In-crop risk management using the Yield Prophet®

By the BCG, and Zvi Hochman and Dean Holzworth (CSIRO – APSRU)

Summary

Climate variability is something we have to learn to live with, and we need to manage it better. Be prepared to learn more about the impact of increasing variability in temperature and rainfall on the bottom line of your farm.

The in-crop seasonal forecasting tools presented in the monthly Yield Prophecy fax out were quite accurate in 2005.

The Yield Prophet® through APSIM crop modelling simulations described the outcomes at Birchip and Marnoo well – especially in relation to N input requirements during the season. At Sea Lake, the model needed improving in the soil characterisation.

At Birchip and Marnoo, the BCG established a series of 'risk management' demonstration plots where a variety of pre-sowing and in-crop management options were put in place. The outcomes of the in-crop risk management demonstrations at Birchip and Marnoo field day sites were related to the:

1. potential of the soil; and
2. performance of the crop during the season requiring tailored inputs to potential profit

At Birchip, where the potential of the soil was low due to subsoil limitations and where the crop struggled throughout the season the 'Low Input' system returned the highest profit. At Marnoo, where the potential of the soil was high and the crop grew well throughout the season but was N deficient, the 'Topdressing N in responsive seasons' was the most profitable.

Background

There is no denying that we are living through a long dry spell, the last time it was as dry for so long was in the 1930s to 40s (Figure 1). Most areas in northern Victoria have not had above average growing season rainfall since 1996, that is nine years in a row, and some of these seasons have been well below average. It is a challenge for any farming enterprise to survive such a long dry period, especially now that there is more pressure on the cost of production.

What is the cause of this dry spell? Is it climate change or is it just natural variability? There has been a massive and unprecedented increase in greenhouse gases in the world's atmosphere since the start of the industrial revolution, and many scientists believe that this is the cause of climate change, it certainly has had an impact on temperatures but the impact on rainfall is less clear.

Regardless of the cause of climate change, those making a living out of cropping in northern Victoria, have to become much better at managing the variability in our climate.

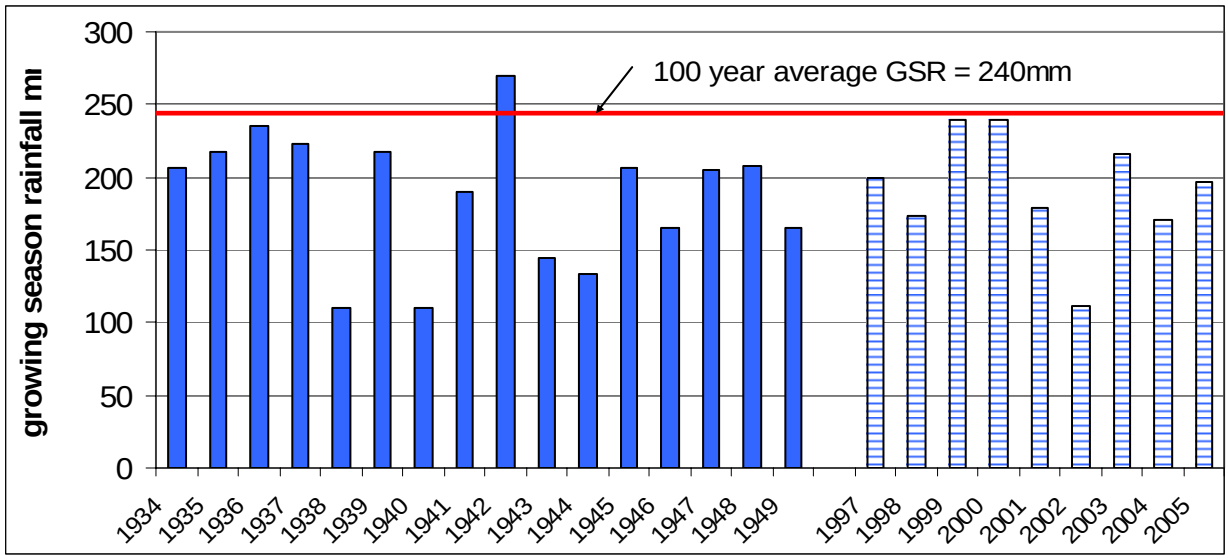


Figure 1: Comparison of the two longest dry spells over the last century for Growing Season Rainfall (Birchip) for 1934 to 1949 and 1997 to 2005.

Mark Howden (CSIRO) spoke about climate change and variability at the BCG Main Field Day in October. Mark explained that the immediate future is likely to get warmer and drier than the current average. He explained it was all a matter of probabilities and that these were not stacking up in a positive way. He did emphasise the need to start managing climate variability because in his view, the weather patterns are changing and it is likely that we will have a more variable climate rather than a more stable climate pattern developing.

What is urgently needed is to look at managing the crop better during the season. Currently, most decisions regarding a crop are made at sowing. Most of the inputs and costs are upfront and there is not really much able to be don during the season, except for the opportunity to top-dress in a wet season. Are there things we to do in-crop that will make it more likely to yield well in a good season whilst also maintaining yield in a poorer season? Can we become more responsive to seasonal conditions?

To start work in this area a series of plots were establsiehd at two of our trial sites where in-crop management including (i) high inputs; (ii) targeted inputs such as more N during the season; (iii) low inputs; and (iv) reducing the amount of crop by slashing every third row to reduce the amount of water used by the crop during a dry season. The APSIM model was used through the Yield Prophet, to help in the decision making process, and made this available to members through the monthly Yield Prophecy fax out.

Methods

Two similar trials were set up at two trial sites.

Treatments:	In crop management with a direct outcome on inputs and costs; and crop manipulation utilising the Yield Prophet (APSIM simulations) to estimate potential outcomes
Replicates:	Demonstration only
Sites:	Birchip and Marnoo
Crop:	Wheat – Yitpi

The main treatments in each of the demonstrations are outlined in Table 1.

Unfortunately we did not set up a similar demonstration was not established at the Sea Lake trial site however the Yield Prophet was run on a trial plot at this site, but the success or otherwise of the practices outlined in Table 1 cannot be compared for Sea Lake.

Table 1: Philosophy, description and costs for each risk treatment. Costs are worked out on inputs and machinery costs (machinery is costed at 75% of local contract rates).

Risk Treatment	Philosophy and Description	Costs $/ha	
		Birchip	Marnoo
High Inputs	Go for it from the start! Pre-drill urea; knockdown; seed rate 175pl/m2; moderate rate of Granulock 10Z, stripe rust fungicide with fertiliser; top-dress N in crop; fungicide	178	254
Moderate Inputs	Steady Cultivate; knockdown; seed rate 175pl/m2; moderate rate of NRich 24; low rate of topdressing N in crop when response is very likely; fungicide only if required in crop	117	163
Low Inputs	Save every penny Cultivate; cheap residual herbicide; low rate of MAP; low seed rate 120pl/m2, fungicide only if stripe rust is very bad	93	107
In-crop canopy manipulation	On the ball and play safe in a dry season Inputs same as for Moderate Inputs and watch the season like a hawk – if a decile 3 or less at the end of August, remove every third row of crop (saves water for the two remaining rows)	134	157
Top-dress N	On the ball and increase inputs with a good outlook Inputs the same as for the Moderate Inputs and watch the season like a hawk, if the probabilities stack up then top-dress N at the end of August	144	210

Results

Conditions and forecasts at the end of August

At the end of August, the growing season rainfall was below average at all three sites. Four different forecasting systems were reported on:

- Decile technique: based on rainfall from April 1 to August 30 the forecasts were for Sea Lake and Birchip to finish in a decile 2 to 3; and Marnoo with a decile 3 to 4.
- SOI: the July-August phase of the SOI was rapidly falling – this phase is not a strong indicator of either wet or dry conditions. This phase at this time of the year has little skill in forecasting the next three months. There is no difference in this forecast as to taking the average over the last 100 years of rainfall for September to November.
- Bureau of Meteorology: 40 to 50% chance of achieving average rainfall for September to November.

- GESS (Global ENSO Sequence System) is an experimental model from the Department of Agriculture in WA and presents the forecasts in analogue years. For the September/October forecast, 3 out 5 analogue years were average to above average the other 2 analogue years had below average rainfall. This forecast also had little skill, with a 3 out 5 chance of it being average to above average it is difficult to feel certain about an outcome.

What happened? Season rainfall

September was generally a dry month and October was above average. By the end of October the Growing Season Rainfall was below average at all three sites (Figure 2). Sea Lake finished in a decile 4; Birchip in a decile 3; and Marnoo in a decile 4.

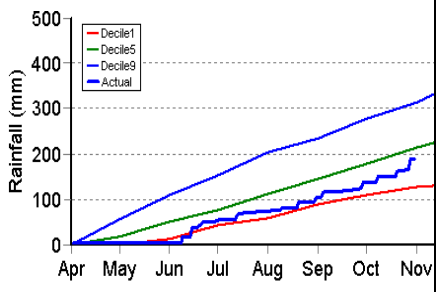
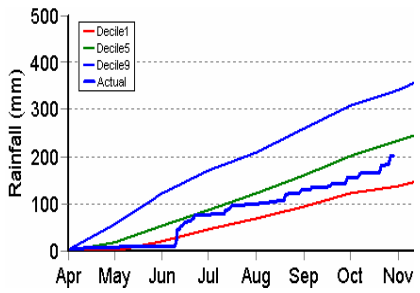
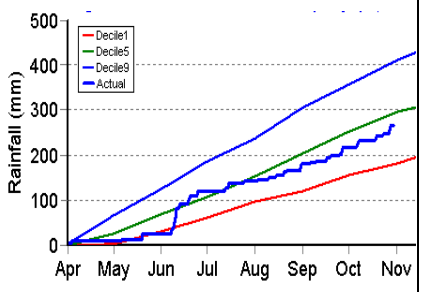
Sea Lake	Birchip	Marnoo
GSR 189mm; Decile 4	GSR 201; Decile 3	GSR 265: Decile 4
		

Figure 2: Growing season rainfall and decile finish for Sea Lake, Birchip and Marnoo.

Which of the forecasting systems was right?

Rainfall for September and October: Sea Lake 84mm (average is 66mm); Birchip 73mm (average is 74mm); and Marnoo 85mm (average is 89mm).

- Decile forecast: spot on for Birchip and Marnoo, and slightly under for Sea Lake
- SOI: little skill in the forecast
- BOM: little skill in the forecast
- GESS: little skill in the forecast

2005 was not a good year for 1) SOI phase system, 2) three month BOM forecast or 3) GESS model to have a forecast with certainty about a particular outcome. This does not mean that these forecasting systems don't work – it just means that in 2005 the signals were not strong enough to make a solid forecast for wet or dry conditions.

Crop performance versus estimated

There is always much uncertainty in rainfall outlooks and even though the forecasts were, at the end of August, unsure about a forecast to the finish to the season, it always pays to have a good knowledge of how a crop is performing, what the crop needs are and what the likely outcome will be.

The Yield Prophet was used to investigate the likely outcomes for crop production in early September (Yield Prophecy #4, 8 September). For the Birchip and Marnoo sites the demonstration results are presented in Table 2 for two treatments-2: Moderate Input (Steady) where no further N was top-dressed; and 5: Top-dress N.

Table 2: APSIM simulated yields on September 8 and actual harvested yields for no N and top-dressed N at Birchip and Marnoo.

Top dressed N (kg/ha)	Birchip				Marnoo			
	Actual	APSIM probability 8 September			Actual	APSIM probability 8 September		
		20%	50%	80%		20%	50%	80%
None	2.2	2.2	1.5	1.2	3.4	3.1	2.9	2.3
+ N*	2.4	2.4	1.5	1.2	4.5	4.7	3.9	3.0

* topdressing at Birchip 25kg N/ha: at Marnoo 60kg N/ha

In early September the Yield Prophet had a very low probability for a response to topdressing N at Birchip – which is exactly what happened; whereas the probability of a response to topdressing N at Marnoo was much more likely – with topdressing the yield increased from 3.4 t/ha to 4.5 t/ha.

Crop yields, gross returns, costs and gross margins in the demonstrations

To calculate gross income the quality of the Yitpi grain was used to determine the classification payment plus bonuses based on protein and screenings using the Grower Rewards payment matrix. Costs were based on input costs plus the cost of the operation (priced at 75% of contract rates). The gross margin is the difference between the gross income and costs (Table 3).

Table 3: Crop yield, income, costs and gross margins for 5 treatments at Birchip and Marnoo

Treatments	Birchip				Marnoo			
	Yield t/ha	Income* $/ha	Costs# $/ha	GM $/ha	Yield t/ha	Income* $/ha	Costs# $/ha	GM $/ha
1. High Inputs	2.1	422	178	242	4.7	777	254	523
2. Moderate Inputs	2.2	442	117	325	3.8	600	163	437
3. Low Inputs	2.3	459	93	366	3.5	460	107	354
4. In-crop canopy manipulation	2.5	487	134	353	3.7	561	157	404
5. Top-dress N	2.4	469	144	325	4.5	843	210	633

* Income calculated from grain yield, delivery classification, bonuses for variety, protein and screenings
# Costs calculated from inputs costs and operations (charged at 75% of contract rates)

At Birchip, the High Inputs gross margin was much less compared to the other four treatments. This was primarily due to all five treatments yielding similarly but the input costs for the High Inputs treatment was much higher compared to the others.

At Marnoo the highest gross margin is for the treatment which had few inputs up front and put out Nitrogen fertiliser as a top-dressing. The treatments with low N inputs did not yield very well and had lower protein and suffered consequently in financial return.

Yield Prophet at Sea Lake

The Yield Prophet was also run for the Sea Lake site although the full risk management demonstration was not available as at Birchip and Marnoo. At Sea Lake there were plots specifically set up for the Yield Prophet where detailed soil monitoring was undertaken during the season.

The yield, as estimated by the APSIM model in early September, was much lower than the actual yield achieved (Table 4). This may have been due to the wrong soil type description being used for the Sea Lake site. Based on the work done with describing the soil at the site in 2005, APSIM was re-configured to take better account of the full soil factors and the new APSIM runs for September would have predicted a better outcome (Table 4).

Table 4: Actual yield achieved for Sea Lake and Old model run (using the wrong soil set up) and the New model run (using the updated soil set up) – 8 September 2005.

	Actual	Old APSIM probability 8 September			New APSIM probability 8 September		
		20%	50%	80%	20%	50%	80%
Yield t/ha	4.0	2.3	1.9	1.8	3.3	2.8	2.4

The new simulation run shows clearly how important the right soil set up is. In addition, we had a problem at Sea Lake was the lack of accuracy with the sowing soil moisture content. If the correct initial information is not put into Yield Prophet it cannot perform to expectations.

Interpretation

Rainfall forecasts during the season

The in-crop rainfall forecasts presented in the Yield Prophecy were mixed for the 2005 season. The decile technique was close enough with predicting the decile outcome, however the decile technique could not have predicted the very favourable conditions for crop growth in October (cool and average to above average rainfall). The other forecasting systems did not have much skill in early September in being able to predict an outcome. In many seasons the four forecasts used in combination provide a powerful tool in estimating likely rainfall for the rest of the season. Unfortunately, in 2005 the signals in the forecasts were not strong enough to come to a conclusion in September about a likely outcome. It was a 50/50 situation – which when considering further inputs suggested that Birchip was highly unlikely to get a topdressing N response whereas at Marnoo the response was very likely.

Yield estimates using the Yield Prophet

Birchip: this site had severe subsoil restrictions to root growth (high Boron, EC, Chlorides and Sodicity) and the yield potential was estimated quite accurately by the Yield Prophet. The model also predicted that N inputs in crop were never going to be a paying proposition.

Marnoo: a site on deep Wimmera clay with no restrictions to root growth. The Yield Prophet underestimated the yield achieved without N fertiliser in the system; but was accurate in predicting the large response to topdressing N at this site.

For both sites the Yield Prophet proved to be an excellent tool for pre-crop and in-crop decisions in relation to seasonal outcomes and input requirements.

Risk management demonstrations

The risk management demonstration results were a timely reminder of the importance of knowing the potential of your soils and crops.

Birchip: the combination of a site with low potential (high subsoil limitations resulting in low plant available water holding capacity) and a relatively dry season meant that low expenditure played a major role in profit. The more spent the less profit was made. Even removing every third row of wheat in September appeared to have had some success at this site – this risk management strategy needs to be studied in more detail.

Marnoo: on a good soil with a better rainfall outlook, the higher inputs payed off. The top-dressing N fertiliser treatment proved to be the most economic because the late application of N improved yield as well as protein which resulted in a higher classification of the grain compared with the pre-drilling of N treatment.

Commercial Practice

How can farmers better manage climate variability?

- Know the potential of your soils (subsoil limitations; water-holding capacity)
- Know the nutrient and moisture status of your paddocks before sowing
- Tailor crop choice and sowing time according to seasonal conditions and paddock potential in April and May
- Do not put all your inputs up front
- Use tools to follow your crops potential and likely response to inputs during the season
- Keep a close eye on season forecasting tools
- Watch expenditure but take the opportunity to make a profit when the probabilities are stacked in your favour
- Spend more time with your crops – look for tell tale signs of nutrient deficiencies, diseases and very importantly weeds
- Take time this year to learn more about climate variability and how it will affect the bottom line on your farm.