Minimising yield loss in grazed crops

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KEY MESSAGES

- Grazing did not change grain yield or quality. Rather, moisture stress was more important in a dry finish
- In a dry year, the ratio of grain yield to crop biomass at flowering is 0.40. In an average year it is around 0.55
- Grazing slows crop maturity by one to two weeks, which meant Revenue (long season variety) was still booting during the October heat wave

BACKGROUND

While crops can provide a much needed supplement to meet stock feed requirements during the growing season, there is often a hesitancy to open the gate to let animals in the paddock. The fear of yield loss from grazing crops is, understandably, a key reason that crops are not grazed more. The Grain and Graze program, funded by the GRDC, has been investigating the best methods for grazing crops for several years. This trial aimed to take a step back and look at how important rainfall and variety choice are in grazing crops to maintain grain yield, in the hope that having a better understanding the different risks involved would create opportunities to mitigate risk of yield loss from grazing.

It is important to make mention of the value of crop biomass consumed by animals during grazing which can still make it economically viable to have some yield decline. This trial is looking at the yield decline component, not the trade-off of feed and grain yield. However, it is important to keep in mind that economic gain from a grazed crop is not only in the harvested grain.

METHOD

The trial looked at the interaction of three factors:

- Grazing (grazed or ungrazed)
- Variety (Bolac or Revenue)
- Soil water (dryland or watered)

The trial was sown to wheat (cv. Bolac and Revenue) on the 1st of May, 2015. In 2016 the trial will be repeated with barley.

The trial area was sown to bulk peas in 2014, with the limited broadleaf weed control options in that year leading to issues with wild radish in 2015 that required increased work to control (see herbicides in table 1).

The other management decision of note from table 1 was the lack of a late season fertiliser application. Urea was spread shortly after the sheep were taken off to promote crop recovery, but due to the nature of the season and forecasts no other nitrogenous fertilisers were applied.

Table 1. Inputs throughout the season

	Date	Product
Seed	1/05/2015	82 kg/ha Bolac and Revenue
Fertiliser	1/05/2015	100 kg/ha MAP
	10/07/15	100 kg/ha urea
	10/09/15	250 mL/ha Coptrel
Herbicides	1/05/15	Sakura, Avadex Xtra, Roundup
	24/06/15	Jaguar, MCPA LVE 570
	7/08/15	Logran
	21/08/15	Tigrex, Tilt
	2/09/15	Logran
	8/10/15	Radial
Fungicide	10/09/15	Prosaro

Figure 1. Grazed wheat plots at Inverleigh, demonstrating the cycling of nutrients in manure from sheep

Varieties

Bolac and Revenue were selected as representative mid maturing and slow maturing varieties respectively, both have been used in commercial grazing of crops and grazed plot trials in the past. Bolac was used in Grain and Graze trials in 2010, 2011 and 2012 with yield loss from grazing in the latter two years. Revenue was grown across two sites in 2012 with Inverleigh yielding 26% lower with grazing (4.88 t/ha) than not grazing, and Lake Bolac not receiving a significant change in yield (Falkiner et al 2013).

Grazing

In the current trial, plots were grazed for five days (July 3-8), by the end of which plants were grazed down to about 3 cm (see figure 1). Two plots that were meant to be ungrazed had to be removed from the analysis because sheep got through the fences and grazed the plots. Several other plots with the fence close to the edge of the plot had a few meters grazed as well. This provided a striking demonstration for the remainder of the season for how grazing slows plant development, with the grazed sections being roughly two weeks behind the maturity levels of the ungrazed crop.

Watering

The intention of watering was to create a differential in moisture to see how grazed and ungrazed plants responded to different seasons when all other factors were kept constant. Watered plots received an additional 50 mm between the end of July (27th) and mid-October (15th) in seven applications. This was planned to coincide with the end of grazing and start of grain fill and meant plants were still being watered through the heat wave in early October. In order to prevent water running between plots, the trial was designed with internal buffer rows between each trial row.

The decision will be made as the season unfolds in 2016 as to whether plots will be watered again or rain exclusion tents erected to create a soil water differential.

Results and discussion

The dry season in 2015 proved to be a challenge for finishing crops across the region. There has to be a silver lining to every cloud though, with one being the difference in soil moisture that could be achieved between the watered and dryland treatments. At the end of grazing in early July, the Inverleigh2 soil moisture probe soil water at depth (30-100 cm) was around 333 mm. By the start of October and early flowering this had dropped to 197 mm, and just two weeks later after the heat wave and at the end of the watering period, there was 127 mm stored water at depth while watered plots had around 177 mm. This represents a 39% difference in soil water between the watered and dryland plots.

Interestingly, even with a dry season and a reasonably hard grazing, there was not a significant change in yield with grazing, with the average grazed yield across the trial being 3.9 t/ha and ungrazed 3.9 t/ha (p=0.5). The mean yields and grain quality for each treatment are given in table 1.

Table 1. Mean dry matter at anthesis and harvest data across treatments

			Dry matter at anthesis (t/ha)	Yield (t/ha)	Test weight (kg/hL)	Moisture (%)	Protein (%)	Screenings (%)	TGW (g/1000 grains)
Bolac	Dryland	Ungrazed	9.13	3.4	75.9	11.3	12.6	5.4	28.5
		Grazed	9.20	3.7	76.6	11.5	12.4	5.7	27.5
	Watered	Ungrazed	9.00	4.1	75.1	11.5	12.9	5.3	28.5
		Grazed	9.10	4.0	75.6	11.4	13.2	5.2	29.4
Revenue	Dryland	Ungrazed	9.94	3.4	72.1	11.7	13.7	5.9	32.6
		Grazed	9.15	3.4	71.5	11.6	14.1	5.8	34.1
	Watered	Ungrazed	13.38	4.6	76.7	11.6	12.7	6.3	33.5
		Grazed	9.90	4.6	73.7	11.7	12.6	6.9	32.8

Means did not differ significantly

When comparing individual treatments, the yields did not differ significantly. This meant we could collate some of the treatments to see if there was anything in particular that caused differences and then work back up to see where the differences could no longer be called significant.

Soil water

The main difference was driven by soil water, which had a very significant (p=0.0001) effect on yield with the dryland treatments averaging 3.5 t/ha and the watered treatments 4.3 t/ha. There was also an interaction between soil water and variety, with watering creating a yield difference between varieties and dryland leading to no yield change (figure 2). Watering plots and variety however, did not substantially influence how efficiently plants converted water to grain, seen in figure 2.

It is interesting to note that the combination of watering and grazing did not create a yield difference.

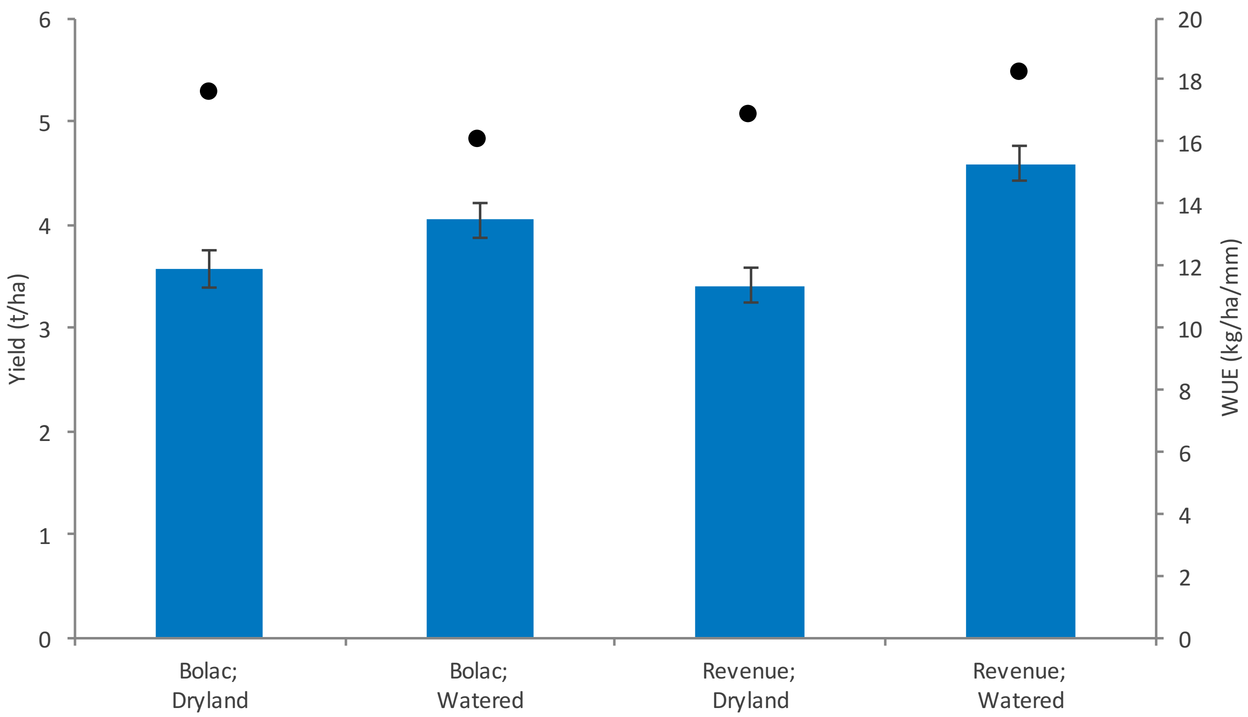

Figure 2. Yields (bars) and WUE (dots) for variety by soil water. Grazing was not a significant variable so data is for both grazed and ungrazed plots

Error bars represent the standard error of the mean (p<0.02)

Biomass recovery

Recent research has begun to highlight that to reach target yields after grazing it is important to have adequate biomass by flowering. Trials in New South Wales found the ratio of grain yield to biomass at flowering to be 0.4 in both 2013 and 2014

(Sprague et al 2015). In 2015 at Inverleigh, the ratio of yield to flowering biomass was also 0.4. All three trials experienced dry springs at their respective locations. This provides the helpful rule of thumb that in a dry finish, 1 t DM/ha biomass at flowering gives around 0.4 t/ha of grain. Other work suggests that in a more normal season, to achieve a target yield of 5 t/ha grain, 9t DM/ha is required at flowering, or a ratio of 0.55 (John Kirkegaard pers comm).

In the current trial at flowering, there was a significant difference in dry matter accumulated between varieties ($p<0.05$) when the skew of the data set was taken into consideration, with Bolac growing 9.11 t DM/ha and Revenue 10.59 t DM/ha by flowering. The difference in biomass at flowering between grazed (9.34 t DM/ha) and ungrazed (10.36 t DM/ha) was just significant ($p=0.05$). There were high levels of variability in the dry matter data though (CV = 17.626) that meant although there was over 1 t/ha difference between the watered and dryland treatments, it could not be said to be significant.

Variety performance

Significant attention has been given over the past few years to the appropriateness of different varieties for grazing. The general rule of thumb is to use longer season varieties that can be sown earlier to allow earlier grazing and longer recovery before flowering and therefore more biomass at flowering.

As both varieties were grazed at the same time, some of the advantage of having a longer season variety was lost in not grazing early. Nonetheless, Revenue had significantly more biomass by flowering than the Bolac. This is possibly linked to the higher number of tillers it typically produces and therefore has a greater propensity for recovering rapidly after grazing. By the time the October heat wave rolled around, there was a range of growth stages (GS) based on the maturity length of the variety and whether it was grazed or not. At the start of October they were as follows:

Ungrazed Bolac:	GS65 (mid flowering)
Grazed Bolac:	GS59 (ear emerged)
Ungrazed Revenue:	GS49 (end of booting)
Grazed Revenue:	GS43 (start of booting)

At the end of October, after having 14 days with temperatures in the 90th percentile, Bolac which managed to flower was running out of water to fill grains, and Revenue which was coming in later aborted florets so that only part of the heads actually grew grains (figure 4). Watering helped compensate for the heat and lack of rain, with more grains filling in the watered plots which saw an increase in yield.

It is most likely that the varieties did not yield differently because of the impact of the hot and dry finish which saw a reduction in Revenue grain number and Bolac grain size. This was seen in the thousand grain weights, where Revenue had significantly larger grains (33.24 g/1000 grains) than Bolac (28.46 g/1000 grains) ($p<0.01$). Interestingly there was no difference in grain weight between the watered/dryland treatments, indicating that the heat had significant impact, not just moisture stress.

Figure 4. Revenue wheat that has been watered (left) and dryland (right). Revenue was flowering during the October heat wave so some upper florets aborted, seen as the white spikelets at the top of the head.

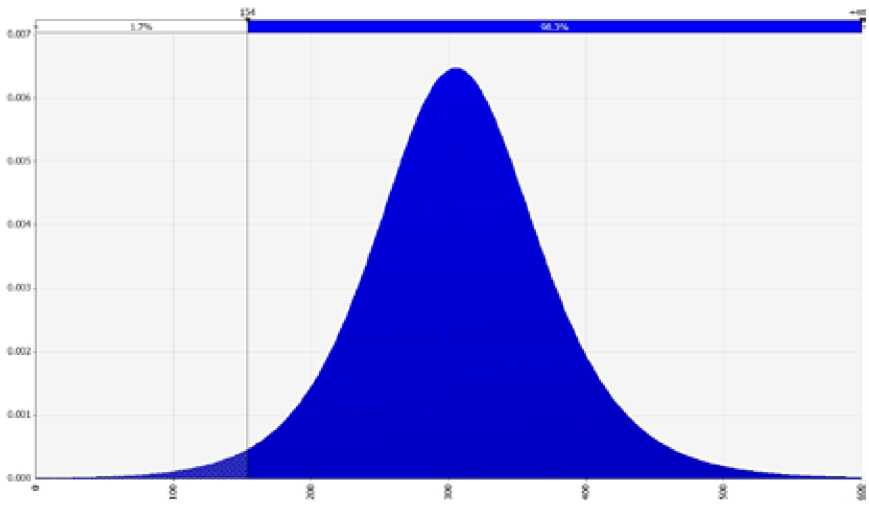

Figure 3. Probability distribution of combined winter and spring rainfall at Inverleigh. The black line shows the probability of a year like 2015.

Seasonal risk

Seeing as water was the most significantly affecting factor, the question to answer is what where the odds of having a spring like 2015?

Total spring rainfall around Inverleigh in 2015 (September to November) was 89 mm, following a dry winter where we received only 65mm, making for a combined 154mm from June to November. This places 2015 in the bottom 2% of years for winter and spring rainfall (figure 3) along with years like 2006 and 1982. By comparison, 2014 had a dry spring but the reasonable winter meant there was a total of 251mm rainfall between June and November.

Horizontal axis is rainfall (mm) and vertical axis is the probability of receiving that amount.

CONCLUSION

Tips on managing the risk of a dry season

Farming is a risky business and always will be so long as we are at the mercy of the seasons. However there are ways of managing risk to optimise production even in a tough season.

- Keep an eye on the long range forecasts when making decisions for the coming season – the predictions from early on were that 2015 was going to be a dry season and for once they turned out to be correct. The prediction for 2016 is average February to April rainfall and an average to slightly wetter winter (DEDJTR, 2016)
- Keep on top of weeds and disease that can reduce soil water available for crops and crop performance. Be mindful of the economics of your inputs though and whether you would get your expenses back if harvest is poor
- If you still decide to graze crops in what you think is going to be a poor season, make sure you get animals in and out early. The longer that stock are on the crop, the longer it will take to recover, so it is better to graze with more stock for a shorter time than drag out the grazing window
- Recognise the value of grazed crop for livestock production and resting of pasture, brief as it may be
- Grazing will not necessarily reduce yields in a dry year – in fact there is some thought that a reduction in biomass from grazing can help crops finish better because there is less foliage to support so more resources can be allocated to grain production. Moisture monitoring of grazed/ungrazed plots in 2011 and 2012 found grazed plots consistently used less water between grazing and crop flowering
- Apply enough fertiliser for crop to recover after grazing, but be mindful of putting out too much early on and growing a lot of biomass that the crop may struggle to support if the season turns dry.

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