Enterprise 1

Question: Does a Phalaris based pasture system impact the "feed gap" productivity issue compared with a lucerne pasture system and so thereby increase a sheep enterprise productivity/profitability and overall resilience to drought?

Location: Nimmitabel

Enterprise: Self-replacing Composite (4 sheep/ha); joined April, lambs sold 28 April

Pasture Species Compared: 1. Phalaris 2. Lucerne 3. Phalaris/lucerne mix

Years simulated: 1970-2019

Introduction

The choice of different pasture species impacts on feed gaps and potential production from sheep enterprises. Nimmitabel and Bombala are cold winter environments which restricts winter growth of pastures but also is a challenge for lamb survival, meaning lambing in this region tends to be after the winter period. This results in young weaners requiring pastures over the summer/autumn period with a high nutritive value if fast weight gain is to be achieved. The aim of this analysis was to compare the patterns of pasture growth for different pasture species to identify the impacts on feed gaps, productivity and resilience to drought.

Note that while GrassGro simulates the persistence of annual species through varying seed production, the persistence of perennials is not modelled. Impacts of drought have therefore been assessed through effects on biomass production and the sheep enterprise.

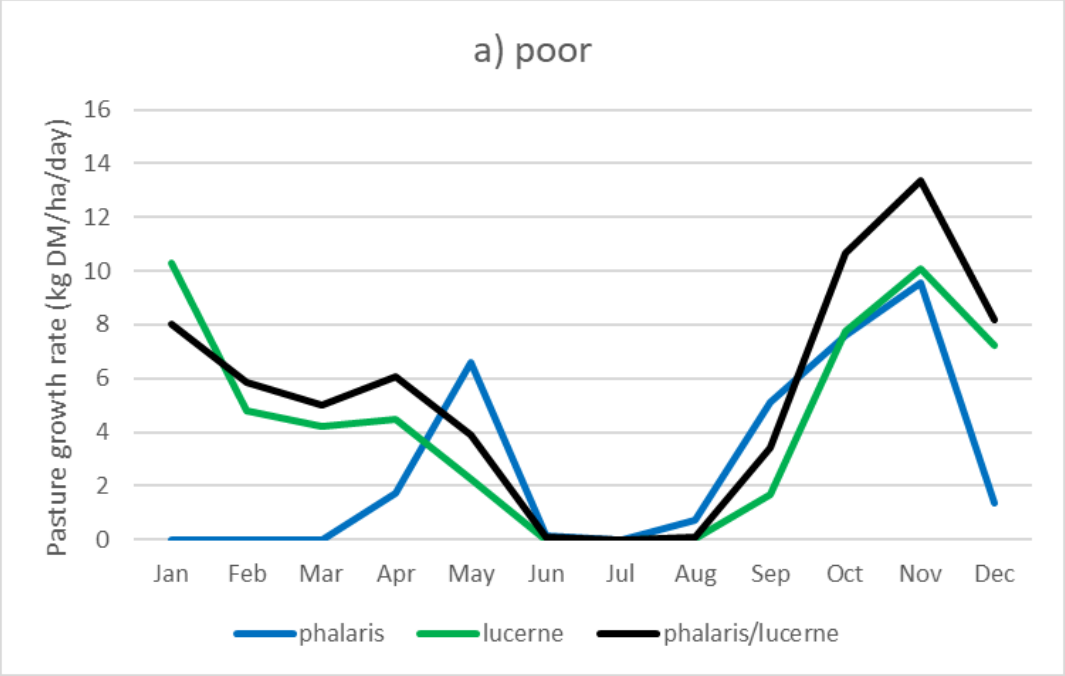
Results and Discussion

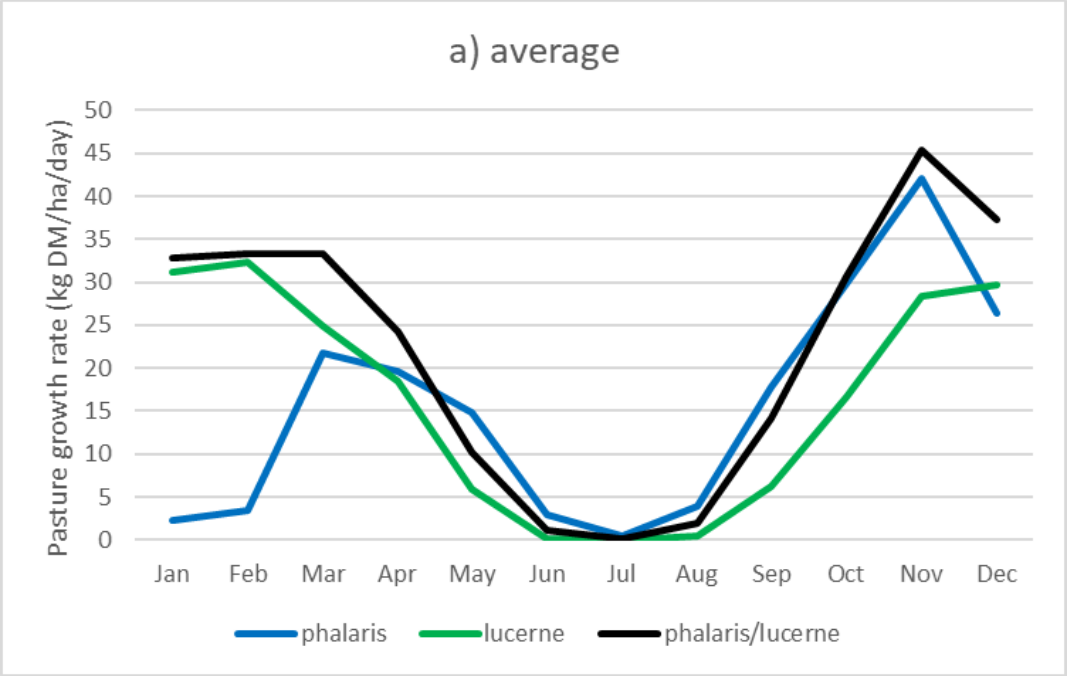
The pasture growth rates for Phalaris were lower than for lucerne between December and March **(Figure 1).** During winter months lucerne growth rates were zero or < 2.1 kg DM/ha due to the cold environment. Phalaris also had very low growth during winter, however it maintained growth for longer in late autumn, and grew more quickly at the end of winter than lucerne, thereby reducing the winter feed gap.

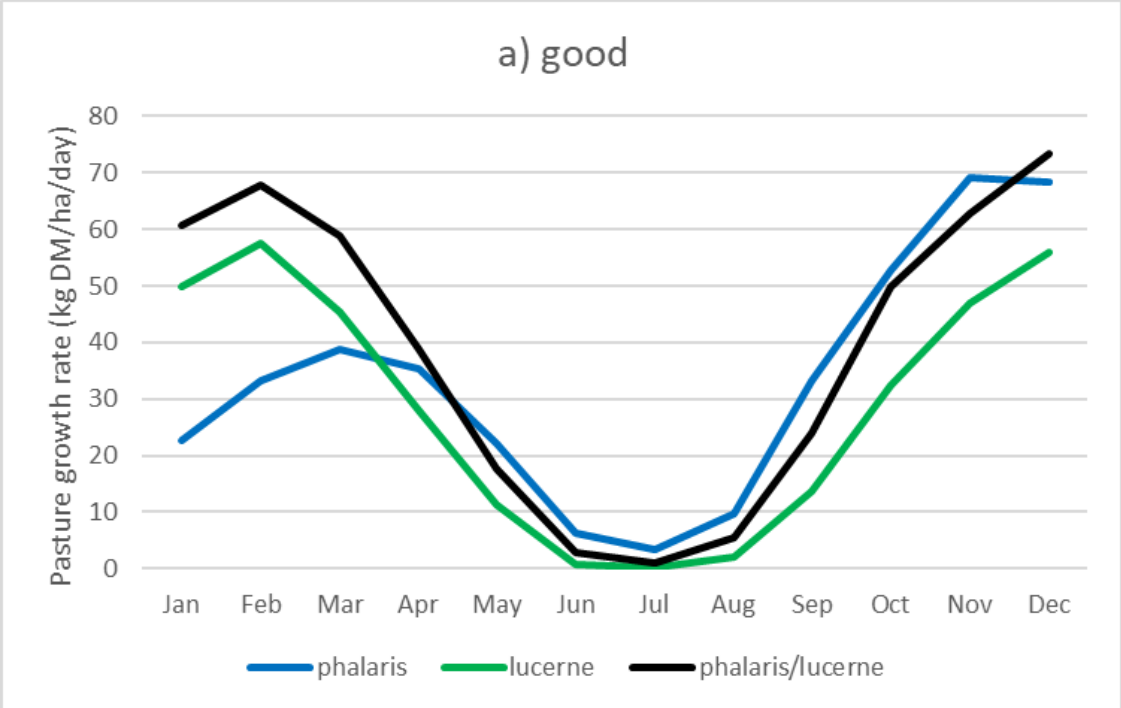
However, as expected, lucerne grew more quickly between December and March, more effectively filling the summer/autumn feed gap. This was most evident in average seasons when the growth of Phalaris in January/February was minimal but lucerne grew at approximately 30 kg DM/ha/day, and in poor seasons when Phalaris did not grow while lucerne grew at 5-10 kg DM/ha/day. The growth of

a Phalaris/lucerne mix tended to follow the same pattern as the lucerne pasture, but the mix simulated was a very lucerne dominant pasture with Phalaris a minor pasture component, which may not reflect reality. The fertility scalar for the mixed pasture contributed to the higher growth of the mixed pasture because for pure stands the paddock fertility scalar was set lower for lucerne than for Phalaris, which was not possible when grown in the same paddock. Further results for the Phalaris/lucerne mix are presented but not discussed.

Figure 1. Average monthly pasture growth rates for Phalaris, lucerne and a Phalaris/lucerne mix at Nimmitabel in a) poor, b) average and c) good seasonal conditions when stocked at 4.0 ewes/ha.







The level of supplementary feeding was excessive at the simulated stocking rate of 4 ewes/ha (**Table 1)** although this stocking rate was typical for the region. A pasture mass above 800 kg DM/ha in January to April was maintained in more than 20% of years for Phalaris but not lucerne. Groundcover fell below the target 70% threshold more frequently in lucerne than the Phalaris pasture. Note both pastures were pure species, and the addition of an annual legume to the lucerne

pasture is expected to increase groundcover. Groundcover was maintained at an adequate level in the lucerne dominant mixed pasture.

Table 1. Mean sustainability variables for Phalaris, lucerne and Phalaris/lucerne pastures at Nimmitabel 1970-2019.

Pasture	% of years <800 kg DM/ha in Jan-Apr	% of years supplementary feed > 30 kg/ewe	Long-term pasture utilisation (%)	Long-term average groundcover (%)	Months per year < 70% groundcover at 30th percentile
Phalaris	10	82	46	85	0
lucerne	26	45	54	62	12
Phalaris/lucerne	3	66	44	80	3

The median gross margin for the sheep enterprise grazing lucerne pastures was $225/ha higher than for Phalaris **(Figure 2).** This was driven by a higher sale weight of lamb (65 vs 52 kg) and a lower requirement for supplementary feed **(Table 2).** Higher sale weights of weaned lambs were associated with a 5 to 10% higher digestibility of the diet selected from lucerne compared with Phalaris pasture during the summer/autumn period. In average years, supplementary feeding of mature ewes occurred mainly in September/October around the lambing period for both Phalaris and lucerne. Wether weaners were rarely fed in average seasons.

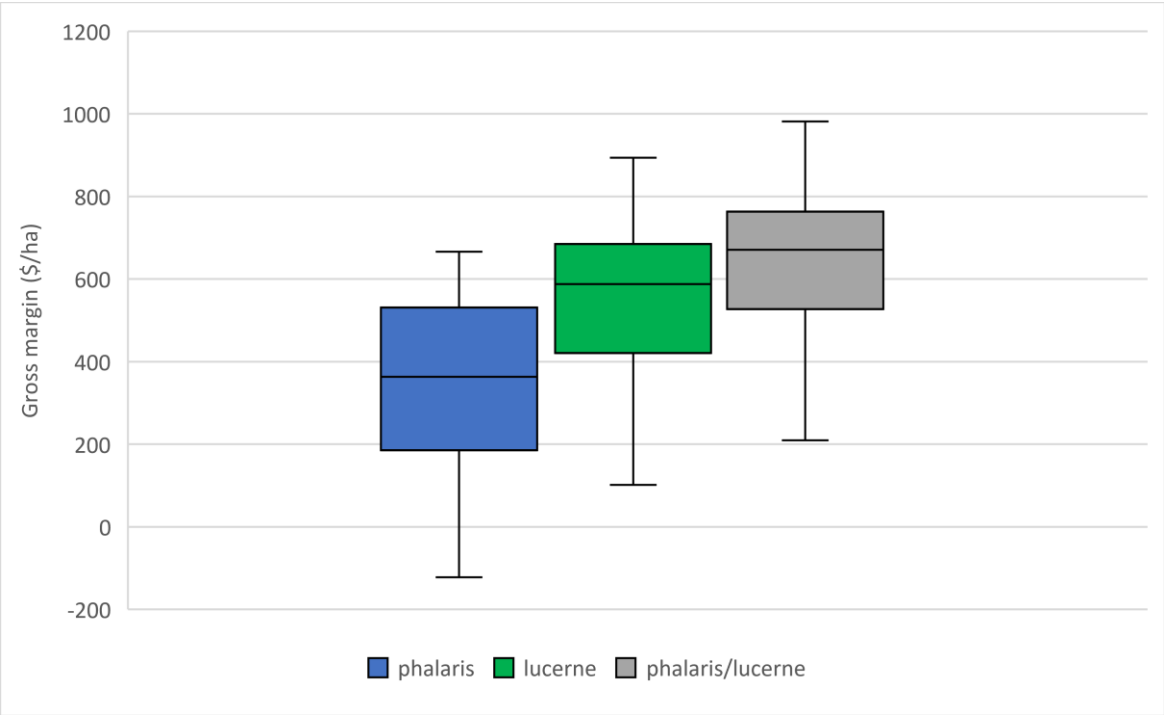


Figure 2. Box plots of gross margins for a composite enterprise grazing Phalaris, lucerne or Phalaris/lucerne pastures at Nimmitabel 1970-2019. Boxplots represent median, range and interquartile range.

Table 2. Mean production variables and gross margin for a Composite enterprise grazing Phalaris, lucerne or a Phalaris/lucerne pasture at 4 ewes/ha at Nimmitabel 1970-2019.

Pasture	Lambs marked/ewe joined (%)	No. of lambs sold (no./ha)	Sale weight of lamb[A] (kg)	Value of lamb sold ($/ha)	Wool value ($/ha)	Supplement ($/ha)	Supplement (kg/ewe)	**Mean (median) gross margin ($/ha)**
Phalaris	122	4.0	51.9	687	19	211	118	339 (363)
lucerne	127	4.1	64.7	878	20	189	116	545 (588)
Phalaris/lucerne	129	4.2	64.8	898	20	107	66	646 (671)

[A] Weights are for wether lambs.

The condition score of ewes in average seasons (the 50th percentile) grazing lucerne pasture increased during late summer and autumn due to pasture growth and the ability to select a diet of higher digestibility, whereas those grazing Phalaris only maintained condition **(Figure 2).** This produced a higher condition at the April joining for those grazing lucerne, which enabled 5% more lambs marked per ewe than Phalaris pastures **(Table 2).** However, the condition of ewes grazing lucerne declined more rapidly during winter due to the lack of lucerne growth during winter and selection of a diet up to 10% lower in digestibility compared with Phalaris. This meant that ewes grazing lucerne or Phalaris were in the same condition score at lambing in September, before both rapidly increased with pasture growth in spring. Loss of condition of ewes during late pregnancy needs to be managed as large losses will reduce lamb birthweights and the survival of lambs at birth. Restricted nutrition during late pregnancy may also reduce the staple strength of wool produced if ewes are not shorn close to this period, although the value of wool is more relevant to Merino rather than Composite ewes.

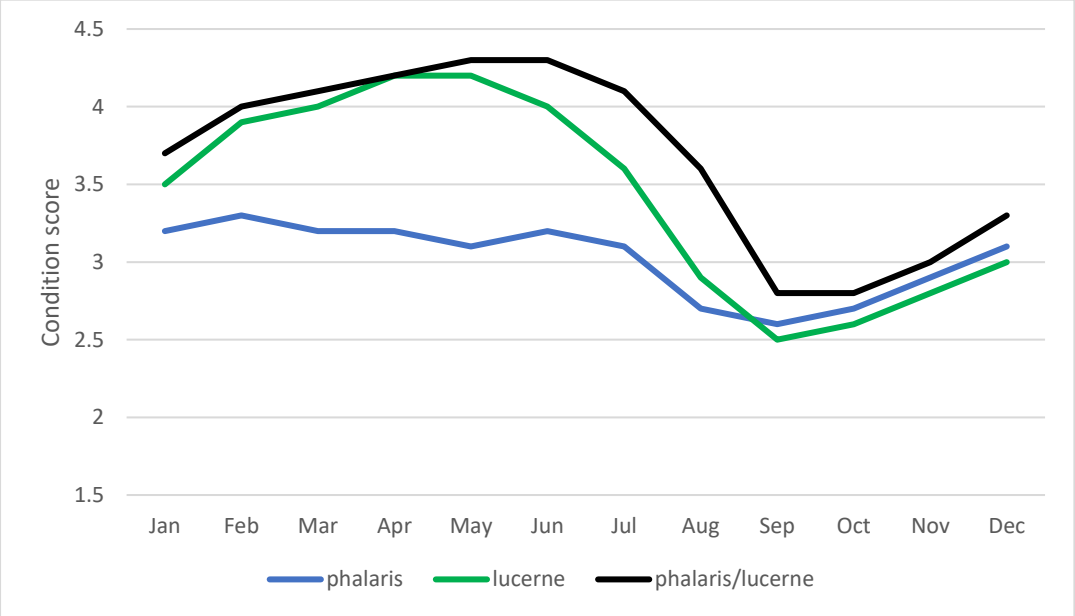


Figure 2. Monthly mean condition score of ewes in average seasons (50th percentile) for a composite enterprise grazing Phalaris, lucerne or Phalaris/lucerne pasture at 4 ewes/ha at Nimmitabel 1970-2019.

Performance in drought years

The gross margins, income from wool and sheep sales and supplementary feeding costs for poor (lowest 10%), average (50th percentile) and good (highest 10%) seasons are shown in **Table 3.** The ability to increase lamb sale weights in all types of seasons was the driver for the higher gross margins of lucerne compared with Phalaris pasture, since supplementary feed costs were relatively similar. The cumulative gross margin from 1970-2019 demonstrated a significantly higher financial position for lucerne compared with Phalaris pasture**(Figure 3).** However, the stocking rate for a pure lucerne pasture needs to be lower than for Phalaris to avoid groundcover below 70% for long periods. The optimal stocking rate for each species has not been evaluated, and differences in the frequency of re-sowing of pastures has also not been considered in this analysis.

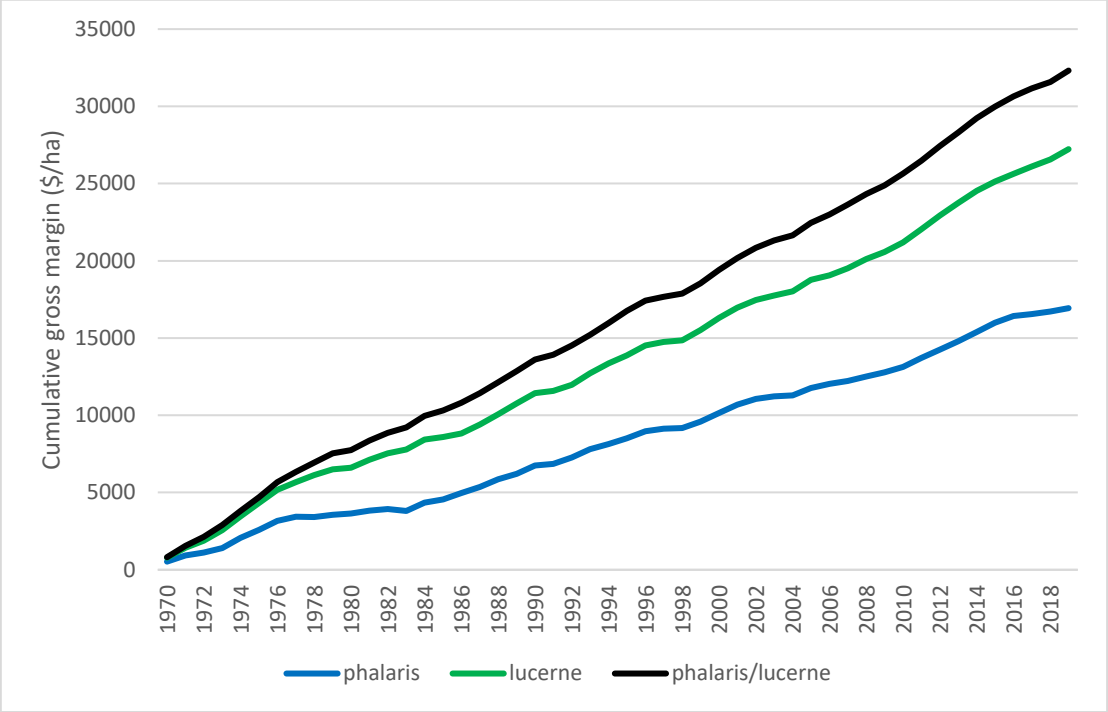


Figure 3. Cumulative gross margin ($/ha) for a composite enterprise grazing Phalaris, lucerne or Phalaris/lucerne pasture at 4 ewes/ha at Nimmitabel 1970-2019.

Table 3. Gross margin and key income and cost variables in poor, average and good seasons for a composite enterprise grazing Phalaris, lucerne or Phalaris/lucerne pasture at 4 ewes/ha at Mangoplah 1970-2019.

	Season	Gross margin $/ha	Total income ($/ha)	Total Expense ($/ha)	Net Wool Income ($/ha)	Sheep sale income ($/ha)	Maintenance supplement ($/ha)	Production supplement ($/ha)
Phalaris	**poor**	89	732	661	18	712	279	191
	average	363	808	455	19	789	141	0
	good	553	879	279	20	859	16	0
lucerne	**poor**	241	817	595	19	796	211	187
	average	588	999	451	20	978	139	0
	good	812	1143	310	22	1121	50	0
Phalaris/lucerne	**poor**	343	836	510	20	817	190	100
	average	671	1023	348	20	1002	73	0
	good	878	1154	271	21	1134	0	0

Drought years were classified at Nimmitabel in 11 of the 50 years during the period 1970-2019 as shown in **Figure 4**. Lucerne pasture allowed weaners to grow at higher rates than Phalaris during drought as well as other years, without increasing supplementary feed costs. Wool production was similar between seasons but higher for ewes grazing lucerne due to the higher nutritive value of lucerne during summer/autumn.

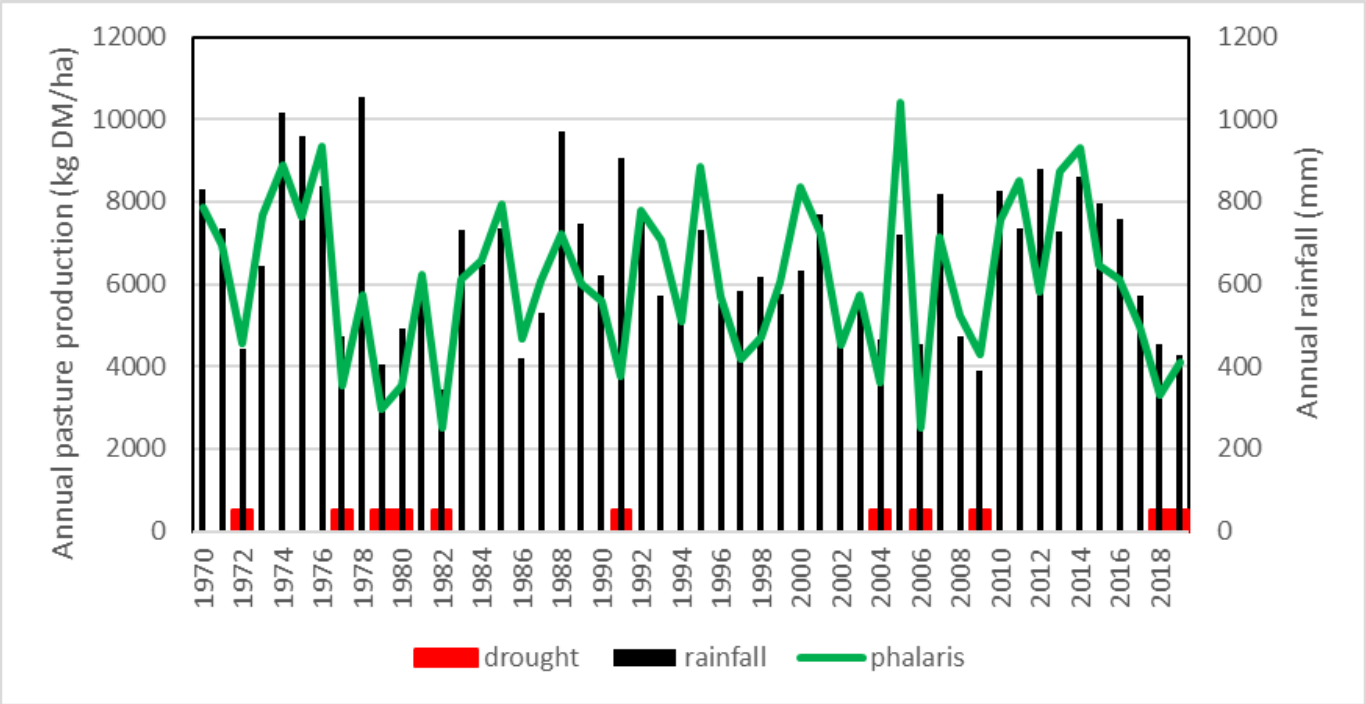


Figure 4. Annual rainfall (mm), production of Phalaris pasture (kg DM/ha) and classification as a drought year for Nimmitabel 1970-2019.

Table 4. Production from a composite enterprise in drought years for Phalaris, lucerne or Phalaris/lucerne pasture at 4.0 ewes/ha at Nimmitabel 1970-2019.

Pasture	Season	Lambs weaned/ewe joined (%)	Wether weight at weaning (kg)	Weaner growth Jan to Apr (g/day)	Production supplement (kg/ewe)	Clean fleece weight (kg/ewe)
Phalaris	drought	120	29.9	115	61	2.1
	other	122	34.8	140	22	2.1
lucerne	drought	125	32.7	159	67	2.4
	other	126	37.6	225	19	2.4
Phalaris/lucerne	drought	126	33.4	169	37	2.5
	other	129	38.4	214	5	2.4

Key messages:

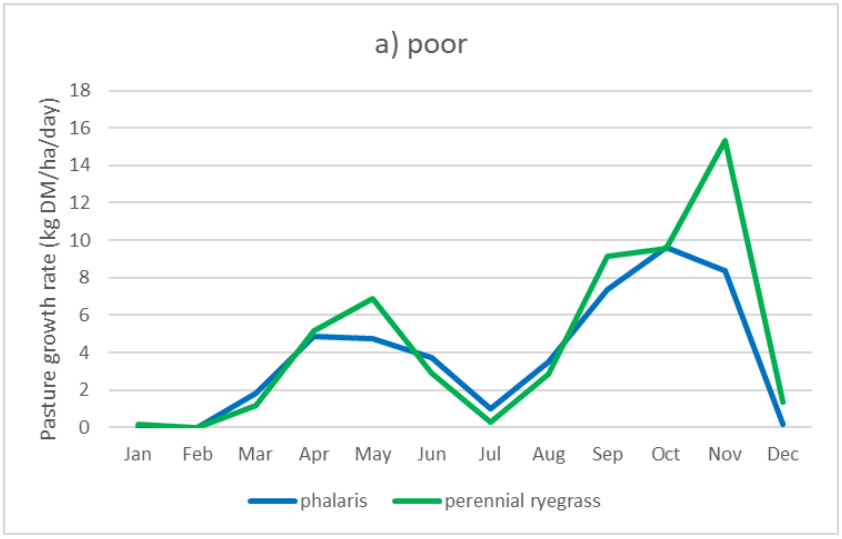
- Lucerne extends the winter feed gap compared with Phalaris but fills the summer/autumn feed gap when Phalaris has poor growth.
- Sheep enterprises which can better utilise high quality summer/autumn pasture will gain more benefit from lucerne, while enterprises with a high winter demand would be disadvantaged by lucerne compared with Phalaris due to the different times of feed gap.
- An established lucerne pasture provided higher quality feed and allowed faster lamb growth rates and sale weights compared with Phalaris when weaners were finished over the summer/autumn period, and the advantage occurred in drought and better seasons.
- Low groundcover in lucerne pastures needs to be managed, and for pure stands may require lower annual stocking rates than Phalaris pastures to protect soils. Including other species with lucerne will reduce the risk of low groundcover.
- Gross margins may be increased through use of lucerne rather than Phalaris pastures if additional income produced is greater than establishment and maintenance costs. Long-term persistence is necessary to minimise costs and lucerne may require more frequent re-sowing than Phalaris.
- Strategic sale of stock in response to dry seasons may reduce the impact on pasture persistence, risk of low groundcover and requirement for supplementary feeding.

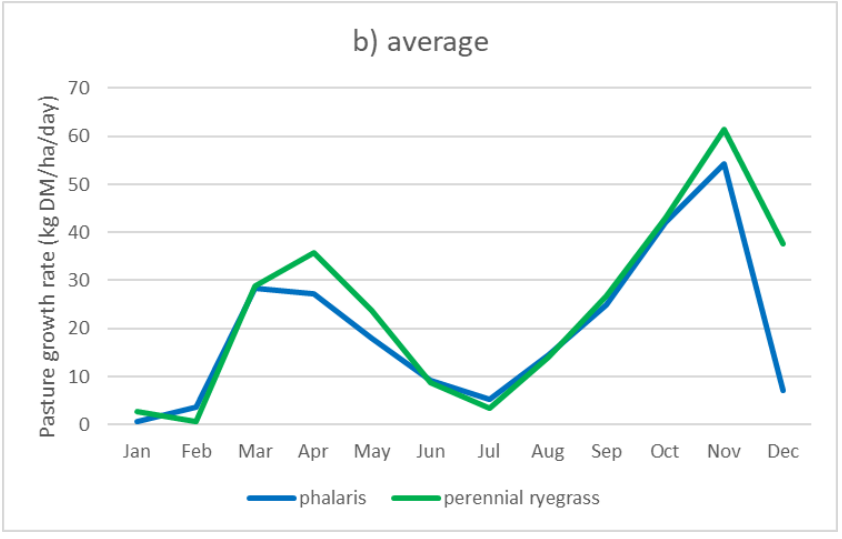
Enterprise 2

- **Question:** Do Phalaris and perennial ryegrass pastures have different growth patterns and nutritive value which will improve sheep enterprise resilience to drought at Bombala?
- **Location:** Bombala
- **Sheep enterprise**: Self-replacing fine wool Merino (5.1 sheep/ha), joined April, selling hoggets March and May.
- **Pasture Species Compared:** 1. Phalaris 2. Ryegrass
- **Years simulated:** 1970-2019

Results and Discussion

The monthly pasture growth rates for Phalaris and perennial ryegrass were similar in poor seasons. In average and good seasons perennial ryegrass maintained higher growth rates than Phalaris into summer and autumn, but winter and spring growth was similar **(Figure 5).**





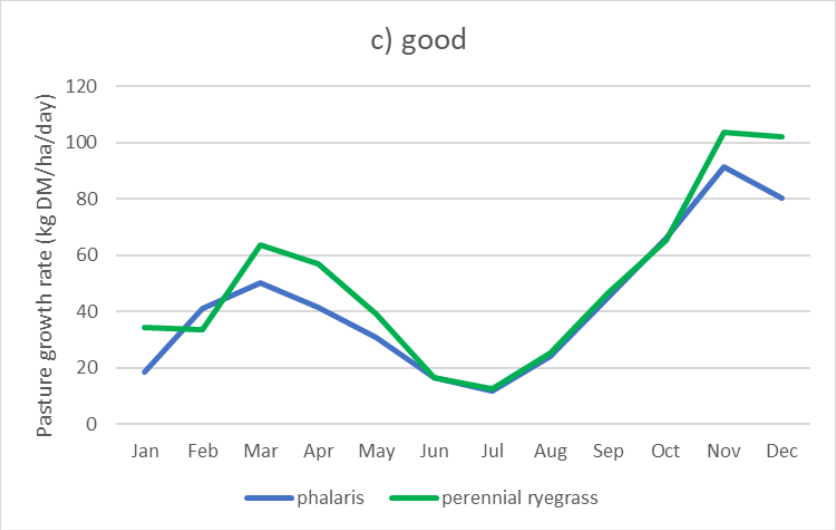


Figure 5. Mean monthly pasture growth rates for a Phalaris and perennial ryegrass pasture in a) poor, b) average and c) good seasons at Bombala 1970-2019.

A high level of groundcover was maintained for both Phalaris and perennial ryegrass pastures when stocked at 5.1 sheep/ha **(Table 5).** A pasture mass above 800 kg DM/ha in the January to April period was maintained in most years, but the Phalaris pasture did require supplementary feeding of ewes above 30 kg/ewe in more years than for perennial ryegrass. The median gross margin was $38/ha higher for perennial ryegrass compared with Phalaris pasture **(Figure 6).** This resulted mostly from lower supplementary feeding costs, with higher sale weights and weight of wool produced also contributing **(Table 6).**

Table 5. Mean sustainability variables for Phalaris and perennial ryegrass pastures at Bombala 1970-2019.

	Sheep/ha	% of years <800 kg DM/ha in Jan-Apr	% of years feed > 30 kg/ewe	Long-term pasture utilisation	Long-term average groundcover %	Months < 70% groundcover at 30th percentile
Phalaris	5.1	9	36	40	91	0
perennial ryegrass	5.1	7	24	36	91	0

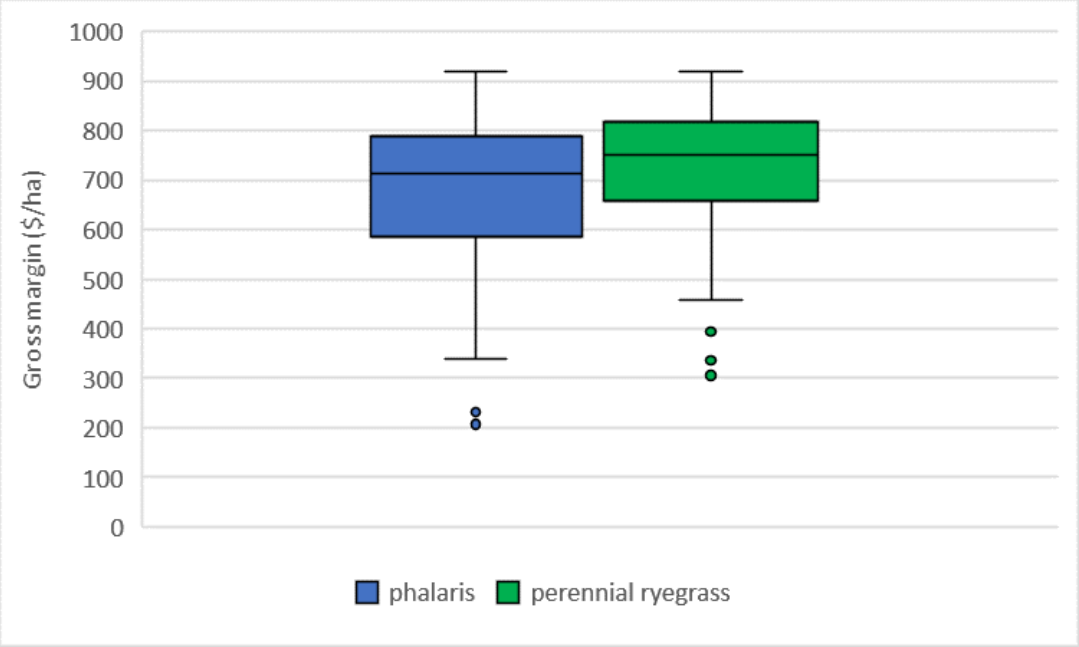


Figure 6. Box plots of gross margins for a self-replacing Merino enterprise grazing Phalaris and perennial ryegrass pastures at Bombala 1970-2019. Boxplots represent median, range and interquartile range, and o indicates extreme values.

The mean condition score of ewes was generally maintained at or above 3.5 between January and July. However, condition score declined rapidly during winter during late pregnancy and during the lambing period before increasing during late spring **(Figure 7a).** Controlling this loss has the potential to improve lamb survival and the staple strength of wool, although alternative management was not compared in this analysis. Perennial ryegrass maintained ewes in 0.2 score higher throughout most of the year, although this did not result in more lambs marked per ewe joined **(Table 6).** The higher condition score of ewes grazing perennial ryegrass compared with Phalaris was associated with a higher digestibility of pasture consumed, rather than differences in the quantity of green pasture except during summer **(Figure 7b**). A higher condition score provides resilience against periods of low feed availability, or alternatively, indicates a higher stocking rate could be used.

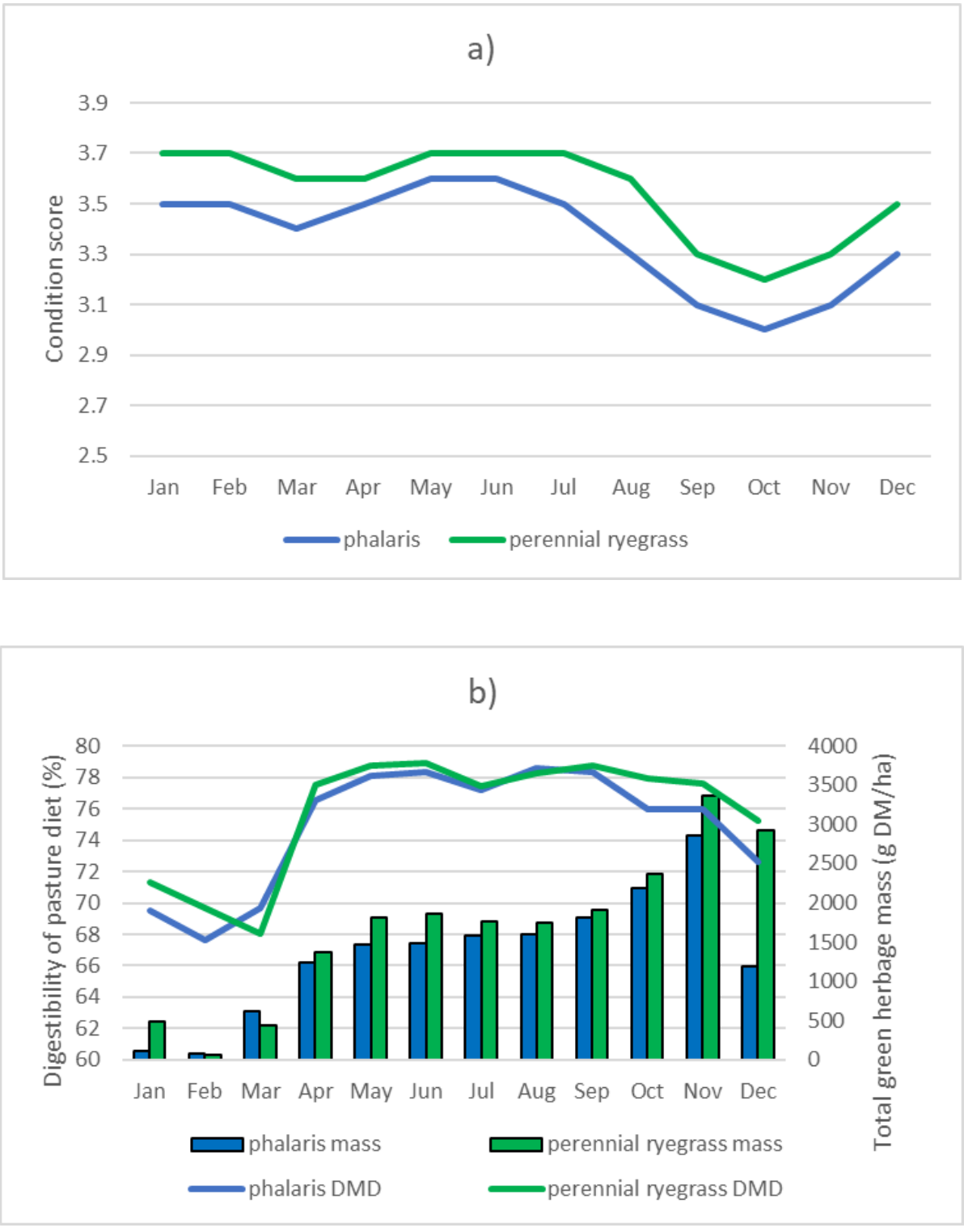


Figure 7. Monthly mean a) condition score of ewes and b) green pasture mass (kg DM/ha) digestibility of pasture diet (%) for young stock in average seasons (50th percentile) for a self-replacing Merino enterprise grazing Phalaris or perennial ryegrass pastures at Bombala 1970-2019.

Table 6. Mean production variables and gross margin for a self-replacing Merino enterprise grazing Phalaris or perennial ryegrass pastures at Bombala 1970-2019.

Soil fertility	Lambs marked/ewe joined (%)	No. of young stock sold (no./ha)*	Sale weight of wethers (kg)	Value of young stock sold ($/ha)*	Mean fibre diameter of ewes (μ)	Wool value ($/ha)	Supplement ($/ha)	Supplement (kg/ewe)	Mean (median)gross margin $/ha
Phalaris	90	2.6	56.2	409	17.8	610	87	29.1	668 (712)
perennial ryegrass	91	2.6	58.1	421	17.8	617	64	19.3	711 (750)

*Wether hoggets and surplus young ewe hoggets.

Table 7. Mean gross margin and key income and cost variables in poor, average and good seasons for a self-replacing Merino enterprise grazing Phalaris or perennial ryegrass pasture at Bombala 1970-2019.

Pasture	Season	Gross margin $/ha	Total income ($/ha)	Total Expense ($/ha)	Net Wool Income ($/ha)	Sheep sale income ($/ha)	Maintenance supplement ($/ha)	Production supplement ($/ha)
Phalaris	poor	386	961	622	559	405	122	150
	average	712	1115	390	618	501	36	0
	good	863	1219	346	649	568	0	0
perennial ryegrass	poor	451	1013	558	577	429	78	153
	average	750	1133	366	623	509	10	0
	good	880	1256	341	659	591	0	0

Performance in drought years

Drought was classified in 8 of the 50 years at Bombala **(Figure 8).** The gross margins, income from wool and sheep sales and supplementary feeding costs for poor (lowest 10%), average (50th percentile) and good (highest 10%) seasons are shown in **Table 7.** The gross margin for perennial ryegrass was $65, $38 and $17/ha higher than Phalaris in poor, average and good seasons, indicating an advantage for perennial ryegrass in poor seasons. The benefit was largely associated with lower feeding costs. The cumulative effect on gross margin produced a higher financial level for perennial ryegrass in the long term, although the difference was small **(Figure 9).** The differences should be viewed cautiously because the analysis assumes both pastures will persist and require re-sowing at the same frequency, whereas Phalaris is expected to have better persistence and the ryegrass production simulated may only represent productivity in the first 5 years after establishment (D. Alcock, personal communication).

When years classified as drought were compared with other years, the reduction in the growth rate of weaners during drought were similar, but perennial ryegrass allowed higher weaning weights of lambs than Phalaris **(Table 8).** Ryegrass also allowed wool production to be maintained at a higher level during drought.

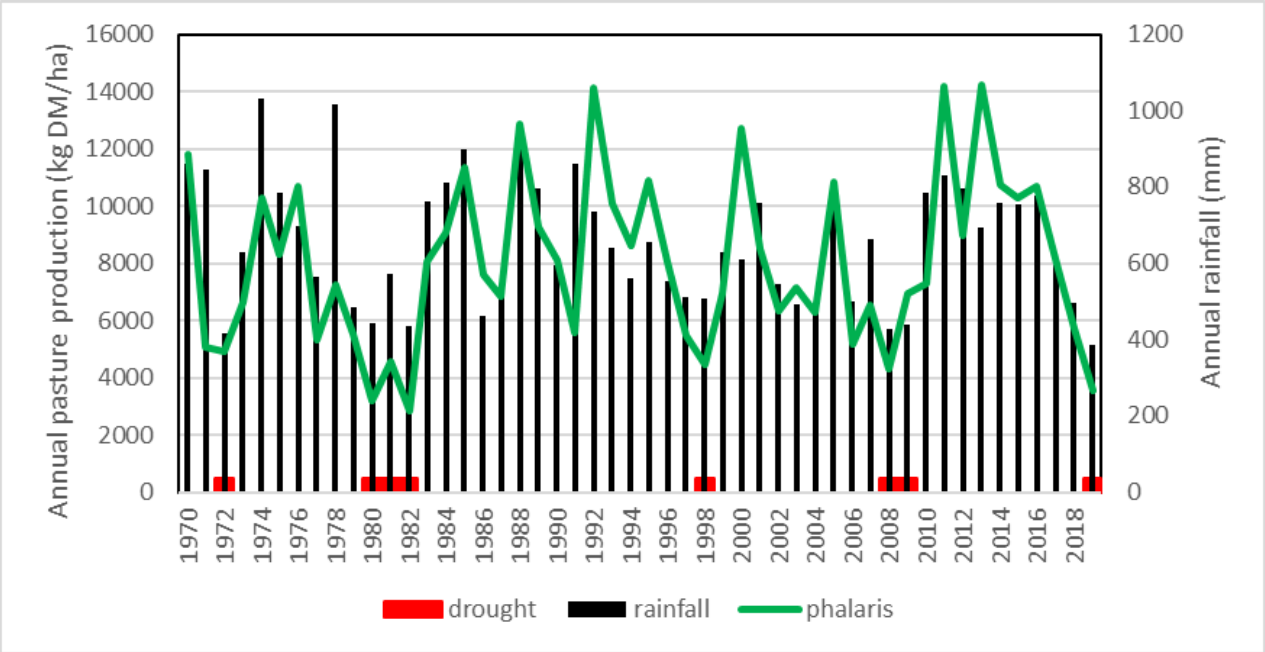


Figure 8. Annual rainfall (mm), production of Phalaris pasture (kg DM/ha) and classification as a drought year for Bombala 1970-2019.

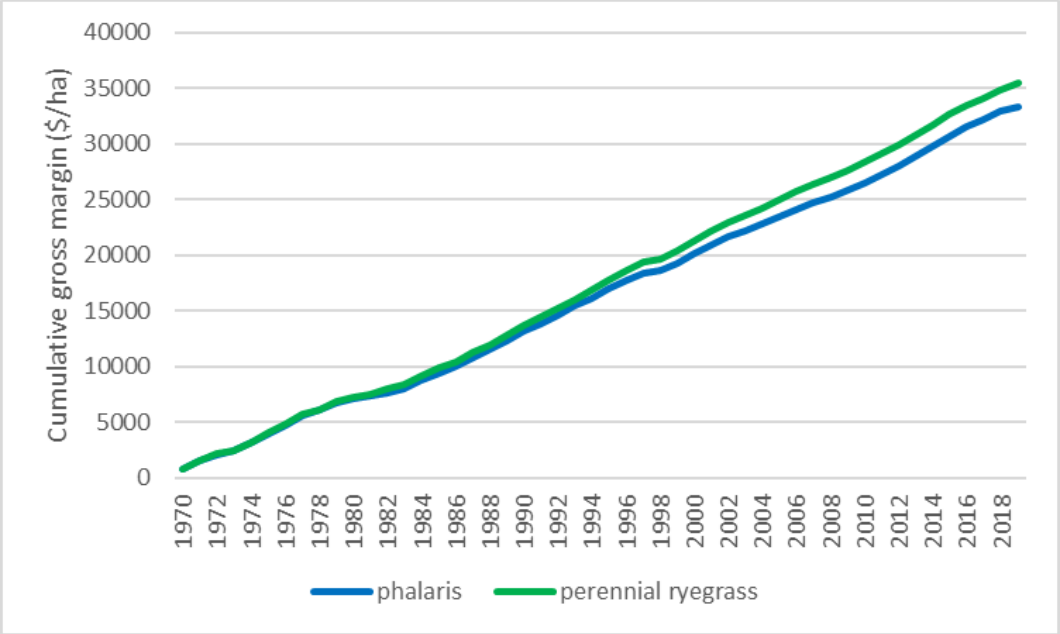


Figure 9. Cumulative gross margin ($/ha) for a self-replacing Merino enterprise grazing Phalaris or perennial ryegrass pasture at Bombala 1970-2019.

Key Messages

- Perennial ryegrass may produce higher pasture growth rates in autumn and summer than Phalaris and provide a higher quality diet for sheep in suitable regions, increasing sheep production.
- The persistence of sown pastures impacts on profitability. Pastures with lower persistence may become less productive and require more frequent re-sowing which increases costs. Persistence was not considered in this analysis.
- Perennial species which increase autumn growth and the length of the growing season during drought years may reduce the need for supplementary feeding.
- Managing ewe nutrition to avoid large loss in condition score during late pregnancy is recommended to optimise lamb survival.
- Managing ewe nutrition to avoid large loss in condition in autumn or around lambing is recommended to minimise reductions in the staple strength of wool.

Table 8. Production from a self-replacing Merino enterprise grazing native pastures with low or high soil fertility in drought or other years.

Pasture	Season	Lambs weaned/ewe joined (%)	Wether weight at weaning (kg)	Weaner growth Jan to May (g/day)*	Production supplement (kg/ewe)	Clean fleece weight (kg/ewe)	Fibre diameter ewes (µ)
Phalaris	drought	88	17.7	85	36	3.0	17.4
	other	90	22.8	95	5	3.5	17.8
perennial ryegrass	drought	89	18.7	85	33	3.2	17.5
	other	91	23.8	97	6	3.5	17.9

***Wether weaners**

Limitations of the modelling

- The results represent a farm with a ***single type of pasture*** to enable the impact of pasture type on the sheep enterprise to be clearly defined. Farms with a range of feed sources with differing patterns of supply throughout the year may increase resilience to drought but were not considered in this analysis.
- The analysis considered stock sales at defined dates with ***no reduction in stocking rate in poor seasons***. Flexibility in sale date to respond to seasonal conditions may reduce the risk of high feeding costs and improve sustainability measures.
- Stable price and costs were used, but ***feed costs are expected to increase during periods of drought.*** Pastures which attract lower feeding costs may therefore improve the resilience of the system to drought. The financial results presented reflect the prices and costs used, so the *financial performance of different choices will vary if different values are used*.
- The analysis used established pastures and did not consider the time ***nor cost required to establish a pasture prior to grazing***. Establishment reduces the effective grazing area of pastures, but the degree to which this occurs will depend upon the longevity of the pasture and the percentage re-sown each year. This establishment phase can make perennial pastures less productive than an annual pasture (Moore 2014). **Well-managed Phalaris pastures sown in suitable locations (soil type, environment) can remain productive for decades, reducing the cost of establishment.**
- The analysis used single representation of both Phalaris and perennial ryegrass pasture. Both types of pasture *may vary widely in their performance*, altering the relative benefit or disadvantage of either pasture, but a large analysis was beyond the scope of this study.
- The cost to increase or vary stocking rates has not been considered in this analysis, although **different pasture species may allow different stocking rates**.

References

Moore AD (2014) The case for and against perennial forages in the Australian sheep–wheat zone: modelling livestock production, business risk and environmental interactions. *Animal Production Science* **54**, 2029-2041.