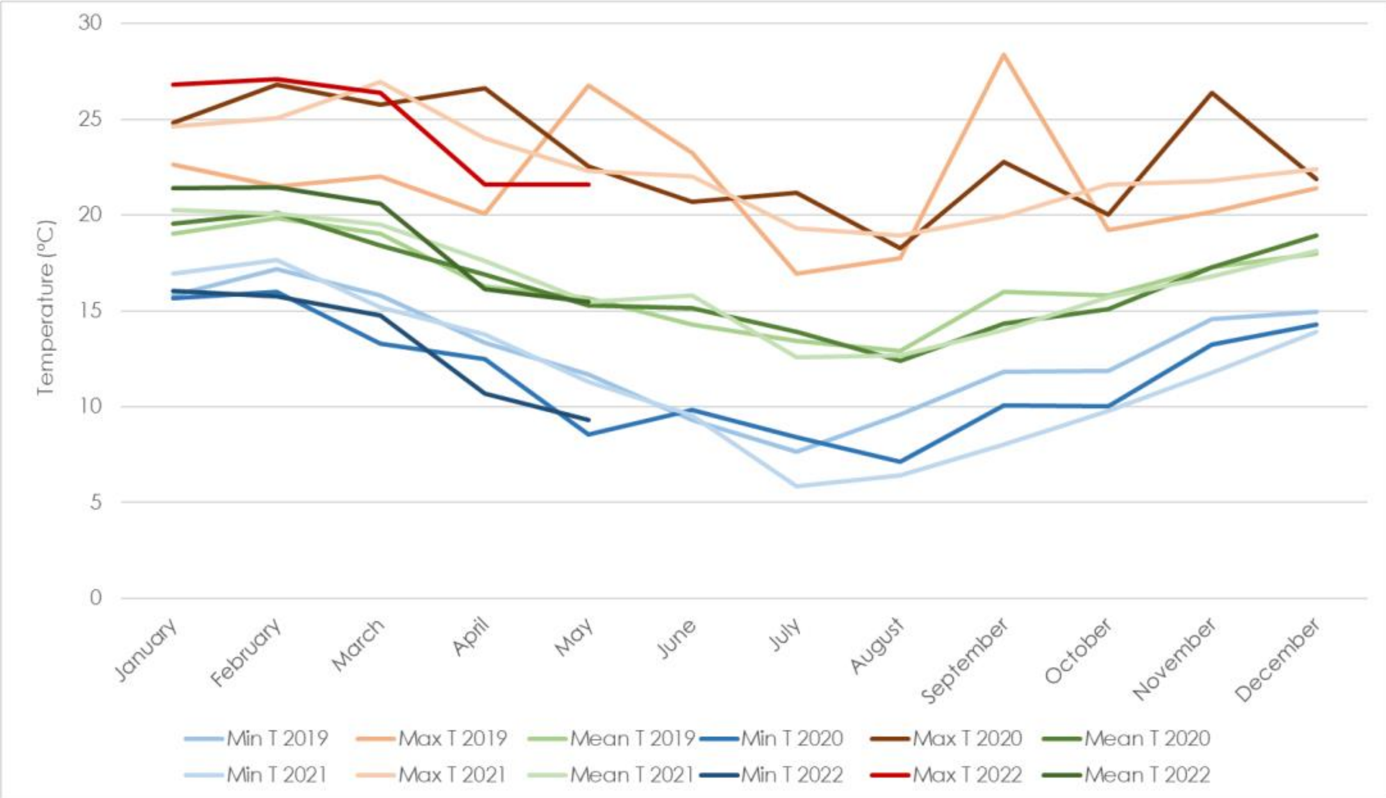

Figure 3. Temperatures recorded on Outeniqua Research Farm for the period January 2019 to May 2022

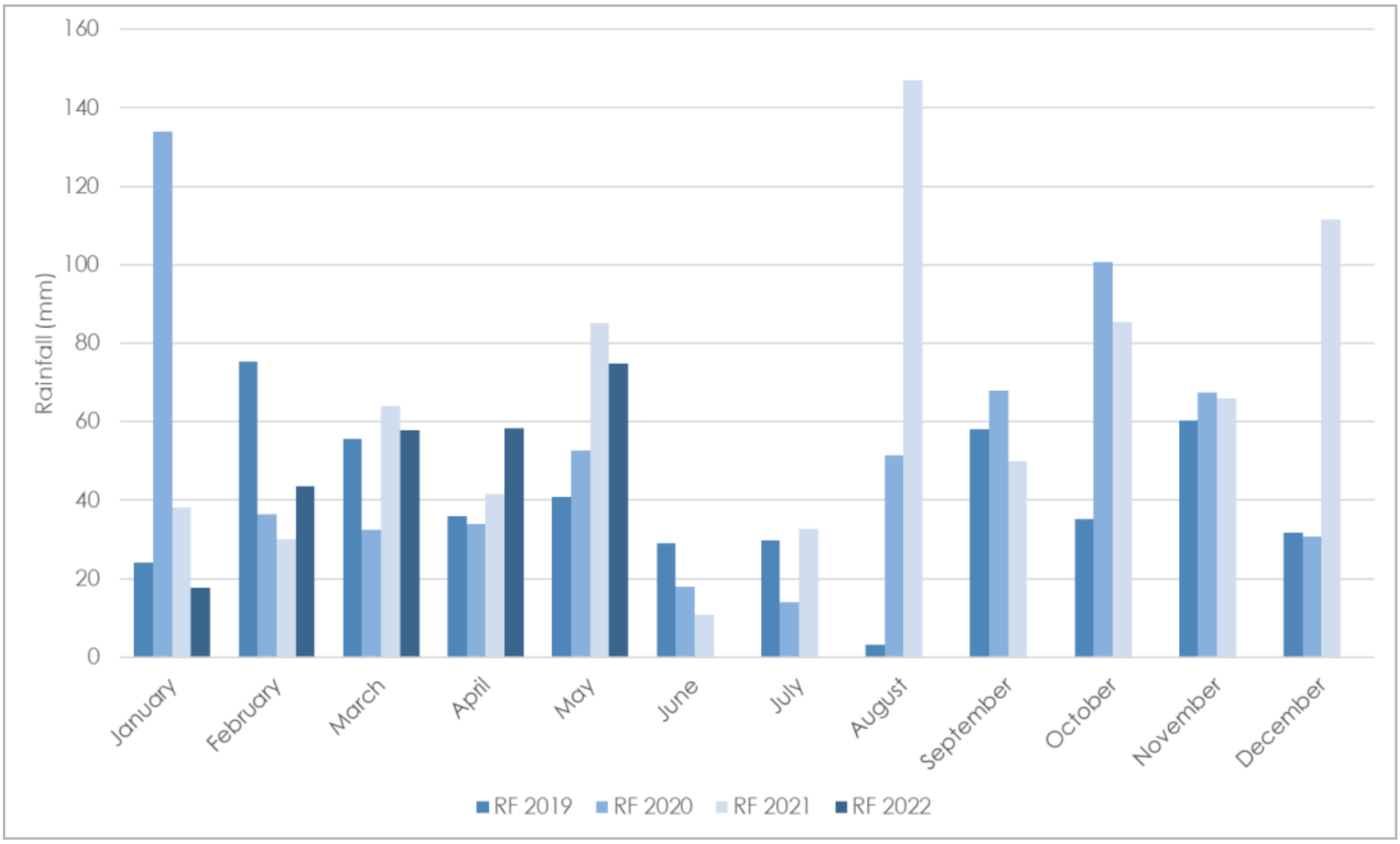

Figure 4. Temperatures recorded on Outeniqua Research Farm for the period January 2019 to May 2022