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Outeniqua Research Farm: Directorates Plant and Animal Sciences

Information Day 2020

Milk production from planted pastures

CONTENTS

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VIRTUAL INFORMATION DAY:

OUTENIQUA RESEARCH FARM
MILK PRODUCTION FROM PLANTED PASTURE

PROGRAMME

Date : 30 September 2020

Virtual information day streamed from Outeniqua Research Farm, George

10 min	**Welcoming and opening**	**Dr Ivan Meyer, Minister of Agriculture Western Cape**
15 min	Cultivar evaluation data for ryegrass (Italian and perennial) and forage herbs up to summer 2019/20	Sigrun Ammann
15 min	Comparing the production potential of perennial ryegrass, tall fescue, chicory and plantain.	Sigrun Ammann
20 min	Preliminary results for farmlet research aimed at the inclusion of forage herbs in pasture systems	Janke van der Colf
10 min	Forage herbs: Practical lessons learnt from farmlets	Janke van der Colf
15 min	Concentrate supplementation to Jersey cows grazing plantain and ryegrass pasture	Zander Pretorius
15 min	Essential oils as a feed additive for Jersey cows grazing ryegrass pasture	Benri van Greunen
10 min	The Outeniqua Jersey herd and upgrades to the dairy parlor	Dr Ivan Meyer and Prof Robin Meeske

To register please send your E-mail to
Janke van der Colf: **JankeVdC@elsenburg.com**

https://www.elsenburg.com

VOORWOORD

Die Outeniqua navorsingspan het na die suksesvolle aanbieding van die Outeniqua inligtingsdag in 2019 hulle navorsing met toewyding voortgesit en die beplanning vir vanjaar se dag begin. Min het ons geweet watter groot uitdaging Suid-Afrika in die gesig sou staar – die COVID-19 pandemie met al die gepaardgaande uitdagings en geleenthede.

Die landbousektor is gekonfronteer met nuwe en amper onverstaanbare en onnatuurlike uitdagings, maar ook het landbou 'n kernrolspeler geraak in die bekamping van hierdie virus met voedsel ondersteuning in areas waar voedselnood so groot was. En hiervoor bedank ons u opreg!

Ons eie twee navorsingsmelkerye het deelgeneem aan "Projek Een" van die MPO en het melk (en melkprodukte) ter waarde van R100 000, via ons melkprosesseerders Nestlé en Lactalis, aan twee nie-regeringsorganisasies in George en Kaapstad, geskenk.

In hierdie COVID tyd het die navorsing egter nie stilgestaan nie en die werk is voortgesit, alhoewel onder "vreemde" omstandighede wat sosiale distansieëring en ander reëls ingesluit het. Die aanbied van inligtingsdae in die "ou" formaat was nie moontlik nie en die span het met 'n nuwe, vars en innnoverende aanslag gekom en met interne tegnologie en kapasiteit is virtuele inligtingsdae beplan en aangebied.

Die virtuele Outeniqua inligtingsdag, een van ons vlagskip tegnologie-oordrag geleenthede, is die vyfde van sy soort wat onder COVID omstandighede aangebied word en ons hoop dat ons nuwe aanslag en tegnologie u ook sal inspireer tot nuwe hoogtes – waar daar 'n wil is, is daar 'n weg, en ons sal met ons produsente en ander rolspelers kommunikeer oor die jongste navorsingsinligting al beteken dit alternatiewe metodes en benaderings.

Ons bring vanjaar weer vars en innoverende navorsingsoplossings ten opsigte van weiding- en melkproduksie uitdagings en hoop ons navorsing kan u eie onderneming ook tot groter hoogtes en volhoubaarheid neem.

Ons weiding- en suiwelnavorsingspan is van die bestes in die land, en ons nuwe generasie navorsers en navorsingstegnici word ook op Outeniqua opgelei om te verseker dat die navorsingsprogramme met die nodige kundigheid voortgesit kan word tot voordeel van die suiwelbedryf in die Suid-Kaap.

Geniet die virtuele dag saam met ons!

Dr. Ilse Trautmann

HOOFDIREKTEUR: NAVORSING EN TEGNOLOGIE ONTWIKKELING, DEPARTEMENT LANDBOU WES -KAAP

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Italian and hybrid ryegrass cultivar evaluation results for 2019

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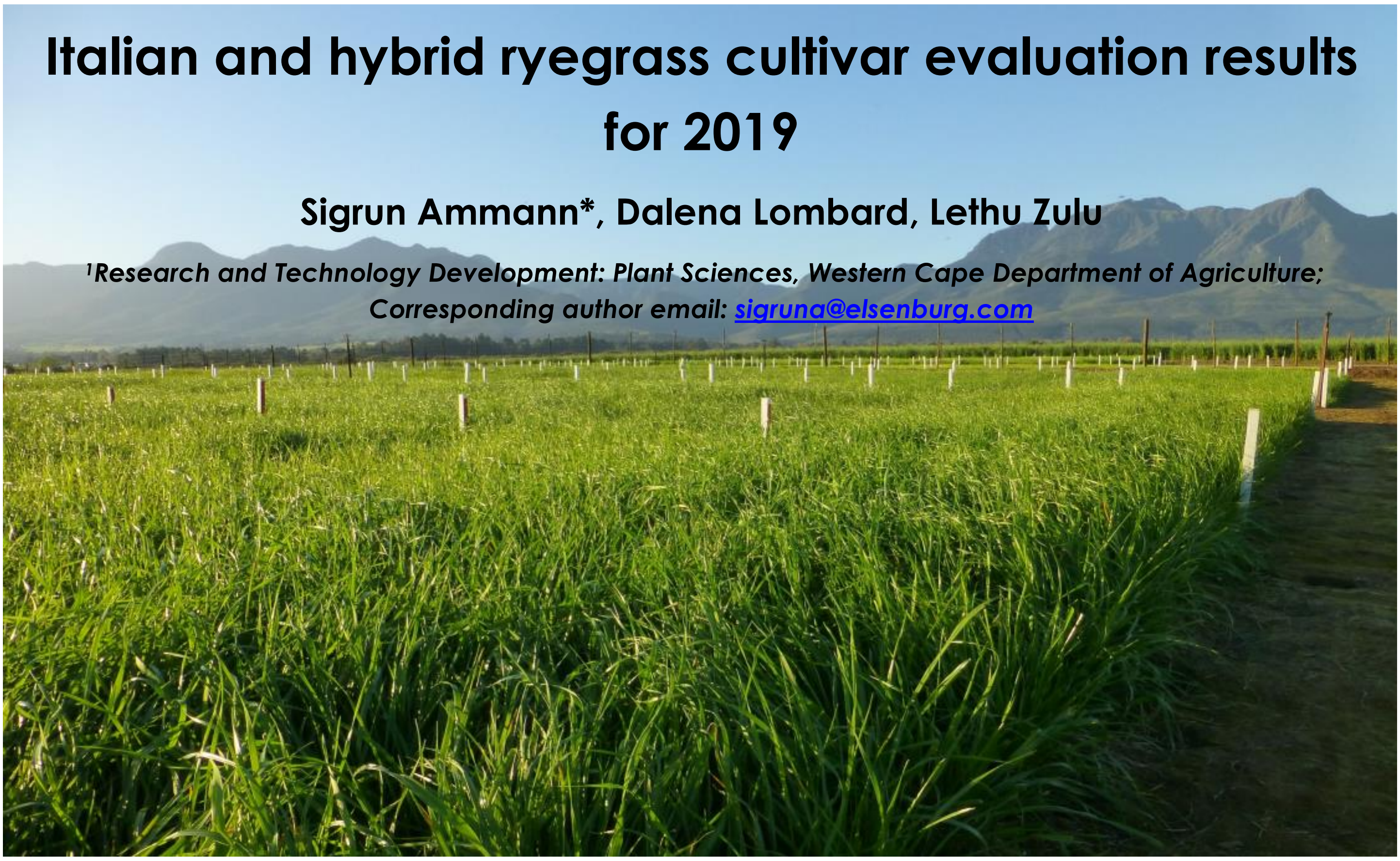

Introduction

The Italian and hybrid ryegrass (*Lolium multiflorum* and *L. hybridum*) elite cultivar evaluation trial for 2019 was planted on 14 March 2019 at the Outeniqua Research Farm. The aim of the trial is to evaluate the recent Italian and hybrid 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 application. Preferably the cultivars evaluated in this trial should be ones that persist for at least a 12-month period. Since most ryegrass cultivars are imported, this data provides insight into the genetic potential and adaption for the southern Cape region. This data is specific for 2019 but the best cultivars are evaluated in successive trials. For previous data refer to the Outeniqua Information Day booklets for 2018 and 2019.

Cultivars evaluated

The trial consisted of 26 cultivars of which 20 are Italian and six are hybrid ryegrass. Of the Italian cultivars 12 are diploid and eight are tetraploid, while the hybrid cultivars are one diploid and five tetraploid.

- ***Italian diploid***: Awesome, Belluci, Bond, Charger, Davinci, Icon, Podium, Sukari, Surge, Tabu+, Vibe, Yolande
- ***Italian tetraploid***: Barmultra II, Cazzano, Elvis, Goldini, Itarzi, Turgo, Udine, Zorro
- ***Hybrid diploid***: Barsenna
- ***Hybrid tetraploid***: Bison 2, Fortimo, Lampard, Scapino, Shogun

Parameters reported in this article

- Total DM yield
- Seasonal DM yield
- DM content
- Flowering behaviour (autumn and spring)
- 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 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.

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. 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.

Individual harvest yields and ***growth rates*** are given in **Table 2 and 3.**

Dry matter (DM) content **(Table 4)** 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.

Flowering behaviour **(Table 5)** is important since it results in a higher stem component which implies a higher fibre content and thus lower nutritive value. The percentage of the sward that is reproductive varies significantly between cultivars as does the duration of reproductive tillers in the sward. 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.

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

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. In **Table 7** the flowering results are given from a spring-planted assessment. Preferably cultivars with a flowering incidence of less than 5% can be considered for spring-planting. Since this was only a flowering assessment, there is no yield data for a spring-planting.

Table 1: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Lm 9, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2019 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid, I = Italian, H = Hybrid

Cultivars	Type	Autumn 2019	Rank	Winter 2019	Rank	Spring 2019	Rank	Summer 2019	Rank	Total Year 1	Rank
Awesome	DI	**3.69** abcde	12	2.46 bcdefgh	15	3.76 efg	20	1.88 cde	22	11.79 fg	21
Barmultra II	TI	3.56 bcde	19	2.60 bcdefgh	13	**4.85** ab	2	**2.91** ab	6	**13.91** abcde	7
Barsenna	DH	**3.90** abcd	5	2.75 bcdef	10	3.42 gh	24	**2.85** ab	8	12.92 cdef	14
Belluci	DI	**4.16** a	1	**3.03** abc	3	**4.80** ab	5	**2.85** ab	7	**14.84** a	1
Bison 2	TH	**3.85** abcde	8	2.22 defgh	20	1.71 i	26	0		7.78 i	26
Bond	DI	**3.91** abcd	4	**3.13** ab	2	**4.79** ab	6	**2.93** ab	5	**14.77** ab	2
Cazzano	TI	3.47 cdef	20	2.59 bcdefgh	14	**4.77** ab	7	**2.33** abcd	16	13.16 bcdef	12
Charger	DI	**3.65** abcde	14	2.20 defgh	21	3.01 h	25	0.38 f	25	9.25 h	25
Davinci	DI	3.08 f	24	2.05 fgh	24	4.10 cde	17	**2.54** abc	13	11.76 fg	22
Elvis	TI	**3.75** abcde	10	2.70 bcdefg	11	**4.82** ab	4	**2.69** abc	11	**13.97** abcde	6
Fortimo	TH	3.02 f	25	2.01 gh	25	4.10 cde	16	**2.59** abc	12	11.71 fg	23
Goldini	TI	**3.68** abcde	13	2.37 cdefgh	19	4.61 bc	10	1.95 cde	20	12.62 def	17
Icon	DI	**3.73** abcde	11	2.42 bcdefgh	17	**4.63** abc	9	**3.10** a	1	**13.87** abcde	8
Itarzi	TI	3.64 bcde	16	2.38 cdefgh	18	**5.20** a	1	**3.07** a	2	**14.29** abc	4
Lampard	TH	3.38 ef	23	2.14 efgh	23	3.63 efg	21	**2.71** abc	9	11.83 fg	20
Podium	DI	**3.86** abcde	7	**2.84** abcde	8	3.82 efg	19	2.13 bcde	18	12.66 def	16
Scapino	TH	3.58 bcde	18	1.92 h	26	**4.84** ab	3	**2.97** ab	3	**13.32** abcdef	10
Shogun	TH	3.64 bcde	15	**2.99** abc	4	4.51 bcd	14	**2.95** ab	4	**14.09** abcd	5
Sukari	DI	**4.16** a	1	**3.48** a	1	4.59 bcd	11	**2.46** abc	15	**14.68** ab	3
Surge	DI	**4.01** ab	2	**2.96** abc	5	3.53 fgh	22	1.92 cde	21	12.42 efg	18
Tabu+	DI	**3.77** abcde	9	**2.86** abcd	7	4.40 bcd	15	1.96 cde	19	13.0 cdef	13
Turgo	TI	3.37 ef	22	2.17 defgh	22	4.04 def	18	1.40 e	24	10.97 g	24
Udine	TI	3.42 def	21	2.60 bcdefgh	12	4.54 bcd	13	**2.70** abc	10	**13.27** abcdef	11
Vibe	DI	**3.94** abc	3	2.43 bcdefgh	16	3.50 fgh	23	**2.26** abcd	17	12.14 fg	19
Yolande	DI	**3.89** abcd	6	**2.84** abcde	9	4.58 bcd	12	**2.48** abc	14	**13.80** abcde	9
Zorro	TI	3.60 bcde	17	**2.88** abcd	6	**4.76** ab	8	1.53 de	23	12.77 cdef	15
LSD (0.05)		0.42		0.60		0.49		0.70		1.37	
CV %		6.99		14.1		7.09		17.9		6.53	

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

Table 2: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Lm 9, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2019 **Yield** (t DM/ha) **Individual harvests**

Cultivars	Type	Cut 1 6/5/2019	Cut 2 4/6/2019	Cut 3 11/7/2019	Cut 4 22/8/2019	Cut 5 25/9/2019	Cut 6 24/10/2019	Cut 7 25/11/2019	Cut 8 2/1/2020	Cut 9 30/1/2020	Cut 10 26/2/2020
Awesome	DI	**1.44** ab	1.41 bcd	1.18 bcdef	1.71 bcdef	1.52 def	1.22 ijk	1.26 efghij	**1.29** ab	0.53 ij	0.24 ghi
Barmultra II	TI	1.02 de	**1.63** abc	1.29 bcde	1.76 bcdef	1.71 bcde	**1.81** abc	**1.64** abc	**1.14** abc	**0.95** abcdef	**0.97** ab
Barsenna	DH	**1.26** abcde	**1.67** ab	**1.38** abc	**1.94** abcde	1.51 def	1.04 kl	1.12 hij	**1.18** abc	**1.01** abcd	**0.82** abcde
Belluci	DI	**1.52** a	**1.63** abcd	**1.44** ab	**2.09** abc	**1.94** abc	**1.75** abcd	**1.48** abcdef	**1.13** abc	**1.10** ab	**0.76** abcdef
Bison 2	TH	**1.35** abcde	**1.65** ab	1.23 bcdef	1.57 cdef	1.07 g	0.55 m	0.37 k	0	0	0
Bond	DI	**1.39** abcd	**1.51** abcd	**1.44** ab	**2.19** ab	**1.96** abc	1.72 bcde	**1.48** abcdef	**1.20** abc	**0.94** abcdef	**0.95** abc
Cazzano	TI	**1.15** abcde	**1.53** abcd	1.13 bcdef	1.76 bcdef	**1.85** abcd	1.66 bcdef	**1.59** abcd	**1.26** ab	0.69 efghi	0.54 cdefg
Charger	DI	**1.43** ab	**1.52** abcd	1.01 def	1.55 cdef	1.34 efg	0.90 l	1.07 j	0.44 d	0	0
Davinci	DI	1.02 de	1.36 cd	0.99 def	1.36 ef	1.48 def	1.62 cdefgh	1.25 efghij	**1.04** abc	0.77 defghi	**0.86** abcd
Elvis	TI	**1.20** abcde	**1.70** a	1.22 bcdef	**1.86** abcde	**1.82** abcd	**1.76** abcd	**1.55** abcde	**1.32** ab	**0.89** abcdef	**0.66** abcdef
Fortimo	TH	1.04 cde	1.35 d	0.88 f	1.36 ef	1.48 def	1.53 cdefgh	1.36 cdefghij	0.98 bc	**0.85** abcdefg	**0.89** abcd
Goldini	TI	**1.30** abcde	**1.60** abcd	1.12 bcdef	1.60 bcdef	1.67 bcde	**1.92** ab	1.32 defghij	**1.10** abc	0.61 ghij	0.39 fghi
Icon	DI	**1.43** ab	**1.59** abcd	1.01 def	1.63 bcdef	**1.84** abcd	1.63 bcdefg	**1.49** abcde	**1.18** abc	**1.07** abc	**1.00** ab
Itarzi	TI	**1.21** abcde	**1.68** ab	1.08 bcdef	1.60 bcdef	**1.75** abcd	**2.02** a	**1.74** ab	**1.16** abc	**1.04** abcd	**1.02** a
Lampard	TH	0.98 e	**1.60** abcd	1.10 bcdef	1.48 def	1.25 fg	1.42 efghij	1.17 fghij	0.96 bc	**0.97** abcde	**0.90** abcd
Podium	DI	**1.23** abcde	**1.68** ab	**1.34** abcd	**2.00** abcd	1.67 bcde	1.32 hij	1.14 ghij	**1.04** abc	0.71 efghi	0.52 defgh
Scapino	TH	1.13 bcde	**1.72** a	1.04 cdef	1.20 f	1.55 cdef	**1.78** abc	**1.77** a	**1.18** abc	**0.94** abcdef	**1.00** ab
Shogun	TH	**1.19** abcde	**1.61** abcd	1.21 bcdef	**2.15** abc	**1.80** abcd	1.38 fghij	**1.65** abc	**1.21** abc	**1.12** a	**0.78** abcdef
Sukari	DI	**1.27** abcde	**1.72** a	**1.66** a	**2.44** a	**2.07** ab	1.34 ghij	**1.54** abcde	**1.47** a	0.80 cdefghi	0.38 fghi
Surge	DI	**1.49** ab	**1.51** abcd	**1.43** ab	**2.11** abc	1.60 cdef	0.98 kl	1.25 efghij	0.99 bc	0.66 fghij	0.40 fghi
Tabu+	DI	**1.16** abcde	**1.66** ab	**1.35** abcd	**1.97** abcd	**1.88** abcd	1.47 defghi	1.41 cdefghi	**1.12** abc	0.54 hij	0.44 efghi
Turgo	TI	**1.20** abcde	**1.48** abcd	0.98 ef	1.48 def	1.50 def	1.53 cdefgh	1.30 defghij	0.81 c	0.57 ghij	0.12 i
Udine	TI	1.02 de	**1.51** abcd	1.26 bcde	1.75 bcdef	**1.79** abcd	1.65 bcdef	1.43 bcdefgh	**1.06** abc	**0.94** abcdef	**0.84** abcde
Vibe	DI	**1.42** abc	**1.65** ab	1.25 bcde	1.67 bcdef	1.47 def	1.18 jk	1.10 ij	**1.09** abc	0.72 efghi	0.59 bcdefg
Yolande	DI	**1.24** abcde	**1.67** ab	**1.40** ab	**1.91** abcde	**1.94** abc	1.66 bcdef	1.37 cdefghij	0.98 bc	0.82 bcdefgh	**0.82** abcde
Zorro	TI	**1.17** abcde	**1.61** abcd	1.17 bcdef	**1.97** abcd	**2.14** a	1.59 cdefgh	1.44 bcdefg	**1.12** abc	0.41 j	0.14 hi
LSD (0.05)		0.31	0.23	0.30	0.50	0.34	0.25	0.27	0.36	0.24	0.34
CV %		15.2	8.84	15.1	17.0	12.4	10.5	11.9	20.0	17.9	31.2

Note: treatments with the same letter are similar i.e. not significantly different. D = Diploid, T = Tetraploid, I = Italian, H = Hybrid

Table 3: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Lm 9, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2019 **Growth rate** (kg DM/day/ha)

Cultivars	Type	Cut 1 6/5/2019	Cut 2 4/6/2019	Cut 3 11/7/2019	Cut 4 22/8/2019	Cut 5 25/9/2019	Cut 6 24/10/2019	Cut 7 25/11/2019	Cut 8 2/1/2020	Cut 9 30/1/2020	Cut 10 26/2/2020
Awesome	DI	**27.2** ab	48.7 bcd	32.0 bcdef	40.7 bcdef	44.7 def	41.9 ijk	39.3 efghi	**34.0** ab	18.9 ij	8.8 ghi
Barmultra II	TI	19.3 de	**56.3** abc	34.7 bcde	42.0 bcdef	50.3 bcde	**62.3** abc	**51.1** abc	**30.1** abc	**33.8** abcdef	**35.8** ab
Barsenna	DH	**23.8** abcde	**57.5** ab	**37.4** abc	**46.3** abcde	44.3 def	35.8 kl	35.1 hij	**30.9** abc	**36.0** abcd	**30.2** abcde
Belluci	DI	**28.7** a	**56.1** abcd	**38.9** ab	**49.7** abc	**56.9** abc	**60.5** abcd	**46.2** abcdef	**29.8** abc	**39.4** ab	**28.3** abcdef
Bison 2	TH	**25.4** abcde	**56.7** ab	33.2 bcdef	37.3 cdef	31.5 g	19.1 m	11.7 k	0	0	0
Bond	DI	**26.3** abcd	**52.1** abcd	**38.8** ab	**52.1** ab	**57.6** abc	59.3 bcde	**46.2** abcdef	**31.7** abc	**33.7** abcdef	**35.1** abc
Cazzano	TI	**21.7** abcde	**52.7** abcd	30.6 bcdef	42.0 bcdef	**54.4** abcd	57.2 bcdef	**49.7** abcd	**33.2** ab	24.7 efghj	20.0 cdefg
Charger	DI	**26.9** ab	**52.4** abcd	27.2 def	36.9 cdef	39.3 efg	31.0 l	33.3 j	11.6 d	0	0
Davinci	DI	19.3 de	46.9 cd	26.8 def	32.4 ef	43.5 def	55.8 cdefgh	39.2 efghij	**27.4** abc	27.5 efghi	**32.0** abcd
Elvis	TI	**22.6** abcde	**58.6** a	32.9 bcdef	**44.2** abcde	**53.4** abcd	**60.8** abcd	**48.4** abcde	**34.6** ab	**31.8** abcdef	**24.4** abcdef
Fortimo	TH	19.7 cde	46.7 d	23.9 f	32.4 ef	43.5 def	52.6 cdefgh	42.4 cdefghij	25.7 bc	**30.3** abcdefg	**32.9** abcd
Goldini	TI	**24.5** abcde	**55.2** abcd	30.3 bcdef	38.0 bcdef	49.2 bcde	**66.4** ab	41.1 defghij	**28.9** abc	21.6 ghij	14.4 fghi
Icon	DI	**27.0** ab	**54.7** abcd	27.3 def	38.8 bcdef	**54.2** abcd	56.4 bcdefg	**46.5** abcde	**31.0** abc	**38.3** abc	**37.0** ab
Itarzi	TI	**22.8** abcde	**57.8** ab	29.1 bcdef	38.1 bcdef	**51.5** abcd	**69.7** a	**54.3** ab	**30.5** abc	**37.3** abcd	**37.8** a
Lampard	TH	18.6 e	**55.3** abcd	29.7 bcdef	35.3 def	36.6 fg	48.9 efghij	36.5 fghij	25.2 bc	**34.7** abcde	**33.4** abcd
Podium	DI	**23.3** abcde	**58.0** ab	**36.3** abcd	**47.7** abcd	49.0 bcde	45.6 hij	35.6 ghij	**27.5** abc	25.2 efghi	19.2 defgh
Scapino	TH	21.4 bcde	**59.3** a	28.0 cdef	28.7 f	45.6 cdef	**61.2** abc	**55.4** a	**31.1** abc	**33.5** abcdef	**37.2** ab
Shogun	TH	**22.4** abcde	**55.4** abcd	32.6 bcdef	**51.3** abc	**52.9** abcd	47.7 fghij	**51.5** abc	**31.9** abc	**39.9** a	**29.0** abcdef
Sukari	DI	**23.9** abcde	**59.4** a	**44.8** a	**58.1** a	**60.8** ab	46.3 ghij	**48.0** abcde	**38.7** a	28.6 cdefghi	14.1 fghi
Surge	DI	**28.2** ab	**52.2** abcd	**38.5** ab	**50.2** abc	47.0 cdef	33.6 kl	39.1 efghij	26.1 bc	23.6 fghij	14.9 fghi
Tabu+	DI	**21.8** abcde	**57.3** ab	**36.5** abcd	**46.8** abcd	**55.2** abcd	50.6 defghi	43.9 cdefgh	**29.8** abc	19.1 ij	16.4 efghi
Turgo	TI	**22.6** abcde	**51.0** abcd	26.4 ef	35.2 def	44.1 def	52.9 cdefgh	40.5 defghij	21.4 c	20.4 ghij	4.3 i
Udine	TI	19.3 de	**52.2** abcd	34.1 bcde	41.7 bcdef	**52.7** abcd	56.9 bcdef	44.8 bcdefgh	**27.9** abc	**33.6** abcdef	**31.0** abcde
Vibe	DI	**26.8** abc	**56.8** ab	33.8 bcde	39.8bcdef	43.4 def	40.6 jk	34.4 ij	**28.7** abc	25.5 efghi	22.0 bcdef
Yolande	DI	**23.4** abcde	**57.5** ab	**37.9** ab	**45.5** abcde	**57.2** abc	57.3 bcdef	42.7 cdefghij	25.8 bc	29.2 bcdefg	**30.3** abcde
Zorro	TI	**22.2** abcde	**55.3** abcd	31.8 bcdef	**46.9** abcd	**63.0** a	54.9 cdefgh	45.1 bcdef	**29.6** abc	14.8 j	5.0 hi
LSD (0.05)		5.85	7.93	8.10	11.80	10.01	8.80	8.30	9.52	8.60	12.70
CV %		15.2	8.84	15.1	17.0	12.4	10.5	11.9	20.0	17.9	31.2

Note: treatments with the same letter are similar i.e. not significantly different. D = Diploid, T = Tetraploid, I = Italian, H = Hybrid

Table 4: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Lm 9, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2019 **DM content** (%)

Cultivars	Type	Cut 1 6/5/2019	Cut 2 4/6/2019	Cut 3 11/7/2019	Cut 4 22/8/2019	Cut 5 25/9/2019	Cut 6 24/10/2019	Cut 7* 25/11/2019	Cut 8 ** 2/1/2020	Cut 9 30/1/2020	Cut 10 26/2/2020
Awesome	DI	11.3 bcd	9.4 ef	**12.6** abc	**20.8** abcdef	18.9 bcdef	**19.7** abcdef	**25.0** abc	**29.0** abcde	18.9 bcdefg	**18.3** abcde
Barmultra II	TI	**12.2** abcd	9.7 cdef	**12.3** abc	18.9 defg	17.8 defg	17.8 de	22.2 ef	27.1 cdef	17.8 efg	16.8 de
Barsenna	DH	**12.0** abcd	**10.1** abcde	**13.2** ab	**21.1** abc	19.9 b	**20.6** abc	**25.2** ab	**28.1** abcde	19.0 bcdefg	**18.8** abc
Belluci	DI	**12.7** ab	**10.1** abcde	**12.8** abc	**19.9** abcdefg	19.2 bcde	**19.4** abcde	**24.3** abcd	**27.9** abcde	**20.3** abc	**18.9** abc
Bison 2	TH	11.0 bcd	9.2 f	**12.6** abc	19.5 bcdefg	18.5 bcdefg	**19.7** abcde	23.3 de	-	-	-
Bond	DI	**11.8** abcd	**10.0** abcdef	**13.0** abc	**20.4** abcdefg	19.0 bcdef	19.2 bcde	**24.2** abcd	**28.3** abcde	**20.1** abcd	**18.9** abc
Cazzano	TI	11.1 bcd	**9.8** abcdef	**13.2** ab	**20.4** abcdefg	17.6 efg	19.0 bcde	21.6 f	27.2 bcdef	17.4 fg	17.3 cde
Charger	DI	11.3 bcd	9.7 cdef	**13.2** abc	**21.8** a	19.9 b	**20.3** abc	**25.2** ab	23.9 f	-	-
Davinci	DI	**11.8** abcd	**10.5** ab	**13.8** a	**21.2** abc	19.7 bc	**20.5** abc	**25.4** a	**29.4** abcde	**19.4** abcdef	**18.6** abcd
Elvis	TI	**12.2** abcd	9.4 ef	**12.4** abc	19.3 bcdefg	17.8 defg	**19.4** abcde	22.6 ef	**27.9** abcde	17.3 g	17.7 bcde
Fortimo	TH	**11.9** abcd	**10.3** abcd	**13.7** a	19.3 bcdefg	18.5 bcdefg	18.9 cde	**24.6** abcd	**30.3** abc	19.1 bcdefg	**18.6** abcd
Goldini	TI	11.1 bcd	9.8 bcdef	**12.7** abc	18.7 fg	17.4 fg	17.8 de	22.2 ef	**31.2** ab	18.9 bcdefg	17.9 bcde
Icon	DI	**11.8** abcd	**10.2** abcde	**13.9** a	**21.3** ab	19.5 bcd	**20.3** abc	23.6 bcde	**28.3** abcde	18.1 efg	17.4 cde
Itarzi	TI	11.0 bcd	9.6 def	**13.1** abc	19.4 bcdefg	17.6 efg	17.5 e	22.5 ef	27.2 bcdef	17.7 efg	16.5 e
Lampard	TH	**12.3** abcd	**9.9** abcdef	**13.1** abc	**20.5** abcdefg	19.0 bcdef	**21.3** ab	**24.6** abcd	**30.7** abc	**19.2** abcdef	**18.7** abc
Podium	DI	**12.5** abc	**10.4** abc	**13.1** abc	**20.8** abcde	19.2 bcde	**20.9** abc	**25.1** ab	**30.8** abc	**20.1** abcd	**19.9** a
Scapino	TH	11.4 bcd	**10.1** abcde	**13.6** a	18.9 defg	17.6 efg	19.2 bcde	22.4 ef	**30.2** abc	18.4 cdefg	17.8 bcde
Shogun	TH	11.2 bcd	9.5 ef	11.6 bc	19.4 bcdefg	18.3 bcdefg	**19.3** abcde	**24.4** abcd	25.9 ef	**19.1** abcdefg	17.3 cde
Sukari	DI	**12.2** abcd	**10.6** a	**13.0** abc	**22.0** a	**21.5** a	**21.6** a	**25.7** a	**29.5** abcde	**20.2** abcd	**19.2** abc
Surge	DI	**13.3** a	9.5 ef	11.2 c	18.4 g	18.2 bcdefg	17.7 de	**24.6** abcd	**30.3** abc	**19.5** abcde	**18.2** abcde
Tabu+	DI	10.7 cd	**9.9** abcdef	**12.2** abc	19.1 cdefg	18.0 cdefg	**20.0** abcd	23.5 cde	**29.9** abcd	**19.7** abcde	**18.7** abcd
Turgo	TI	**11.6** abcd	**9.8** abcdef	**13.3** ab	**20.8** abcde	19.3 bcde	**20.3** abc	**25.2** a	**30.7** abc	18.0 efg	17.9 bcde
Udine	TI	**11.5** abcd	9.5 ef	**12.0** abc	18.6 g	17.0 g	18.8 cde	22.5 ef	26.1 def	18.3 defg	17.8 bcde
Vibe	DI	10.8 cd	9.2 f	**11.9** abc	**20.1** abcdefg	19.2 bcde	**20.4** abc	**25.7** a	**31.4** a	**21.0** a	**19.4** ab
Yolande	DI	**11.9** abcd	**10.0** abcde	**12.9** abc	**21.0** abcd	19.3 bcde	**19.9** abcd	**25.1** ab	**29.4** abcde	**20.6** ab	**18.4** abcde
Zorro	TI	10.7 d	**10.0** abcdef	**12.8** abc	18.7 efg	17.1 g	18.8 cde	23.1 def	**27.6** abcdef	19.0 bcdefg	**18.4** abcde
LSD (0.05)		1.45	0.64	1.64	1.77	1.48	1.93	1.35	3.28	1.62	1.58
CV %		7.59	3.97	7.81	5.38	4.82	6.04	3.43	6.96	5.18	5.28

Note: treatments with the same letter are similar i.e. not significantly different. D = Diploid, T = Tetraploid, I = Italian, H = Hybrid
* harvested prior to weekly irrigation. **harvested at 3.75-leaf stage.

Table 5: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Lm 9, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2019 **Reproductive tillers (Bolting)** (%, rating based)

Cultivars	Type	Cut 1 6/5/2019	Cut 2 4/6/2019	Cut 3 11/7/2019	Cut 4 22/8/2019	Cut 5 25/9/2019	Cut 6 24/10/2019	Cut 7 25/11/2019	Cut 8 2/1/2020	Cut 9 30/1/2020	Cut 10 26/2/2020
Awesome	DI	0	0	0	13	**71**	**63**	**75**	**88**	8	0
Barmultra II	TI	0	0	0	8	**63**	**79**	**75**	**25**	4	0
Barsenna	DH	0	0	0	4	**38**	**25**	13	13	0	0
Belluci	DI	0	0	0	17	**38**	**42**	13	4	0	0
Bison 2	TH	0	0	0	**88**	**96**	**96**	**100**	-	-	-
Bond	DI	0	0	0	8	**33**	**46**	8	21	0	0
Cazzano	TI	0	0	0	0	**33**	**63**	**71**	**71**	17	0
Charger	DI	0	0	0	25	**75**	**71**	**88**	**92**	-	-
Davinci	DI	0	0	0	0	13	**38**	21	**29**	4	0
Elvis	TI	0	0	0	0	**29**	**54**	**67**	**63**	17	0
Fortimo	TH	0	0	0	0	8	**38**	**42**	**29**	8	0
Goldini	TI	0	0	0	0	17	**79**	**67**	**42**	0	0
Icon	DI	0	0	0	0	21	**33**	21	17	4	0
Itarzi	TI	0	0	0	0	21	**71**	**58**	21	0	0
Lampard	TH	0	0	0	0	0	13	8	13	0	0
Podium	DI	0	0	0	8	**54**	**46**	**33**	**33**	0	0
Scapino	TH	0	0	0	0	4	**33**	**46**	**25**	0	0
Shogun	TH	0	0	0	0	**58**	**29**	**33**	8	0	0
Sukari	DI	0	0	0	21	**83**	**75**	**83**	**88**	13	0
Surge	DI	0	0	0	0	4	13	8	13	0	0
Tabu+	DI	0	0	0	8	**50**	**50**	**67**	**79**	13	0
Turgo	TI	0	0	0	0	21	**50**	**54**	21	0	0
Udine	TI	0	0	0	0	**42**	**58**	**33**	21	0	0
Vibe	DI	0	0	0	0	0	8	0	21	0	0
Yolande	DI	0	0	0	0	**29**	**29**	17	13	0	0
Zorro	TI	0	0	0	0	**38**	**67**	**79**	**67**	13	0

Table 6: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Lm 9, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2019 **Sward density** (%, rating based)

Cultivars	Type	Cut 1 6/5/2019	Cut 2 4/6/2019	Cut 3 11/7/2019	Cut 4 22/8/2019	Cut 5 25/9/2019	Cut 6 24/10/2019	Cut 7 25/11/2019	Cut 8 2/1/2020	Cut 9 30/1/2020	Cut 10 26/2/2020
Awesome	DI	100	100	100	100	100	96	96	96	79	38
Barmultra II	TI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**88**
Barsenna	DH	100	100	100	100	100	100	100	100	96	88
Belluci	DI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Bison 2	TH	100	100	100	88	83	63	25	0	0	0
Bond	DI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**96**	**88**
Cazzano	TI	100	100	100	100	100	100	100	100	88	54
Charger	DI	100	100	100	100	96	88	83	58	0	0
Davinci	DI	100	100	100	100	100	100	100	100	100	88
Elvis	TI	100	100	100	100	100	100	100	100	96	71
Fortimo	TH	100	100	100	100	100	100	100	100	100	88
Goldini	TI	100	100	100	100	100	100	100	100	92	58
Icon	DI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Itarzi	TI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**96**
Lampard	TH	100	100	100	100	100	100	100	100	100	88
Podium	DI	100	100	100	100	100	100	100	100	88	58
Scapino	TH	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Shogun	TH	100	100	100	100	100	100	100	100	96	79
Sukari	DI	100	100	100	100	100	100	100	100	92	50
Surge	DI	100	100	100	100	100	100	100	100	92	54
Tabu+	DI	100	100	100	100	100	100	100	100	88	50
Turgo	TI	100	100	100	100	100	100	100	96	79	17
Udine	TI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**96**	**83**
Vibe	DI	100	100	100	100	100	100	100	100	100	79
Yolande	DI	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**92**
Zorro	TI	100	100	100	100	100	100	100	100	79	29

Table 7: Italian and hybrid ryegrass (*Lolium multiflorum* & *L. hybridum*), Outeniqua Research Farm:

Spring-planted bolting resistance 2019 assessment: % flowering from spring-planting

Planted: 14 August 2019

Cultivar	Awesome	Barmultra II	Barsenna	Belluci	Bison 2	Bond	Cazzano	Charger	Davinci
% plants flowering	**71**	**0**	**25**	**4**	**98**	**13**	**15**	**96**	**4**
Days to 50% flowering	136	-	126	140	104	146	149	122	154
Flower emergence duration (weeks)	7	-	8	1	6	4	4	8	1

Cultivar	Elvis	Fortimo	Goldini	Icon	Itarzi	Lampard	Podium	Scapino	Shogun
% plants flowering	**18**	**2**	**6**	**2**	**0**	**0**	**15**	**0**	**24**
Days to 50% flowering	148	122	147	154	-	-	149	-	133
Flower emergence duration (weeks)	6	1	2	1	-	-	6	-	9

Cultivar	Sukari	Surge	Tabu +	Turgo	Udine	Vibe	Yolande	Zorro	
% plants flowering	**69**	**14**	**52**	**0**	**4**	**19**	**4**	**15**	
Days to 50% flowering	140	133	129	-	145	136	142	149	
Flower emergence duration (weeks)	6	6	7	-	4	6	3	3	

Summary

Total or annual yield

- ***Highest yielding cultivar:*** Belluci
- ***Cultivars similar to the highest:*** Bond, Sukari, Itarzi, Shogun, Elvis, Barmultra II, Icon, Yolande, Scapino, Udine

Winter yield

- ***Highest yielding cultivar:*** Sukari
- ***Cultivars in the group similar to the highest:*** Bond, Belluci, Shogun, Surge, Zorro, Tabu+, Podium, Yolande

Summer yield

- ***Highest yielding cultivars:*** Icon, Itarzi
- ***Similar yielding:*** Shogun, Bond, Belluci, Sukari (These cultivars are also in the best group of cultivars for winter yield.)

Flowering

- ***Prolific flowering in summer*** with higher stem component
  E.g. Barmultra II, Sukari
- ***High yield and low flowering incidence***
  E.g. Belluci, Bond, Icon, Scapino, Shogun, Yolande
- ***High yield and high sward density through summer***
  E.g. Belluci, Icon, Scapino followed by Itarzi and Yolande
- ***Suitability for spring planting based on flowering or bolting resistance*** (less than 5%)
  (yield was not assessed)
  Barmultra II, Belluci, Davinci, Fortimo, Icon, Itarzi, Lampard, Turgo, Udine, Yolande
- ***Cultivars with low bolting from spring-planting and good autumn-planted yield***:
  Barmultra II, Belluci, Icon, Itarzi, Scapino, Udine, 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.

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

Perennial ryegrass cultivar evaluation results for 2018/19

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Introduction

The perennial ryegrass (*Lolium perenne*) elite cultivar evaluation trial for 2018/19 to the end of summer Feb 2020, was planted on 14 March 2018 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. This trial provides local data to assist farmers with choosing cultivars best adapted to the 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 2018 (March) to February 2020 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 and 2019.

Cultivars evaluated

The trial consisted of 25 cultivars 13 were diploid and 12 tetraploid types.

- **Diploid cultivars**: 24Seven, Ansa, Bronte, Delika, Everlast, Govenor, Lindor II, Nui, One50, Telstar, Thermal, Trooper, Tyson
- **Tetraploid cultivars**: Base, Billabong, Dexter, Diwan, Flintstone, Fusta, Halo, Hydro, Munch, Sucral, Tanker, Viscount

Parameters reported in this article

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

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 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. Total yield is given for both year 1 and 2 and both years combined. The yield comparison of year 1 and year 2 give an indication of yield stability over the two years. An important factors is the percentage yield reduction in the second year compared to the first and in which season that yield is lower.

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. 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. A high yielding spring cultivar can for instance be considered for silage making of surplus production.

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.

Individual harvest yields and ***growth rates*** are given in **Table 2 and 3.**

Dry matter (DM) content **(Table 4)** 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.

Flowering behaviour **(Table 5)** is important since it results in a higher stem component which implies a higher fibre content and thus lower nutritive value. The percentage of the sward that is reproductive varies significantly between cultivars 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 vernalisation 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 6)** gives an indication of persistence especially after the summer when a decrease in plant population often occurs from later February onwards. The cultivars that retain good sward density or plant population after the challenging summer conditions are desirable.

Rust incidence **(Table 7)** 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 reduce water-soluble carbohydrates and reduced digestibility.

Table 1: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2018	Rank	Winter 2018	Rank	Spring 2018	Rank	Summer 2018/19	Rank	Total Year 1	Rank
24Seven	D	**2.20** abcd	9	2.71 cdef	15	**4.20** abcd	16	2.61 cdef	15	11.73 cdef	14
Ansa	D	**2.38** ab	4	2.77 bcdef	13	**4.28** abc	13	2.87 bcdef	11	12.30 bcde	10
Base	T	1.71 cdef	19	**3.07** abcd	9	**4.55** ab	5	2.90 bcde	10	12.23 bcde	11
Billabong	T	**1.86** abcdef	16	2.85 bcdef	11	**4.49** abc	6	2.18 efg	19	11.37 def	15
Bronte	D	1.45 f	23	2.43 efg	17	4.01 bcde	17	2.62 cdef	14	10.51 fghi	20
Delika	D	**2.33** ab	6	2.54 defg	16	**4.23** abc	14	**3.26** abcd	4	12.35 bcde	9
Dexter	T	1.53 ef	22	1.96 g	24	3.33 e	23	2.18 efg	20	9.00 j	24
Diwan	T	1.53 ef	21	2.09 g	22	**4.21** abcd	15	2.68 cdef	13	10.52 fghi	19
Everlast	D	**2.11** abcde	12	2.95 bcde	10	**4.28** abc	7	2.46 def	17	11.99 bcdef	13
Flintstone	T	1.72 cdef	18	2.07 g	23	3.87 bcde	19	1.52 g	23	9.18 ij	23
Fusta	T	**2.44** a	1	2.78 bcdef	12	**4.84** a	3	**3.44** abc	3	**13.49** ab	2
Govenor	D	**1.98** abcdef	14	**3.66** a	1	**4.43** abc	10	3.01 bcde	8	**13.08** abc	6
Halo	T	**2.34** ab	5	**3.15** abcd	7	**4.43** abc	9	**3.55** ab	2	**13.48** ab	3
Hydro	T	**2.08** abcde	13	2.27 fg	21	3.68 cde	21	1.61 g	22	9.63 ghij	21
Lindor II	D	**2.12** abcde	10	2.32 efg	20	3.30 e	24	3.09 bcd	7	10.83 efg	17
Munch	T	**1.97** abcdef	15	2.37 efg	18	3.43 de	22	1.47 g	24	9.23 hij	22
Nui	D	1.61 def	20	**3.25** abc	5	3.77 bcde	20	2.04 fg	21	10.67 fgh	18
One50	D	**2.41** a	2	**3.26** abc	4	**4.44** abc	8	**3.91** a	1	**14.02** a	1
Sucral	T	**2.41** a	3	2.72 cdef	14	**4.29** abc	12	2.94 bcde	9	12.37 bcd	8
Tanker	T	1.43 f	24	**3.09** abcd	8	**4.88** a	2	2.78 bcdef	12	12.18 bcde	12
Telstar	D	**2.11** abcde	11	2.36 efg	19	4.01 bcde	18	2.47 def	16	10.95 defg	16
Thermal	D	0.89 g	25	1.13 h	25	2.35 f	25	0.58 h	25	4.95 k	25
Trooper	D	**2.21** abc	8	**3.22** abc	6	**4.57** ab	4	2.43 def	18	12.44 bcd	7
Tyson	D	**2.25** abc	7	**3.41** ab	2	**4.42** abc	11	**3.15** abcd	6	**13.22** abc	5
Viscount	T	1.80 bcdef	17	**3.33** abc	3	**4.99** a	1	**3.21** abcd	5	**13.33** ab	4
LSD (0.05)		0.50		0.53		0.68		0.70		1.31	
CV %		15.7		12.0		9.97		16.5		7.01	

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

Table 1 cont.: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Seasonal Yield** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2019	Rank	Winter 2019	Rank	Spring 2019	Rank	Summer 2019/20	Rank	Total Year 2	Rank	Total Yr 1+2	Rank
24Seven	D	3.57 bcd	17	1.65 cdefg	12	3.54 fghij	18	1.84 cde	18	10.60 defg	16	22.33 def	15
Ansa	D	3.63 bcd	16	**2.10** abc	6	3.84 bcdefghij	13	**2.21** abcd	12	**11.78** abcde	12	24.08 bcde	12
Base	T	**3.75** abcd	11	1.92 bcde	9	**4.42** abc	3	**2.82** a	1	**12.91** abc	4	**25.15** abc	7
Billabong	T	**3.86** abc	6	**2.13** ab	5	**4.76** a	1	**2.39** abc	10	**13.14** a	1	**24.52** abcd	8
Bronte	D	3.55 bcde	18	1.59 defgh	14	3.72 cdefghij	15	1.47 de	22	10.33 efgh	18	20.84 f	19
Delika	D	**4.14** ab	2	1.34 fghj	17	**4.04** abcdefghi	11	**2.43** abc	9	**11.95** abcde	10	24.30 bcde	11
Dexter	T	3.19 defg	20	1.17 hi	22	2.44 k	24	1.45 de	23	8.25 i	24	17.25 g	24
Diwan	T	3.65 bcd	14	1.04 i	24	3.60 efghij	17	**2.05** abcde	15	10.34 efgh	17	20.86 f	18
Everlast	D	**3.76** abcd	9	1.60 defgh	13	**4.24** abcdef	8	**2.16** abcde	13	**11.77** abcde	13	23.76 cde	13
Flintstone	T	3.01 efg	21	1.07 i	23	3.31 ij	22	1.55 de	19	8.95 ghi	22	18.13 g	22
Fusta	T	**3.89** abc	5	1.57 defgh	15	**4.18** abcdefg	9	**2.65** ab	6	**12.29** abcd	7	**25.78** abc	5
Govenor	D	**4.03** abc	3	**2.19** ab	2	**4.34** abcde	5	**2.54** abc	8	**13.10** ab	2	**26.18** ab	3
Halo	T	**3.96** abc	4	**2.06** abc	7	3.18 j	23	**2.68** abc	4	**11.87** abcde	11	**25.25** abc	6
Hydro	T	2.83 g	23	1.27 ghi	21	3.46 ghij	20	1.45 e	24	9.00 ghi	21	18.63 g	21
Lindor II	D	**3.76** abcd	10	1.48 efghi	16	**4.10** abcdefg	10	2.00 bcde	16	11.33 cdef	15	22.16 ef	16
Munch	T	2.96 fg	22	1.28 ghi	19	3.52 fghij	19	1.54 de	20	8.72 hi	23	17.96 g	23
Nui	D	2.68 g	23	1.84 bcde	10	4.01 bcdefghi	12	1.53 de	21	10.05 fgh	20	20.72 f	20
One50	D	**4.25** a	1	**2.14** ab	3	3.65 defghi	16	**2.72** ab	2	**12.76** abc	5	**26.78** a	1
Sucral	T	**3.69** abcd	13	1.27 ghi	20	3.76 cdefghij	14	**2.66** ab	5	11.38 bcde	14	23.75 cde	14
Tanker	T	3.65 bcd	15	1.75 bcdef	11	**4.55** ab	2	**2.33** abc	11	**12.27** abcd	8	24.45 bcd	10
Telstar	D	**3.78** abc	7	1.30 fghi	18	3.38 hij	21	1.85 cde	17	10.31 efgh	19	21.26 f	17
Thermal	D	0.82 h	25	0		0	25	0	25	0.82 j	25	5.77 h	25
Trooper	D	3.48 cdef	19	**2.14** ab	4	**4.33** abcde	6	**2.12** abcde	14	**12.08** abcd	9	**24.51** abcd	9
Tyson	D	**3.78** abc	8	**2.40** a	1	**4.30** abcde	7	**2.58** abc	7	**13.07** abc	3	**26.28** ab	2
Viscount	T	**3.69** abcd	12	**1.97** abcd	8	**4.38** abcd	4	**2.70** ab	3	**12.74** abc	6	**26.07** ab	4
LSD (0.05)		0.49		0.40		0.63		0.65		1.46		1.96	
CV %		8.50		14.3		9.84		18.3		8.19		5.36	

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

Table 2: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Yield: Individual cuts** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 1 3/5/2018	Cut 2 28/5/2018	Cut 3 5/7/2018	Cut 4 8/8/2018	Cut 5 20/9/2018	Cut 6 25/10/2018	Cut 7 22/11/2018	Cut 8 20/12/2018	Cut 9 28/1/2019	Cut 10 28/2/2019
24Seven	D	**0.90** abcde	**1.21** abcd	1.19 bcdef	**1.09** abcdefg	0.98 defgh	**1.83** abcde	**1.50** abcdef	1.43 defg	0.94 bcde	**0.65** abcd
Ansa	D	**1.13** ab	**1.16** abcd	1.19 bcdef	**1.10** abcdefg	1.08 bcdefgh	**1.91** abcd	**1.41** abcdefg	1.61 bcdef	1.13 bcde	**0.59** abcde
Base	T	0.64 efgh	0.97 bcdef	1.20 bcdef	**1.26** abcd	**1.29** abcd	1.72 bcde	**1.71** a	**1.81** abc	0.86 cdef	**0.75** ab
Billabong	T	0.75 bcdefg	**1.02** abcdef	1.10 defg	**1.15** abcde	**1.27** abcd	**1.90** abcd	**1.52** abcdef	1.67 abcd	0.40 fgh	**0.59** abcde
Bronte	D	0.56 efgh	0.82 f	0.93 g	0.94 bcdefgh	**1.18** abcdef	**1.76** abcde	1.26 efgh	1.52 bcdefg	1.00 bcde	0.54 bcde
Delika	D	**1.05** abc	**1.19** abcd	1.11 cdefg	**1.09** abcdefg	0.79 fgh	1.60 bcde	**1.72** a	**1.87** ab	1.14 bcde	**0.79** ab
Dexter	T	0.53 efgh	0.92 def	0.97 g	0.64 hi	0.80 fgh	1.55 bcde	1.06 h	1.20 g	0.75 defg	**0.57** abcde
Diwan	T	0.49 fgh	0.96 bcdef	1.12 cdefg	0.68 ghi	0.72 gh	**1.74** abcde	**1.72** a	1.44 cdefg	0.92 bcde	**0.73** ab
Everlast	D	**0.87** abcdef	**1.15** abcde	1.08 defg	**1.10** abcdef	**1.58** a	**2.37** a	1.03 h	1.23 g	0.95 bcde	**0.63** abcde
Flintstone	T	0.65 defgh	**0.99** abcdef	0.97 g	0.72 fghi	0.86 efgh	**1.79** abcde	1.31 cdefgh	1.25 fg	0.35 gh	0.27 ef
Fusta	T	**1.07** abcd	**1.27** a	1.23 bcdef	**1.06** abcdefg	1.11 bcdefg	**2.20** ab	**1.62** abcd	**1.77** abcd	**1.23** abcd	**0.94** a
Govenor	D	0.63 efgh	**1.23** ab	**1.50** a	**1.43** a	**1.57** a	**1.97** abcd	1.26 efgh	1.62 bcde	1.15 bcde	**0.69** abc
Halo	T	**1.01** abc	**1.23** abc	1.28 bcde	**1.27** abcd	**1.31** abcd	**1.79** abcde	**1.50** abcdef	**1.86** ab	**1.27** abc	**0.95** a
Hydro	T	**0.87** abcdef	**1.12** abcde	1.12 cdefg	0.83 efgh	0.75 gh	1.69 bcde	1.28 defg	1.23 g	0.45 fgh	0.27 ef
Lindor II	D	**0.86** abcdef	**1.17** abcd	1.11 defg	0.92 cdefgh	0.70 h	1.45 cde	1.15 gh	1.31 efg	**1.39** ab	**0.76** ab
Munch	T	**0.85** abcdefg	**1.04** abcdef	1.07 efg	0.96 bcdefgh	0.79 fgh	1.41 de	1.32 bcdefgh	1.18 g	0.31 gh	0.32 cdef
Nui	D	0.56 efgh	0.94 cdef	**1.32** abc	**1.37** ab	**1.25** abcde	1.57 bcde	1.20 fgh	1.50 bcdefg	0.66 efg	0.30 def
One50	D	**1.16** a	**1.15** abcd	1.28 bcde	**1.35** ab	**1.36** abcd	1.72 bcde	**1.51** abcdef	**2.00** a	**1.65** a	**0.84** ab
Sucral	T	**1.14** ab	**1.17** abcd	1.28 bcde	**1.02** abcdefgh	0.98 defgh	1.68 bcde	**1.66** ab	**1.77** abcd	0.98 bcde	**0.70** ab
Tanker	T	0.46 gh	0.87 ef	1.19 bcdef	**1.22** abcde	**1.44** abc	**2.14** ab	**1.59** abcde	**1.73** abcd	1.02 bcde	0.52 bcde
Telstar	D	**0.90** abcde	**1.13** abcde	1.04 fg	0.85 defgh	1.03 cdefgh	**2.11** ab	1.06 h	1.26 fg	0.99 bcde	**0.58** abcde
Thermal	D	0.34 h	0.51 g	0.37 h	0.42 i	0.69 h	1.22 e	0.65 i	0.58 h	0.05 h	0.11 f
Trooper	D	**0.98** abcd	**1.13** abcde	1.29 bcd	**1.27** abcd	**1.42** abc	**2.07** abc	1.35 bcdefgh	**1.71** abcd	0.71 efg	0.51 bcde
Tyson	D	**0.97** abcd	**1.16** abcd	**1.39** ab	**1.34** abc	**1.46** ab	**1.83** abcde	**1.43** abcdefg	**1.71** abcd	**1.21** abcd	**0.71** ab
Viscount	T	0.74 cdefg	0.96 bcdef	1.28 bcde	**1.32** abc	**1.57** a	2.13 ab	**1.63** abc	**1.73** abcd	**1.21** abcd	**0.77** ab
LSD (0.05)		0.33	0.24	0.18	0.35	0.35	0.53	0.29	0.31	0.41	0.31
CV %		24.8	13.5	9.51	20.4	18.8	17.8	12.7	12.4	27.5	31.6

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

Table 2 cont: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Yield: Individual cuts** (t DM/ha) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 11 29/3/2019	Cut 12 26/4/2019	Cut 13 31/5/2019	Cut 14 15/7/2019	Cut 15 29/8/2019	Cut 16 10/10/2019	Cut 17 7/11/2019	Cut 18 17/12/2019	Cut 19 24/1/2020	Cut 20 20/2/2020
24Seven	D	0.92 bcdef	1.22 bcde	**1.44** abc	0.82 bcdef	0.75 cd	1.60 bcdef	1.23 defgh	1.37 defgh	0.55 c	**0.71** abcdefgh
Ansa	D	**1.17** abcde	1.10 cde	**1.36** abcd	**0.93** abcd	**1.09** ab	1.70 bcde	1.36 cdefg	1.50 cdefg	**0.82** abc	**0.75** abcdef
Base	T	**1.38** a	1.08 cde	**1.30** abcd	**0.89** abcde	**0.94** abc	1.77 bcd	**1.63** abc	**1.91** ab	**1.10** a	**0.91** abc
Billabong	T	**1.25** abcd	1.06 def	**1.56** a	**0.99** abc	**1.06** abc	1.83 bcd	**1.83** a	**2.07** a	**0.77** abc	**0.74** abcdefg
Bronte	D	**1.19** abcde	1.01 ef	**1.35** abcd	0.72 defgh	0.80 bcd	1.56 cdef	1.32 defg	1.60 bcdefg	0.50 c	0.29 h
Delika	D	**1.12** abcde	**1.57** a	**1.45** abc	0.74 defgh	0.52 de	1.67 bcdef	1.53 bcde	1.60 bcdefg	**0.82** abc	**0.93** ab
Dexter	T	**1.04** abcde	0.84 fg	**1.31** abcd	0.62 fgh	0.51 de	0.87 g	1.01 h	1.05 h	0.61 bc	0.39 efgh
Diwan	T	**1.21** abcd	1.20 cde	1.24 bcd	0.56 gh	0.41 e	1.39 def	1.30 defg	**1.71** abcde	**0.73** abc	0.59 bcdefgh
Everlast	D	**1.21** abcd	1.19 cde	**1.35** abcd	0.69 efgh	0.79 bcd	**2.49** a	1.17 gh	1.22 gh	**0.83** abc	**0.82** abcde
Flintstone	T	0.91 cdef	0.77 g	**1.33** abcd	0.52 h	0.49 de	1.27 efg	1.29 defgh	1.42 defg	0.48 c	0.47 defgh
Fusta	T	**1.31** ab	1.30 bcd	**1.29** abcd	0.71 defgh	0.77 bcd	1.84 bcd	1.48 bcdef	1.65 bcde	**1.05** ab	**0.90** abcd
Govenor	D	**1.31** a	1.34 bc	**1.38** abcd	**1.02** ab	**1.08** ab	1.82 bcd	1.53 bcde	**1.87** abc	**0.86** abc	**0.90** abcd
Halo	T	**1.26** abcd	1.21 bcde	**1.49** abc	**1.02** ab	**0.98** abc	1.19 fg	1.21 fgh	1.45 defg	**1.01** ab	**1.05** a
Hydro	T	0.87 def	0.66 g	**1.29** abcd	0.62 fgh	0.58 de	1.50 cdef	1.26 efgh	1.36 efgh	0.54 c	0.32 gh
Lindor II	D	**1.16** abcde	1.16 cde	**1.44** abc	0.76 cdefg	0.64 de	1.67 bcdef	**1.55** abcd	1.66 bcde	**0.71** abc	0.58 bcdefgh
Munch	T	0.60 f	0.64 g	1.14 d	0.62 fgh	0.59 de	1.41 cdef	1.32 defg	1.50 cdefg	0.47 c	0.43 efgh
Nui	D	0.81 ef	0.66 g	1.21 cd	0.80 bcdefg	**0.96** abc	1.62 bcdef	1.45 bcdefg	**1.77** abcd	0.43 c	0.35 fgh
One50	D	**1.28** abc	**1.45** ab	**1.51** ab	**0.98** abc	**1.09** ab	1.42 cdef	1.36 cdefg	1.63 bcdef	**1.09** a	**0.94** ab
Sucral	T	**1.09** abcde	1.24 bcde	**1.35** abcd	0.68 efgh	0.52 de	1.50 cdef	1.42 bcdefg	1.58 bcdefg	**1.01** ab	**0.97** ab
Tanker	T	**1.27** abc	1.11 bcd	**1.26** abcd	**0.86** abcde	0.81 bcd	1.77 bcd	**1.67** ab	**2.07** a	**0.69** abc	**0.76** abcdef
Telstar	D	**1.07** abcde	1.22 bcde	**1.49** abc	0.73 defgh	0.49 de	1.52 cdef	1.21 fgh	1.24 fgh	**0.83** abc	0.49 cdefgh
Thermal	D	0.10 g	0.20 h	0.52 e	0	0	0	0	0	0	0
Trooper	D	**1.11** abcde	1.02 ef	**1.36** abcd	**1.01** ab	**1.04** abc	1.88 bcd	**1.57** abcd	**1.70** abcde	**0.81** abc	0.58 bcdefgh
Tyson	D	**1.10** abcde	1.22 bcde	**1.46** abc	**1.07** a	**1.23** a	2.07 b	1.40 bcdefg	1.63 bcdef	**1.10** a	**0.78** abcdef
Viscount	T	**1.20** abcd	1.23 bcde	**1.26** abcd	**0.84** abcdef	**1.04** abc	1.88 bc	1.41 bcdefg	**2.05** a	**0.85** abc	**0.98** ab
LSD (0.05)		0.32	0.22	0.25	0.20	0.27	0.40	0.28	0.33	0.38	0.36
CV %		18.2	12.3	11.3	15.0	20.3	15.0	12.4	12.5	30.1	31.8

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

Table 3: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Growth rate: Individual cuts** (kg DM/ha/day)

Cultivars	Type	Cut 1 3/5/2018	Cut 2 28/5/2018	Cut 3 5/7/2018	Cut 4 8/8/2018	Cut 5 20/9/2018	Cut 6 25/10/2018	Cut 7 22/11/2018	Cut 8 20/12/2018	Cut 9 28/1/2019	Cut 10 28/2/2019
24Seven	D	**19.2** abcde	**48.3** abcd	31.3 bcdef	**32.2** abcdefg	22.8 defgh	**52.3** abcde	**53.6** abcdef	51.2 defg	24.1 bcdef	**21.0** abc
Ansa	D	**24.0** ab	**46.2** abcd	31.3 bcdef	**32.3** abcdefg	25.2 bcdefgh	**54.4** abcd	**50.4** abcdefg	57.6 bcdef	28.9 bcde	**19.0** abcd
Base	T	13.7 defgh	38.8 bcdef	31.7 bcdef	**37.2** abcd	**30.1** abcd	49.2 bcde	**61.2** a	**64.7** abc	21.9 cdefg	**24.3** ab
Billabong	T	15.9 bcdefg	**41.0** abcdef	29.0 defg	**33.9** abcde	**29.5** abcd	**54.3** abcd	**54.2** abcdef	**59.8** abcd	10.2 ghi	**19.0** abcd
Bronte	D	11.9 efgh	32.6 f	24.6 g	27.7 bcdefg	**27.5** abcdef	**50.3** abcde	45.1 efgh	54.2 bcdefg	25.5 bcde	17.4 bcd
Delika	D	**22.3** abc	**47.6** abcd	29.2 cdefg	**32.2** abcdefg	18.3 fgh	45.8 cdef	**61.5** a	**66.7** ab	29.2 bcde	**25.4** ab
Dexter	T	11.3 efgh	36.9 def	25.4 g	18.8 hi	18.6 fgh	44.3 bcde	38.0 h	42.9 g	19.3 cdefgh	**18.4** abcd
Diwan	T	10.3 fgh	38.3 bcdef	29.4 cdefg	20.0 ghi	16.8 gh	**49.8** abcde	**61.4** a	51.5 cdefg	23.7 bcdef	**23.5** ab
Everlast	D	**18.6** abcdef	**46.0** abcde	28.3 defg	**32.5** abcdef	**36.7** a	**67.8** a	36.6 h	43.9 g	24.4 bcdef	**20.4** abcd
Flintstone	T	13.9 defgh	**39.8** abcdef	25.5 g	21.1 fghi	20.1 efgh	**51.3** abcde	46.8 defgh	44.8 fg	9.0 hi	8.7 de
Fusta	T	**22.8** abc	**50.7** a	32.3 bcdef	**31.1** abcdefg	25.9 bcdefg	**62.8** ab	**57.9** abcd	**63.2** abcd	**31.6** abc	**30.3** a
Govenor	D	13.4 defgh	**49.3** ab	**39.5** a	**42.1** a	**36.6** a	**56.4** abcd	45.0 efgh	58.2 bcde	29.6 abcde	**22.3** ab
Halo	T	**21.5** abcd	**49.2** abc	33.7 bcde	**37.2** abcd	**30.5** abcd	**51.2** abcde	**53.6** abcdef	**66.6** ab	**32.6** abc	**30.6** a
Hydro	T	**18.5** abcdef	**44.7** abcde	29.6 cdefg	24.4 efgh	17.5 gh	48.4 bcde	45.7 defg	44.1 g	11.6 fghi	8.8 de
Lindor II	D	**18.4** abcdef	**46.9** abcd	29.1 defg	27.2 cdefgh	16.2 h	41.4 cde	41.2 gh	46.8 efg	**35.8** ab	**24.4** ab
Munch	T	**18.0** abcdefg	**41.4** abcdef	28.2 efg	28.2 bcdefgh	18.4 fgh	40.2 de	47.1 bcdefgh	42.1 g	11.8 fghi	15.6 bcd
Nui	D	11.9 efgh	37.8 cdef	**34.8** abc	**40.3** ab	**29.0** abcde	44.8 bcde	42.8 fgh	53.5 bcdefg	17.0 efgh	9.7 cde
One50	D	**24.6** a	**46.2** abcd	33.6 bcde	**39.8** ab	**31.6** abcd	49.3 bcde	**54.0** abcdef	**71.4** a	**42.2** a	**27.0** ab
Sucral	T	**24.2** ab	**46.9** abcd	33.8 bcde	30.0 abcdefgh	22.7 defgh	47.9 bcdef	**59.2** ab	**63.3** abcd	25.1 bcde	**22.5** ab
Tanker	T	9.9 gh	34.8 ef	31.2 bcdef	36.0 abcde	**33.5** abc	**61.0** ab	**56.6** abcde	**61.7** abcd	26.2 bcde	16.8 bcd
Telstar	D	**19.1** abcde	**45.2** abcde	27.4 fg	25.0 defgh	24.0 cdefgh	**60.2** ab	37.8 h	45.0 fg	25.4 bcde	**18.8** abcd
Thermal	D	7.3 h	20.6 g	9.7 h	12.5 i	16.0 h	34.8 e	23.2 i	20.8 h	3.9 i	3.6 e
Trooper	D	**20.8** abcd	**45.3** abcde	33.9 bcd	37.5 abcd	**33.0** abc	**59.1** abc	48.3 bcdefgh	**61.0** abcd	18.1 defgh	16.5 bcd
Tyson	D	**20.7** abcd	**46.6** abcd	**36.5** ab	39.5 abc	**33.9** ab	**52.3** abcde	**50.9** abcdefg	**61.2** abcd	**31.0** abcd	**23.0** ab
Viscount	T	15.7 cdefg	38.5 bcdef	33.6 bcde	38.7 abc	**36.5** a	**60.9** ab	**58.2** abc	**61.9** abcd	**30.9** abcd	**24.7** ab
LSD (0.05)		6.95	9.41	4.70	10.43	8.03	15.12	10.22	11.07	11.13	10.19
CV %		24.8	13.5	9.5	20.4	18.8	17.8	12.7	12.4	26.6	31.1

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

Table 3 cont.: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Growth rate: Individual cuts** (kg DM/ha/day) D = Diploid, T = Tetraploid

Cultivars	Type	Cut 11 29/3/2019	Cut 12 26/4/2019	Cut 13 31/5/2019	Cut 14 15/7/2019	Cut 15 29/8/2019	Cut 16 10/10/2019	Cut 17 7/11/2019	Cut 18 17/12/2019	Cut 19 24/1/2020
24Seven	D	31.7 bcd	43.4 bcde	**41.0** abc	18.3 bcdef	16.7 cd	39.0 bcdef	43.8 defgh	34.5 defgh	14.4 c
Ansa	D	**40.4** abc	39.2 cde	**38.9** abcd	**20.6** abcd	**24.2** ab	41.6 bcde	48.4 bcdefg	37.5 cdefg	**21.7** abc
Base	T	**47.4** a	38.6 cde	**37.1** abcd	**19.9** abcde	**21.0** abc	43.2 bcd	**58.3** abc	**47.8** ab	**28.9** a
Billabong	T	**42.9** ab	37.8 def	**44.5** a	**21.9** abc	**23.5** abc	44.6 bcd	**65.4** a	**51.7** a	**20.4** abc
Bronte	D	**40.9** abc	35.9 ef	**38.7** abcd	15.9 defgh	17.8 bcd	38.0 cdef	47.2 cdefgh	39.9 bcdefg	13.1 c
Delika	D	**38.6** abcd	**56.2** a	**41.3** abc	16.4 defgh	11.5 de	40.7 bcdef	**54.7** abcdef	40.2 bcdefg	**21.6** abc
Dexter	T	**35.8** abcd	29.8 fg	**37.4** abcd	13.7 fgh	11.4 de	21.2 g	35.9 h	26.4 h	16.2 bc
Diwan	T	**41.6** abc	42.8 cde	35.6 bcd	12.6 gh	9.1 e	33.9 def	42.3 cdefgh	**42.8** abcde	**19.3** abc
Everlast	D	**41.8** abc	42.7 cde	**38.6** abcd	15.3 efgh	17.6 bcd	**60.8** a	41.6 gh	30.5 gh	**21.8** abc
Flintstone	T	31.3 bcd	27.6 g	**38.0** abcd	11.5 h	11.0 de	31.0 efg	46.0 defgh	35.5 defgh	12.6 c
Fusta	T	**45.2** a	46.4 bcd	**36.7** abcd	15.7 defgh	17.2 bcd	44.8 bcd	52.9 bcdef	41.1 bcde	**27.7** ab
Govenor	D	**45.3** a	47.8 bc	**39.5** abcd	**22.6** ab	**24.1** ab	44.5 bcd	**54.6** abcdef	**46.6** abc	**22.5** abc
Halo	T	**43.4** a	43.1 bcde	**42.5** abc	**22.8** ab	**21.8** abc	29.1 fg	43.1 fgh	36.3 defg	**26.6** ab
Hydro	T	30.1 cd	23.7 g	**37.0** abcd	13.7 fgh	12.8 de	36.5 cdef	44.9 defgh	33.9 efgh	14.3 c
Lindor II	D	**40.0** abc	41.3 cde	**41.2** abc	16.9 cdefg	14.1 de	40.8 bcdef	**55.5** abcd	41.5 bcde	**18.9** abc
Munch	T	31.2 dc	22.7 g	32.5 d	13.8 fgh	13.2 de	34.4 cdef	47.2 cdefgh	37.4 cdefg	12.5 c
Nui	D	27.9 d	23.7 g	34.4 cd	17.7 bcdefg	**21.4** abc	39.5 bcdef	51.8 bcdefg	**44.2** abcd	11.3 c
One50	D	**44.3** a	**51.9** ab	**43.1** ab	**21.9** abc	**24.2** ab	34.6 cdef	48.7 bcdefg	40.8 bcdef	**28.6** a
Sucral	T	**37.7** abcd	44.4 bcde	**38.6** abcd	15.1 efgh	11.5 de	36.7 cdef	50.8 bcdefg	39.5 bcdefg	**26.7** ab
Tanker	T	**43.9** a	39.8 cde	**36.0** abcd	**19.0** abcde	17.9 bcd	43.1 bcd	**59.7** ab	**51.8** a	**18.2** abc
Telstar	D	**37.0** abcd	43.7 bcde	**42.6** abc	16.3 efgh	10.9 de	37.2 cdef	43.2 efgh	31.1 fgh	**21.9** abc
Thermal	D	3.5 e	7.3 h	14.8 e	0	0	0	0	0	0
Trooper	D	**38.1** abcd	36.5 ef	**38.8** abcd	**22.4** abc	**23.1** abc	45.8 bcd	**56.0** abcd	**42.5** abcde	**21.3** abc
Tyson	D	**37.9** abcd	43.7 bcde	**41.8** abc	**23.8** a	**27.4** a	50.4 b	50.1 bcdefg	**40.7** bcdef	**29.1** a
Viscount	T	**41.4** abc	43.8 cdef	**36.1** abcd	**18.7** abcdef	**23.1** abc	45.9 bc	50.4 bcdefg	**51.1** a	**22.2** abc
LSD (0.05)		9.72	7.72	7.03	4.40	5.92	9.83	10.18	8.29	10.13
CV %		15.6	12.3	11.3	15.0	20.3	15.0	12.4	12.5	30.1

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

Table 4. Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm
Planted: 14 March 2018 **DM content (%)**

Cultivars	Type	Cut 1 3/5/2018	Cut 2 28/5/2018	Cut 3 5/7/2018	Cut 4 8/8/2018	Cut 5 20/9/2018	Cut 6 25/10/2018	Cut 7 22/11/2018	Cut 8 20/12/2018	Cut 9 28/1/2019	Cut 10 28/2/2019
24Seven	D	**13.5** abcd	12.6 bcdef	15.3 bcd	16.3 cdefg	**21.4** abc	**24.2** abc	**21.7** ab	21.3 bc	**29.4** ab	**20.6** abc
Ansa	D	11.9 def	12.2 bcdefg	14.5 cde	15.2 defgh	**21.0** abcde	23.8 bcd	**21.5** abc	20.0 bcdef	**25.9** abcde	**19.9** abcde
Base	T	**12.6** abcdef	12.7 bcde	14.6 cde	14.4 fgh	19.3 defghij	21.6 defghi	19.2 def	18.9 defg	23.9 cde	17.3 hi
Billabong	T	**13.2** abcde	12.2 bcdefg	14.4 cde	15.4 defg	18.7ghij	22.0 cdefgh	19.3 def	18.6 efg	23.5 cde	17.9 ghi
Bronte	D	**13.6** abcd	12.9 bc	15.6 bcd	15.8 defg	19.6 cdefghij	23.5 bcdef	20.5 bcde	21.1 bcd	**26.7** abcde	**19.5** abcdefg
Delika	D	**13.3** abcde	12.2 bcdefg	16.1 bc	**18.0** abc	19.9 cdefghi	21.4 efghi	20.9 bcde	21.0 bcd	**27.2** abcd	**19.4** abcdefg
Dexter	T	**14.7** ab	12.6 bcdef	15.5 bcd	17.0 bcd	20.4 bcdefg	22.3 bcdefgh	19.5 cdef	20.6 bcdef	**27.0** abcde	18.9 cdefgh
Diwan	T	**13.0** abcdef	12.6 bcdef	16.0 bcd	16.9 bcde	20.5 bcdefg	20.9 ghi	20.1 bcdef	19.3 cdefg	24.1 cde	19.1 bcdefg
Everlast	D	12.4 bcdef	11.6 defgh	15.7 bcd	16.4 bcdef	20.4 bcdefg	**24.6** ab	20.7 bcde	20.4 bcdef	**26.8** abcde	**20.0** abcd
Flintstone	T	**13.5** abcd	12.2 bcdefg	16.1 bc	16.0 cdefg	19.8 cdefghi	21.6 defghi	18.2 f	20.4 bcdef	**28.0** abc	17.9 ghi
Fusta	T	10.9 ef	10.9 h	14.7 cde	14.9 efgh	19.0 efghij	21.2 fghi	19.2 def	18.9 defg	22.5 e	17.1 i
Govenor	D	**13.0** abcdef	12.4 bcdefg	15.2 bcd	15.1 defgh	20.7 bcdef	**24.1** abc	21.1 bcd	20.4 bcdef	24.4 cde	**19.8** abcde
Halo	T	10.5 f	11.4 fgh	13.4 e	13.3 h	18.0 ij	21.9 cdefgh	19.0 def	19.2 cdefg	**25.8** abcde	18.5 defghi
Hydro	T	**14.6** abc	12.6 bcdef	15.3 bcd	16.0 cdefg	19.7 cdefghij	22.3 bcdefgh	19.2 def	21.4 bc	**25.7** abcde	18.3 defghi
Lindor II	D	**13.2** abcde	13.2 b	16.8 b	16.6 bcde	**22.6** a	23.2 bcdefg	20.9 bcde	20.0 cdef	**30.1** a	**19.5** abcdefg
Munch	T	**12.6** abcdef	12.2 bcdefg	15.3 bcd	16.1 cdefg	20.5 bcdefg	23.4 bcdef	18.9 ef	20.8 bcde	**29.6** ab	18.0 fghi
Nui	D	**13.8** abcd	13.2 b	15.1 bcde	15.0 defgh	**22.2** ab	**24.3** abc	**22.1** ab	21.3 bc	**26.9** abcde	**19.7** abcdefg
One50	D	**12.5** abcdef	12.6 bcdef	14.4 cde	16.0 cdefg	**21.1** abcd	**24.2** abc	**21.6** abc	20.9 bcd	**25.6** abcde	**20.7** ab
Sucral	T	**13.6** abcd	11.5 efgh	14.8 cde	15.5 defg	19.2 efghij	20.5 hi	19.6 cdef	19.0 defg	25.3 bcde	18.2 efghi
Tanker	T	**13.4** abcde	12.1 bcdefg	15.0 bcde	14.3 gh	18.1 hij	19.3 i	18.4 f	17.8 g	23.0 de	17.3 hi
Telstar	D	11.7 def	12.4 bcdefg	16.7 b	18.3 ab	20.4 bcdefg	23.8 bcde	20.9 bcde	22.3 b	29.1 ab	**20.9** a
Thermal	D	**15.0** a	**15.7** a	**18.5** a	**19.3** a	**22.7** a	**26.2** a	**23.2** a	**25.3** a	24.0 cde	**19.7** abcdef
Trooper	D	**13.0** abcdef	12.8 bcd	14.8 cde	15.0 efgh	20.1 cdefgh	23.0 bcdefg	20.7 bcde	21.0 bcd	24.2 cde	**19.6** abcdefg
Tyson	D	12.1 cdef	11.3 gh	14.2 de	14.5 fgh	18.8 fghij	23.4 bcdef	20.7 bcde	20.4 bcdef	**26.7** abcde	**19.8** abcde
Viscount	T	11.9 def	11.9 cdefgh	13.3 e	13.5 h	17.8 j	21.3 fghi	18.9 ef	18.5 fg	23.5 cde	18.0 fghi
LSD (0.05)		2.12	0.98	1.50	1.71	1.65	1.97	1.80	1.90	3.78	1.47
CV %		9.98	4.79	6.0	6.58	5.0	5.29	5.43	5.69	8.43	4.66

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

Table 4 cont. Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm
Planted: 14 March 2018 **DM content (%)**

Cultivars	Type	Cut 11 29/3/2019	Cut 12 26/4/2019	Cut 13 31/5/2019	Cut 14 15/7/2019	Cut 15 29/8/2019	Cut 16 10/10/2019	Cut 17 7/11/2019	Cut 18* 17/12/2019	Cut 19 24/1/2020	Cut 20 20/2/2020
24Seven	D	**16.6** abcde	**12.0** abcde	**14.1** abcd	**17.1** abcde	**22.7** abc	**21.7** ab	**22.0** abcd	**34.2** abcd	**23.1** abcd	**22.4** a
Ansa	D	**16.7** abcd	**12.3** abc	**14.4** abc	16.8 bcdef	**21.1** abcde	**20.9** abc	21.4 bcde	**33.4** abcde	**24.1** ab	**21.8** abc
Base	T	15.2 cdef	10.8 def	13.6 bcde	15.7 fg	20.0 de	**19.6** abc	19.4 hijk	29.9 ghijk	21.0 abcde	19.6 def
Billabong	T	15.0 efg	10.8 def	13.2 de	15.2 g	19.7 e	**19.8** abc	18.9 jkl	27.2 k	18.7 f	19.6 def
Bronte	D	15.9 bcde	**11.7** abcdef	**14.0** abcd	**17.2** abcd	**21.3** abcde	**20.8** abc	20.8 defgh	**33.1** abcde	**22.2** abcde	20.6 bcde
Delika	D	15.1 cdefg	**12.0** abcde	**14.0** abcd	**18.2** a	**23.4** ab	**21.7** ab	**22.2** abc	29.9 ghijk	**23.4** abc	**21.8** abc
Dexter	T	16.2 bcde	**11.4** abcdef	**14.0** abcd	16.4 bcdef	**21.9** abcde	**21.5** ab	20.0 efghij	**35.3** abc	**23.3** abc	**21.1** abcd
Diwan	T	15.3 cdef	**12.4** ab	13.8 bcd	**17.1** abcde	**21.8** abcde	**20.7** abc	20.3 efghi	30.1 ghijk	**22.0** abcde	20.5 bcde
Everlast	D	**16.7** abc	**12.1** abcd	**14.0** abcd	**17.5** abc	**22.2** abcd	**21.2** abc	21.0 cdef	30.3 fghij	**24.3** a	**22.7** a
Flintstone	T	16.1 bcde	10.7 ef	13.8 bcd	16.8 bcdef	**21.2** abcde	**20.0** abc	20.3 efghi	**35.9** a	**21.9** abcde	20.6 bcde
Fusta	T	13.6 g	10.5 ef	13.1 de	16.2 cdefg	20.3 cde	18.9 c	18.0 l	28.6 ijk	20.1 def	18.4 f
Govenor	D	15.9 bcde	**12.0** abcde	**14.4** abc	**16.9** abcdef	**21.3** abcde	**21.4** abc	18.0 l	31.0 efghi	**21.1** abcde	**21.6** abc
Halo	T	15.5 bcdef	10.0 cdef	13.0 de	15.7 fg	20.9 bcde	**21.1** abc	19.6 ghijk	32.7 cdefg	**22.4** abcde	19.2 ef
Hydro	T	16.1 bcde	**11.3** abcdef	13.3 cde	**17.1** abcde	**21.9** abcde	**20.7** abc	19.6 ghijk	33.0 bcdef	**22.5** abcde	20.5 bcde
Lindor II	D	15.4 bcdef	**12.6** ab	**14.5** ab	**17.7** ab	**22.6** abcd	**20.5** abc	20.7 efgh	30.1 ghijk	**22.9** abcd	**21.8** abc
Munch	T	**17.0** ab	**11.4** abcdef	13.4 bcde	**17.3** abcd	**21.4** abcde	**21.6** ab	19.1 ijkl	**35.1** abcd	**22.6** abcd	**22.2** abc
Nui	D	**17.0** ab	**12.3** abc	**14.1** abcd	**17.3** abcd	**21.1** abcde	**21.9** ab	20.9 cdefg	32.5 cdefg	**22.3** abcde	**21.5** abc
One50	D	**16.7** abc	**12.7** a	**15.0** a	**16.9** abcdef	**22.7** abc	**22.1** a	**23.0** a	**34.0** abcd	**23.6** abc	**21.3** abcd
Sucral	T	14.0 gf	10.8 ef	**14.0** abcd	**17.2** abcd	**22.6** abcd	**19.7** abc	19.8 fghijk	29.4 hijk	20.8 cdef	19.2 ef
Tanker	T	15.0 defg	**11.5** abcdef	12.6 e	16.3 cdefg	20.3 cde	19.5 bc	18.5 kl	27.6 jk	18.8 f	19.2 ef
Telstar	D	**16.5** abcde	**12.1** abcd	**13.9** abcd	**17.7** ab	**23.6** a	**22.1** a	**22.4** ab	**35.7** ab	**24.6** a	**21.8** abc
Thermal	D	**18.0** a	**11.5** abcdef	13.0 de	-	-	-	-	-	-	
Trooper	D	16.3 bcde	**11.9** abcde	**14.1** abcd	**17.3** abcd	20.9 bcde	**21.3** abc	21.4 bcde	29.9 ghijk	**23.3** abc	**21.5** abc
Tyson	D	15.8 bcde	**12.0** abcde	13.7 bcd	16.1 defg	**21.9** abcde	**21.2** abc	20.7 efgh	32.2 defgh	**23.2** abc	**22.3** ab
Viscount	T	14.1 gf	11.3 bcdef	13.3 bcde	15.8 efg	**21.1** abcde	**21.0** abc	18.7 kl	28.6 ijk	19.4 ef	20.4 cde
LSD (0.05)		1.38	1.12	0.95	1.11	2.14	2.16	1.15	2.49	2.59	1.47
CV %		5.26	5.84	4.19	14.2	6.02	6.29	3.42	4.79	7.11	4.27

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

Table 5: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Reproductive tillers (Bolting)** (%, rating based)

Cultivars	Type	Cut 1 3/5/2018	Cut 2 28/5/2018	Cut 3 5/7/2018	Cut 4 8/8/2018	Cut 5 20/9/2018	Cut 6 25/10/2018	Cut 7 22/11/2018	Cut 8 20/12/2018	Cut 9 28/1/2019	Cut 10 28/2/2019
24Seven	D	0	0	0	0	0	8	8	4	4	0
Ansa	D	0	0	0	0	0	13	13	13	0	0
Base	T	0	0	0	0	0	13	25	25	13	0
Billabong	T	0	0	0	13	25	29	30	42	8	0
Bronte	D	0	0	0	0	8	13	25	13	0	0
Delika	D	0	0	0	0	0	4	0	0	0	0
Dexter	T	0	0	0	0	0	13	25	0	0	0
Diwan	T	0	0	0	0	0	4	29	21	0	0
Everlast	D	0	0	0	17	**79**	**88**	21	38	17	0
Flintstone	T	0	0	0	0	4	17	17	4	0	0
Fusta	T	0	0	0	0	21	63	29	21	8	0
Govenor	D	0	0	0	0	8	29	4	13	0	0
Halo	T	0	0	0	0	0	13	8	13	0	0
Hydro	T	0	0	0	0	0	21	21	4	0	0
Lindor II	D	0	0	0	13	17	21	17	8	0	0
Munch	T	0	0	0	0	0	13	21	8	0	0
Nui	D	0	0	0	0	13	21	17	0	0	0
One50	D	0	0	0	0	0	13	13	21	8	0
Sucral	T	0	0	0	0	0	8	13	13	0	0
Tanker	T	0	0	0	0	8	38	29	42	13	0
Telstar	D	0	0	0	0	0	38	17	4	0	0
Thermal	D	0	0	0	0	0	8	17	4	0	0
Trooper	D	0	0	0	0	21	25	21	33	13	0
Tyson	D	0	0	0	0	21	29	4	8	0	0

Table 5 cont.: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Reproductive tillers (Bolting)** (%, rating based)

Cultivars	Type	Cut 11 29/3/2019	Cut 12 26/4/2019	Cut 13 31/5/2019	Cut 14 15/7/2019	Cut 15 29/8/2019	Cut 16 10/10/2019	Cut 17 7/11/2019	Cut 18 17/12/2019	Cut 19 24/1/2020	Cut 20 20/2/2020
24Seven	D	0	0	0	0	0	0	4	8	0	0
Ansa	D	0	0	0	0	0	0	8	13	0	0
Base	T	0	0	0	0	0	0	13	17	0	0
Billabong	T	0	0	0	0	0	4	21	21	0	0
Bronte	D	0	0	0	0	0	0	13	13	0	0
Delika	D	0	0	0	0	0	0	0	0	0	0
Dexter	T	0	0	0	0	0	0	8	8	0	0
Diwan	T	0	0	0	0	0	0	0	4	0	0
Everlast	D	0	0	0	0	13	**83**	25	17	0	0
Flintstone	T	0	0	0	0	0	0	17	13	0	0
Fusta	T	0	0	0	0	0	17	33	17	0	0
Govenor	D	0	0	0	0	0	0	8	4	0	0
Halo	T	0	0	0	0	0	0	0	0	0	0
Hydro	T	0	0	0	0	0	0	8	8	0	0
Lindor II	D	0	0	0	0	0	0	13	0	0	0
Munch	T	0	0	0	0	0	4	33	13	0	0
Nui	D	0	0	0	0	0	0	13	0	0	0
One50	D	0	0	0	0	0	0	8	17	0	0
Sucral	T	0	0	0	0	0	0	0	0	0	0
Tanker	T	0	0	0	0	0	4	17	33	0	0
Telstar	D	0	0	0	0	0	4	21	0	0	0
Thermal	D	0	0	0	-	-	-	-	-	-	-
Trooper	D	0	0	0	0	0	4	17	17	0	0
Tyson	D	0	0	0	0	0	13	13	4	0	0
Viscount	T	0	0	0	0	0	4	13	21	0	0

Table 6: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Sward density** (%, rating based)

Cuts 1-9 sward density for all cultivars is 100%

Cultivars	Type	Cut 10 28/2/19	Cut 11 29/3/19	Cut 12 26/4/19	Cut 13 31/5/19	Cut 14 15/7/19	Cut 15 29/8/19	Cut 16 10/10/19	Cut 17 7/11/19	Cut 18* 17/12/19	Cut 19 24/1/20	Cut 20 20/2/20
24Seven	D	96	100	100	100	100	100	100	100	100	83	79
Ansa	D	92	100	100	96	100	100	100	100	100	71	75
Base	T	88	100	92	96	100	100	100	100	100	83	83
Billabong	T	79	96	88	96	100	96	100	100	100	63	67
Bronte	D	92	96	96	100	100	100	100	100	100	38	42
Delika	D	92	100	100	100	100	100	100	100	100	79	88
Dexter	T	92	96	96	100	100	100	100	100	96	67	67
Diwan	T	88	100	100	100	100	96	100	100	100	67	67
Everlast	D	96	100	96	100	100	100	100	100	96	83	79
Flintstone	T	83	83	83	96	100	96	100	100	96	42	63
Fusta	T	100	100	100	100	100	96	100	100	100	83	83
Govenor	D	100	100	100	100	100	100	100	100	100	88	88
Halo	T	100	100	100	100	100	100	100	100	100	92	88
Hydro	T	79	75	79	92	96	92	100	100	100	54	50
Lindor II	D	96	96	100	100	100	100	100	100	100	75	75
Munch	T	58	63	75	83	88	88	100	96	96	54	46
Nui	D	67	79	75	83	96	96	100	100	100	46	46
One50	D	100	100	100	100	100	100	100	100	100	83	83
Sucral	T	96	100	100	100	100	100	100	100	100	92	92
Tanker	T	83	96	92	92	100	92	100	100	100	58	67
Telstar	D	96	100	100	100	100	100	100	100	100	88	71
Thermal	D	92	58	71	71	0	0	0	0	0	0	0
Trooper	D	79	100	92	92	100	100	100	100	96	75	58
Tyson	D	92	100	96	96	100	100	100	100	100	83	79
Viscount	T	96	100	96	96	100	100	100	100	100	79	79

*Hot day with berg wind, temperature >30°C

Table 7: Perennial ryegrass (*Lolium perenne*), Lp 4, Elite Evaluation, Outeniqua Research Farm

Planted: 14 March 2018 **Rust %** (ratings based) D = Diploid, T = Tetraploid

Cultivars	Type	Autumn 2018	Winter 2018	Spring 2018	Summer 2018/19	Autumn 2019	Winter 2019	Spring 2019	Summer 2019/20
24Seven	D	4	2	7	22	19	2	11	32
Ansa	D	2	0	13	27	22	11	36	43
Base	T	2	2	4	25	22	2	23	43
Billabong	T	0	0	10	36	25	0	26	28
Bronte	D	0	4	22	**66**	35	21	40	53
Delika	D	0	0	1	11	4	0	2	4
Dexter	T	7	8	35	**68**	43	34	48	**72**
Diwan	T	0	0	8	32	8	6	11	28
Everlast	D	2	0	0	25	15	0	0	35
Flintstone	T	2	6	48	63	47	27	42	**65**
Fusta	T	0	0	0	8	4	0	2	15
Govenor	D	0	0	0	8	7	0	0	7
Halo	T	0	0	25	36	17	2	34	57
Hydro	T	11	4	59	**67**	47	38	**61**	**75**
Lindor II	D	0	0	6	21	18	0	6	25
Munch	T	4	6	68	61	37	27	**67**	**80**
Nui	D	4	2	33	57	43	19	38	56
One50	D	0	0	10	18	7	0	17	29
Sucral	T	0	0	0	10	3	0	0	8
Tanker	T	2	0	9	24	28	0	30	37
Telstar	D	0	7	32	51	25	13	27	49
Thermal	D	15	38	**61**	**78**	**78**	0	-	-
Trooper	D	0	0	0	42	25	2	28	39
Tyson	D	0	0	0	15	20	2	8	29
Viscount	T	0	0	0	8	3	0	11	22

Summary

Total yield over two years (Year 1+2)

- ***Highest yielding cultivar:*** One50
- ***Similar to the highest yielding:*** Tyson, Govenor, Viscount, Fusta, Halo, Base, Billabong, Trooper

Total yield Year 1

- ***Highest yielding cultivar***: One50
- ***Similar:*** Fusta, Halo, Viscount, Tyson, Govenor

Total yield Year 2

- ***Highest:*** Billabong
- ***Similar to the highest yielding:*** Govenor, Tyson, Base, One50, Viscount, Fusta, Tanker, Trooper, Delika, Halo, Ansa, Everlast

Yield stability of best cultivars in year 1:

- Yield reduction from year 1 to year 2 (percentage lower yield given in brackets)
- One50 (9%), Fusta (9%), Halo (12%), Viscount (4%), Tyson (1%), Govenor (0%).

Winter yield year 1 (2018)

- ***Highest yielding:*** Govenor
- ***Similar yield:*** Tyson, Viscount, One50, Nui, Trooper, Halo, Tanker, Base

Winter yield year 2 (2019)

- ***Highest yielding:*** Tyson
- ***Similar yield:*** Govenor, One50, Trooper, Billabong, Ansa, Halo, Viscount

Winter yield 2018 vs 2019:

- Percentage lower yield in the second winter given in brackets for cultivars with best yield in the first winter
- Govenor (40% lower), Tyson (30%), Viscount (41%), One50 (34%), Nui (43%), Trooper (34%), Halo (35%), Tanker (43%), Base (37%)

Summer yield year 1 (2018/19)

- ***Highest yielding:*** One50
- ***Similar yield:*** Halo, Fusta, Delika, Viscount, Tyson

Summer yield year 2 (2019/20)

- Highest yielding: Base
- Similar yield: One50, Viscount, Halo, Sucral, Fusta, Tyson, Govenor, Delika, Billabong, Tanker, Ansa, Everlast, Trooper, Diwan

Summer 2018/19 vs Summer 2019/20:

- Percentage lower yield in the second summer given in brackets for cultivars with best yield in the first summer
- One50 (30% lower), Halo (25%), Fusta (23%), Delika (25%), Viscount (16%), Tyson (18%)

Sward density:

- Above 75% at the end of the second summer (February 2020)
- ***90-100%***: Sucral
- ***80 – 89% :*** Halo, Govenor, Delika, Base, One50, Fusta,
- ***75 – 79%:*** 24Seven, Everlast, Tyson, Viscount, Lindor II, Ansa

Lowest rust incidence:

- ***Lowest rust incidence*** (chances over the seasons with the highest incidence in spring and summer)
- ***15% or less throughout the two-year period:*** Govenor, Sucral, Delika, Fusta
- ***30% or less:*** One50, Lindor II, Tyson, Viscount

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

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.

Forage herbs (Chicory and plantain) cultivar evaluation results for October 2018 to February 2020

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Introduction

The production potential of chicory (*Cichorium intybus*) and plantain (*Plantago lanceolata*) cultivars was assessed from a spring-planting in October 2018. Forage herbs are most productive in the warmers months of the year but the best cultivars yield equally well to ryegrass in the winter months. The advantage of chicory and plantain is this high productivity in spring, summer and going into autumn, which tend to be the more challenging months for temperate grasses. Additionally the criterion for suitable cultivars is that they are not winter dormant and should retain a good plant population for at least two years. The deep root system of both plantain and especially chicory is valuable in terms of accessing water and nutrients and providing carbon related to root growth into the deeper soil layers.

Both these species are commonly utilized in mixed pastures but can also be utilized in pure stands and then often alternately grazed with a grass pasture. Forage herbs are highly digestible, generally high in energy and should be used in combination with a high fibre concentrate, if concentrate is fed.

More detailed information about the species, basic management principles and the different types of cultivars is available in the 2017, 2018 and 2019 Outeniqua Information Day booklets.

The data reported on in this article is from the cultivar evaluation trial planted on the Outeniqua Research Farm on 10 October 2018. The trial consists of 10 chicory and 5 plantain cultivars sown at 8 kg/ha. The first harvest was done after the cultivars had at least six fully extended leaves. Thereafter harvests were determined by sward height. Generally for plantain between 25 and 30 cm and chicory 30 to 35cm depending on the time of the year. Harvesting was done with a reciprocating mower at 5cm blade height with the entire net plot weighed and sampled.

Cultivars in the trial

- ***Chicory***: 501, Affila, Choice, Commander, Estero Quality, Forage Feast, Puna II, Spada
- ***Plantain***: Agritonic, Boston, Captain, Hercules, Tonic

Parameters reported in this article

- Total yield
- Seasonal yield
- Growth rates
- Flowering incidence
- Sward height at harvest
- Plant population counts

***Total yield* (Table 1)** is important since the establishment and input costs are also similar regardless of yield, hence the importance of choosing the cultivars with the best yield. In mixed pastures that contain plantain it is also possible to make silage of surplus yield.

***Seasonal yield (Table 1*)** is important for fodder flow purposes and to choose the best cultivars for the seasons that are most challenging in terms of fodder flow needs. For chicory and plantain the yields in summer and autumn are valuable in relation to the yield challenges of ryegrass in summer and the over-sowing in autumn resulting in an extended grazing rotation on many paddocks on the farm.

Yield and growth rates for individual harvests are given in ***Table 2 and 3***.

Flowering incidence (Table 4) is reported as a percentage of the sward flowering for plantain and as number of flowering plants per m^2 for chicory. Flowering in both species lowers the quality but since the plantain flowers are relatively small they are either eaten or left with the animals grazing all the leaves which are not obstructed by the flowering stems. For chicory it is important to graze before the flowering stems become fully extended and become too tall and woody resulting in the grazing animals avoiding those plants. From a spring-planting the flowering incidence in the first summer is much lower and occurs over a shorter time period than in the second summer when especially for chicory the plants have been vernalized and flowering induced.

Sward height at harvest (Table 5 and Figure 1) over the seasons varies especially for chicory as it has longer leaves in the warmer months. The winter dormant cultivars show up clearly. The plant height is of importance especially in mixed pastures where much shorter growing components would likely be overshadowed. There are however competition effects on sward height in mixtures but these values in the pure stands can give some indication of the potential height the plants can attain.

Plant population counts (Figure 2) were done in January 2020 and again in June 2020. The counts show a significant decrease in population. For chicory this is mainly associated with plants that previously flowered and with plants that succumbed to fusarium wilt. For plantain the plant population also decreased but was generally associated with an increase in plant size for the remaining plants resulting in the similar sward density especially for the winter-active cultivars.

Table 1: Forage herbs: *Plantago lanceolata, Cichorium intybus*, Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Yield (t DM/ha)**

	Spring* 2018	Rank	Summer 2018/19	Rank	Autumn 2019	Rank	Winter 2019	Rank	Spring 2019	Rank	Summer 2019/20	Rank	Total 17 months	Rank
Narrow-leaved plantain														
Agritonic	1.27	13	**8.70** ^{abcd}	4	**6.09** ^{a}	1	3.06 ^{bc}	3	**6.24** ^{a}	7	**6.62** ^{a}	1	**32.0** ^{a}	1
Boston	1.36	10	**9.19** ^{a}	1	4.03 ^{c}	14	0.15 ^{e}	15	**5.89** ^{ab}	12	**6.10** ^{ab}	4	26.7 ^{c}	14
Captain	1.32	12	**9.07** ^{ab}	2	**6.04** ^{a}	4	**3.44** ^{ab}	2	**5.79** ^{ab}	13	**5.98** ^{ab}	7	**31.6** ^{a}	3
Hercules	1.74	8	**8.93** ^{abc}	3	3.97 ^{c}	15	0.16 ^{e}	14	**6.48** ^{a}	5	**6.10** ^{ab}	5	27.4 ^{bc}	13
Tonic	1.33	11	**8.48** ^{abcde}	6	**5.99** ^{a}	5	**3.55** ^{a}	1	**5.93** ^{ab}	11	**6.49** ^{a}	2	**31.8** ^{a}	2
Forage chicory														
501	2.15	1	**8.25** ^{abcde}	8	**5.92** ^{a}	6	2.52 ^{d}	9	**6.59** ^{a}	1	**5.66** ^{ab}	12	**31.1** ^{ab}	5
Affila	2.10	2	**8.21** ^{abcde}	9	**5.83** ^{a}	8	2.61 ^{cd}	6	**6.49** ^{a}	4	**6.24** ^{a}	3	**31.5** ^{a}	4
Choice	1.87	5	8.00 ^{bcde}	11	**5.35** ^{ab}	12	2.22 ^{d}	12	5.21 ^{b}	14	4.88 ^{bc}	14	27.5 ^{bc}	12
Commander (2016)	1.23	15	7.67 ^{de}	14	**5.63** ^{ab}	11	2.27 ^{d}	11	**6.03** ^{ab}	9	**5.54** ^{abc}	13	**28.4** ^{abc}	11
Commander (2018)	1.77	6	**8.48** ^{abcde}	5	**6.07** ^{a}	2	2.49 ^{d}	10	**6.21** ^{a}	8	**5.85** ^{ab}	9	**30.9** ^{ab}	7
Estero Quality	1.75	7	**8.23** ^{abcde}	7	**5.83** ^{a}	7	2.65 ^{cd}	4	**6.02** ^{ab}	10	**5.82** ^{ab}	10	**30.4** ^{ab}	9
Forage Feast	1.24	14	7.42 ^{e}	15	4.91 ^{b}	13	0.41 ^{e}	13	2.59 ^{c}	15	4.45 ^{c}	15	21.0 ^{d}	15
Puna II	1.63	9	7.87 ^{cde}	12	**6.06** ^{a}	3	2.62 ^{cd}	5	**6.40** ^{a}	6	**5.87** ^{ab}	8	**30.5** ^{ab}	8
Spada (2016)	1.91	4	**8.12** ^{abcde}	10	**5.73** ^{a}	9	2.59 ^{cd}	7	**6.56** ^{a}	2	**5.98** ^{ab}	6	**30.9** ^{ab}	6
Spada (2018)	2.00	3	7.77 ^{de}	13	**5.68** ^{a}	10	2.57 ^{cd}	8	**6.56** ^{a}	3	**5.66** ^{ab}	11	**30.2** ^{abc}	10
LSD (0.05)	NS		0.97		0.71		0.44		0.88		1.09		3.25	
CV %	39.6		6.94		7.65		11.9		8.84		11.2		6.59	

*includes establishment phase of 6 weeks

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

Table 2: Forage herbs: *Plantago lanceolata, Cichorium intybus* , Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Yield (t DM/ha) Individual harvests**

	Cut 1 30/11/18	Cut 2 19/12/18	Cut 3 14/1/19	Cut 4 5/2/19	Cut 5 25/2/19	Cut 6 20/3/19	Cut 7 11/4/19	Cut 8 10/5/19	Cut 9 13/6/19	Cut 10 1/8/19
Narrow-leaved plantain	t DM/ha									
Agritonic	1.27	**1.73** ab	**2.82** abc	**2.03** a	**2.11** ab	**2.07** a	**1.41** abc	**1.77** ab	**1.38** ab	1.35 b
Boston	1.36	**1.77** ab	**3.10** a	**2.12** a	**2.21** a	**1.92** abc	1.05 c	0.97 c	0.16 d	0.02 d
Captain	1.32	**1.91** ab	**2.99** ab	**2.20** a	**1.97** abcd	**1.98** ab	**1.48** ab	**1.70** ab	**1.45** ab	**1.57** ab
Hercules	1.74	**2.04** a	**2.90** abc	**1.95** ab	**2.04** abc	**1.78** abcd	1.11 bc	0.97 c	0.18 d	0.02 d
Tonic	1.33	**1.66** ab	**3.02** ab	**1.97** ab	**1.83** abcd	**1.82** abcd	**1.42** ab	**1.75** ab	**1.60** a	**1.62** a
Forage chicory	t DM/ha									
501	2.15	**1.53** ab	**2.71** abc	**2.09** a	**1.92** abcd	**1.92** abc	**1.44** ab	**1.69** ab	**1.41** ab	0.92 c
Affila	2.10	**1.67** ab	**2.69** abc	**2.02** ab	**1.83** abcd	**1.82** abcd	**1.57** a	**1.64** ab	**1.29** ab	1.00 c
Choice	1.87	1.41 b	**2.95** ab	**1.89** ab	1.75 bcd	1.65 cd	**1.35** abc	1.55 b	**1.31** ab	0.90 c
Commander (2016)	1.23	1.48 b	**2.56** abc	**1.94** ab	1.70 cd	1.68 cd	**1.55** a	**1.67** ab	1.19 b	0.82 c
Commander (2018)	1.77	**1.89** ab	**2.75** abc	**1.95** ab	**1.88** abcd	**1.87** abcd	**1.50** a	**1.78** ab	**1.49** ab	0.91 c
Estero Quality	1.75	**1.89** ab	**2.69** abc	**1.97** ab	1.77 bcd	1.62 d	**1.44** ab	**1.87** ab	**1.47** ab	1.03 c
Forage Feast	1.24	**1.56** ab	2.39 c	1.70 b	1.77 bcd	1.65 cd	**1.24** abc	1.46 b	0.91 c	0.05 d
Puna II	1.63	**1.57** ab	2.54 bc	**1.98** ab	1.79 bcd	1.76 bcd	**1.50** a	**2.05** a	1.22 b	1.03 c
Spada (2016)	1.91	**1.54** ab	**2.62** abc	**2.01** ab	**1.94** abcd	1.77 bcd	**1.41** abc	**1.69** ab	**1.37** ab	0.98 c
Spada (2018)	2.00	**1.59** ab	2.53 bc	**2.04** a	1.61 d	1.73 bcd	**1.50** a	**1.63** ab	**1.32** ab	1.02 c
LSD (0.05)	NS	0.47	0.47	0.28	0.34	0.25	0.32	0.38	0.27	0.23
CV %	39.6	16.7	10.1	8.3	11.0	8.5	13.9	14.0	13.6	15.9

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

Table 2 cont: Forage herbs: *Plantago lanceolata, Cichorium intybus* , Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Yield (t DM/ha) Individual harvests**

	Cut 11 6/9/19	Cut 12 4/10/19	Cut 13 25/10/19	Cut 14 20/11/19	Cut 15 12/12/19	Cut 16 7/1/20	Cut 17 29/1/20	Cut 18 24/2/20	Cut 19 23/3/20	Cut 20 28/5/20
Narrow-leaved plantain	t DM/ha									
Agritonic	**1.42** ab	**1.88** ab	**1.60** ab	1.69 bcd	**1.86** abc	**1.88** ab	**1.46** ab	**2.26** a	**1.53** ab	**1.46** abc
Boston	0.08 d	1.32 c	**1.71** a	**1.93** abcd	**1.96** ab	**1.95** ab	**1.27** abcd	**1.81** ab	**1.30** ab	0.28 e
Captain	**1.58** a	**1.91** ab	1.31 b	1.59 cd	1.58 cd	**1.78** ab	**1.41** abc	**1.93** a	**1.53** ab	**1.77** ab
Hercules	0.09 d	**1.57** abc	**1.71** a	**2.21** a	**2.14** a	**1.86** ab	**1.23** abcd	**1.84** ab	1.17 bc	0.49 e
Tonic	**1.59** a	**1.77** ab	1.30 b	1.82 bcd	1.71 bc	**1.77** ab	**1.57** a	**2.22** a	**1.80** ab	**1.98** a
Forage chicory	t DM/ha									
501	**1.27** abc	**2.00** a	**1.58** ab	**1.98** ab	**1.81** abc	**1.80** ab	1.10 bcd	**1.77** abc	**1.35** ab	1.15 cd
Affila	**1.34** abc	**1.80** ab	**1.69** a	**1.98** ab	1.77 bc	**2.07** a	1.16 bcd	**2.04** a	**1.45** ab	**1.53** abc
Choice	0.98 c	1.48 bc	1.30 b	0.57 d	1.53 cd	**1.87** ab	0.93 d	1.26 bc	0.61 c	0.51 e
Commander (2016)	1.19 bc	**1.72** abc	**1.53** ab	**1.84** abcd	1.64 bcd	**1.69** ab	1.19 bcd	**1.76** abc	**1.39** ab	1.34 bc
Commander (2018)	1.20 bc	**1.85** ab	**1.55** ab	1.82 bcd	1.73 bc	**1.88** ab	1.19 bcd	**1.84** ab	**1.60** ab	**1.49** abc
Estero Quality	**1.27** abc	**1.77** ab	**1.58** ab	1.76 bcd	1.53 cd	**1.89** ab	1.20 bcd	**1.90** a	**1.51** ab	**1.41** abc
Forage Feast	0.02 d	0.49 d	0.56 c	0.95 e	1.30 d	1.41 b	1.12 bcd	1.20 c	**1.44** ab	0.74 de
Puna II	**1.34** abc	**1.77** ab	**1.57** ab	**2.01** ab	**1.80** abc	**1.90** ab	1.13 bcd	**1.86** a	**1.35** ab	1.17 cd
Spada (2016)	**1.30** abc	**1.80** ab	**1.81** a	**1.96** abc	1.70 bc	**1.92** ab	1.11 bcd	**2.02** a	**1.90** a	**1.45** abc
Spada (2018)	**1.26** abc	**1.91** ab	**1.65** a	**1.99** ab	1.74 bc	**1.91** ab	1.06 cd	**1.75** abc	**1.49** ab	1.25 bcd
LSD (0.05)	0.32	0.39	0.27	0.33	0.32	0.51	0.32	0.52	0.58	0.51
CV %	18.0	13.9	10.8	10.9	11.0	16.6	15.7	16.9	23.9	22.9

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

Table 3: Forage herbs: *Plantago lanceolata, Cichorium intybus* , Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Growth rate (kg DM/ha/day)**

	Cut 1 30/11/18	Cut 2 19/12/18	Cut 3 14/1/19	Cut 4 5/2/19	Cut 5 25/2/19	Cut 6 20/3/19	Cut 7 11/4/19	Cut 8 10/5/19	Cut 9 13/6/19	Cut 10 1/8/19
Narrow-leaved plantain	t DM/ha									
Agritonic	24.8	82.3	**108.7** ^{abc}	**92.3** ^{ab}	**105.6** ^{ab}	**90.0** ^{a}	**63.9** ^{abc}	**61.0** ^{ab}	**40.4** ^{ab}	27.5 ^{b}
Boston	26.7	82.3	**119.2** ^{a}	**100.1** ^{a}	**110.5** ^{a}	**83.3** ^{abc}	47.8 ^{c}	33.4 ^{c}	4.7 ^{d}	0.02 ^{d}
Captain	26.0	85.7	**115.2** ^{ab}	**100.1** ^{a}	**98.3** ^{abcd}	**86.0** ^{ab}	**67.1** ^{ab}	**58.5** ^{ab}	**42.6** ^{ab}	**32.1** ^{ab}
Hercules	34.2	94.7	**111.6** ^{abc}	**96.5** ^{ab}	**102.2** ^{abc}	**77.6** ^{abcd}	50.4 ^{bc}	33.2 ^{c}	5.3 ^{d}	0.02 ^{d}
Tonic	26.0	75.1	**116.2** ^{ab}	**89.6** ^{ab}	**91.4** ^{abcd}	**79.4** ^{abcd}	**64.7** ^{ab}	**60.3** ^{ab}	**47.0** ^{a}	**33.0** ^{a}
Forage chicory	t DM/ha									
501	42.1	80.5	**104.2** ^{abc}	**95.1** ^{a}	**96.0** ^{abcd}	**83.5** ^{abc}	**65.4** ^{ab}	**58.3** ^{ab}	**41.5** ^{ab}	18.8 ^{c}
Affila	41.2	88.0	**103.2** ^{abc}	**91.7** ^{ab}	**91.6** ^{abcd}	**79.1** ^{abcd}	**71.6** ^{a}	**56.4** ^{ab}	**38.0** ^{ab}	20.3 ^{c}
Choice	36.6	71.3	**113.4** ^{ab}	**85.8** ^{ab}	87.6 ^{bcd}	71.8 ^{cd}	**61.1** ^{abc}	53.3 ^{b}	**38.7** ^{ab}	18.4 ^{c}
Commander (2016)	24.1	77.8	**98.7** ^{abc}	**87.9** ^{ab}	84.9 ^{cd}	72.9 ^{cd}	**70.6** ^{a}	**57.6** ^{ab}	35.0 ^{b}	16.7 ^{c}
Commander (2018)	34.6	91.6	**105.8** ^{abc}	**88.7** ^{ab}	**93.9** ^{abcd}	**81.4** ^{abcd}	**67.9** ^{a}	**61.5** ^{ab}	**43.9** ^{ab}	18.7 ^{c}
Estero Quality	34.4	88.0	**103.4** ^{abc}	**89.4** ^{ab}	88.8 ^{bcd}	70.4 ^{d}	**65.2** ^{ab}	**64.4** ^{ab}	**43.3** ^{ab}	21.0 ^{c}
Forage Feast	24.3	64.8	92.1 ^{c}	77.1 ^{b}	88.8 ^{bcd}	71.6 ^{cd}	**56.3** ^{abc}	50.4 ^{b}	26.8 ^{c}	1.1 ^{d}
Puna II	31.9	76.6	97.6 ^{bc}	**89.9** ^{ab}	89.5 ^{bcd}	76.4 ^{bcd}	**68.3** ^{a}	**70.7** ^{a}	35.9 ^{b}	21.1 ^{c}
Spada (2016)	37.4	75.6	**100.8** ^{abc}	**91.4** ^{ab}	**96.9** ^{abcd}	77.0 ^{bcd}	**64.2** ^{abc}	**58.4** ^{ab}	**40.3** ^{ab}	19.9 ^{c}
Spada (2018)	39.2	83.7	97.4 ^{bc}	**92.6** ^{ab}	80.5 ^{d}	75.4 ^{bcd}	**68.2** ^{a}	**56.3** ^{ab}	**38.8** ^{ab}	20.8 ^{c}
LSD (0.05)	NS	NS	17.9	14.7	17.2	11.1	14.8	13.1	7.93	4.80
CV %	39.6	19.2	10.1	9.6	11.0	8.4	13.9	14.0	13.6	15.9

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

Table 3 cont.: Forage herbs: *Plantago lanceolata, Cichorium intybus* , Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Growth rate (kg DM/ha/day)**

	Cut 11 6/9/19	Cut 12 4/10/19	Cut 13 25/10/19	Cut 14 20/11/19	Cut 15 12/12/19	Cut 16 7/1/20	Cut 17 29/1/20	Cut 18 24/2/20	Cut 19 23/3/20	Cut 20 28/5/20
Narrow-leaved plantain	t DM/ha									
Agritonic	**39.5** ab	**67.1** ab	**76.1** ab	64.9 bcd	**84.3** abc	**72.2** ab	**66.6** ab	**87.1** a	**56.9** ab	**22.2** abc
Boston	2.3 d	47.1 c	**81.6** a	**74.1** abcd	**89.0** ab	**74.8** ab	**57.9** abcd	**69.4** ab	**48.1** ab	4.2 e
Captain	**44.0** a	**68.1** ab	62.3 b	61.0 cd	71.8 cd	**68.6** ab	**63.9** abc	**74.1** a	**56.5** ab	**26.9** ab
Hercules	2.5 d	**56.3** abc	**81.3** a	**85.0** a	**97.4** a	**71.6** ab	**55.9** abcd	**70.7** ab	43.4 bc	7.4 e
Tonic	**44.0** a	**63.0** ab	62.2 b	70.0 bcd	77.7 bc	**68.0** ab	**71.3** a	**85.6** a	**66.5** ab	**30.0** a
Forage chicory	t DM/ha									
501	**35.3** abc	**71.3** a	**75.1** ab	**76.1** ab	**82.4** abc	**69.1** ab	50.2 bcd	**68.0** abc	**50.1** ab	17.5 cd
Affila	**37.3** abc	**64.4** ab	**80.3** a	**76.2** ab	80.4 bc	**79.8** a	52.8 bcd	**78.4** a	**53.9** ab	**23.1** abc
Choice	27.1 c	52.6 bc	62.0 b	60.5 d	69.3 cd	**71.6** ab	42.1 d	48.4 bc	22.6 c	7.8 e
Commander (2016)	33.0 bc	**61.4** abc	**72.8** ab	**17.7** abcd	74.5 bcd	**65.1** ab	54.1 bcd	**67.7** abc	**51.4** ab	20.2 bc
Commander (2018)	33.5 bc	**66.0** ab	**73.6** ab	70.2 bcd	78.8 bc	**72.2** ab	54.3 bcd	**70.6** ab	**59.1** ab	**22.6** abc
Estero Quality	**35.4** abc	**63.1** ab	**75.4** ab	67.8 bcd	69.5 cd	**72.6** ab	54.6 bcd	**73.0** a	**56.0** ab	**21.4** abc
Forage Feast	0.5 d	17.3 d	26.9 c	36.4 e	59.3 d	54.3 b	51.0 bcd	46.3 c	**53.2** ab	11.1 de
Puna II	**37.2** abc	**63.3** ab	**74.9** ab	**77.5** ab	**81.9** abc	**73.2** ab	51.2 bcd	**71.4** a	**50.0** ab	17.8 cd
Spada (2016)	**36.2** abc	**64.1** ab	**86.3** a	**75.5** abc	77.0 bc	**73.7** ab	50.5 bcd	**77.9** a	**70.4** a	**22.0** abc
Spada (2018)	**34.8** abc	**68.3** ab	**78.7** a	**76.6** ab	79.0 bc	**73.5** ab	48.1 cd	**67.1** abc	**55.3** ab	19.0 bcd
LSD (0.05)	8.94	13.8	12.9	12.6	14.3	19.6	14.5	19.9	21.6	7.66
CV %	18.1	13.9	10.8	10.9	11.0	16.6	15.8	16.9	23.9	22.9

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

Table 4: Forage herbs: *Plantago lanceolata, Cichorium intybus* , Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Flowering incidence**

	Cut 1 30/11/18	Cut 2 19/12/18	Cut 3 14/1/19	Cut 4 5/2/19	Cut 5 25/2/19	Cut 6 20/3/19	Cut 7 11/4/19	Cut 8 10/5/19	Cut 9 13/6/19	Cut 10 1/8/19
Narrow-leaved plantain	Number of flowering plants %									
Agritonic	0	0	46	17	0	0	0	0	0	0
Boston	0	0	0	0	0	0	0	0	0	0
Captain	0	0	50	13	0	0	0	0	0	0
Hercules	0	0	0	0	0	0	0	0	0	0
Tonic	0	0	29	13	0	0	0	0	0	0
Forage chicory	Number of flowering plants/m²									
501	0	0	0.2	0	0	0	0	0	0	0
Affila	0	0	0.1	0.03	0	0	0	0	0	0
Choice	0	0	0.4	0.3	0.03	0	0	0	0	0
Commander (2016)	0	0	0.5	0.5	0.2	0	0	0	0	0
Commander (2018)	0	0	0.1	0.03	0.1	0	0	0	0	0
Estero Quality	0	0	0.2	0.03	0.03	0	0	0	0	0
Forage Feast	0	0	0	0	0.1	0	0	0	0	0
Puna II	0	0	0.2	0.2	0.2	0	0	0	0	0
Spada (2016)	0	0	0.03	0.03	0.1	0	0	0	0	0
Spada (2018)	0	0	0.1	0.03	0.03	0	0	0	0	0

Table 4 cont.: Forage herbs: *Plantago lanceolata, Cichorium intybus* , Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Flowering incidence**

	Cut 11 6/9/19	Cut 12 4/10/19	Cut 13 25/10/19	Cut 14 20/11/19	Cut 15 12/12/19	Cut 16 7/1/20	Cut 17 29/1/20	Cut 18 24/2/20	Cut 19 23/3/20	Cut 20 28/5/20
Narrow-leaved plantain	Number of flowering plants %									
Agritonic	0	13	25	38	58	68	8	13	0	0
Boston	0	0	0	0	0	17	4	0	0	0
Captain	0	38	38	67	50	42	0	0	0	0
Hercules	0	0	0	8	33	54	8	0	0	0
Tonic	0	13	17	33	42	38	4	0	0	0
Forage chicory	Number of flowering plants/m²									
501	0	0	0.1	3.6	**6.0**	**7.2**	2.3	1.2	0.8	0.2
Affila	0	0.1	0.1	3.2	4.7	**7.0**	3.3	2.1	1.2	0.7
Choice	0	0	0	1.5	3.3	4.5	3.0	0.5	0	0.1
Commander (2016)	0	0.1	0.4	2.3	4.8	**7.3**	2.5	1.3	0.3	0.3
Commander (2018)	0	0.03	0.2	3.1	**5.2**	**6.8**	3.2	1.6	0.8	0.4
Estero Quality	0	0	0.3	2.5	4.7	**6.8**	3.2	1.8	0.9	0.3
Forage Feast	0	0	0	0	0.2	0.3	0.1	0	0	0
Puna II	0	0	0.1	3.9	**5.8**	**9.3**	3.8	2.3	1.1	0.4
Spada (2016)	0	0	0.3	3.7	**5.3**	**8.2**	3.8	1.6	1.2	1.2
Spada (2018)	0	0	0.3	3	**5.0**	**7.7**	3.3	1.8	1.3	0.6

Table 5: Forage herbs: *Plantago lanceolata, Cichorium intybus*, Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Sward height at harvest (cm)**

	Cut 2 19/12/18	Cut 3 14/1/19	Cut 4 5/2/19	Cut 5 25/2/19	Cut 6 20/3/19	Cut 7 11/4/19	Cut 8 10/5/19	Cut 9 13/6/19	Cut 10 1/8/19
Narrow-leaved plantain	Height (cm) at harvest								
Agritonic	26	28	27	28	28	23	26	24	22
Boston	23	28	25	28	24	19	16	5	7
Captain	24	28	29	30	28	29	31	27	28
Hercules	23	29	23	25	21	18	18	7	8
Tonic	25	29	28	28	27	28	30	27	23
Forage chicory	Height (cm) at harvest								
501	29	37	34	38	34	36	40	35	25
Affila	28	38	35	38	35	35	40	32	27
Choice	26	33	31	35	32	30	37	29	23
Commander (2016)	28	32	33	39	35	35	39	32	27
Commander (2018)	26	33	33	38	34	35	40	32	27
Estero Quality	27	32	34	37	33	35	40	33	25
Forage Feast	27	29	23	23	23	23	26	13	10
Puna II	26	34	35	38	35	36	38	33	25
Spada (2016)	27	34	31	37	33	35	40	34	25
Spada (2018)	28	38	33	36	33	35	38	34	27
LSD (0.05)	NS	6.8	4.4	5.5	4.4	2.7	2.8	3.7	4.6
CV %	11.5	12.6	8.7	9.9	8.8	5.3	5.0	8.3	12.6

Table 5 cont. : Forage herbs: *Plantago lanceolata, Cichorium intybus*, Fh 5, Evaluation Outeniqua Research Farm

Planted: 10 October 2018 **Sward height at harvest (cm)**

	Cut 11 6/9/19	Cut 12 4/10/19	Cut 13 25/10/19	Cut 14 20/11/19	Cut 15 12/12/19	Cut 16 7/1/20	Cut 17 29/1/20	Cut 18 24/2/20	Cut 19 23/3/20	Cut 20 28/5/20
Narrow-leaved plantain	Height (cm) at harvest									
Agritonic	20	24	24	23	23	30	23	26	22	22
Boston	8	13	2	23	24	26	22	23	19	12
Captain	25	25	25	28	24	27	24	26	24	30
Hercules	9	15	28	29	24	25	19	22	20	13
Tonic	24	23	25	27	24	25	24	28	27	28
Forage chicory	Height (cm) at harvest									
501	25	36	37	38	35	36	30	30	35	37
Affila	25	36	39	39	35	38	30	32	33	37
Choice	18	25	30	30	33	37	27	28	29	28
Commander (2016)	23	36	38	37	35	36	28	33	34	33
Commander (2018)	24	35	37	39	33	34	30	32	37	37
Estero Quality	24	33	37	40	36	35	31	32	34	38
Forage Feast	8	12	15	19	20	23	19	21	20	23
Puna II	26	38	40	40	35	37	28	32	32	35
Spada (2016)	28	35	38	41	36	42	30	35	38	40
Spada (2018)	27	36	37	38	35	39	30	32	37	36
LSD (0.05)	4	4	4	3	3	5	3	4	3	3
CV %	12.4	9.1	7.8	5.9	6.2	9.8	6.7	8.1	11.9	15.4

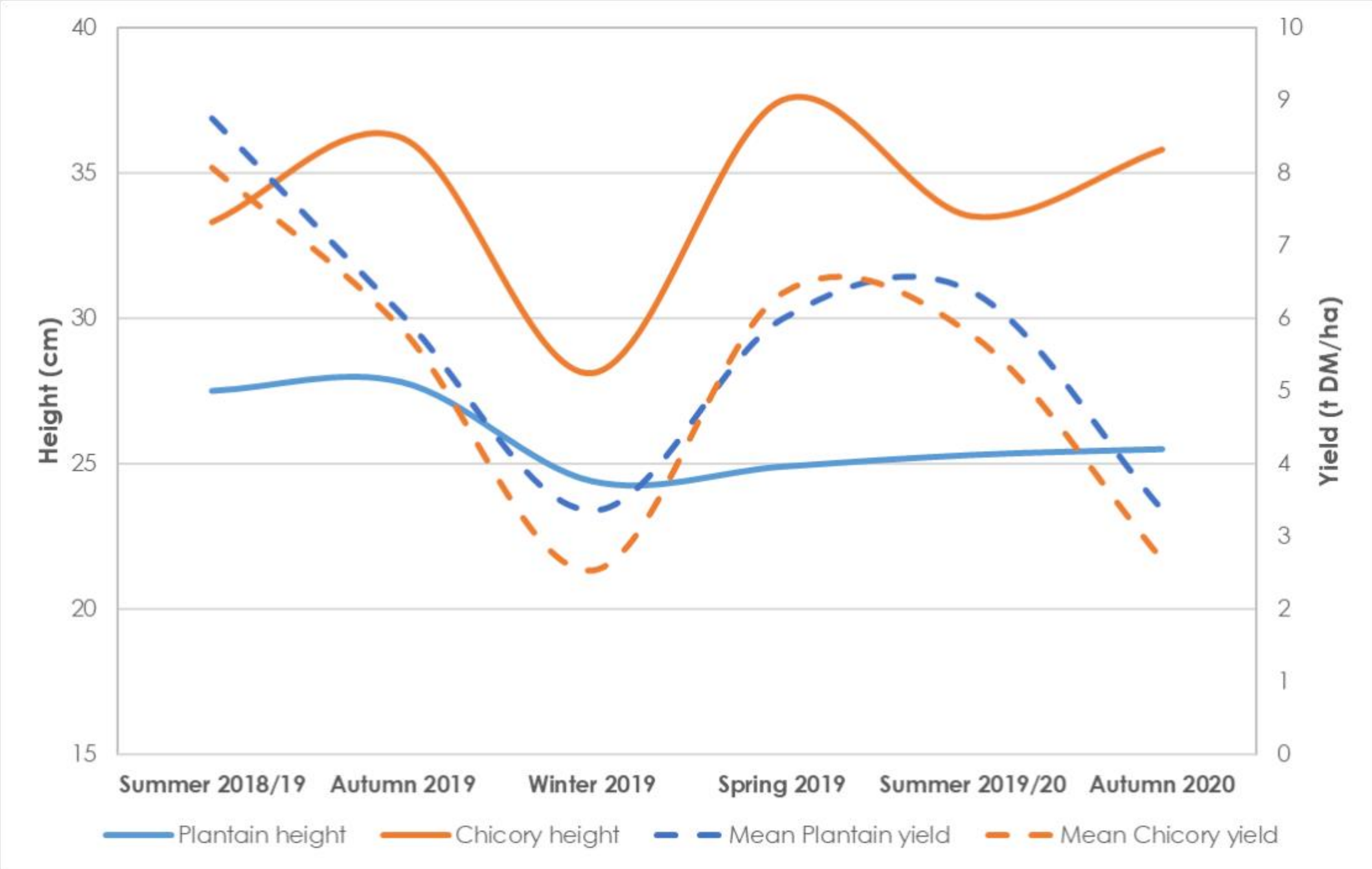

Figure 1: Mean sward height for chicory and plantain (solid lines), excluding winter dormant cultivars, as it varies over seasons with yield represented by dotted lines.

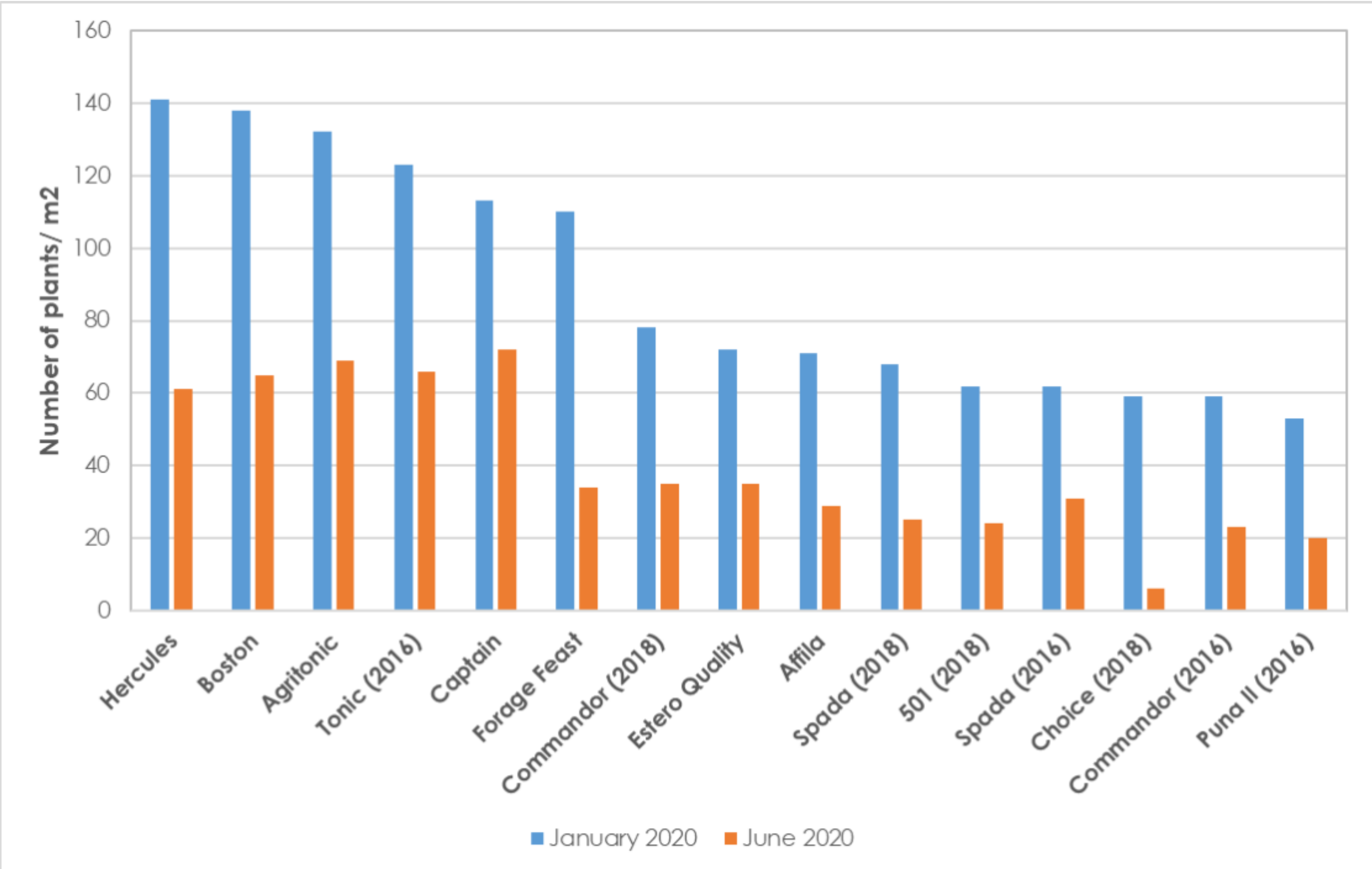

Figure 2: Plant population counts for chicory and plantain on January and June 2020.

Summary

Total yield over 17 months:

- Highest yielding were the plantain cultivars Agritonic, Tonic, Captain and the chicory cultivar Affila. The cultivars with similar yields were 501, Spada, Commander Puna II, and Estero Quality.
- The yield of the best four cultivars was between 31,5 and 32,0 t DM/ha for 17 months which included the establishment period.

First summer:

The best cultivar was Boston with 9.2 T DM/ha, but unfortunately this is a very winter dormant cultivar with almost no winter yield at all. The cultivars with a similar yield ranged from 9.1 t DM/ha down to 8.1 t DM/ha. Hercules was in that group but is also very winter dormant. The other cultivars were Captain, Agritonic, Commander, Estero Quality, 501, Affila and Spada.

Second summer:

The best cultivars were Agritonic, Tonic and Affila. Compared to the first summer their yield was 24%, 23% and 24% respectively lower than the first summer. However with a yield of between 6.2 and 6.6 t DM/ha this is still double the yield of ryegrass in the second summer. These plants are six months younger though in the second summer than the ryegrass since they were spring-planted. The following cultivar evaluation trial for forage herbs will be autumn-planted.

Autumn:

The ***autumn yield*** was good for most of the cultivars with 10 out of the 15 cultivars yielding between 5.7 and 6.1 t DM/ha. Another two were similar with 5.6 and 5.2 t DM/ha and only the three winter dormant cultivars were significantly lower yielding ($p < 0.05$).

Winter:

The ***winter yield*** showed the greatest differences between cultivars. Tonic was highest yielding 3.6 t DM/ha with Captain at 3.4 t DM/ha being similar. Agritonic was lower (p, 0.05) at 3.1 t DM/ha followed by most of the chicory cultivars in a group yielding between 2.7 and 2.2 t DM/ha. The three winter dormant cultivars Forage Feast, Hercules and Boston yield 0.4 t DM/ha and less. For winter production it would thus be best to choose one of the three winter active plantain cultivars.

Both chicory and plantain have the potential for very good summer and autumn yield. Winter yield comparable with ryegrass is possible with the winter active plantain cultivars. The good cultivars also show persistence which can mean reduced requirements for reseeding in the second year.

Comparing the production potential of perennial ryegrass, tall fescue, chicory and plantain

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Introduction

The temperate species most commonly used for intensive pasture production are *Lolium multiflorum* and *L. perenne*, which are productive under intensive irrigated pasture systems and have good forage quality required for milk production. In South Africa the ryegrass species have also formed the basis of intensive dairy pastures for many decades. However more recently there has been an ever increasing realization that dairy pastures require more resilience and robustness. Contributing factors are drought and reduced irrigation water availability as are overall changes in climate. Some of the reasons for reduced irrigation water availability are drought, increased area under irrigation as well as increased human and industrial needs. Costs are a consideration in terms of annual establishment as are for instance nitrogen use efficiency. The objective was to compare yield and forage quality of alternative species with perennial ryegrass to determine their potential and suitability for use as dairy pastures.

The species considered as possible alternatives are *Festuca arundinacea* (Tall fescue) and forage herbs, being *Cichorium intybus* (chicory) and *Plantago lanceolata* (plantain). The characteristics that the species should have are perenniality, be deeper rooted than ryegrass, highly productive, stable yielding potential over years and sufficient forage quality for dairy production requirements.

Species diversity on either a paddock scale as mixtures or on a farm scale where paddocks are planted to different species and rotated over time, could increase robustness.

Data for the comparison

The data is taken from cultivar evaluation trials conducted on the Outeniqua Research Farm. Defoliation was determined according to the requirements for each species being leaf stage (physiological stage) for the grasses and height for the forage herbs. They all received similar fertilizer and irrigation rates and data from the same seasons were used for each species. The data are compared on a seasonal and annual basis. (More comprehensive data is available in the presentation given on this topic).

Results and discussion

The total DM yield (Figure 1) for fall fescue, forage herbs (chicory and plantain) and perennial ryegrass are 13.8, 21.9 and 13.2 t DM ha^{-1} respectively for the first year and 13.4, 19.2 and 12.8 t DM ha^{-1} for the second year (Figure 2). Within the forage herbs chicory yielded 22.6 and plantain 25.8 t DM ha^{-1}. The annual yield clearly shows that the alternative species not only have potential but are similar to or higher yielding than ryegrass (Figures 1,2 and 3).

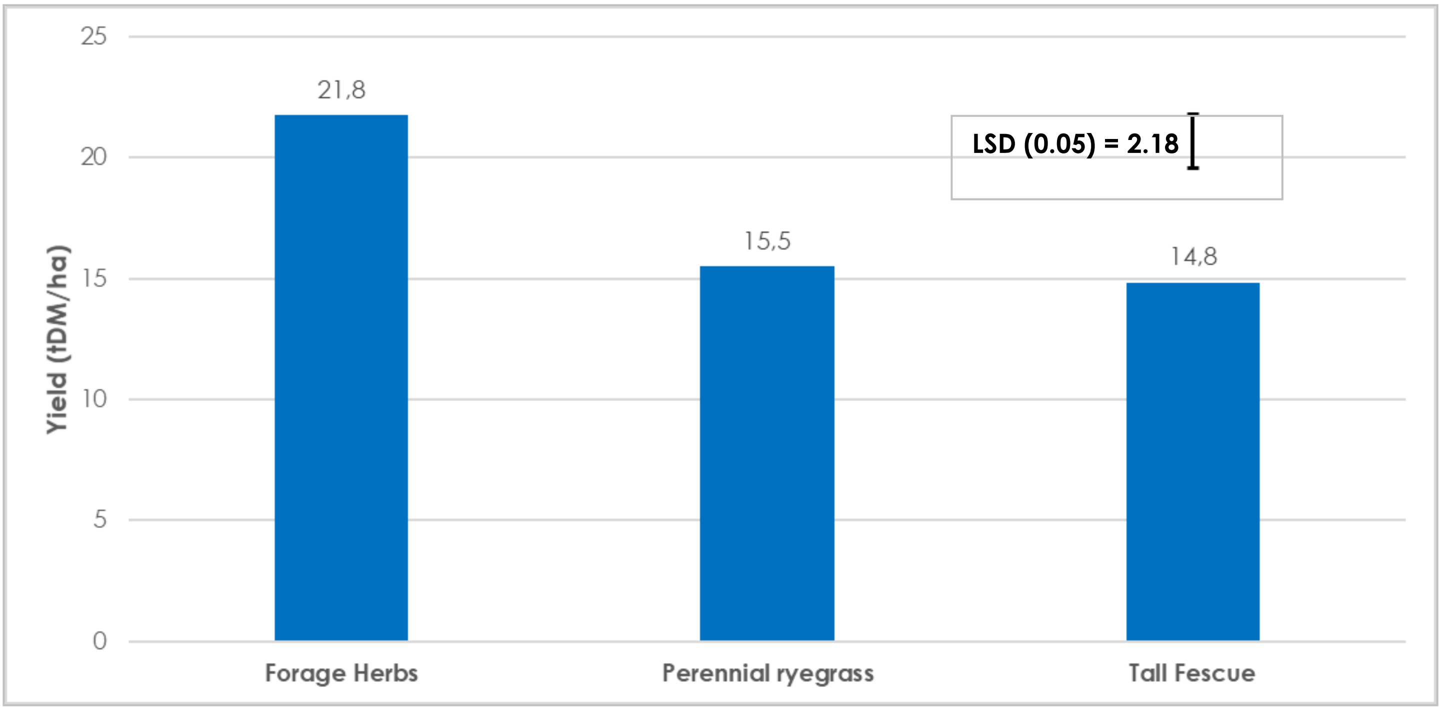

Figure 1: Annual yield for the first year, including the establishment period for forage herbs (mean of chicory and plantain), perennial ryegrass and tall fescue (mean of the cultivars for each species).

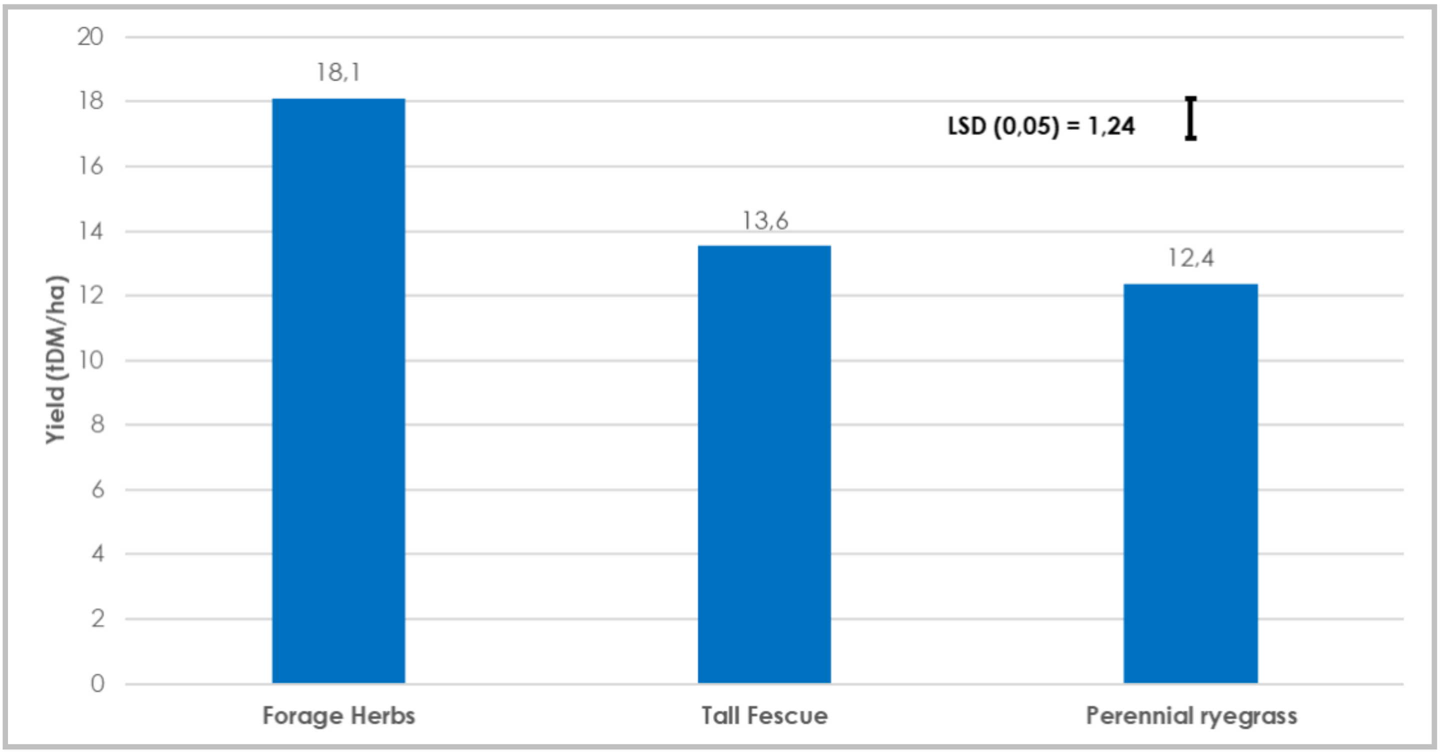

Figure 2: Annual yield for the second year for forage herbs (mean of chicory and plantain), perennial ryegrass and tall fescue (mean of the cultivars for each species).

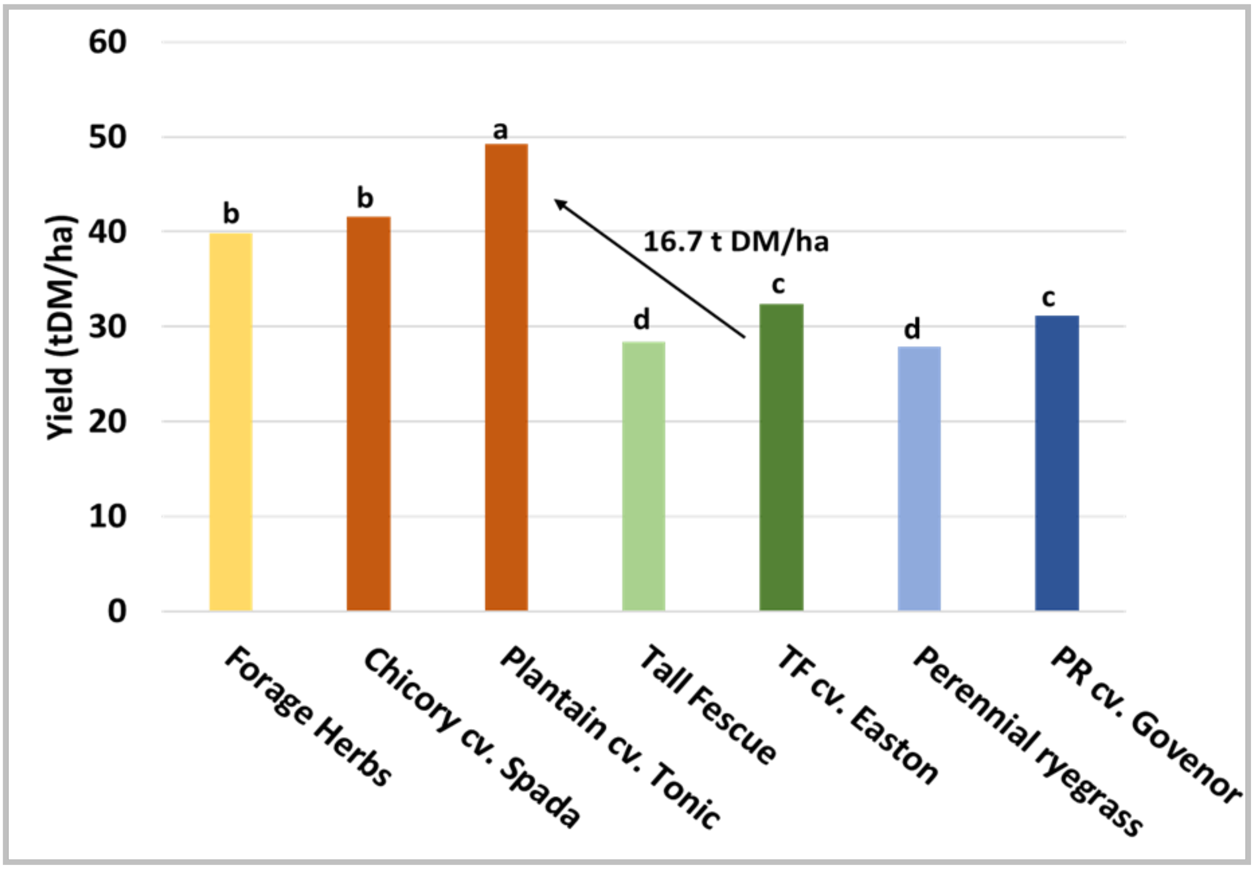

Figure 3. Total yield for two years for the mean of the species and for the best cultivar in each species in the trials.

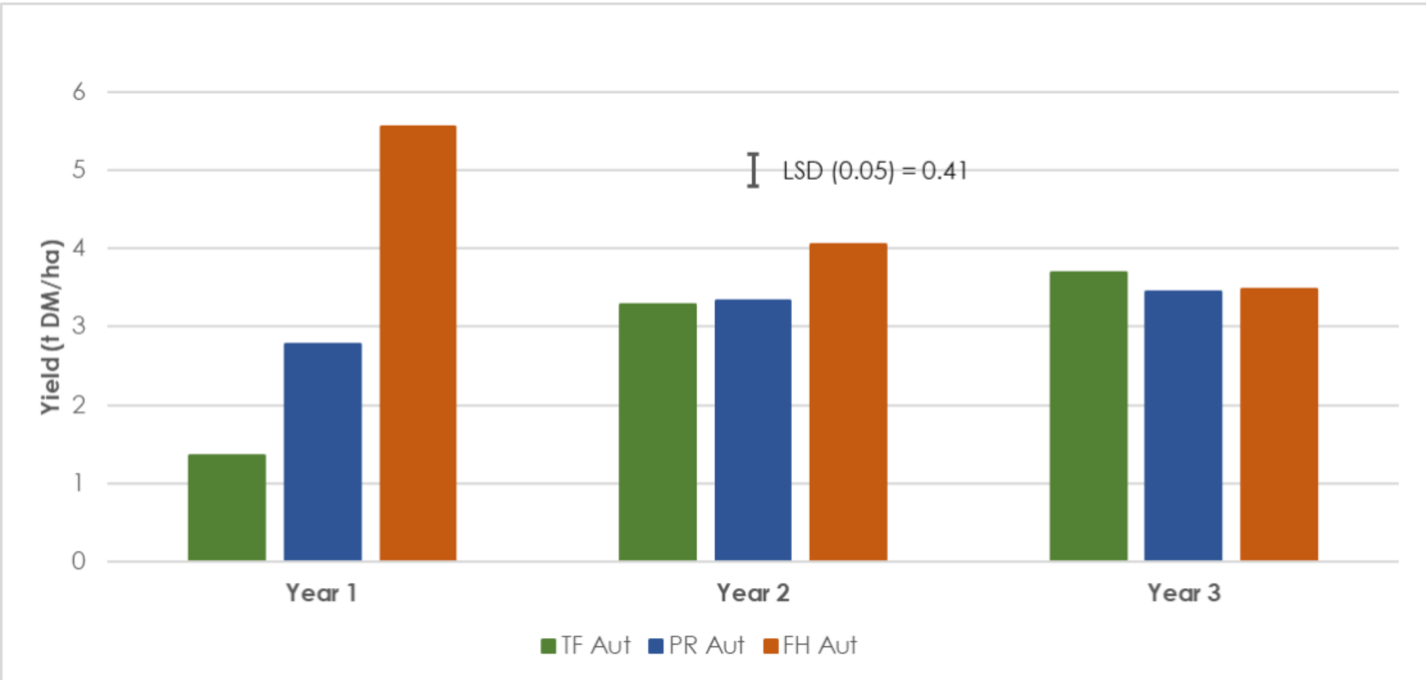

Figure 4. Autumn yield (t DM/ha) over three consecutive years for tall fescue (TF), perennial ryegrass (PR) and forage herbs (FH).

For the first autumn forage herbs are significantly superior with 5.56 t DM ha^{-1} ($p<0.05$) with perennial ryegrass at 2.78 and tall fescue at 1.36 t DM ha^{-1}. This is however the establishment month for grasses while the forage herbs are established in spring already. In the second autumn the forage herbs are significantly higher yielding than the grasses ($p<0.05$), while there are no differences ($p<0.05$) in the third autumn. (Figure 4).

In winter perennial ryegrass (3.2 t DM ha-1) is higher yielding ($p<0.05$) than the other species however on a cultivar level there are differences with plantain at 4.1 and the forage herb mean for all cultivars at 2.1 t DM ha-1 (Figure 5 and 6).

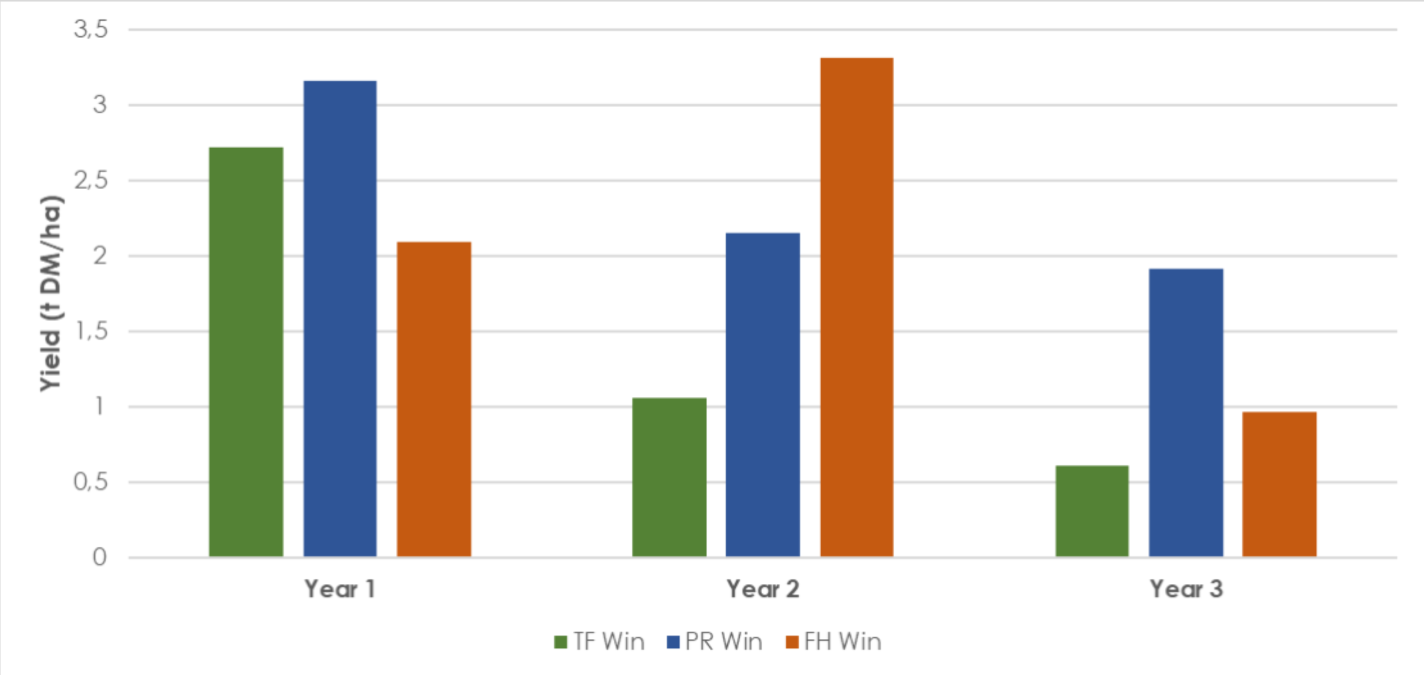

Figure 5. Winter yield (t DM/ha) over three consecutive years for tall fescue (TF), perennial ryegrass (PR) and forage herbs (FH)(LSD (0.05) is 0.41).

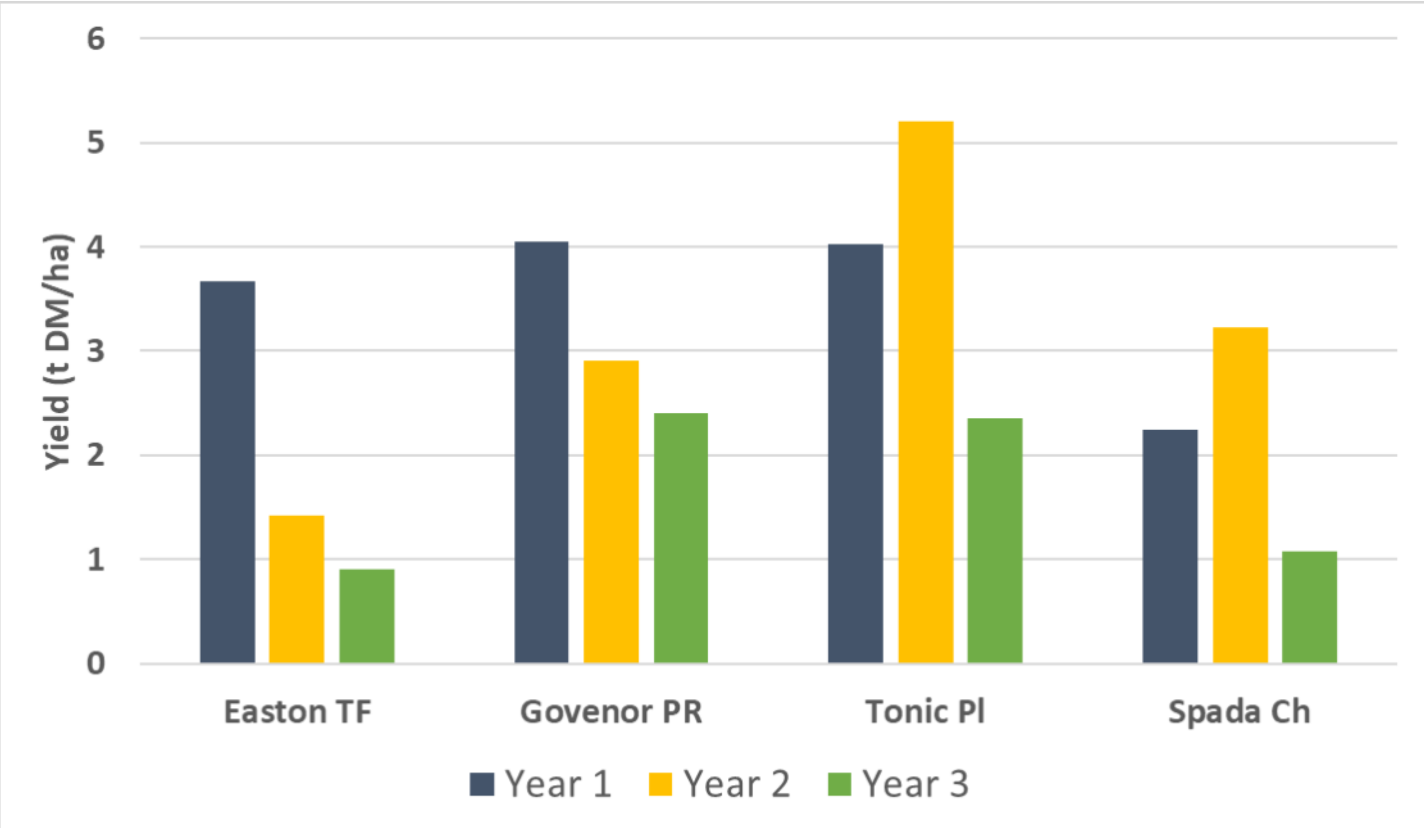

Figure 6. Winter yield (t DM/ha) for three consecutive years for specific cultivars of tall fescue (TF), perennial ryegrass (PR), plantain (Pl) and chicory (Ch).

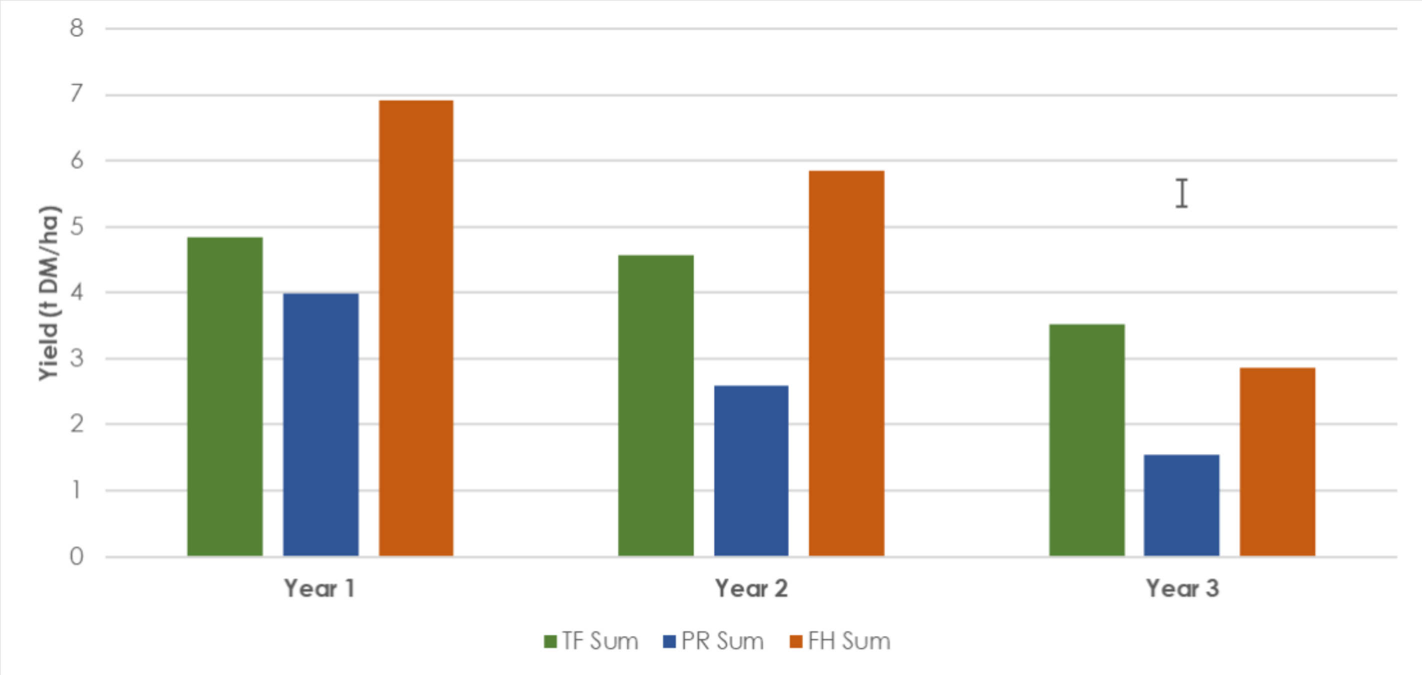

Figure 7. Summer yield (t DM/ha) over three consecutive years for tall fescue (TF), perennial ryegrass (PR) and forage herbs (FH) (LSD (0.05) is 0.41).

Similarly for summer (Figure 7) the forage herbs are significantly superior ($p < 0.05$) over all three years. Figure 3 shows the DM yields for the total yield over two years.

Crude protein (CP) levels are comparable between perennial ryegrass (20 to 28%) and tall fescue (16 to 28%) with a strong seasonal variation, while the forage herbs maintain a more constant level above 20% peaking at 26%. The fibre content (NDF) in tall fescue ranges from 40 to 54%, for forage herbs 30 to 38% and perennial ryegrass 42 to 48%, season dependent.

For these species to be successful, it is important to take note of their requirements for the establishment phase which are more specific than for ryegrass.

Soil temperature requirements

- Tall fescue >15 °C (for rapid establishment) – early autumn (Dairy NZ 2010 a)
- Chicory >12 °C
- Plantain 10 – 12 °C (Lee and Minnee 2012, Agricom 2015)

First grazing

- Tall fescue the plants must be firmly rooted and should have more than 2 leaves
- Chicory 7-leaf stage
- Plantain 6 to 7-leaf stage (Lee and Minnee 2012, Agricom 2015)

Grazing management after establishment

- Tall fescue is a 4-leaf plant but maximum growth rate is at 2.5-leaf (Chapman et al 2014)
- Chicory 25 – 30cm height, not grazed lower than 4-5cm (Dairy NZ 2010 b)
- Plantain 20 - 25cm height, not grazed lower than 4-5 cm(Dairy NZ 2010 c)

Conclusions

The alternative species tall fescue, forage chicory and plantain are highly productive and compare favourably with perennial ryegrass although the seasonal yield distributions do differ. They have a stable yielding potential over years and can be grown for two years without over sowing. The forage quality parameters fall within the suitable range for dairy production requirements off pasture.

References

Agricom 2015. Herb and Legume Guide. www.agricom.co.nz

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

Dairy NZ 2010 a. 1-28 Farmfact Tall Fescue establishment and management

Dairy NZ 2010 b. 1-72 Farmfact Chicory - establishment and management

Dairy NZ 2010 c. 1-78b Farmfact Plantain management (1-78b)

Lee J and Minnee E. 2012. Chicory and plantain – your questions answered. Dairy NZ Technical Series Issue 11.

Farm system study: Development of dairy systems based on forage herb pastures in the southern Cape

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Introduction

High stocking rates, poor persistence of pastures, an increase in weed ingression in no-till pastures and increasing input costs associated with irrigation and fertilisation, are putting a strain on the ability of pasture based dairy producers to maintain acceptable forage quality and pasture yields within their systems in the southern Cape. This in turn, threatens the continued sustainability of these systems. Research should thus focus on strategies that can improve the resilience and efficiency of pasture systems.

The inclusion of forage herbs, such as Plantain, 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
- 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).

However, before 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, but also related to the rate of weed ingression, over years 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.

The aim of this study is thus to determine the whole system production potential and efficiency of three pasture systems based on the current system (Kikuyu -ryegrass), monocultures of alternative species (Tall fescue and plantain) and a pasture mixture that includes alternative species (Tall fescue, plantain and red clover). This paper will focus on the preliminary data collected during year one of the planned three year study, with data primarily presented in the form of index values for comparison purposes.

Site description

The study is being carried out on the Outeniqua Research Farm (altitude 210 m, 33°58'38" S and 22° 25'16"E) in the Western Cape Province of South Africa. The mean annual rainfall (30 year average) in this area is 725 mm, with mean minimum and maximum temperatures ranging between 7-15°C and 18-25°C respectively (ARC 2010).

Treatments, site selection and layout

The project is evaluating three pasture systems based on different pasture species and types. The first system, which will be referred to as "Unimproved" (UI), is based on kikuyu-ryegrass pasture, and is aimed at representing a typical long term no-till pasture in the region. The second system, or "Monoculture" (MC), consists of two separate areas, one planted to a monoculture of plantain (*Plantago lanceolata*) and the other to Tall Fescue (*Festuca arundinacea*). The third system is based on a diverse pasture mixture (DPM) consisting of Tall Fescue, plantain and red clover.

The trial is being conducted in the form of a full farmlet study over a three year period. 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, the planned project will be 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 area identified for the project has a negligible gradient in slope and as such, the primary criteria utilised to identify the research site(s) was soil type based on a soil survey map of Outeniqua Research Farm (Measured Agriculture, Greyton). Each farmlet is approximately 5 ha in size, with 60% allocated to a Katspruit soil type and the remaining to a Witfontein soil type.

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 (for example botanical composition determination or weekly pasture measurement), 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 allocation), sampling occurred on a grazing strip basis.

Pasture establishment

The plantain pasture was established in October 2018. Two applications of a non-selective contact herbicide (200 g/L Glufosinate ammonium applied at 6L ha^{-1}) were used to spray off the existing pasture approximately a month before establishment. The remaining residue was then mulched to ground level (1.6 meter Nobili with 24 blades) and the plantain planted utilising a modified Aitchison no-till seeder with press wheels.

The other pastures were established during March 2019. The area earmarked for the establishment of Tall Fescue and the diverse pasture mixture was sprayed off with a non-selective contact herbicide (200 g/L Glufosinate ammonium applied at 6L ha^{-1})

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

System	Abbreviation	Species	Scientific name	Variety*	Seeding rate (kg ha^{-1})
Unimproved	**UI**	Kikuyu	*Pennisetum clandestinum*	Existing sward	-
		Perennial ryegrass	*Lolium perenne*	24Seven	25
Monoculture	**MC**	Tall Fescue	*Festuca arundinacea*	Easton	25
		Plantain	*Plantago lanceolata*	Tonic	8
Diverse pasture mixture	**DPM**	Tall fescue	*Festuca arundinacea*	Easton	20
		Plantain	*Plantago lanceolata*	Tonic	3
		Red clover	*Trifolium pratense*	Oregon red	3

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, a follow up application of a non-selective contact herbicide (200g/L Paraquat at 4L ha^{-1}) was undertaken, with remaining residue mulched to ground level just prior to establishment. The mono-culture Tall Fescue, which initially made up 80% of the monoculture system area, was established using a standard planting method with a modified Aitchison no-till seeder with press wheels.

In the autumn of 2019, a further 20% of the monoculture area was converted to plantain by spraying of the Tall Fescue (200 g/L Glufosinate ammonium applied at 6L ha^{-1}) in January, a second time in February and then planting in March.

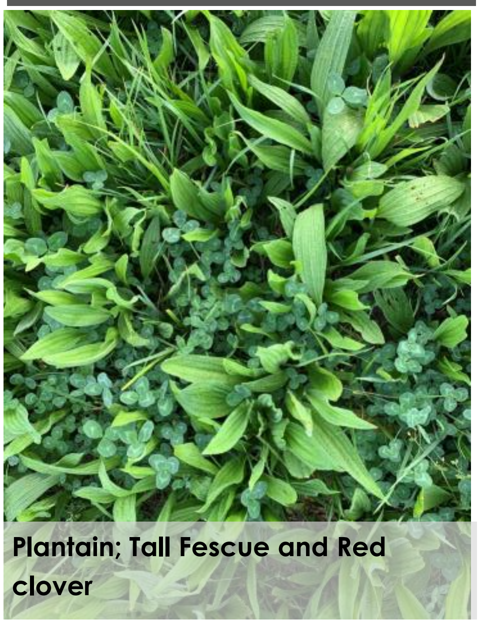
In order to facilitate the shallow planting depth required for the small seeded plantain and clover, this mixture site was "cross-planted". This entailed planting the Tall Fescue parallel to the length of grazing strips (i.e. from front to back), followed by the plantain/red clover mixture perpendicular to this (right to left).

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.

1. Unimproved system:

2. Monoculture system

3. Diverse pasture mixture system



The kikuyu-ryegrass pasture was over-sown on an annual basis (2019 and 2020) as is common practice in the region, motivated by the poor persistence and resultant decline in yield of ryegrass that occurs from year 1 to year 2, even in pure swards under cutting (van der Colf et al. 2016). In addition, during the summer of year 1 (January 2020), 20% of the kikuyu-ryegrass platform was identified as severely degraded due to the ingression of *E. plana*. This area was sprayed of and planted to perennial ryegrass in March.

Trial animals

Each system was allocated its own "mini-herd" of animals, selected to maintain days in milk (DIM) at approximately 150 and provide a constant flow of animals into and out of the system. Milk yield and milk composition form 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" are dried off, they will be replaced by animals from the systems' "dry herd" as they calve. This may result in periods when the pasture area for each system is stocked below or above the 24 animals/system.

Pasture parameters

Pasture yield (kg DM ha-1)

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. 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 will also be used for pasture allocation purposes (see section on "Pasture allocation and conservation").

Botanical composition (%)

Botanical composition will be estimated by placing three 0.098 m2 rings randomly within a sub-plot on monitor strips before grazing/cutting and cutting samples to a height of 50 mm above ground during each grazing cycle. The three samples will be 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 2.

Animal parameters

Cows were milked twice daily at, 07:00 and 15:00, utilising a 20 Point Waikato/Afikim swing over milking machine with electronic meters. The machine is fully automated with weigh-all electronic milk meters that will allow daily milk production of each individual cow to be measured.

Milk composition was determined on an approximately monthly basis from a 24 mL composite morning and afternoon milk sample of 16 mL and 8 mL, respectively. Samples will be analysed for butterfat (BF), lactose and milk urea nitrogen (MUN) content (Milkoscan FT 6000 analyzer; Foss Electric, Denmark) by Merieux Nutriscience Pty (Ltd) (Stellenryk Building, Constantia Square Office Park,

Table 2. Components into which botanical composition samples will be fractioned

System	Sown components	Volunteer/weed grasses	Broadleaf weeds	Volunteer legumes
UI	Kikuyu Ryegrass	*Paspalum urvillei** *Eragrostis plana** *Sporobolus africanus** *Bromus catharticus** *Poa pratensis** Other*	All	All
DPM	Tall Fescue Plantain Red clover	Same as above* (UI) Ryegrass	All	White clover Trefoil
MC	Plantain site	Same as above* (UI) Ryegrass	All	White clover Trefoil
	Fescue site	Same as above* (UI) Ryegrass	All	All

526 16th Street, Randjespark, Midrand, 1685). In addition, daily milk composition in terms of milk protein, lactose and fat will be available as determined by the Afimilk milking system.

Pasture and grazing management

Pasture allocation

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 rate of 10 kg DM cow^{-1} day^{-1} (approximately 2% of body weight), with a fresh piece of pasture provided at a rate of 5 kg DM cow^{-1} after each milking. On the MC system, animals will be allocated plantain according to the proportional availability of the pasture within a period, with the rest of the intake allocated to Tall Fescue. Cows receive 2 kg of dairy concentrate at each milking, equating to a total of 4kg cow^{-1} day^{-1}.

Weekly farm walks and fodder flow management

In order to facilitate ease of management of fodder flow within the respective systems, pasture will be measured on a weekly basis for the entire study site. For this purpose, grazing strips were allocated to 0.5 ha monitoring blocks on which average leaf number and pasture height will be determined using a RPM. Based dry matter yield on a farmlet scale and the estimated pasture requirement for animals, it was determined whether pasture availability on the pasture platform was in excess of animal requirements (surplus) or lower than requirements (shortfall). The following strategies were followed under these circumstances:

- ***Shortfall in winter of year 1:*** Animals will be supplemented with bought in feed in the form of lucerne hay.
- ***Shortfall in year 2 and 3:*** Grass silage from system fed to cow groups in isolation. Any shortfall beyond silage will be met by Lucerne.
- ***Surplus:*** Area will be cut to make wrapped grass silage. Plantain will 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 allow for the determination of fodderflow dynamics within the tree systems.

Fertilisation

Corrective fertilisation application for the entire project site will be based on annual soil sample analysis results for the 0-100 mm soil depth and the recommend soil nutrient levels as per Beyers (1973).

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.

Determination of index values

The parameters that were included in the construction of the preliminary index values are shown in Table 3 (modified from Scott et al. 2013b).

As per Scott et al. (2013b), data will undergo normalisation as follows:

- For desirable traits, such as pasture or milk yield, the values will be divided by the maximum value achieved across the three systems.
- For undesirable traits, such as weed content or costs, the minimum value over the three farmlets will be divided by the value for each farmlet.

Table 3. Parameters included in the index values for three farmlets

Pasture index	Fodder-flow index	Milk index
Pasture yield	Grazing capacity	Milk yield per cow
Sown component contribution	Cow days on pasture vs. on bales	Butterfat content
	Area cut for silage	Milk protein content
	Number of bales	
	Proportion of pasture available during re-establishment for grazing	

For example, if the three treatments yielded UI= 1200 kg DM/ha; MC = 1400 kg DM/ha and MIX=1600 kg DM/ha, respectively, the "index values" would be:

- UI: 1200 ÷1600 = ***0.75***
- MC: 1400 ÷ 1600 = ***0.875***
- MIX: 1600 ÷ 1600 = ***1.00***

These values will be used to construct non-weighted composite index values for various aspects within each system viz. pasture, fodderflow and milk (Table 3). For the purpose of this paper, component index values were totalled within season and eventually over year 1.

Results and Discussion

Pasture yield

The mean monthly pasture yield (kg DM/ha) for the three pasture systems is shown in Figure 1.

The mixture system yielded higher than the other two systems from July to April. Compared to the kikuyu-ryegrass system, the monoculture system had a higher or similar yield from July to October. Thus, both of the alternative systems have the potential to compete favourably with the kikuyu-ryegrass system during winter and spring in terms of pasture yield.

During summer and early autumn (from January to April) the monoculture system had lower yields than the kikuyu-ryegrass system. However, data on forage quality may provide more insights on the potential of these two pasture systems to support high yielding dairy cows.

During May, the pasture yield of the kikuyu-ryegrass pasture was appreciably lower than for the other two systems. This period coincided with the period when newly over-sown ryegrass pastures were being grazed on this system. In contrast, the majority of pastures on the other two systems were well established pastures that were not over-sown, and were thus higher yielding.

The total annual pasture yield of the three systems were:

- Kikuyu-ryegrass: 14.3 t DM/ha
- Mono-culture: 15.8 t DM/ha
- Mixture: 18.0 t DM/ha

During year one, the mixture and monoculture yielded 3.7 and 1.5 t DM/ha more than the kikuyu-ryegrass system, respectively.

To determine how well pastures will persist and their potential to yield over more than one year, the second year of data will be invaluable, particularly in terms of yielding ability in winter of year 2.

Milk yield

The monthly average milk yield per cow (kg/cow/day) is shown in Figure 2.

The highest yielding treatment in terms of milk yield per cow during winter was not stable. From October onwards, in other words from spring to autumn, the mixture system supported a higher milk yield per cow than both the kikuyu-ryegrass and monoculture system. The difference between the latter two systems was relatively small from September to February, but during April the monoculture system yielded 1.5 L/cow/day more than the kikuyu-ryegrass system.

The extremely low milk yields reported during April can be attributed to the change from twice a day milking to once a day milking during this period. This was done to reduce labour requirements during the COVID 19 lockdown period. Of interest is that during

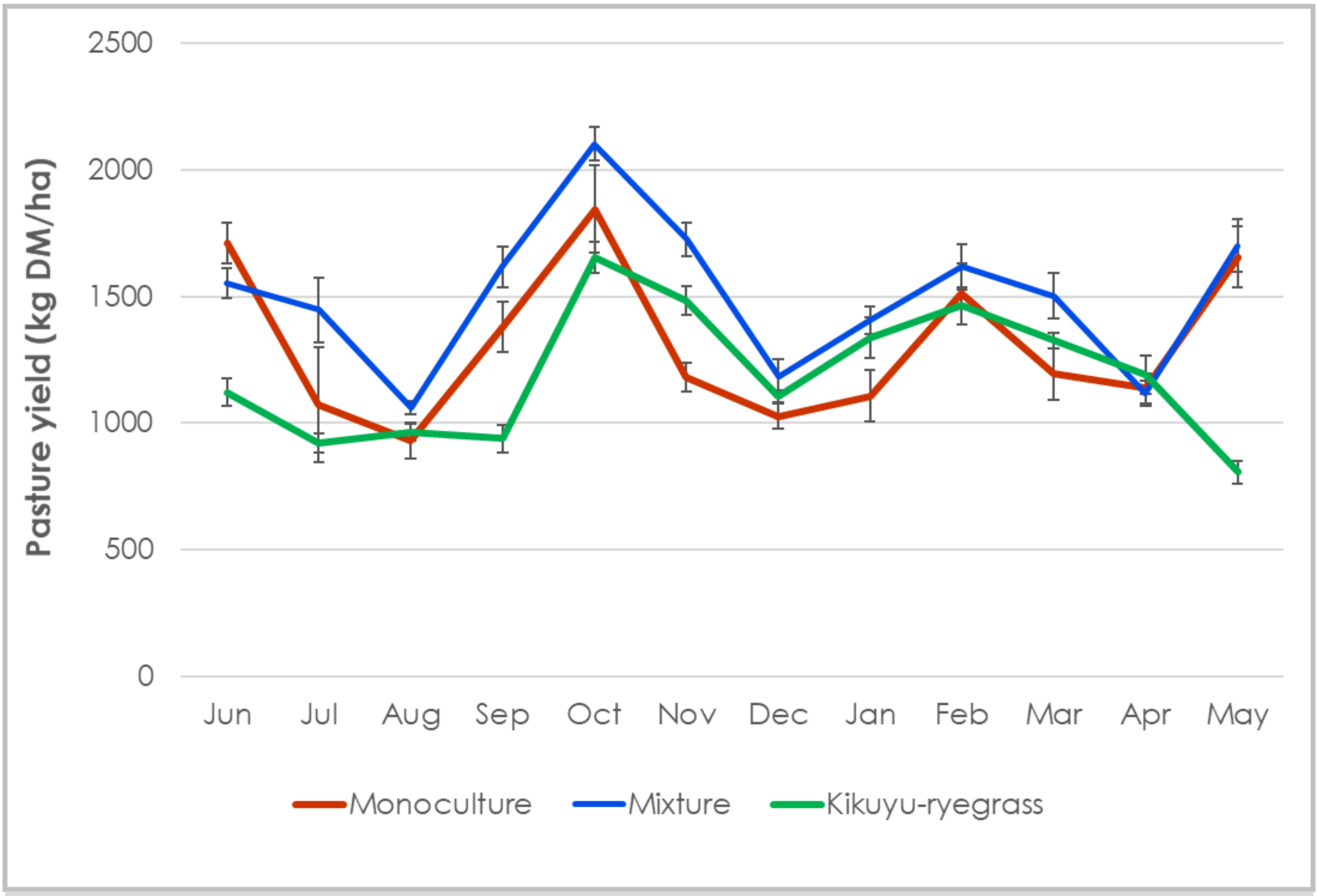


Figure 1. Monthly pasture yield (kg DM/ha) of the mixture, monoculture and kikuyu-ryegrass systems

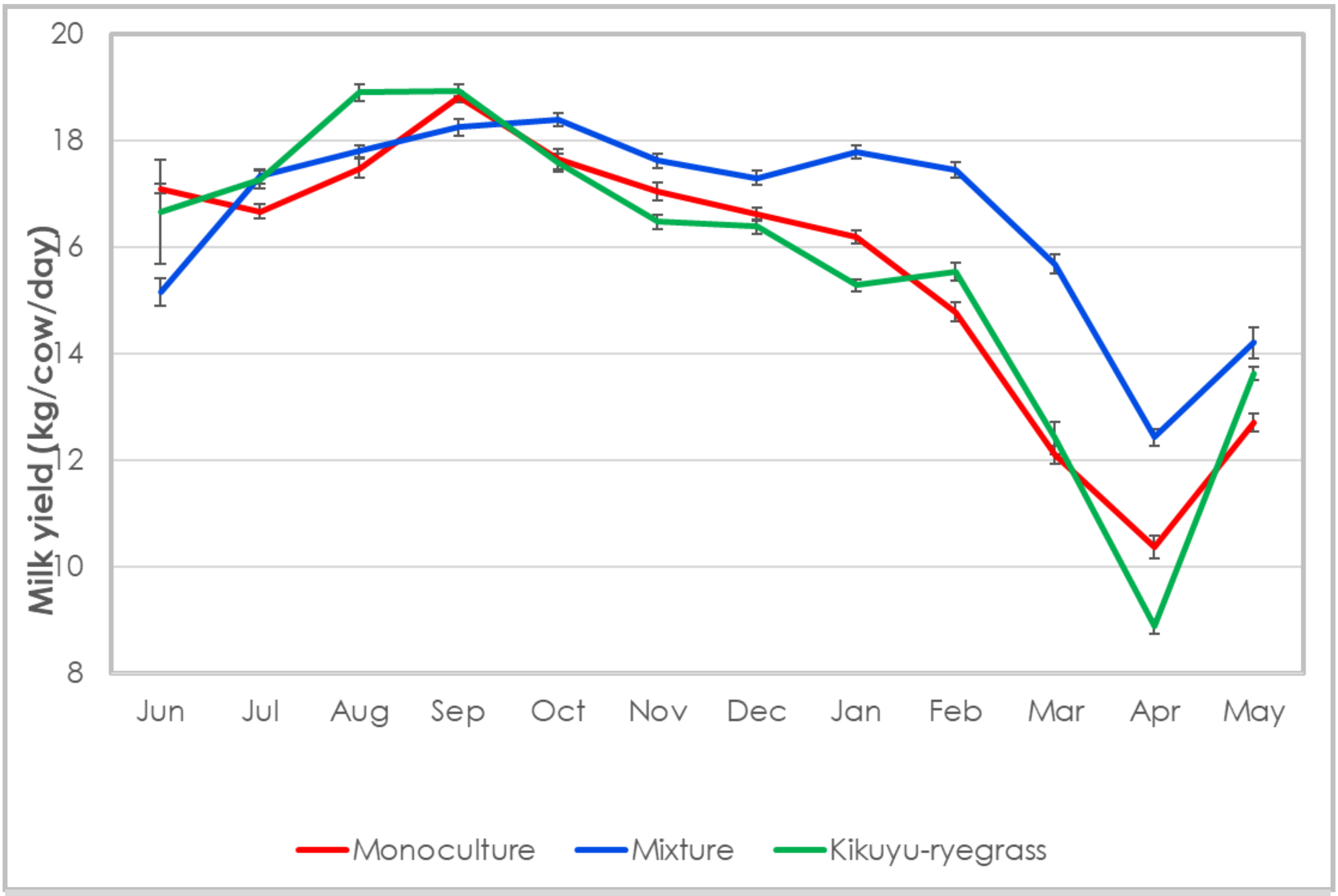


Figure 1. Monthly milk yield per cow (kg/cow/day) of the mixture, monoculture and kikuyu-ryegrass systems

April the mixture system yielded 4 kg more milk per day than the kikuyu-ryegrass system.

The total annual milk yield per hectare of the three systems was:

- Kikuyu-ryegrass: 27126 kg milk/ha
- Mono-culture: 29834 kg milk/ha
- Mixture: 31592 kg milk/ha

The mixture yielded 4 466 kg and the monoculture 2 708 kg more milk per ha than the kikuyu-ryegrass system during year one. This was the result of a combined effect of higher grazing capacity and milk yield per cow achieved by the mixture system during year 1, particularly during spring and summer. The higher milk yield per ha in the monoculture system than the kikuyu-ryegrass system, was primarily driven by grazing capacity and not milk yield per cow.

Index values

The total annual and seasonal index values of the three pasture systems is shown in Table 4. When interpreting index values, the following should be kept in mind:

- Index values do not have units, and function solely to compare parameters relative to each other
- For this paper, a higher index value indicates a more favourable performance for a specific parameter
- Monthly index values were summed to obtain seasonal index values.

The mixture system had the highest ***pasture index*** during all seasons, while it also maintained the highest index values for pasture yield and sown components, respectively, during this period This indicates that as a pasture, the mixture was capable of maintaining a good yield and favourable botanical composition during year 1. In contrast, the kikuyu-ryegrass system had the lowest pasture index form spring to autumn due to its poor performance in terms of pasture yield and botanical composition.

The purpose of the ***fodder flow index*** is to evaluate how the systems will compare in terms of their potential to be self-sustaining in terms of roughage supply. In terms of grazing capacity, there was no one system that performed well over all the seasons. A potential reason for this could be that different parameters drove favourable index values during different seasons viz.

- ***Winter:*** grazing capacity and the need for supplemental feeding to fill fodderflow gaps.
- **Spring and summer:** the potential to conserve pasture as silage.
- **Autumn:** the potential of a system to support animals on pasture rather than feeding conserved fodder. This is indirectly related to the need to re-establish pastures, as this will reduce the graze-able area.

The highest annual fodderflow index was achieved by the mixture system. Although it only had the highest seasonal index value during spring, it did tend to show more stability across seasons for this index than the other two systems, particularly in terms of grazing capacity.

The mixture had the highest total ***milk index value*** (31.2), followed by the monoculture (29.8) and the kikuyu-ryegrass (29.6). On seasonal basis, the milk index was highest for the mixture during spring summer and autumn, for the kikuyu-ryegrass during winter and for the monoculture during spring. In terms of milk yield, the mixture had the highest index during all seasons, except winter. Milk components had no discernible seasonal trends, but it should be noted that the higher yield in the mixture system from spring to summer was not associated with a suppression of milk components.

When constructing a index value that consists of all index values and totalled over the seasons, the mixture had the over-all highest index value. This is expected, as it also had the overall highest pasture, fodder-flow and milk index values.

Conclusion

Results reported in this paper are still very preliminary, but do indicate that the inclusion of plantain 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. When all parameters for pasture, milk and fddderflow are considered, the mixture system performed the best during year 1. However, it is likely that a combination of the systems on a whole farm scale will be the most effective at spreading risk for the producer. In this way the producer can use a kikuyu-ryegrass (or

Table 4. The total seasonal and annual index values for three pastures systems (index values do not have units and are determined by normalizing actual values).

	Pasture yield	Sown component	Pasture index	Grazing capacity	Cow days on pasture vs silage	Area conserved	Number of bales made	Re-establishment*	Fodder flow index	Milk yield (kg/day)	Milk fat (kg/day)	Milk Protein (kg/day)	Milk index	Total
Winter[1]														
MC[2]	2,62	2,40	5,02	**2,91**	**1,80**				**4,71**	2,90	1.92	1.90	6.68	16.41
MIX[3]	**2,91**	**2,97**	**5,88**	2,75	1,47				4,22	2,80	1.86	1.90	6.60	**16.70**
UI[4]	2,21	2,93	5,14	2,38	1,70				4,08	**3,00**	**1.95**	**1.95**	**6.90**	16.12
Spring														
MC	2,41	2,37	4,78	2,62		1,32	1,23		5,17	2,92	**2.95**	2.95	**8.82**	18.77
MIX	**3,00**	**3,00**	**6,00**	**3,00**		**1,63**	**1,58**		**6,21**	**2,96**	2.70	**2.97**	8.63	**20.84**
UI	2,23	2,27	4,50	2,32		1,33	1,08		4,73	2,89	2.85	2.90	8.64	17.87
Summer														
MC	2,59	2,51	5,10	2,74		0,46	0,38	0,74	4,32	2,72	2.87	2.80	8.39	17.81
MIX	**3,00**	**3,00**	**6,00**	**2,89**		1,00	0,63	**1,00**	5,52	**3,00**	**2.99**	**3.00**	**8.99**	20.51
UI	2,79	2,13	4,92	2,77		**2,00**	**2,00**	0,79	**7,56**	2,70	2.74	2.72	8.17	**20.65**
Autumn														
MC	2,72	1,69	4,41	2,51	**2,70**			1,47	**6,68**	2,50	1.76	1.68	5.94	17.03
MIX	**2,94**	**2,00**	**4,94**	1,99	2,51			**2,00**	6,50	**3,00**	**2.00**	**2.00**	**7.00**	**18.44**
UI	2,36	1,58	3,94	**2,57**	2,14			1,13	5,84	2,47	1.69	1.74	5.90	15.68
Annual														
MC	10,34	8,97	19,31	**10,78**	**4,50**	1,78	1,61	2,21	20,88	11,04	9.50	9.29	29.83	70.02
MIX	**11,85**	**10,97**	**22,82**	10,63	3,98	2,63	2,21	**3,00**	**22,45**	**11,76**	**9.55**	**9.92**	**31.22**	**76.49**
UI	9,59	8,91	18,50	10,04	3,84	**3,33**	**3,08**	1,92	22,21	11,06	9.23	9.31	29.61	70.32

[1]Seasonal index value is obtained from summation of monthly index values within a season

[2]MC: Monoculture [3]MIX: Mixture [4]UI: Unimproved kikuyu-ryegrass

Highest value within season is in **BOLD–** higher values are more favorable ryegrass) system for winter its fodderflow, the mixture system for its superior milk and pasture yielding ability in spring and summer and the monoculture swards to reduce the need to re-establish pastures during autumn and thereby improving fodderflow in this season. Going forward, a weighted index, that contains forage quality data and a ecological index, could be of value to further refine the systems and their comparison.

References

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.

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.

Lowe KF, Bowdler TM. 1995. Growth, persistence, and rust sensitivity of irrigated, perennial temperate grasses in Quennsland subtropics. Australian Journal of Experimental Agriculture, 35,571-8

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.

Murrison R, Scott JM. 2013. Statistical methodologies for drawing causal inference from an unreplicated farmlet experiment conducted by the Cicerone project. Animal Production Science 53:643-648.

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.

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.

van der Colf J, Ammann SB, Zulu LB, Lombard MM. 2016. Pasture dry matter yield of perennial ryegrass and ryegrass hybrids in the southern Cape. Outeniqua Research Farm Day 2016 Booklet. 21-27.

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.

Essential oils as a feed additive for Jersey cows grazing ryegrass pasture in the spring

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Introduction

Milk production from a pasture-based system is a common practice used in the Southern Cape region of South Africa (Botha et al., 2008). Pasture-based systems are the most cost-effective way of producing milk, because pasture is the cheapest form of forage available to dairy cows (Clark and Kanneganti, 1998). Although a kikuyu-ryegrass pasture is suitable for sustaining high production rates it is not sufficient to meet the required nutrient and mineral levels of high producing dairy cows (Botha, 2003). Supplementing dairy cows with a high energy concentrate is needed. Concentrates should be formulated to meet the dietary needs of the animals.

Feed additives are feed ingredients that may cause a wanted animal response in a non-nutrient role and help animals utilize nutrients better. Feed additives are regularly included when concentrates are formulated for dairy cows (Hutjens, 2011). The use of ionophores in animal feed has been very successful in manipulating the rumen environment and increase growth, milk yield and feed intake (DiLorenzo and Galyean, 2010). However the use of ionophores in animal feed has been banned in the European Union since 2006 and is facing increasing concerns from public health aspects and reduced social acceptance (Promotion, 2011). Since the banning of ionophores much research has focused on plant extracts, like essential oils, as a more sustainable alternative to improve feed efficiency and animal performance (Benchaar et al., 2010). The aim of the study was to determine the effect of supplementing a combination of three essential oils thymol, eugenol and cinnamaldehyde on milk production, milk composition and rumen environment of cows grazing kikuyu/ryegrass pasture in spring.

Materials and methods

The study was conducted during the late winter and early spring of 2019 at the Outeniqua Research farm close to George in the Garden Route of South Africa (22º 25´ 16´´E and 33º 58´ 38´´S). George has a mean rainfall of 731.45 mm per annum over the last 50 years and is known to have a temperate climate. The study took place over 67 days from 6 September to 12 October 2019.

The grazing camp where the study was conducted is called "Lughawe 1" and consists of 7 ha kikuyu/ ryegrass (*Lolium*) pastures under permanent irrigation. The camp is divided into 40 grazing strips of approximately 120 m x 15 m each. Pasture was grazed when a height of 20-25 on the rising plate meter (RPM) was met. Cows grazed the pasture to a height of 50 mm or 10 on the RPM to ensure proper pasture utilization. The pasture strips were top -dressed with 100 kg/ha limestone ammonium nitrate (LAN) after each grazing. The LAN contained 28% Nitrogen (N), Thus 28 kg N/ha was applied per grazing cycle. The cows grazed at a cycle of approximately 21-24 days of rotational grazing depending on the growth rate of the pastures.

Experimental design

Thirty-four (34) multiparous Jersey cows from the Outeniqua research herd were used in a completely randomized block design. The cows were blocked according to milk production (previous three weeks), lactation number, days in milk (DIM) and live weight and randomly allocated to two treatments within each block (Table 1). This resulted in (17) cows per treatment.

Treatment 1:

Control treatment: Ryegrass pasture plus 6 kg per day of a pelleted dairy concentrate.

Treatment 2:

Essential oil treatment: Ryegrass pasture plus 6 kg per day of pelleted dairy concentrate with addition of 12 g essential oil mixture consisting of cinnamaldehyde, eugenol and thymol.

Table 1: The pre-trial mean and standard deviation for milk yield, DIM, lactation number and Weight of the two treatment concentrate groups (n = 17)

Parameter	Treatment[1]	
	Control	Essential oil
Milk Yield (L)	19.9 ± 2.56	19.8 ± 2.46
Days in milk	94.2 ± 51.46	95.2 ± 51.84
Lactation number	2.8 ± 1.33	2.7 ± 1.49
Weight (kg)	362 ± 32.0	372 ± 40.5

[1]DM: Dry matter
[2]Control: Concentrates containing no feed additive
Essential oil : concentrate containing essential oils. (12 g/day/cow).

Data collection and analysis.

Daily milk production was recorded automatically with using the Afikim milk meter and management system. Composite milk samples (Ratio 8 ml: 16 ml, afternoon: morning milking) (06h00 and 14h30) were collected every two weeks. The preserved samples were analysed for fat, protein, lactose, somatic cell count (SCC) and MUN. Blood samples were collected by lifting the tail and taking the sample from the tail vain. The body condition score (BCS) and live weight (LW) of the cows were determined before milking, both at the beginning and end of the trial. Composite ryegrass samples were taken weekly on Tuesdays and Thursdays before grazing. Four ryegrass samples were taken by blindly at random, throwing a 35.4 cm in diameter ring and cutting (3 cm from the ground) the area of grass in the ring for collection. The concentrate was sampled representatively on Wednesday and pooled for every two weeks resulting in 8 concentrate samples. Ruminal pH was recorded over a 72- hour period using a pH logging system. Volatile fatty acids (VFA) and ammonia-nitrogen (NH_3-N) concentrations were determined by taking rumen liquor samples at three different times during the day. The composition of concentrates is presented in Table 2.

Table 2: The ingredients of the two concentrate treatments fed at 6 kg per day to cows grazing ryegrass in spring

Parameter (% of DM)[1]	Treatment[2]	
	Control	Essential oil
Ingredients		
Maize meal	622	622
Hominy chop	100	100
Wheat bran	81.5	80
Molasses syrup	50	50
Soy bean oilcake	110	110
Feed lime	25.5	25
Salt	5	5
MgO	3	3
Premix	3	3
Essential oils	0	2

[1]DM: Dry matter
[2]Control: Concentrates containing no feed additive
Essential oil : concentrate containing essential oils. (12 g/day/cow).

Results and discussion

The chemical composition of concentrate and pastures are presented in Table 3. As expected the chemical composition of the two treatments did not differ from each other with the only difference being the essential oil additive.

Table 3: Chemical nutrient composition (Mean) of the two concentrate treatments and pasture collected over an eight-week period, expressed on a dry matter basis (n=8).

Parameter[1] (g/kg DM[1])	Treatment[2]		
	Control	Essential oil	Pasture
Dry matter	901	901	173
Ash	62.6	63.0	112
Metabolisable energy (MJ/kg)	12.5	12.5	11.7
Crude protein	130	129	168
Neutral detergent fibre	123	117	454
Acid detergent fibre	45.3	47.8	269
Acid detergent insoluble fibre			6.39
Calcium	10.7	11.0	3.81
Phosphorous	4.37	0.42	3.87
Magnesium	3.91	3.98	3.11
Potassium	9.59	9.76	33.5
Sodium	2.31	2.40	13.3

[1]DM: Dry matter [2]Control: concentrates containing no feed additive;

Essential oil: concentrate containing essential oils. (12g/day/cow); Pasture: Pasture samples collected over an 8-week period.

Table 4: Mean and standard deviation of the pre- and post-grazing rising plate meter readings (n=89), pasture yield, pasture allowance and pasture intake determined using a single calculated regression (Y =86.301*H – 385.7)

Parameter[1]	Pasture values
Before grazing	
RPM reading	21.9 ± 3.1
Pasture yield (kg DM/ha)	1503 ± 269
Allocated pasture (kg DM/cow per day)	11.9 ± 1.2
After grazing	
RPM reading	10.3 ± 1.2
Pasture yield (kg DM/ha)	510 ± 102
Pasture intake (kg DM/cow/day)	7.9 ± 1.0
Pasture removed (kg DM/ha)	993 ± 264
Correlation coefficient (R^2)	0.589

[1]RPM = Rising plate meter; DM = Dry matter; ± = Mean and standard deviation

As specified by Stockdale (2000) the post grazing height was within the specified range of 10 -12 on the RPM (Table 4). This indicates that pasture was optimally grazed and it ensures maximum regrowth and high quality pasture. The average daily pasture intake per cow was 7.9 kg DM.

The average daily milk yield and milk components (4% FCM, ECM, fat%, protein %, lactose %, SCC and MUN) did not differ between the treatments. These results are similar to a study conducted by Benchaar et al. (2007b) were no changes in milk composition was reported, when cows were supplemented with a mixture of essential oils. However, results have been inconsistent and dose dependent. Several other studies reported changes in milk composition with the addition of essential oils (Santos et al., 2010; Spanghero et al., 2009).

The BCS (1-5) and LW (kg) was measured in the beginning and at the end of the trail (Table 5). There were no significant differences between treatments with regards to BCS and LW changes. However, there was a significant difference in BCS between

Table 5: Milk components, live weight and BCS of cows receiving two different treatment concentrates fed at 6 kg/cow/d (as is) and grazing ryegrass pasture in spring (n=17).

Parameter[1]	Treatment[2]		SEM[3]	P-value[4]
	Control	Essential oil		
Milk yield (kg/cow/day)	19.4	19.3	0.53	0.73
4% FCM (kg/cow/day)	22.7	22.1	0.67	0.41
ECM (kg/cow/day)	24.5	24.0	0.69	0.44
Fat%	5.11	4.99	0.27	0.45
Protein%	3.97	3.98	0.06	0.91
Lactose%	4.82	4.70	0.03	0.19
SCC (x 1000/ml)	138	124	63.1	0.33
MUN (mg/dl)	11.6	12.1	0.25	0.14
BUN (mg/dl)	10.7	10.9	0.31	0.57
LW before (kg)	377	383	10.1	0.65
LW After (kg)	402	406	9.5	0.75
LW change (kg)	+25.2	+23.3	4.37	0.76
BCS before	2.13	2.25	0.03	0.02
BCS after	2.41	2.37	0.04	0.37
BCS change	+0.28	+0.12	0.08	0.11

[1]FCM: 4% fat corrected milk; ECM: Energy corrected milk; SCC: Somatic cell count; MUN: Milk urea nitrogen; BUN: Blood urea Nitrogen, LW: Live weight, BCS = Body condition score scale 1-5.
[2]Control: concentrates containing no feed additive; Essential oil: concentrate containing essential oils. (12g/day/cow).
[3]SEM = Standard error of the mean. [4]P ≤ 0.05 = significant difference; P > 0.05 = no significant difference

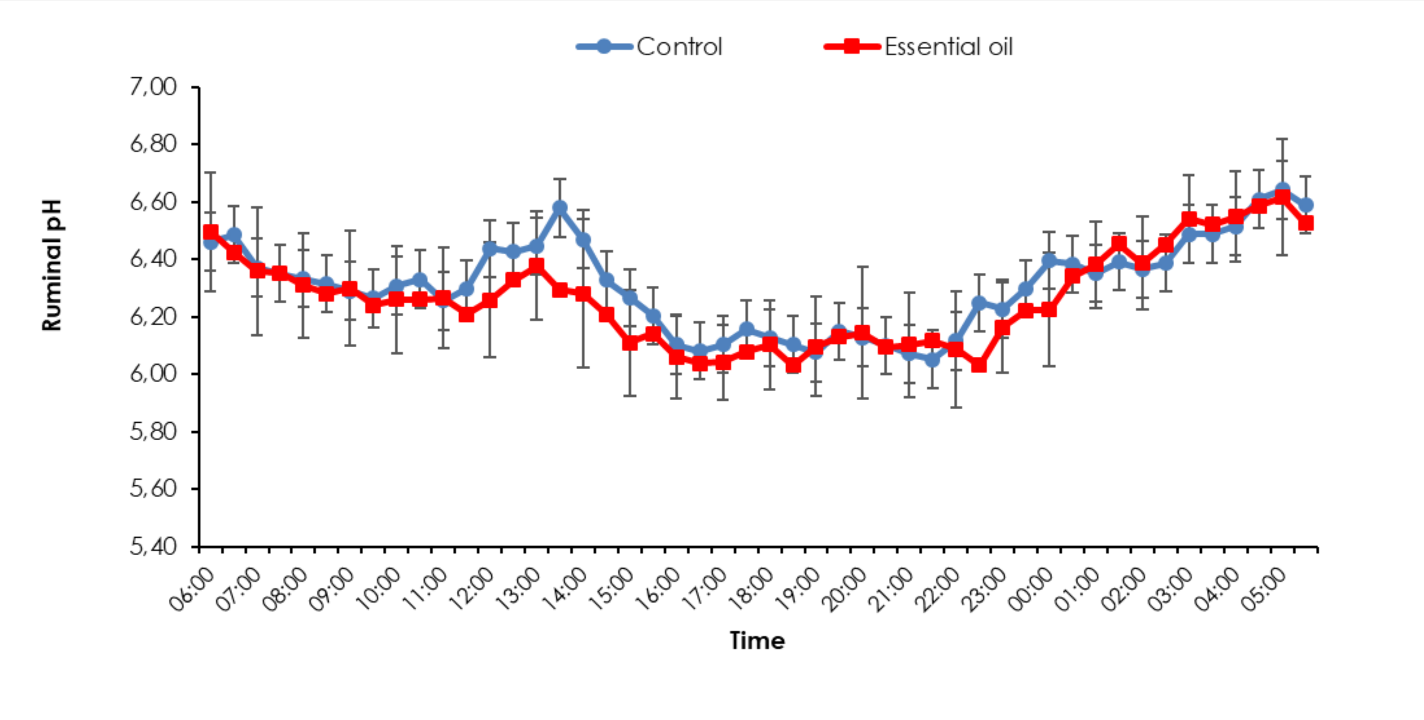

Figure 1: The mean diurnal fluctuations of ruminal pH (indwelling loggers) over a 24-hour period of Jersey cows (n = 6) fed a treatment concentrate at 6 kg/cow/day (as is), which include no feed additive (control) or concentrate containing essential oils. (12 g/day/cow).

treatments at the start of the study. The study was conducted over a period of 57 days and no significant differences in BCS and LW were expected. The two treatment groups both showed an increase in BCS and LW during the duration of the study.

Ruminal pH recorded over a 24-hour period is presented in Figure 1. The ruminal pH did not differ between treatments.

In Figure 1 it can be seen that the ruminal pH for the two treatments had a similar pattern and no differences in ruminal pH were recorded. A drop in pH was recorded after the cows received 3 kg of concentrate in the milking parlour at 6:00 and 14:00. The decline in pH post feeding is due to readily fermentable carbohydrates (RFC) present in the concentrate treatments (Dixon and Stockdale, 1999). The highest pH value for both treatments was recorded at 5:00 in the morning, just before morning milk time, 6.64 for the control treatment and 6.62 for the essential oil treatment. This could indicate that cows did not eat as much during the early morning hours and spent more time ruminating, causing a decrease in fermentable substrates and VFA produced, leading to an increased ruminal pH. A mean ruminal pH of 6 – 6.9 stimulates optimum rumen health and fibre digestion (Kolver et al., 1998). Both of the treatments are well within this range.

There were no significant differences in VFA concentrations and the molar proportions of VFA (Table 6). The only significant differences ($P < 0.05$) between treatments were found in the molar proportions of butyrate. The molar proportion of butyrate was higher for the control treatment. However, no differences in butyrate concentration were reported. Butyrate is an important contributor to milk yield.

Table 6: Daily mean of ruminal volatile fatty acids (VFA) and rumen ammonia nitrogem concentrations, measured in the ruminal fluid of cows receiving two different concentrates (n=6/treatment) fed at 6 kg (as is) and grazing kikuyu/ryegrass pasture in the spring.

Parameter[1]	Treatment[2]		SEM[3]	P-value[4]
	Control	Essential oil		
Total VFA (mM/L)	117	115	3.04	0.66
Acetate	84.4	82.8	2.34	0.66
Propionate	17.7	18.1	0.61	0.74
Butyrate	11.9	11.4	0.46	0.27
Valerate	1.45	1.38	0.09	0.60
Iso-Butyrate	1.09	0.99	0.06	0.19
Iso-Valerate	0.87	0.8	0.06	0.32
Acetate:Propionate	4.97	4.56	0.31	0.47
Total VFA molar%				
Acetate	71.9	71.7	0.53	0.84
Propionate	15.1	15.7	0.39	0.33
Butyrate	10.1	9.87	0.07	0.03
Valerate	1.23	1.20	0.07	0.72
Iso-Butyrate	0.93	0.85	0.04	0.18
Iso-Valerate	0.74	0.69	0.04	0.37
Rumen ammonia nitrogen concentration (mg/dl)				
06:00	9.4	8.9	0.933	0.85
12:00	8.1	11.0	1.47	0.22
20:00	11.5	12.8	2.16	0.58
Mean	9.7	10.9	1.21	0.49

[1]VFA: Volatile fatty acid.
[2]Control: concentrates containing no feed additive; Essential oil:concentrate containing essential oils. (12g/day/cow).
[3]SEM = Standard error of the mean.
[4]$P \leq 0.05$ = significant difference; $P > 0.05$ = no significant difference

The mean rumen ammonia concentrations (mg/dL) measured at three different time intervals are presented in Table 6. The rumen ammonia concentrations did not differ among treatments. The daily mean rumen ammonia nitrogen concentration falls within the suggested range (8.7 to 32.2 mg/dl) by Bargo et al. (2003). This suggests that the N from the pasture was efficiently utilized in the rumen. Benchaar et al. (2006) and Benchaar et al. (2007a) reported no differences in ruminal ammonia N concentrations when lactating dairy cows were supplemented with an essential oil blend at 0.75 and 2 g/day.

Conclusions

Supplementing an essential oil mixture consisting of cinnamaldehyde, eugenol and thymol to lactating dairy cows grazing ryegrass pasture in spring did not affect milk production, milk composition, live weight gain and rumen parameters.

References

Bargo, F., L.D. Muller, E.S. Kolver, and J.E. Delahoy. 2003. Invited review: Production and digestion of supplemented dairy cows on pasture. J. Dairy Sci. 86:1–42. doi:10.3168/jds.S0022-0302(03)73581-4.

Benchaar, C., A. V. Chaves, G.R. Fraser, K.A. Beauchemin, and T.A. McAllister. 2007a. Effects of essential oils and their components on in vitro rumen microbial fermentation. Can. J. Anim. Sci. 87:413–419. doi:10.4141/CJAS07012.

Benchaar, C., H. V. Petit, R. Berthiaume, D.R. Ouellet, J. Chiquette, and P.Y. Chouinardt. 2007b. Effects of essential oils on digestion, ruminai fermentation, rumen microbial populations, milk production, and milk composition in dairy cows fed alfalfa silage or corn silage. J. Dairy Sci. 90:886–897. doi:10.3168/jds.S0022-0302(07)71572-2.

Benchaar, C., H. V. Petit, R. Berthiaume, T.D. Whyte, and P.Y. Chouinard. 2006. Effects of addition of essential oils and monensin premix on digestion, ruminal fermentation, milk production, and milk composition in dairy cows. J. Dairy Sci. 89:4352–4364. doi:10.3168/jds.S0022-0302(06)72482-1.

Benchaar, C., H.V. Petit, R. Berthiaume, D.R. Ouellet, J. Chiquette, and P.Y. Chouinard. 2010. Effects of Essential Oils on Digestion, Ruminal Fermentation, Rumen Microbial Populations, Milk Production, and Milk Composition in Dairy Cows Fed Alfalfa Silage or Corn Silage. J. Dairy Sci. 90:886–897. doi:10.3168/jds.s0022-0302(07)71572-2.

Botha, P.R. 2003. Die produksiepotensiaal van oorgesaaide kikoejoeweiding in die gematigde kusgebied van die Suid-Kaap.

Botha, P.R., R. Meeske, and H.A. Snyman. 2008. Kikuyu over -sown with ryegrass and clover: Grazing capacity, milk production and milk composition. African J. Range Forage Sci. 25:103–110. doi:10.2989/AJRF.2008.25.3.2.599.

Clark, D.A., and V.R. Kanneganti. 1998. Grazing management systems for dairy cattle: Grass for dairy cattle 331.

DiLorenzo, N., and M.L. Galyean. 2010. Applying technology with newer feed ingredients in feedlot diets: Do the old paradigms apply? doi:10.2527/jas.2009-2362.

Dixon, R.M., and C.R. Stockdale. 1999. Associative effects between forages and grains: Consequences for feed utilisation. Aust. J. Agric. Res. 50:757–773. doi:10.1071/AR98165.

Hutjens, M.F., 2011. Feed additives for dairy cattle. [Online] Available: http://livestocktrail.illinois.edu/uploads/dairynet/papers/Spain%20Feed%20Additives.pdf Accessed: 1 September 2020.

Kolver, E.S., L.D. Muller, M.C. Barry, and J.W. Penno. 1998. Evaluation and Application of the Cornell Net Carbohydrate and Protein System for Dairy Cows Fed Diets Based on Pasture. J. Dairy Sci. 81:2029–2039. doi:10.3168/jds.S0022-0302(98)75777-7.

Promotion, G. 2011. Antibiotic Use in Animal Agriculture Is Dangerous and Unnecessary. Assessment 531–541.

Santos, M.B., P.H. Robinson, P. Williams, and R. Losa. 2010. Effects of addition of an essential oil complex to the diet of lactating dairy cows on whole tract digestion of nutrients and productive performance. Anim. Feed Sci. Technol. 157:64–71. doi:10.1016/j.anifeedsci.2010.02.001.

Spanghero, M., P.H. Robinson, C. Zanfi, and E. Fabbro. 2009. Effect of increasing doses of a microencapsulated blend of essential oils on performance of lactating primiparous dairy cows. Anim. Feed Sci. Technol. 153:153–157. doi:10.1016/j.anifeedsci.2009.06.004.

Stockdale, C.R. 2000. Levels of pasture substitution when concentrates are fed to grazing dairy cows in northern Victoria. Aust. J. Exp. Agric. 40:913–921. doi:10.1071/EA00034.

Concentrate supplementation to Jersey cows grazing plantain and ryegrass pasture

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Introduction

Perennial ryegrass (*Lolium perenne*) is widely used in pasture based dairy production systems. Forage plantain's herbage yield and milk production potential exceeds that of ryegrass-clover pasture mixes (Rumball *et al*., 1997). Plantain (*Plantago lanceolata)* is a rosette forming, densely tillering perennial forage herb with an erect growth habit. The herb has high production potential of quality herbage. The leaves are highly palatable and cows tend to select plantain above grasses and clovers in mixed swards (Stewart, 1996). Ample rest time between defoliations is beneficial for plantain. Plantain supplies sufficient protein, energy and minerals to the ruminant. The mineral content generally meets or exceeds that of grasses (Sanderson *et al*., 2003). The low fibre content of plantain can be detrimental to rumen health and can cause milk fat depression.

Aim

Determining the effect that low starch, medium starch and high starch concentrates will have on production and rumen parameters of Jersey cows grazing plantain and ryegrass pasture.

Materials and methods

Two paddocks containing perennial ryegrass and plantain pasture respectively were used during the trial. The trial commenced on 12 September 2019 and ended 30 October 2019 on the Outeniqua Research Farm in the Western Cape province of South Africa (22° 25´ 16´´E and 33˚ 58´ 38´´S). The George area has a temperate climate with a long term mean rainfall of 732.45mm per annum over 50 years. Nine hectares of perennial ryegrass pasture with permanent irrigation was divided into 39 strips of approximately 150m x 15m each. Perennial ryegrass (*Lolium multiflorum)* cv. 24Seven was planted at 20kg/ha in April 2019. Plantain (Agritonic) was planted at 9kg/ha on five hectares under irrigation during April 2019. Fertilizer was applied at 42kg N after each grazing (150kg/ha limestone ammonium nitrate (LAN) which contains 28% nitrogen). Tensiometer readings determined need for irrigation. Pasture yield and allocation was estimated using a rising plate meter. Seasonal regression equations: Y=103 X H – 261 and Y= 67 X H - 392, were used for ryegrass and plantain, respectively. Weekly pasture and concentrate samples were taken for nutritive value prediction and trends over the course of the trial (Table 3). Cows on average were offered a total of 12 kg pasture per day.

Production study

Fifty-one multiparous Jersey cows were blocked according to milk production (of previous 3 weeks), days in milk (DIM) and lactation number (Table 1). Cows within a block were randomly allocated to 1 of 3 treatments: High starch, medium starch or low starch (Table 2). A 14-day adaptation period was followed by 34 days data collection. Before milking, cows were sorted into their respective groups. Cows were milked twice a day and received 3kg/milking of their respective concentrate treatments. Cows strip grazed plantain after morning milking (6:00-13:00) and perennial ryegrass after, afternoon milking (14:00-5:00).

Table 1. Mean (± standard deviation) of milk yield, DIM and lactation number of cows allocated to the three concentrate treatments (n=17)

Parameters[1]	Treatment		
	High starch	Medium starch	Low starch
Milk yield (kg/cow/day)	21.1 ± 2.86	21.2 ± 3.18	21.1 ± 2.93
Days in milk (d)	166 ± 58.5	161 ± 54.3	165 ± 48.3
Lactation nr	4.00 ± 2.06	3.76 ± 1.78	4.23 ± 2.32

Table 2. Compositions of concentrate treatments differing in starch content

Ingredient[1] (g/kg)	Treatment		
	High starch	Medium starch	Low starch
Maize	800	500	200
Hominy chop	0	175	350
Wheat bran	50	115	180
Soybean hulls	0	90	180
Soybean oilcake	77	490	210
Molasses	40	40	40
Feed lime	20	20	20
MCP	4	2	0
Salt	5	5	5
Mgo	3	3	3
Vitamin and mineral premix[2]	1	1	1

[1]MCP – monocalcium phosphate; MgO - magnesium oxide

Daily milk yield was recorded using the Afikim milk meter and management system. Composite milk samples (16ml: 8ml, morning: afternoon) were taken for every cow on three occasions during the trial. The samples were analysed for fat, protein, lactose, somatic cell count (SCC) and milk urea nitrogen (MUN). Body weight and body condition score was determined at the beginning and the end of the trial (Table 5).

Rumen study

Six rumen cannulated cows were allocated to the high starch and low starch treatment groups in a 2 X 2 crossover design with two treatments and two periods. Periods consisted of 14 days adaptation and 6 days measuring. Rumen pH was measured using Tru test loggers to indicate rumen pH trends over 24 hours (readings were taken every 10 minutes for two days). Rumen fluid was sampled at 6:00, 12:00 and 20:00 to analyse for volatile fatty acid (VFA) and rumen ammonia content.

Results and discussion

Table 3 indicates the chemical composition of the three concentrate treatments as well as ryegrass and plantain pasture. The concentrate treatments have a similar DM, CP, ME and mineral concentration. A clear increase in NDF from the high to the low starch treatments was observed. Protein content of ryegrass and plantain meets that of suggested levels. Ryegrass supplies more energy than plantain. The low NDF content of plantain causes concern for rumen health and milk fat production (Waghorn., 2007). As reported by Sanderson et al. (2003) plantain has a higher mineral content compared to that of ryegrass.

Table 4 shows that plantain was grazed to very low post-grazing heights. It had the ability to re-grow to recommended pre-grazing heights within 30 days. This could be attributed to the herb's deep rooting system (Labreveux et al., 2006). Table 5 shows production parameters for the study. No significant differences were found in milk yield, fat corrected milk (FCM) and energy corrected milk (ECM) between treatments. Milk component yields did not differ between treatments. Live weight (LW) gain and body condition score (BCS) did not differ between treatments. Milk urea nitrogen (MUN) levels shows that sufficient protein was supplied to the cows.

Table 3. Mean chemical composition of concentrate treatments (n=3) and pasture (n=2) fed to Jersey cows during the production and rumen study

Nutrient[1] (g/kg DM, or as stated)	Concentrate treatments			Pasture	
	High starch	Medium starch	Low starch	Ryegrass	Plantain
DM	92.3	91.2	89.9	188	103
ME (MJ/kg DM)	11.8	11.8	11.8	10.5	9.6
IVOMD (%)	80.8	77.6	76.8	63.8	55.3
CP	109	114	116	199	169
NDF	66.9	129	189	396	285
ADF	25.3	63.2	109	240	217
Ash	54.8	58.2	60.6	100	157
Ca	11.1	11.5	11.3	4.24	16.1
P	4.49	4.70	4.65	3.06	2.72
Ca:P ratio	2.47	2.45	2.43	1.39	6.07
Mg	3.64	3.85	4.11	3.21	4.41
K	8.79	9.30	11.1	25.7	19.6
Na	2.39	2.10	2.31	7.29	18.6
Mn (mg/kg)	129	148	164	49	32.8
Cu (mg/kg)	30.5	33.5	37	6.15	11.4
Fe (mg/kg)	213	242	289	151	159
Zn (mg/kg)	152	183	200	48.7	66.7

[1]DM: dry matter; ME: metabolisable energy; IVOMD: in vitro organic matter digestibility; CP: crude protein; NDF: neutral detergent fibre; ADF: acid detergent fibre; Ash: mineral fraction; Ca: calcium; P: phosphor; Ca:P: calcium to phosphorous ratio; Mg: magnesium; K:potassium; Na: sodium; Mn: manganese; Cu: copper; Fe: iron; Zn: zinc

Table 4: Mean (± standard deviation) yield, allowance and removal of ryegrass and plantain pasture

Parameter[1]	Ryegrass	Plantain
Pre-grazing		
RPM reading	23.7 ±3.74	26.1 ±4.34
Yield (kg DM/ha)	2203 ±245	1868 ± 253
Pasture allowance (kg DM/cow/day	7.16±1.04	4.90±0.81
Post-grazing		
RPM reading	9.82±1.73	6.78±1.07
Yield (kg DM/ha)	1293 ± 114	739 ± 62.6
Pasture removed (kg DM/ha)	910 ± 216	1129 ± 234
R^2 value of prediction	0.66	0.46

[1]RPM – rising plate meter; DM – dry matter; ha – hectares ±- mean and standard deviation

Table 5. Mean milk yield, milk composition, body weight and body condition score of cows in their respective treatment groups (n=17)

Parameter[1]	Treatment concnetrates[2]			SEM[3]	Contrast P-values		
	HS	MS	LS		HS vs MS	HS vs LS	LS vs MS
Milk yield (kg/cow/day)	20.9	21.9	20.8	0.42	0.10	0.87	0.07
FCM (kg/cow/day)	23.5	24.7	23.5	0.52	0.11	0.10	0.11
ECM (kg/cow/day)	25.4	26.8	25.4	0.53	0.08	0.99	0.08
Milk composition							
Milk fat (%)	4.88	4.91	4.90	0.12	0.85	0.89	0.96
Milk protein (%)	3.89	3.92	3.89	0.06	0.71	1.0	0.71
Milk lactose (%)	4.72	4.69	4.69	0.03	0.47	0.47	1.0
MUN mg/dl	8.89	8.22	9.97	0.46	0.30	0.10	0.01
SCC X 1000	120	190	185	40.5	0.23	0.26	0.94
Live weight (kg)							
LW before	396	389	400	6.62	0.45	0.71	0.26
LW after	419	415	422	6.87	0.69	0.79	0.50
LW change	+23	+26	+22	1.79	0.22	0.73	0.12
Body condition score							
BCS before (scale 1-5)	2.31	2.28	2.43	0.047	0.66	0.087	0.035
BCS After (scale 1-5)	2.28	2.29	2.46	0.044	0.81	0.008	0.014
BCS change (scale 1-5)	-0.03	+0.01	+0.03	0.039	0.43	0.30	0.79

[1]FCM: 4 % fat corrected milk; ECM: energy corrected milk; MUN: Milk urea nitrogen; SCC: somatic cell count; LW: live weight; BCS: body condition score
[2]HS: high starch concentrate; M: medium starch concentrate; LS: low starch concentrate
[3]SEM: standard error of mean

Table 6 shows that the mean rumen pH values had no significant differences between the high starch and low starch treatment groups. Production of volatile fatty acids (VFA) showed a tendency to be slightly higher for the low starch treatment group. No significant differences were observed for rumen ammonia (NH3-N) between treatment groups.

Table 6. Mean rumen pH as measured by handheld pH meter and pH logger system for high starch and low starch treatments

Time	Treatment[1]		SEM[2]	P-value[3]
	HS	LS		
6:00	6.42	6.42	0.047	0.981
12:00	5.88	5.80	0.040	0.185
20:00	5.85	5.83	0.033	0.781
Handheld pH average	6.04	6.02	0.018	0.242
Logger pH average	6.28	6.21	0.053	0.344

[1] HS – high starch concentrate; LS – low starch concentrate
[2]SEM – standard error of means
[3] P ≤ 0.05 = Significant difference; P > 0.05 = non-significant difference

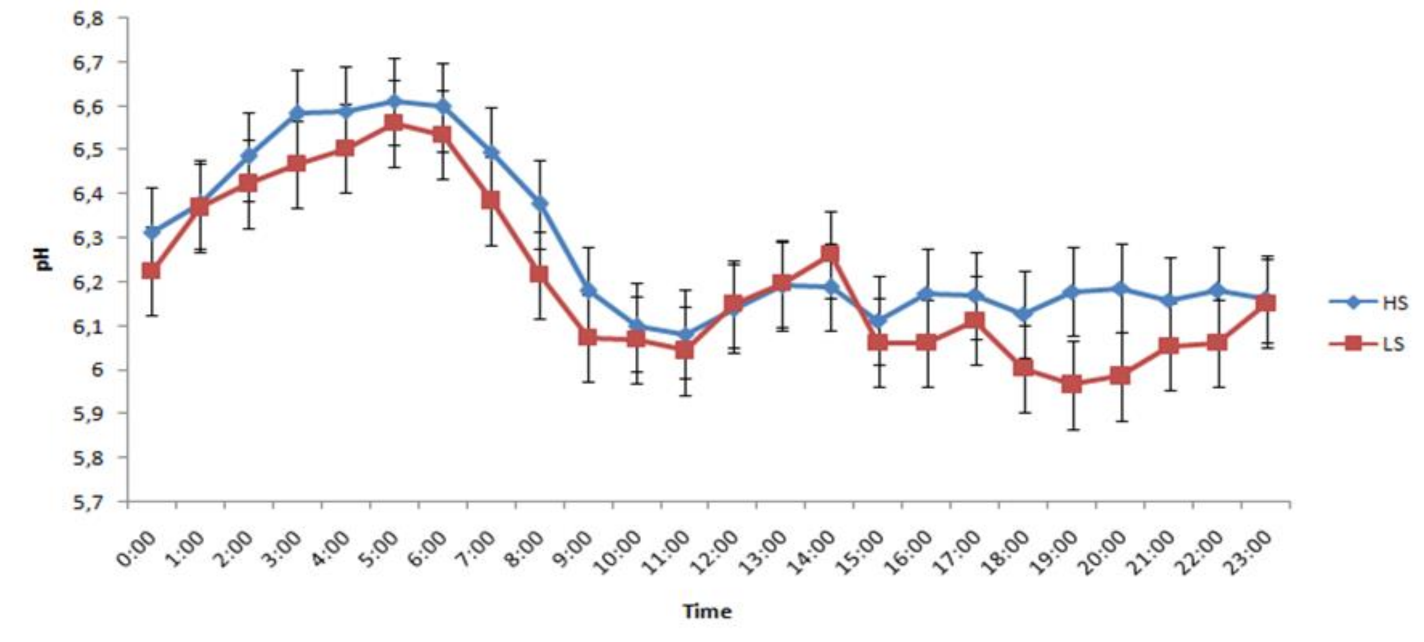

Figure 2. Rumen pH for dairy cows receiving high starch (HS) and low starch (LS) concentrate when grazing perennial ryegrass and plantain, as measured by rumen logger

Table 7. Volatile fatty acid (VFA) and NH_3-N production of high starch and low starch treatments

Parameter[1]	Treatment[2]		SEM[3]	P-value[4]
	High starch	Low starch		
Total VFA (mmol/L)	123	125	0.46	0.067
Acetate	76.5	78.6	1.02	0.177
Propionate	23	23.5	0.076	0.555
Butyrate	20	20	0.368	0.969
Valerate	2.03	1.98	0.038	0.413
Iso-Butyrate	0.133	0.149	0.009	0.245
Iso- Valerate	1.41	1.20	0.088	0.124
Acetate: Propionate	3.34	3.41	0.076	0.533
NH_3-N (mg/dl)	13.1	13.8	0.823	0.538

[1]VFA: volatile fatty acid; NH_3N [2]HS: high starch; LS – low starch [3]SEM: standard error of mean
[4] $P \leq 0.05$ = Significant difference; $P > 0.05$ = non-significant difference

Economic implications

With no differences in milk solids between, we can expect the same milk price (R5.50/litre) for all treatments. Cows on the medium starch treatment produced 1 litre more milk compared to the high and low starch treatments. If the price of maize is the same as that of by-products used in this study, profitability of a 400 cow in milk herd on the medium starch treatment will increase by R2200 per day or R66 000 per month, compared to the control treatment.

Conclusion

Decreasing maize content of a dairy concentrate from 80% to 50% and replacing it with high fibre by-products, increased milk production and live-weight of cows grazing ryegrass and plantain. Reducing maize content from 80% to 20% with the same approach did not affect condition of cows, milk production or milk composition. The system has potential to increase profit margins.

References

Labreveux, M., Sanderson, M. A., & Hall, M. H. (2006). Forage Chicory and Plantain. *Agronomy Journal*, *98*(2), 231.

Rumball, W., Keogh, R. G., Lane, G. E., Miller, J. E., & Claydon, R. B. (1997). Grasslands lancelot' plantain (plantago lanceolata l.). *New Zealand Journal of Agricultural Research*, *40*(3), 373–377.

Sanderson, M. A., Labreveux, M., Hall, M. H., & Elwinger, G. F. (2003). Nutritive value of chicory and English plantain forage. *Crop Science*, *43*(5), 1797–1804.

Stewart, A. (1996). Plantain (Plantago lanceolata): a potential pasture species. *Proceedings of the New Zealand Grassland Association*, *58*, 77–86.

Waghorn, G. C. (2007). What is dietary metabolisable energy? *Proceedings of the New Zealand Grassland Association*, 153–159.