Feed365 - a grazing system to optimise animal production all year round in Mediterranean environments

Real D[1], Payne CE[2], Sanford P[3], Loi A[1], Revell CK[1], Cunningham K[2], Collins JP[2], Hardy J[2], Cox, D[2], Conte J[1] and van Burgel A[3]

[1] Department of Primary Industries and Regional Development, Perth, WA 6151, daniel.real@dpird.wa.gov.au
[2] Department of Primary Industries and Regional Development, Katanning, WA 6317
[3] Department of Primary Industries and Regional Development, Albany, WA 6330

Abstract
Rainfed grazing systems in the Mediterranean climate of southern Western Australia are challenged by climate change with increasingly hotter, drier, and more variable seasons. To adapt to these changes livestock producers require new drought-tolerant forage systems that involve the limited use of supplementary feed. The Feed365 project is evaluating forages that have the potential to provide quality feed all year round. Forty-eight grazing plots of 0.5 ha (about 20 forage treatments x minimum 2 reps) were sown at Katanning Research Station (425 mm of average annual rainfall) in Western Australia in 2021. In 2022, 2023 and 2024, plots with annual species were either allowed to regenerate from the previous year's seed set, or re-sown, depending on the sequence of the rotation. Plots with perennial species were allowed to continue from 2021. Above-ground forage biomass was measured every three weeks all year round. Sheep liveweight and condition score were measured when treatments were grazed. During winter and spring (wet season) sheep grazed experimental treatments that contained mostly annual species (legumes and grasses), whilst in the summer and autumn (dry season) sheep grazed either (a) dry residues of annual species or winter crop stubbles or (b) green forages provided by perennial legumes, grasses and herbs, summer crops and shrubs. Here we report results for the period March 2023 to March 2024, where treatments that provided the most feed during feed gaps included triticale/cereal rye combined with subclover or serradella, veldt grass/serradella, tedera, tall wheat grass/subclover and lucerne/cocksfoot/chicory.

Keywords
Annual and perennial forage types, sheep, feed all year, no supplementation.

Introduction
In Mediterranean climates with little rainfall in summer, it is a challenge for farmers to grow forages all year round to feed their livestock (Real et al., 2014). One solution is to grow a diverse range of forages that provide green feed at different times of the year. Feed during the growing season (winter and spring) could be provided by mostly temperate annual species (legumes and grasses), whilst in the dry season (summer and autumn) feed could be provided by (a) dry residues of annual species or winter crop stubbles or (b) green forages provided by perennial legumes, grasses and herbs, summer crops and shrubs. Using a replicated field trial, the Feed365 project, co-funded by the Department of Primary Industries and Regional Development and Meat & Livestock Australia, is testing the hypothesis that (a) the production of green feed all year round is possible in southern Western Australia (WA) with a diverse range of forages without irrigation and (b) the treatments combined as a forage system could support animal grazing without the use of supplementary feed all year round. Here we report results for the period March 2023 to March 2024.

Methods
Forage treatments
In 2021, two sites (paddocks B1 and B14) at the Department of Primary Industries and Regional Development (DPIRD) Katanning Research Station, WA (425 mm of average annual rainfall) were sown with a range of forage species (Table 1). B1, with a well-drained pale deep sand/duplex sandy gravel soil mix, was sown to 11 forage treatments x 2 replicates and B14, with a yellow/brown deep sandy duplex soil prone to winter waterlogging, was sown to 13 forage treatments x 2 replicates for a total of 48 grazing plots (0.5 ha each). Some treatments were common between the sites. In 2022, 2023 and 2024 plots with annual species were either allowed to regenerate from the previous year's seed set, or re-sown, depending on the species sequence of the rotation. Plots with perennial species were allowed to continue from 2021. Changes in forage treatments from 2021 to 2024 are presented in Table 1. Above-ground forage biomass or Feed-on-Offer (FOO) was measured every three weeks and forage quality when plots were being grazed. The control

treatments were subclover/ annual ryegrass for the growing season and crop stubble for out-of-season as these represent current farming practice.

Table 1. Forage treatments from 2021 to 2024 at Katanning Research Station.

Site/Plots	Site/Plots	Winter 2021	Autumn 2022	Spring 2022
B1-1/13		Pink Serradella	Oats	
B1-2/18		Pink Serradella + Yellow Serradella + Tall wheat Grass	Regenerating serradellas	Kikuyu
B1-3/15	B14-12/25	Pink Serradella + Yellow Serradella + annual ryegrass	Regenerating serradellas + annual ryegrass	
B1-4/12	B14-5/17	Vetch + annual ryegrass + cereal rye	Cereal rye + Triticale + Oats + Vetch + Tillage radish	
B1-5/11	B14-2/14	Wheat	Barley	
B1-6/22	B14-3/21	Pink serradella	Pink serradella	Japanese Millet + Tillage Radish
B1-7/16	B14-4/19	Lucerne + Chicory + Cocksfoot	Lucerne + Chicory + Cocksfoot	
B1-8/21		Pink serradella	Biserrula	
B1-9/17		Veldt grass + Pink Serradella + Yellow Serradella	Veldt grass + Pink Serradella + Yellow Serradella	
B1-10/19	B14-7/18	Subclover + annual ryegrass	Regenerate subclover + annual ryegrass	
B1-14/20	B14-1/20	Mixed shrubs	Mixed shrubs + subclover + gland clover + Pink Serradella	
B14-6/15		Tedera	Tedera	
B14-8/16		Subclover	Oats	
B14-9/26		Biserrula	Pink serradella	Pearler Millet + Sunflower
B14-10/24		Arrowleaf + Gland + Crimson + Bladder + Balansa + annual ryegrass	Regenerating Trifolium mix + annual ryegrass	Pearler Millet + Rape + Tillage Radish + Sorghum
B14-11/22		Subclover + Tall Wheat Grass	Subclover + Tall Wheat Grass	
B14-13/23		Wheat, Barley, Canola, Pink Serradella, Vetch, Gland clover	Tillage radish	

Site/Plots	Site/Plots	Autumn 2023	Spring 2023	Autumn 2024	Spring 2024
B1-1/13		Pink Serradella + Triticale + Rye		Pink Serradella + Triticale + Rye	
B1-2/18		Kikuyu + Pink Serradella + Subclover		Kikuyu + Pink Serradella + Subclover	
B1-3/15		Serradellas + annual ryegrass		Serradellas + annual ryegrass	
B1-4/12		Pink Serradella + Triticale + subclover + Crimson clover		Serradella + clovers + Triticale + Cereal rye	
B1-5/11	B14-2/14	Wheat		Barley	
B1-6/8		Lupins + Triticale + Cereal rye	Japanese Millet + Tillage Radish	Lupins + Triticale + Cereal rye	Yes
B1-7/16	B14-4/19	Lucerne + Chicory + Cocksfoot		Lucerne + Chicory + Cocksfoot	
B1-9/17		Veldt grass + Pink Serradella + Yellow Serradella		Veldt grass + Pink Serradella + Yellow Serradella	
B1-10/19		Subclover + annual ryegrass		Subclover + annual ryegrass	
B1-14/20	B14-1/20	Mixed shrubs		Mixed shrubs + Triticale	
B1-21/22		Biserrula		Biserrula	
B14-3/21		Triticale + Cereal rye	Japanese Millet + Tillage Radish	Oats	Yes
B14-5/17		Triticale + Cereal rye + Balansa + gland +crimson clover + subclover		Clovers + Triticale + Cereal rye	
B14-6/15		Tedera		Tedera + Oats	
B14-7/18		Subclover + annual ryegrass		Subclover + annual ryegrass	
B14-8/16		Subclover + Triticale + Cereal rye		Subclover + Triticale + Cereal rye	
B14-9/26		Triticale + Cereal rye	Sorghum + Leafy Turnip + LabLab	Awnless Triticale	
B14-10/24		Triticale + Cereal rye	Sunflower	Black Oats + Forage oats	
B14-11/22		Subclover + Tall Wheat Grass		Subclover + Tall Wheat Grass	
B14-12/25		Canola	Pearler Millet + Forage rape	Triticale + Rye	Yes
B14-13/23		Triticale + Cereal rye + Tillage radish		Purple clover + Balansa + Triticale + Cereal rye	

Animal production
Each treatment was grazed with sheep (generally wethers or ewes in the liveweight range of 40-60kg) at strategic times of the year to fill the feed gaps and maximise sheep production. Grazing availability and stocking rate were determined every 3 weeks. During the growing season (June-November) stocking rate for each treatment was determined by using a forage allowance and the 'put and take' method to standardise grazing pressure across treatments (Mott, 1960, Burns, 2006, Sollenberger and Burns, 2001). We used a forage allowance of 4 kg DM/head/day that is consistent with Moorehead et al. (2002) who used a daily allowance of 2.5 kg DM/head/day for 8 week old lambs of 26 kg of weight. During the out-of-season period (December-May) stocking rate was fixed at 10 sheep/ha. For both seasonal periods, grazing commenced if plots had a minimum FOO for 10 sheep/ha at the above-mentioned forage allowance for three weeks, plus a residual FOO of at least 500 kg DM/ha. Projected forage growth was included in calculations of available FOO for the 3-week grazing period. Stocking rate, grazing days, liveweight and condition score were measured every three weeks during grazing periods. No form of supplement feeding, including straw, hay or mineral licks, were given to sheep whilst grazing the plots.

Results
Forage treatments
The growing season in 2023 commenced in March and was slow to get underway with the subclover/annual ryegrass control only reaching 800 kg DM/ha in June at site B14 and July at site B1. Treatments that outperformed the subclover/ryegrass in terms of FOO in autumn and winter included those with perennial species (a) veldt grass, (b) cocksfoot/lucerne/chicory, (c) tedera, and (d) tall wheat grass and/or treatments that included the forage cereals triticale and cereal rye sown dry in April.

The growing season ended in October 2023 at which point the subclover/ryegrass control in B1 and B14 both had a total FOO of around 1100 kg DM/ha, though they had been grazed in season. By contrast, the wheat control in B1 and B14 had over 4000 and 6000 kg DM/ha respectively but had yet to be grazed (to provide cereal crop stubbles for grazing after harvest). At both sites, FOO for all other treatments fell between the wheat and subclover/ryegrass control.

In late spring and early summer 2023, the only forages that remained green were the perennials tedera, veldt grass, tall wheat grass, lucerne and kikuyu. Other treatments that provided more grazing in summer than the wheat stubble control, included either triticale/cereal rye or serradella/ryegrass dry residues. Among the perennials the best summer grazing was provided by veldt grass, tedera and tall wheat grass. Note kikuyu was not grazed as it was a newly established sward.

Following rain in late summer (February) after a long dry spell there was only patchy germination of the summer crops which resulted in very modest amounts of green FOO in February and March 2024. The most impressive treatments were sunflower and sorghum. Higher yields were recorded in B14 compared to B1 due to its position lower in the landscape and soils with higher water retention capacity.

Interestingly, all perennial treatments outperformed the control treatments with the serradella/veldt mix yielding the most in B1 and the subclover/tall wheat grass mix in B14.

Animal production
The late season break in 2023 delayed the beginning of grazing of the subclover/ryegrass control which commenced in July in B14 and in September in B1. However, rain in March allowed for an early June grazing of the perennial species. The stocking rate of the perennial treatments during this period averaged 22 sheep/ha with an average liveweight gain of 90 g/head/day and an increase in condition score of 0.1.

During late winter and spring, sheep on all treatments averaged a liveweight gain of 156 g/head/day. The best performing treatments in B1 included biserrula, and kikuyu/subclover/serradella with average liveweight gains of 300 g/head/day and 165 g/head/day, average stocking rates of 40 sheep/ha and 42 sheep/ha, and grazed for 21 days and 42 days, respectively. The kikuyu mix with annual legumes sustained the highest stocking rate for the longest period while also having consistent increases in animal production. In B14 the regenerating annual ryegrass/subclover was grazed for 99 days with an average stocking rate of 24 sheep/ha. Sheep gained an average weight of 200 g/head/day and an average condition of 0.15. Similarly, the forage brassica, cereal rye and triticale mix was grazed for 127 days with an average stocking rate of 26 sheep/ha. Sheep gained an average weight of 114 g/head/day and an average condition of 0.13. The highest

liveweight gains were seen in the triticale/clover mix of 223 g/head/day over a grazing period of 63 days at an average stocking rate of 16 sheep/ha.

Animals grazing the cereal rye/triticale mix performed well for the first 21 days, gaining 280 g/head/day at an average stocking rate of 30 sheep/ha. Stocking rate was increased to an average of 66 sheep/ha for the next 21-day grazing period. During this period sheep lost an average of 80 g/head/day in liveweight.

The growing season finished abruptly in October, and summer grazing began in the second week of November with multiple grazing options at both sites. In B1, the cereal rye/triticale/annual legume mix outperformed all other treatments with average liveweight of 83 g/head/d and condition gains of 0.03, grazing for a total of 73 days. In B14, sheep grazed on the mixed shrubs for 41 days gaining an average of 134 g/head/day and putting on 0.05 of a condition score. Similarly, sheep grazed the triticale/clover mix for 62 days in one replicate and 83 days in the other, gaining an average weight of 83 g/head/day and 0.2 of a condition score. The tedera treatments had the highest average liveweight gains of 230 g/head/day over a 21-day grazing period.

Discussion

The first hypothesis, that production of green feed all year round is possible, was supported. The combination of (a) winter annual species during the growing season, (b) summer-dormant/winter-active perennial species providing green forage quickly after the first rains plus late production at the end of the season, and (c) summer-active perennials and/or annual species providing green forage during summer and autumn, achieved a green feed supply all year round.

The second hypothesis, that the animal production all year round is possible without supplementary feeding, was not supported as combined the treatments provided 334 days of grazing in a year characterised by a short growing season and limited summer rainfall. In a better season it is possible that the treatments together could have provided 365 days of grazing without supplement. This result is encouraging as it demonstrates that the current production systems could be changed to become less dependent on supplementary feed.

Conclusion

Treatments that provided the most feed during feed gaps included triticale/cereal rye combined with subclover or serradella, veldt grass/serradella, tedera, tall wheat grass/subclover and lucerne/cocksfoot/chicory. Serradella is proving itself to be a more productive option than subclover on sandy soils. Sorghum and sunflower are potentially useful summer crops however they do require further research and economic assessment before they could be recommended. Encouragingly, the forage treatments were able to provide feed for most of the period reported including a dry summer. This gives us confidence that some combinations of these treatments as a forage system will meet the objectives of the project to increase the number of days of the year that forage grown in the paddock can support livestock production.

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