  

Communicating best practice of grazing cereals

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Cover images

Left: Grazed (left) versus ungrazed (right) crop trial. Photo: BCG
Middle: Ungrazed (left) and Grazed (right) crop trial. Photo: BCG
Right: Variety evaluation trial at Culgoa. Photo: BCG

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Communicating Best Practice of Grazing Cereals

Background

In 2009 BCG and the Rainbow Landcare Group collaborated on a project investigating whether benefits can be obtained by grazing dual purpose crops in the Southern Mallee. Four individual demonstration plots containing different soil characteristics on four separate properties were selected to take part in the winter cereal paddock demonstrations. Four sites in the Rainbow district are currently investigating how two commercially available wheat and barley varieties Clearfield Stilletto and Hindmarsh barley respond to grazing by sheep.

However, a subsequent review of existing dual-purpose cereal literature identified that the winter cereals grown in the Rainbow region (e.g. wheat cv. Clearfield Stilletto and barley cv. Hindmarsh) tend to perform poorly as dual-purpose cereals. Hence to enhance and compliment the current Rainbow project, alternative varieties were included in the project, but at a different and more public site supported by the Mallee CMA. The site chosen was the BCG Main Field Day site 3kms South of Woomelang.

Objective (s)

The key objectives of this project are to establish and investigate how additional varieties of dual purpose crops respond to grazing and how grazing then affects grain yield. This site was established at Watchupga at the 2009 BCG Main Field Day site. This was measured by indicators of sheep health, relative value of feed and by grain quantity and quality. Soil health indicators will also be established and monitored using soil tests and vegetation cover assessments (see Appendix 1).

Methods

1. A full replicated trial was established at Watchupga (BCG Main site) which incorporated 9 cereal varieties 7 wheat and 2 barley including;
   - Yitpi
   - Correll
   - Axe
   - Derrimut
   - Wyalkatchem
   - CLF Stilleto
   - Young
   - & Buloke and Hindmarsh (Barley)

   These varieties were grazed by sheep. This occurred at the 3 leaf stage and stock were removed before GS30, which is the recommendation made be previous research conducted by CSIRO.

   - dry matter quality was tested via feedtests

   Weight gain and body condition scoring was not undertaken as the purpose of this trial was to investigate the amount and quality of feed each wheat and barley variety would produce and how each would recover after grazing.

Stock were used with crash grazing principles and the value of grazing estimated was based on the theoretical Dry Sheep Equivalent (DSE) days that were calculated and the supplementary feed cost required to maintain the same DSE number for the same amount of time. The cost of supplementary feed was valued at $200t/ha and it was assumed that each sheep required 8MJ/day which equates to 500g of grain. For example: theoretical DSE × 0.5kg (supplementary fee) × 0.20cents/kg feed.

2. Literature review and modelling of summer forage crops under known and projected climate conditions (Appendix 2).

3. A factsheet summarising project findings has been completed and will be distributed in May 2010 when farmers are considering grazing of cereals (Appendix 4).

4. Final report on
   - performance of varieties to grazing for livestock production and grain yield
   - comment on best practice for timing of grazing & stocking rate
   - application of grazing cereals in the Victorian Mallee (Appendix 1).

Findings were reported on in the 2010 BCG Members Only Research Results manual.

Delivery

Individual Task/Deliverable	Timeframe	Progress
Additional variety comparisons	Est April 09, monitored on-going	Completed
Modelling of summer forage crops	Feb 10	Completed
Factsheet and field day presentations	Nov 09 & Feb 10	Field Day presentations were made in 2009 on the 10 September and the Members Field Day on the 24 October 2009. A factsheet has been completed.
Reporting	Feb 2010	Completed

APPENDIX 1.

Grazing Cereals (manual article)

Kaylene Nuske (BCG), James Hunt (CSIRO) and Fiona Best (BCG)

Take home messages

- Barley produces more feed than wheat at the time of grazing and is nutritionally superior. However, Hindmarsh suffered the biggest yield reduction from grazing (0.32t/ha) but even when grazed still yielded more than all other varieties in the trial. Grazing did not reduce the yield of Buloke barley but it did increase screenings.
- Early maturing varieties (Hindmarsh barley, Young and Axe wheat) had the greatest yield penalties when grazed.
- Derrimut and Wyalkatchem wheat both yielded well and did not suffer a yield or screenings penalty when grazed. Based on 2009 results, these are the best-bet wheat varieties for grazing in the Mallee.

Aim

To assess the suitability of different wheat and barley cultivars for both grain and grazing production in low rainfall environments.

Background

Farmer experience and research from grain growing regions with higher rainfall (eg south-east NSW, south-west Vic) has shown that cereals can be successfully grazed prior to GS30 without compromising grain production. The success of dual purpose crops in these regions has driven interest in assessing the suitability of grazing cereals in low rainfall areas such as the Mallee. The adoption of this practice may have several benefits to Mallee farming systems. These include helping to fill the early winter feed gap, reducing lodging in barley, reducing stubble loads and providing a technique for controlling canopy development of crops sown early into paddocks with high available nitrogen (N).

The timing and intensity of grazing cereals early in the season can influence grain yields. Greater yield penalties are likely to be seen where grazing occurs at a later time and at higher intensities. Shorter-season cereals have also had mixed results with higher yield penalties occurring in some years (GRDC 2009). The challenge of adopting this practice is to ensure correct grazing techniques are applied to the most suitable varieties to avoid compromising grain production. Grain crops intended for grazing ideally need to be sown early (last half of April, first week of May) as grazing delays crop maturity by about a week, depending on timing and intensity. Grazed crops also need time to recover. Stock can be introduced to cereal crops intended for grazing at around the 3-leaf (GS13) stage or when plants cannot be tugged from the ground. If a grain yield penalty is to be avoided, stock must be removed before the end of tillering (GS30).

Method

This trial was established at Woomelang. Plots (2.8m x 30m) were pegged out using a complete randomised block design with 4 replicates. The plots were sown on 7 May 2009 to various wheat and barley cultivars. Dry matter production was measured at GS14 just prior to grazing. Feed tests were taken to determine the nutritional value of feed on offer – these tests were used to determine theoretical dry sheep equivalent (DSE) grazing days.

On 23 June 2009, a fence was erected around half of the 4 replicates and 10 lambs were placed inside the grazing treatment area (equivalent to 67 lambs/ha). 4 days later the lambs had grazed the plots down to 1cm in height and were removed on 26 June 2009. Almost 3 weeks after stock removal (15 July 2009), dry matter production was measured at GS30 in both the grazed and ungrazed areas. Dry matter production measurements were repeated during flowering at GS65 (18 September 2009 for ungrazed and 23 September 2009 for grazed) and at crop maturity. Heads were also counted at flowering.

Grain yield was measured using a plot harvester and grain quality analysed (protein, screenings and moisture). Grain yields were corrected to 12% moisture.

Location:	Woomelang
Replicates:	4
Sowing date:	7 May 2009
Seeding density:	150 plants/m^2
Crop types:	Wheat (Yitpi, Correll, Axe, Wyalkatchem, Young, Derrimut, CLF_STL)
	Barley (Buloke, Hindmarsh)
Seeding equipment:	BCG cone seeder (knife point, press wheels on 30cm row spacing)
Initial soil fertility:	42.7mg/kg Nitrate, 26mg/kg Colwell P
Fertiliser:	40kg/ha DAP at sowing
GSR:	208.5mm

Results

Available dry matter at grazing

Prior to grazing at GS14, dry matter production was measured to indicate how much available feed was on offer (Figure 1). The 2 barley cultivars, Hindmarsh and Buloke, produced the greatest amount of biomass. This was more than the Derrimut, CLF_STL and Young wheat cultivars which produced less than 130kg/ha of dry matter each.

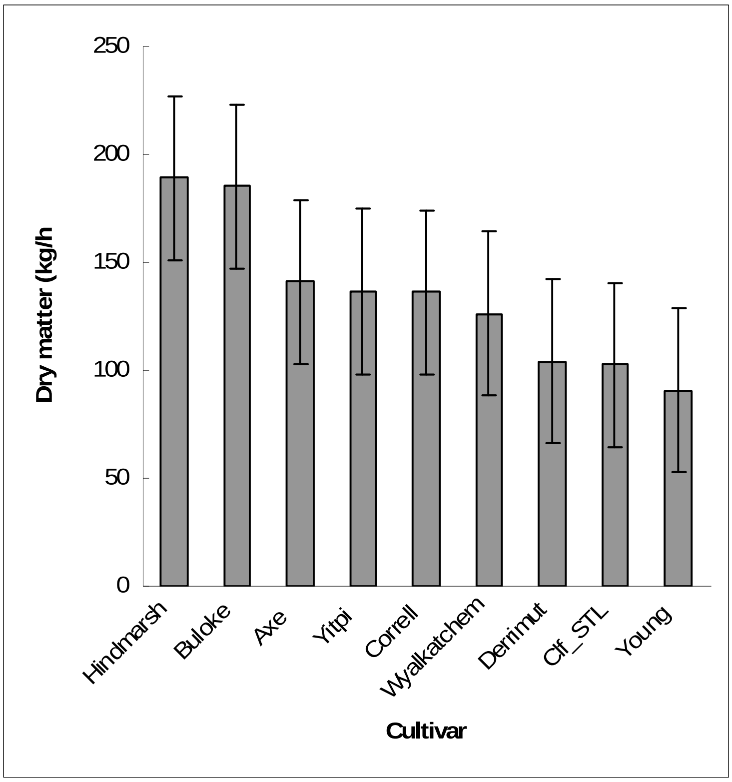

Figure 1. Dry matter (kg/ha) available for each cultivar prior to grazing at GS14. Capped bars represent standard error values showing variation around the mean of 4 replicates.

Nutritional feed values at grazing

Feed tests for each variety determined the metabolisable energy (ME) values for stock prior to grazing at GS14. Consequently, the number of grazing days was calculated assuming one DSE consumes 8MJ/day of dry matter (Table 1). Hindmarsh and Buloke were the standout varieties, with Hindmarsh having the greatest ME of 2018MJ/ha. This equated to 252 DSE grazing days. The less vigorous variety Young had 700MJ/ha of ME, providing 88 DSE grazing days.

Table 1. Average ME values and corresponding number of grazing days calculated prior to grazing at GS14 (assuming 1 DSE consumes 8MJ/day).

Variety	Average of ME (MJ/ha)	Average of DSE grazing days
Hindmarsh	2018	252
Buloke	1874	234
Axe	1295	162
Yitpi	1318	165
Correll	1281	160
Wyalkatchem	1125	141
Derrimut	875	109
CLF_STL	909	114
Young	700	87
Sig. diff	P=<0.001	P=<0.001
LSD (P<0.05)	443.5	55.44
CV%	24%	24%

Biomass recovery following grazing

Three weeks after stock removal, dry matter production was measured at GS30 for both the grazed and ungrazed areas. Biomass recovery was calculated using the dry matter of grazed treatments expressed as a percentage proportional to the dry matter of ungrazed treatments (Figure 2). Wyalkatchem and Derrimut wheat cultivars recovered the best after grazing, producing comparatively more biomass than the other varieties. Correll and Buloke suffered the highest grazing effect and had less vigorous re-growth proportional to their ungrazed biomass.

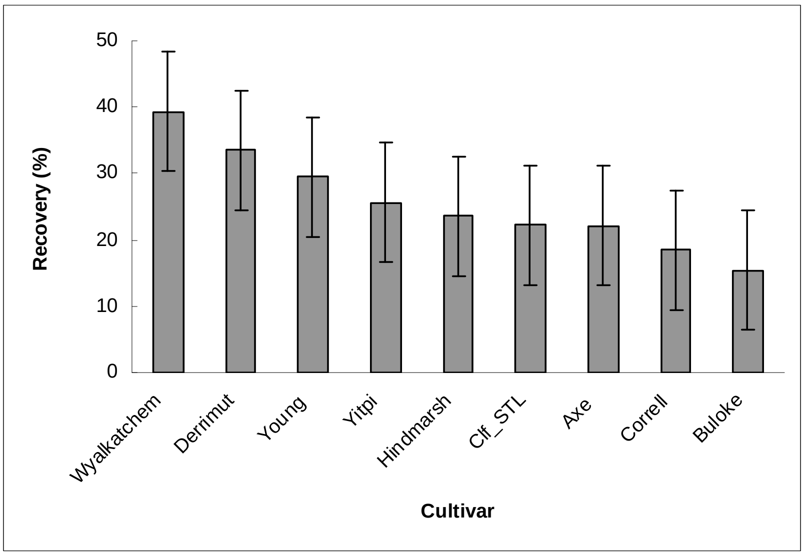

Figure 2. Recovery of grazed cultivars three weeks after stock removal at GS30 (grazed dry matter treatments expressed as a percentage of ungrazed dry matter treatments). Capped bars represent standard error values showing variation around the mean of 4 replicates.

Dry matter measurements at flowering

Dry matter production was analysed at flowering (GS65) which is a key growth stage to determine yield potential. Analysis showed that overall, grazing reduced dry matter by 615kg/ha at flowering and by 624kg/ha at maturity (P=0.002). Differences between varieties showed that barley produced a greater amount of biomass than wheat, with almost 1700kg/ha more produced on average (P=<0.001). However there was no difference between varieties and whether they were grazed or ungrazed (Table 2).

Table 2. Dry matter comparison at flowering (GS65) between ungrazed and grazed treatments 3 months post-grazing.

Variety	Treatment		Difference (DM kg/ha)
	Ungrazed (DM kg/ha)	Grazed (DM kg/ha)	
Buloke	5946	4837	1109
Hindmarsh	5773	5313	460
Yitpi	4536	3516	1020
Correll	4358	3491	867
Wyalkatchem	4264	3932	332
CLF_STL	3944	3360	584
Young	3847	3061	786
Derrimut	3744	3919	-175
Axe	3684	3126	558
Sig. diff LSD (P<0.05) CV%	NS		

Grain yield

Yield penalties occurred for 3 varieties (figures bolded in Table 3). The greatest of these was Hindmarsh which had a yield penalty of 0.32t/ha. Even when grazed however, Hindmarsh still yielded higher than all of the other ungrazed varieties.

Table 3. Grain yield for ungrazed and grazed treatments.

Variety	Maturity	Grain yield (t/ha)		Yield penalty (t/ha)
		Ungrazed	Grazed	
Hindmarsh	Very early	2.29	1.97	0.32
Young	Early – mid	1.88	1.59	0.29
Axe	Early	1.70	1.55	0.16

Wyalkatchem	Early	1.88	1.74	0.14
Correll	Mid	1.80	1.69	0.11
Yitpi	Mid	1.58	1.48	0.10
Derrimut	Early – mid	1.83	1.76	0.07
Buloke	Mod – early	1.73	1.75	-0.02
CLF_STL	Mid	1.40	1.48	-0.08
Sig. diff LSD (P<0.05) CV%		P=0.027 0.16 6.7%		

Grain quality

Grain analysis determined that there was no impact on protein between grazed and ungrazed treatments. Screenings however, showed that several varieties (bolded in Table 4) were higher when grazed. The stand-out variety for this penalty increase was Correll which had almost 77% more screenings when grazed.

Table 4. Grain quality analysis for ungrazed and grazed treatments

Variety	Protein (%)		Screenings (%)	
	Ungrazed	Grazed	Ungrazed	Grazed
Hindmarsh	13.6	14.5	1.9	2.5
Derrimut	12.5	12.5	5.5	5.8
Buloke	14.0	14.4	2.5	5.8
Wyalkatchem	13.1	13.0	1.8	2.1
Correll	13.5	12.8	5.3	9.4
Young	12.7	12.6	3.6	5.6
Axe	13.2	12.6	3.5	4.2
Yitpi	13.6	14.1	4.7	5.2
CLF_STL	14.9	14.4	1.0	4.2
Sig. diff LSD (P<0.05) CV%	NS		P<0.001 1.3 21.4%	

Soil Erosion Risk

Another important consideration is the effect that grazing crops could have on the long term sustainability of the environment. The act of grazing a cereal paddock in early stages of the crops growth can lead to low soil cover and create the potential for wind erosion. Grazing was conducted on the site when the crop was between GS14 and GS30 between 23 and 26 June.

To determine the effect of grazing on ground cover at the site plant counts were conducted at emergence (GS13) and dry matter assessments were conducted on the grazed and ungrazed plots at 3-leaf (GS14), end of tillering (GS30), mid flowering (GS65) and harvest (GS99). It is evident from Table 5 that there were significant differences in dry matter between varieties at each of the assessments. It is apparent that after grazing, some cultivars had significantly less dry matter than others. Buloke barley, immediately post grazing, had significantly more dry matter than Derrimut, Axe, Young, CLF_ STL and Correll wheat. When given the opportunity to recover from grazing Hindmarsh and Buloke barley provided significantly more soil cover than Yitpi, Correll, CLF_STL, Axe and Young wheat when analysed at flowering. At harvest Yitpi wheat and Hindmarsh and Buloke barley provided significantly more cover than Young and Axe wheat thus providing the greatest protection from potential wind erosions over the summer.

Table 5: Plant density at GS13 and dry matter at a GS14, GS30, GS65 and GS99 of different wheat and barley cultivars.

Variety	Plants/m²	Variety	DM (kg/ha)	Variety	DM (kg/ha)	Variety	DM (kg/ha)	Variety	DM (kg/ha)
	GS13		GS14		GS30		GS65		GS99
Hindmarsh	142.9	Yitpi	136.5	Buloke	153.8	Hindmarsh	5,313	Yitpi	5,988
Buloke	141.7	Hindmarsh	189.3	Hindmarsh	148.9	Buloke	4,837	Hindmarsh	5,692
Yitpi	138.5	Buloke	185.3	Wyalkatchem	148.7	Wyalkatchem	3,932	Buloke	5,587
CLF_STL	131.5	Correll	136.1	Yitpi	114.8	Derrimut	3,919	Correll	5,369
Derrimut	131.5	Wyalkatchem	126.2	Derrimut	103.7	Yitpi	3,516	Wyalkatchem	5,108
Correll	129	CLF_STL	102.8	Axe	103.1	Correll	3,491	CLF_STL	5,085
Wyalkatchem	127.5	Derrimut	104.3	Young	91.9	CLF_STL	3,360	Derrimut	5,080
Axe	125.6	Axe	140.9	CLF_STL	84.2	Axe	3,126	Young	4,878
Young	124.4	Young	90.7	Correll	73.4	Young	3,061	Axe	4,368
Sig. diff		Sig. diff	S	Sig. diff	S	Sig. diff	S	Sig. diff	S
LSD (P<0.05)	NS	LSD (P<0.05)	37.68	LSD (P<0.05)	41.17	LSD (P<0.05)	1164	LSD (P<0.05)	685.2
CV%		CV%	19.2%	CV%	24.8%	CV%	20.8%	CV%	9.0%

Interpretation

Previous research has shown that not all varieties can be grazed without suffering biomass, yield and/or grain quality penalties. It was evident that there were yield reductions in particular cultivars, namely Hindmarsh, Young and Axe (Table 3). These particular varieties are notably earlier maturing than most of the other cultivars in this trial. Due to their shorter growing season, the early maturing varieties did not have enough time to recover from grazing to reach their full yield potential. While Hindmarsh experienced the greatest yield penalty of 0.32t/ha, it still yielded higher than all other grazed varieties.

Grazing did not have an effect on protein levels. The screenings however, were considerably higher when grazed for Buloke, Correll, Young and CLF_STL (Table 4). Higher screenings may have resulted because there was not enough time for the grains to fill and therefore grain ended up being small and pinched. This effect on screenings must be considered when choosing a variety to graze, as it will have economic implications if screening levels are pushed over the 5% threshold between grading qualities.

Overall, based on 2009 results, Wyalkatchem and Derrimut are the best-bet wheat varieties for grazing in the Mallee. They did not suffer a yield or screenings penalty and were among the highest yielding varieties in this trial. However, Wyalkatchem is not Cereal Cyst Nematode (CCN) resistant so this must be considered in the decision making process. The barley varieties produced more feed than wheat at grazing. Barley forage has adequate sodium and magnesium levels, unlike wheat forage which should be supplemented with a mineral product such as magnesium/sodium supplement (eg 1:1 mix of causmag and sodium chloride (salt)) to prevent sub-optimal livestock growth rates (GRDC 2009). There was no difference in feed value between Buloke and Hindmarsh. Although Buloke did not suffer a yield penalty unlike Hindmarsh, the grazed Hindmarsh still out-yielded ungrazed Buloke. Malt growers should also be careful when grazing Buloke as screenings increased.

Soil Erosion Risk

It is a commonly held belief that if soil cover is maintained at greater than 1,000kg/ha top soil will not be at risk of erosion. Immediately post grazing all the varieties had very low dry matter, substantially lower than 1000kg/ha. However, if a paddock is left exposed at this time of the year there is virtually no risk of erosion as the conditions are not conducive to such an event. However, if extremely dry conditions eventuated following grazing there may be a risk that the grazed crops would not recover and produce enough biomass to protect the soil from wind erosion in spring and summer. Table 4 shows that in 2009 Yitpi wheat and Hindmarsh and Buloke barley were better at reducing the risk of wind erosion compared to the others. However, the quantum of the dry matter of all cultivars used in the trial was sufficient to ensure that wind erosion would not present any real risk during that season. At GS65 Young wheat had the lowest amount of dry matter with 3,061kg/ha, significantly more than the minimum requirement of 1,000kg/ha.

The 2009 annual and growing season rainfall at the site was 337mm and 208.5mm respectively, between Decile 4 and 5. This quantity of rainfall helped to ensure that erosion would not pose a risk in 2009. However, these conditions do not always eventuate. There is a risk that no rainfall would occur after grazing, leaving the soil exposed. In this trial the sheep were removed from the plots on 27 June. A Decile 1 season finish to the end October would deliver 72mm of rainfall. This quantity of rain should ensure that at least 1000kg/ha of DM is produced. Season finishes with less rainfall are extremely rare and should not affect the decision to graze cereals. Grazing cereals would only be considered after a favourable start to the season when there is adequate soil moisture to enable the crop to recover following grazing. Of greater concern is the affect that grazing may have on the yield and screening potential of the crop.

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APPENDIX 2.

Literature Review

Background of Mallee CMA Mixed Farming Systems

The role of livestock in mixed farming systems in the Mallee has reduced over the past two decades as wool prices have continued to decline, and farmers have been attracted toward the higher returns of cropping. The increased risk of erosion in dry seasons from running livestock has also played a part (Heinjus and Redden, 2009). According to ABARE, between 1990 and 2007 the total sheep numbers in the Victorian Mallee declined by 54%, falling to a point where income from livestock is about 20% of total farm income.

Conversely, during the same period wheat production increased 150%, with the area of land cropped increasing to 60 – 70% of land use and cropping deriving 70% of total farm income (Pengelly et al, 2006). This intensification of cropping has meant higher input systems are required, which in turn can lead to higher seasonal risk for businesses (Heinjus and Redden, 2009).

A decade of drought and increased cost of inputs between 2000 – 10 has renewed interest in livestock, particularly prime lamb production in response to a dramatic increase in lamb prices. The low returns from crops during this period and the risks associated with crop production in a highly variable climate has meant there has been less paddocks continuously cropped and more areas sown or left to pasture.

Several whole farm financial studies across Australia (eg Hunt et al., 2007, Lynch, 2008, and Jones, 2009) are showing that mixed farming systems are able to generate similar, or better, income than single commodity enterprises, but are more robust as they carry less risk. Having mixed enterprises enables business flexibility, eg alternative uses for failed crops, value adding to grain by feeding to animals, or the means to change enterprise mix in response to season or market prices. R&D that facilitates adoption or integration of mixed enterprises will support farm businesses resilience to market and climate variability.

Mallee Pasture Systems

Forage for livestock in the Mallee largely relies on annual legumes, primarily annual medics such as barrel medic (*Medicago truncatula*) and strand medic (*M. littoralis*) and some vetch in the southern Mallee, some sown cereal crops and crop stubbles. Medics and vetch grow over winter and early spring, then usually senesce quickly once dry conditions are reached later in spring. Oats and barley are sometimes sown in March and April if an early rain is received to generate early feed. These crops may be sprayed out for fallow, cut for hay at anthesis or harvested for grain depending on the season. Crop stubbles are mainly from wheat and barley and are available for summer grazing. Typically these residues are exhausted by February, leaving a feedgap in the autumn period before the new season germination of pasture legumes and crops.

There has been little use of perennials except saltbush and lucerne. Saltbush (*Atriplex nummularia*) has been sown extensively on saline affected lands and provided some forage value. Saltbush however is not a balanced feed source on its own and must be supplemented by other forage types to provide fibre and balance excess elements (Cl, K, Mg and Na). Lucerne has been grown in the

Mallee providing fodder over spring and summer. Establishment of lucerne is expensive and failure is common in years with very low spring rainfall (Craig et al., 2008).

An audit was conducted to identify new potential perennial pasture species for grazing systems in the Mallee-Wimmera region in 2006 (Pengelly et al., 2006). For the different forage types it identified the following:

- Native grasses: unlikely to have a major role in providing perennial forage sources in the short term
- Mediterranean grasses: 6 species identified (4 high priority)
- Perennial Mediterranean legumes: 6 species identified (4 high priority)
- Non-legume shrubs: 1 species (high priority)
- Warm season (sub-tropical) forages: 2 species of grass, 1 legume species.

Many of these species have very low seed stocks and are yet to be evaluated in the Mallee region.

However a project by Birchip Cropping Group (BCG) which started in 2006 has been evaluating several sub-tropical pastures which they've found can be successfully established and productively grown in the Wimmera Mallee. Further evaluation is needed to measure persistence under grazing and other seasons. Modelling sub-tropical pasture growth suggests that most of the growth will occur in late spring and early summer, with very little growth past Christmas because of the low incidence of rainfall events and high evaporation (Craig et. al., 2009).

The project found that establishment of any grass or legume species in marginal or poorly prepared paddocks is unlikely to be successful, indicating that they should only be sown into better ground. Given establishment time and costs this means better paddocks will be out of cereal production for a number of years.

Grazing cereals

Grazing cereals could offer Mallee growers a potential forage source to fill the autumn feedgap. In southern NSW where there is likelihood of March and April rainfall, lamb production is partly based on early grazing of cereals, usually spring wheats which have winter dormancy. For the Mallee, rainfall in these autumn months is less common (Pengally et al, 2006).

However, in several parts of Australia winter crops are also now being considered as an alternative forage source to traditional pasture, with intent for grain recovery, as variability in climate becomes more challenging (Grazing Winter Crops Roadshow, Workshop Notes, 2008).

The effect of grazing later sown (April and May) crops on grain yield is not documented for the Victorian Mallee.

Research in other higher rainfall areas has shown that if grazed before growth stage 30 (stem elongation) grain yield will not be significantly compromised and may even increase grain yield (due to reduced disease, delayed maturity may avoid frosts, reduced lodging, canopy management effects) (Grazing Winter Crops Roadshow, Workshop Notes, 2008). However, if there are unfavourable conditions for crop recovery, grain yield will always be affected (McInerney, 2008). In this case the financial benefits of grazing need to be accounted for to evaluate the value of the operation.

Grazing early sown cereals presents an opportunity for the crop to fill the late autumn, early winter feedgap for the livestock enterprise, potentially without compromising grain yield, which in turn reduces erosion risk on extensively grazed stubble paddocks and increasing cover on pasture paddocks by allowing them a 'rest' from grazing pressure while they establish.

The reduced erosion risk benefits fit with the land resource targets for the Mallee CMA which include:
• Soil health maintained at yet to be determined benchmark levels.
• Negligible erosion throughout the Mallee in 6 out of 10 years.
• The extent of actively eroding land in dry years confined to 3%.
(Mallee Regional Catchment Strategy 2003 – 3008)

General conclusions

This review has highlighted the need to find alternative, low risk forage sources to fill the autumn feedgap in the Mallee CMA region. While oat and barley crops have been used for early feed crops for some time, information on grazing conventionally sown wheat and barley crops with intent for grain recovery does not exist for the Victorian Mallee. Research and grower demonstrations would validate the practice for the Mallee, and if successful support grower confidence in handling livestock enterprises which in turn would aid business resilience.

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Appendix 3.

Summer Forage Modelling

Aim

For sorghum established in a Mallee environment, to assess the pattern of reliability of growth and its potential as a fodder source using simulation models.

Background

During the past 20 years the number of livestock in the Mallee has decreased significantly as farmers have moved away from mixed farming system into No-till cropping systems which do not incorporate livestock. It is evident that these systems help to reduce the risk of negative environmental impacts and help to ensure the long-term viability of the soils. The removal of livestock from Mallee farming system has placed a heavy reliance on the profitability of cropping. The current market conditions, low grain prices and a dramatic increase in lamb prices, has meant that growers are looking at ways to incorporate livestock back into their farming systems.

During the last decade the rainfall patters in the Mallee have been significantly different from the long term average. Figure 1 shows the 90 year (1920 – 2009) and 10 year (2000 – 2009) average monthly rainfall at the Woomelang BOM station (No: 07752). The average annual rainfall at the site over the last ten years has decreased by 14.2% from 345mm to 296mm. Further to this the timing of rainfall has altered. Rainfall over the last 10 years has generally declined in early spring and increased in the late spring and early summer. The ten year average rainfall in September and October has decreased by 21.5 and 50.0% respectively from the 90 year average. The ten year average rainfall in November and December has increased by 52.5 and 29.1% respectively from the 90 year average.

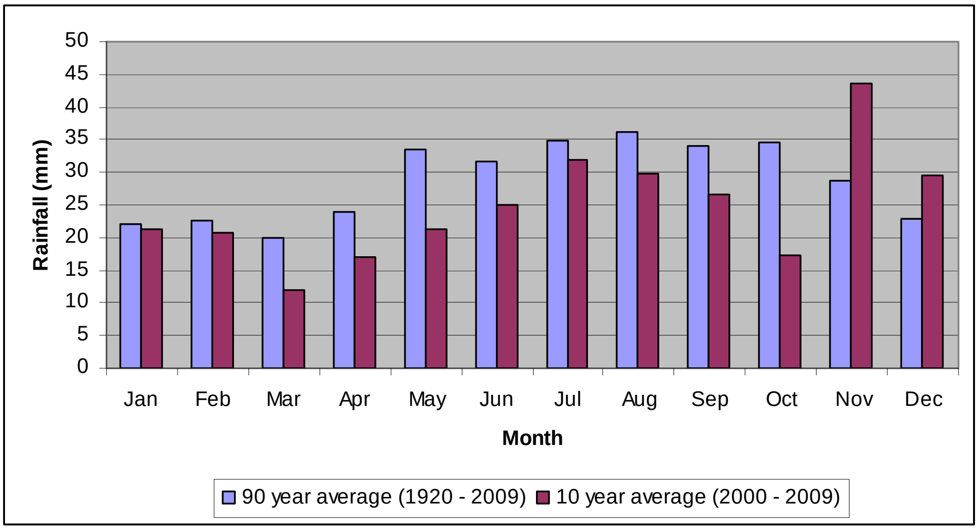

Figure 1: 90 year (1920 – 2009) and 10 year (2000 – 2009) average monthly rainfall at the Woomelang BOM station (No: 07752). Source: BOM 2010

The changes in the timing of rainfall have significant consequences for winter dominant cropping systems in the Mallee. Reductions in rainfall in the early spring significantly reduce the yield potential of winter crops and cause them to reach maturity earlier in the year prior to the increased rainfall received in the November and December. With increased late spring and summer rainfall falling outside the winter crop growing season the majority of this rainfall is lost through evaporation and wasted.

An obvious way to make use of the increased summer rainfall is to grow a summer forage crop. Traditionally lucerne has been grown in the Mallee providing fodder over spring and summer. Establishment of lucerne is expensive and failure is common in years with very low spring rainfall (Craig et al., 2008). In recent years anecdotal reports of successful summer sorghum crops have been received. However, further investigation is needed to identify if summer forage sorghum is a viable option for the Mallee in the long term.

Method

Using a medium maturity sorghum model available in APSIM, simulations of the long-term pattern of wheat and sorghum growth were undertaken for the Mallee environment. These simulations were run continuously from 1889 until 2009 assuming a rotation of wheat-sorghum-wheat-sorghum etc. A second set of simulations were generated assuming continuous wheat with no summer crops. Historical meteorological data was sourced for Woomelang from the Silo database (Jeffrey et al. 2001). A soil that has been characterised previously at Danyo in the Central Mallee was selected from the APSOIL database (www.apsim.info) to be representative of a soil from Woomelang. This was a typical Mallee sandy loam, 100cm deep with a plant available water capacity (PAWC) of 120mm. In each year of the wheat and sorghum simulations a nitrogen top up rule was applied where 200kg N/ha was applied when the soil N dropped below 50kg/ha to ensure that nitrogen was not limiting the potential of the crop simulations. The simulation also assumed that there were no weeds at any time of the year.

Weather records:	Woomelang [Post Office] (1889 to 2009)
Soil type:	Sandy loam, 100cm deep, PAWC = 120mm
Plant density:	Wheat: 150 plants/m^2, Sorghum: 20plants/m^2
Cultivar:	Wheat: Yitpi, Sorghum: Medium Maturity

Assessing the viability of sorghum as a summer forage crop

To assess the seasonal production of sorghum as a useful summer forage crop a spreadsheet analysis of yearly outputs of dry matter was undertaken to assess:

- the number of years where there is the opportunity to plant a summer sorghum crop;
- the sowing conditions that give the greatest likelihood of a successful summer sorghum crop;
- the average feed production of summer sorghum; and
- the number of years where the summer sorghum failed (where crop failure is a DM production of less than 1t/ha).

It is also important to consider the effect that summer sorghum crops have on the yield potential of subsequent winter crops. To assess the affect of the summer sorghum crops on winter crops a spreadsheet analysis of the yearly outputs of wheat yields of the continuous wheat crop and wheat-sorghum-wheat-sorghum rotations have been compared.

The optimal sowing rules have been determined by comparing the simulations of three separate sowing rules:

- A large rainfall event with a long sowing window – Greater than 40mm of rainfall in less than 3 days between 1-Nov and 1-Feb (Sowing Condition 1)
- A medium sized rainfall event with a medium length sowing window – Greater than 30mm of rainfall in less than 3 days between 1-Nov and 1-Jan (Sowing Condition 2)
- A small rainfall event with a short sowing window – Greater than 20mm of rainfall in less than 3 days between 1-Nov and 1-Dec (Sowing Condition 3)

Results

Table 1 shows the potential viability of sorghum crops in a Mallee environment using three different sowing conditions based on the full historic climate record from 1890 to 2009. In a Mallee environment a grower using Sowing Condition 2 would have had seen 37 occurrences out of the 120 years of records when the sorghum crop would have been sown. This is substantially more occasions than would have occurred for Sowing Conditions 1 and 3 with 25 and 24 occurrences respectively. However, Sowing Condition 2 would have resulted in 5 sorghum crop failures substantially more than Sowing Conditions 1 and 3 with 2 and 3 respectively.

The average feed produced under Sowing Conditions 1, 2 and 3 was 3.3, 2.5 and 3.1t/ha respectively (Table 1). It is evident that under Sowing Condition 2 the increased number of years with a sowing opportunity and the greater number of failures compared to Sowing Conditions 1 and 3 results in a substantially lower average yield potential. That said the total biomass production of Sowing Condition 2, over the entire period would have been substantially higher than Sowing Conditions 1 and 3 with 92.5, 79.2 and 77.5t/ha respectively.

Table 1 shows that sowing sorghum crops over the summer, irrespective of the sowing conditions applied, has a limited effect on the yield potential of a subsequent wheat crop. Summer Sorghum crops sown using Sowing Conditions 1, 2 and 3 only generate a 169, 227 and 127 kg/ha reduction in yield potential respectively, relatively insignificant amounts.

Table 1: Viability of sorghum crops in a Mallee environment based on three different sowing conditions using 120 years of data from 1889 to 2009.

	Sowing Condition 1	Sowing Condition 2	Sowing Condition 3
No of years with a sowing opportunity	24 out of 120 years (20.0%)	37 out of 120 years (30.8%)	25 out of 120 years (20.8%)
Average feed production	3.3t/ha	2.5t/ha	3.1t/ha
No of years of crop failure	2 out of 24 years (8.3%)	5 out of 37 (13.5%)	3 out of 25 years (12.0%)
Total feed production	79.2t/ha	92.5t/ha	77.5t/ha
Effect on subsequent wheat yield	-169kg/ha (-5.6%)	-227kg/ha (-7.6%)	-127kg/ha (-4.2%)

With the apparent increases in late spring and early summer rainfall over the last ten years it is important to assess the potential of summer sorghum under these changed conditions. Table 2 shows the potential viability of sorghum crops in a Mallee environment using three different sowing conditions based on the last ten years of the historic climate record. In a Mallee environment a grower using Sowing Condition 2 would have had seen 3 occurrences out of the 10 year period when the sorghum crop would have been sown. This is slightly more than would have occurred for Sowing Conditions 1 and 3 with 2 occurrences each. However, Sowing Condition 2 would have resulted in one sorghum crop failure as opposed to Sowing Conditions 1 and 3 that would have had none.

The average feed produced under Sowing Conditions 1, 2 and 3 was 3.8, 2.7 and 2.4t/ha respectively (Table 2). The total biomass production of Sowing Conditions 1 and 2 over the ten year period would have been substantially higher than for Sowing Conditions 3 with 7.6, 8.1 and 4.8t/ha respectively.

It is evident from Table 2 that sowing summer sorghum crops over the last 10 years would have had an affect on the yield potential of subsequent wheat crops. Sowing Condition 2 for a sorghum crop would have resulted in a reduction in yield potential of 425kg/ha, 21.7% lower than the yield potential of crop following a summer fallow. Summer sorghum crops sown using Sowing Conditions 1 and 3 would have resulted in small reductions in subsequent wheat crop yield potential with 291 and 175kg/ha reductions respectively. However, the small yields achieved in those seasons results in the reductions in yield making up a significant proportion of the total yield with reductions of 14.8% and 8.9% respectively. These percentage yield reductions are substantially higher than those realised in the total climate record.

Table 2: Viability of sorghum crops in a Mallee environment based on three different sowing conditions using 10 years of data from 2000 to 2009.

	Sowing Condition 1	Sowing Condition 2	Sowing Condition 3
Nº of years with a sowing opportunity	2 out of 10 years (20%)	3 out of 10 years (30%)	2 out of 10 years (20%)
Average feed production	3.8t/ha	2.7t/ha	2.4t/ha
Nº of years of crop failure	-	1 out of 10 years (10%)	-
Total feed production	7.6t/ha	8.1t/ha	4.8t/ha
Effect on subsequent wheat yield	-291kg/ha (-14.8%)	-425kg/ha (-21.7%)	-175kg/ha (-8.9%)

The percentage of years with a sowing opportunity has remained relatively unchanged in the last ten years when compared to the entire climate record. Sowing Conditions 1, 2 and 3 have a sowing opportunity in about 20%, 30% and 20% of years respectively in either of the last ten years or the total climate record.

The average feed production potential of over the last ten years has increased under Sowing Condition 1, remained about the same under Sowing Condition 2 and decreased under Sowing condition 3 compared to the total climate record.

A comparison between tables 1 and 2 of the number of crop failures show that over the last ten years the incidence of failure would have decreased given Sowing Conditions 1 and 3 and stayed relatively similar using Sowing Condition 2. However, this decrease is likely to be the result of a much smaller sample size in the 10 year period compared to the total climate record with 120 years.

Interpretation

With a greater percentage of annual rainfall falling outside the traditional growing season over the last ten years it is important for growers in the Mallee to make adjustments in response to this change. Growing summer crops is one way that the growers can utilise valuable summer rainfall. The simulations have revealed that given the right sowing conditions sorghum becomes a viable opportunity crop for summer forage. However, a grower considering the crop should implement strict sowing rules as annual sowing would be likely to result in significant crop failure. The sowing rules applied and the resulting yield will largely be determined by the future rainfall conditions. If climatic conditions of the last ten years persist in the future the most appropriate sowing rules will change.

Under historic climatic conditions Sowing Conditions 1 or 2 would have been most appropriate with good yield potential, an acceptable level of crop failure and minimal impact on subsequent crops. Given the alternative climatic conditions, Sowing Condition 1 provides the greatest potential for a viable summer sorghum forage crop. The combination of yield potential, crop failure and effect on subsequent crops is substantially more favourable than those under Sowing Conditions 2 and 3. With Sowing Condition 1 providing the greatest yield potential it is apparent that the size of the rainfall event is more important than the timing of the event.

If growers were to adopt Sowing Condition 1, a rainfall event of at least 40mm, in less than three days, any time between the 1 November and 1 Feb, growers will have the opportunity to sow a sorghum crop 1 in every 5 years. In these years the average size of the crop based on the historic rainfall records would be 3.3t/ha. This is a sizeable amount of feed that would be available for livestock.

The simulations have revealed that sorghum may be viable summer forage crop. However, in practice is it a practical option.

The sandy loam soil used in these simulations is light in texture and gives a potential sorghum crop the best opportunity for success. If the simulation was repeated on the heavier textured soil the likelihood of success would be substantially lower. Consequently summer forage sorghum, in a Mallee environment, should not be considered on heavier textured soils.

The sowing window assumed in this analysis commences on the 1st of November. In practice sowing a sorghum crop at that time of the year would not be practical. It would be necessary for the previous crop to have reached maturity and have been harvested before a summer crop could be sown. In addition, a grower would need to have the time and resources to be able to sow the crop. In reality it is likely that the grower will devote their time to harvesting the winter crop. Thus the number of opportunities to put in a summer sorghum crop would be limited.

However, if a grower was determined to sow a summer forage crop following a winter crop a sowing opportunity could be created by sowing a short season crop, such as wheat CV Axe or Barley CV Hindmarsh, or they could cut the crop for hay in the spring. Both options would allow a grower to have access to their paddock prior to 1 November.

A more plausible situation is if the paddock was fallowed in the winter season prior to the summer crop. Leaving the paddock out of crop would allow a grower to sow a sorghum crop prior to the start of harvest, assuming an appropriate rainfall event was received. In addition the paddock would most likely carry some stored soil moisture from the winter growing season further enhancing in the viability of a potential sorghum crop and would likely result in a significant increase in the yield potential.

However, if you assume that planting the crop is logistically possible for a profitable outcome to be achieved it is necessary for a grower to have stock to graze the crop. A grower could take two approaches in securing stock to graze a summer sorghum crop: acquire the stock prior to sowing the crop; or purchase the stock after the rainfall event has occurred and the crop planted. There are advantages and disadvantages to either option.

A grower carrying stock into a summer crop will be exposed to the risk of no rainfall event eventuating. If this were to occur the grower would be forced to find an alternative feed source which could erode his potential profitability or alternatively the grower may have to sell his stock, potentially at unprofitable levels. A grower purchasing stock after sowing the crop will likely be exposed to higher prices as other growers in a similar position search for stock, eroding potential profitability. On the positive side a grower in this position has the fall back option of cutting the crop for hay or taking it through to seed.

A low risk strategy for summer sorghum would be for a grower to consider agisting the crop to a neighbour. In a Mallee environment feed sources are often scarce so agistment becomes a viable option. If a grower were unable to source suitable agistment the crop could easily be cut for hay and sold or fed to livestock at a later date.

It is important to note that soil temperature limits the ability of a sorghum crop to germinate and in the Mallee the required temperatures may not be plausible in early November. The temperature of the soil has not been considered in these simulations. In addition, sorghum and other summer grasses often accumulate toxins in hot and dry growing conditions which livestock may not tolerate. Growers should get good advice before trialling a summer forage grass on farm.

The simulations have shown that summer sorghum as a forage crop may a viable option in the Mallee. Conditions will not always be conducive to the crop so it is import that growers implement strict sowing rules to maximise the potential for a viable crop. In a Mallee environment there are problems associated with an overlap in the operations of the summer and winter crops. Given the changing climatic conditions being experienced in the region it is important for growers to diversify their businesses and spread their risk. Thus given the high value of livestock planting summer sorghum for livestock forage may be a good strategy and overcoming the logistical problems could be worth the effort.

Appendix 4.

Grazing cereals at Woomelang factsheet (text only)

Key messages

- Barley produced more feed than wheat at the time of grazing.
- The grain yield of Hindmarsh was more than all other varieties in the trial, even when grazed. However Hindmarsh did suffer a grain yield penalty when grazed, as did Young and Axe wheat.
- Derrimut and Wyalkatchem wheat both yielded well and did not suffer a grain yield or screenings penalty when grazed. These were the best-bet dual purpose wheat varieties in the Mallee in 2009.

The success of dual purpose crops in higher rainfall zones has driven interest in assessing the suitability of grazing cereals in low rainfall areas such as the Victorian Wimmera Mallee.

The challenge of adopting this practice is to ensure correct grazing techniques are applied to the most suitable varieties to avoid compromising grain production. Grain crops intended for grazing ideally need to be sown early as grazing delays crop maturity by about one week, depending on timing and intensity. Stock can be introduced to cereal crops intended for grazing at around the 3-leaf (GS13) stage or when plants cannot be tugged from the ground. If a grain yield penalty is to be avoided, stock should be removed before the end of tillering (GS30). See GRDC's *Cereal Growth Stages* publication for more information on growth stages.

A trial was established at Woomelang to assess the suitability of different wheat and barley cultivars for dual purpose – grain and grazing production – in low rainfall environments.

On 7 May 2009 the plots were sown to Yitpi, Correll, Axe, Wyalkatchem, Young, Derrimut and CLF_STL wheat, and Buloke and Hindmarsh barley on 30cm row spacing using knife points and press wheels.

Grazing results

Dry matter production was measured at GS13 just prior to grazing. The results indicated that there were varying amounts of feed available between varieties. Feed tests were also taken at this time to determine the metabolisable energy (ME) values for stock prior to grazing. Consequently, the number of grazing days was calculated assuming one dry sheep equivalent (DSE) consumes 8MJ/day of dry matter.

Hindmarsh and Buloke were the standout barley varieties, with Hindmarsh having the greatest ME of 2018MJ/ha (Table 1). This equated to 252 DSE grazing days. The less vigorous variety Young had 700MJ/ha of ME, providing 88 DSE grazing days.

On 23 June 2009, a fence was erected around half of the four replicates and 10 lambs were placed inside the grazing treatment area (equivalent to 67 lambs/ha). Four days later the lambs were removed.

In 2009 the trial site received 4 – 5 decile rainfall, an early break and a reasonably good distribution of rainfall throughout the season.

Grain yield

Grain yield was measured using a plot harvester. Significant yield penalties occurred for three varieties, Hindmarsh, Young and Axe (Table 1). These particular varieties are notably earlier maturing than most of the other cultivars in this trial. Due to their shorter growing season, the early maturing varieties did not have enough time to recover from grazing to reach their full yield potential. The greatest yield penalty of 0.32t/ha was suffered by Hindmarsh. However even when grazed Hindmarsh still yielded higher than all of the other ungrazed varieties.

Table 1. Average ME values and corresponding number of grazing days calculated prior to grazing at GS13 (assuming 1 DSE consumes 8MJ/day) and grain yield for ungrazed and grazed treatments.

Variety	Maturity	Average of ME (MJ/ha)	Average of DSE grazing days	Grain yield (t/ha)		Yield penalty (t/ha)
				Ungrazed	Grazed	
Hindmarsh	Very early	2018	252	2.29	1.97	0.32
Young	Early	700	87	1.88	1.59	0.29
Axe	Early	1295	162	1.70	1.55	0.16
Wyalkatchem	Early – Mid	1125	141	1.88	1.74	0.14
Correll	Early – Mid	1281	160	1.80	1.69	0.11
Yitpi	Mid	1318	165	1.58	1.48	0.10
Derrimut	Mid	875	109	1.83	1.76	0.07
Buloke	Mid – early	1874	234	1.73	1.75	-
CLF_STL	Mid	909	114	1.40	1.48	-
Sig. diff		P=<0.001	P=<0.001	P=0.027		
LSD (P<0.05)		443.5	55.44	0.16		
CV%		24%	24%	6.7%		

Grain quality

Grazing did not affect protein, however it did increased screenings in Buloke, Correll, Young and CLF_STL (Table 3). Correll was particularly bad with a 77% increase in screenings when grazed.

Table 3. Grain analysis for ungrazed and grazed treatments.

Variety	Protein (%)		Screenings (%)	
	Ungrazed	Grazed	Ungrazed	Grazed
Hindmarsh	13.6	14.5	1.9	2.5
Derrimut	12.5	12.5	5.5	5.8
Buloke	14.0	14.4	2.5	5.8
Wyalkatchem	13.1	13.0	1.8	2.1
Correll	13.5	12.8	5.3	9.4
Young	12.7	12.6	3.6	5.6
Axe	13.2	12.6	3.5	4.2
Yitpi	13.6	14.1	4.7	5.2
CLF_STL	14.9	14.4	1.0	4.2
Sig. diff LSD (P<0.05) CV%	NS		P<0.001 1.3 21.4%	

Conclusion

Based on the 2009 results, Wyalkatchem and Derrimut are the best-bet dual purpose wheat varieties evaluated in the Mallee. They did not suffer a grain yield or screenings penalty and were among the highest yielding varieties in this trial.

The barley varieties produced more feed than wheat at grazing. There was no difference in feed value between Buloke and Hindmarsh. Hindmarsh yielded the highest, however it suffered a grain yield penalty while Buloke did not. Screenings increased for both varieties.

Grazing cereal farmer demonstrations undertaken at Rainbow Victoria highlighted that there was no negative impact on yield from grazing cereals. For more information on the demonstrations see factsheet 1: *Grazing cereals, Rainbow VIC*. For more information on this trial refer to the *BCG 2009 Season Research Results* manual or BCG's searchable database at www.bcg.org.au.

Farmer demonstrations at Nullawil and Jil Jil and a replicated trial at Culgoa are underway in 2010 to further investigate the profitability of grazing wheat and barley varieties in the Wimmera Mallee.

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