What value are seasonal climate forecasts for dryland cotton?

By Rebecca Darbyshire[1] and Anwar Muhuddin[2]

DRYLAND cotton has increasingly become part of the cropping rotation in NSW and Queensland farming systems due to varietal improvements, high prices and, recently, good soil moisture profiles at planting. With this increased interest in dryland cotton and the sensitivity of dryland cotton yields to in-season rainfall, examining the potential value of seasonal climate forecasts for dryland cotton is timely.

A national project funded through the Australian government's R&D for Profit Program, *Improved Use of Seasonal Forecasting to Increase Farmer Profitability,* is aiming to bridge the gap between seasonal climate forecasts and farm business decisions to improve productivity and profitability. This Australian wide multi-agency project is currently underway and includes a range of industries: Cotton, grains, beef, sheep, rice and sugar. Three key three aspects of seasonal climate forecasts are being investigated:

- Valuing the forecast;
- Using the forecast; and,
- Improving the forecast.

Dryland cotton production has been included as a case study in the valuing the forecast component of the project. For a forecast to have value, it must provide higher returns when used

in a decision than if no forecast (or the historical average) is used. To evaluate this potential value, we have approached our research through a four step process:

- Consultation with industry to identify decision points in a typical dryland cropping operation that are potentially sensitive to seasonal climate forecasts.
- Using these decision points, consider the current conditions or 'known knowns' (eg. starting soil moisture) as well as seasonal climate forecast information and weigh how different combinations of these factors may change the decision.
- Using the description of the decision point, conduct biophysical modelling to represent the varied combination of previous conditions for the historical climate (1889–2015).
- Evaluate the biophysical modelling output through an economic framework to assess the potential value of using a seasonal climate forecast in the decision.

Bungunya near Goondiwindi in Queensland was selected as a case study for dryland cotton. The key decision identified was around planting. Specifically, whether to plant dryland cotton or to put the area to fallow for a winter crop or for next year's summer crop. Of course, there are many other decisions that could be made at this time (eg. switch to sorghum, put in a smaller/larger area) but this choice was seen as one that is often made.

Two prior conditions that are known, which influence this decision were highlighted:

- Starting soil moisture; and,
- Whether sowing rains were received.

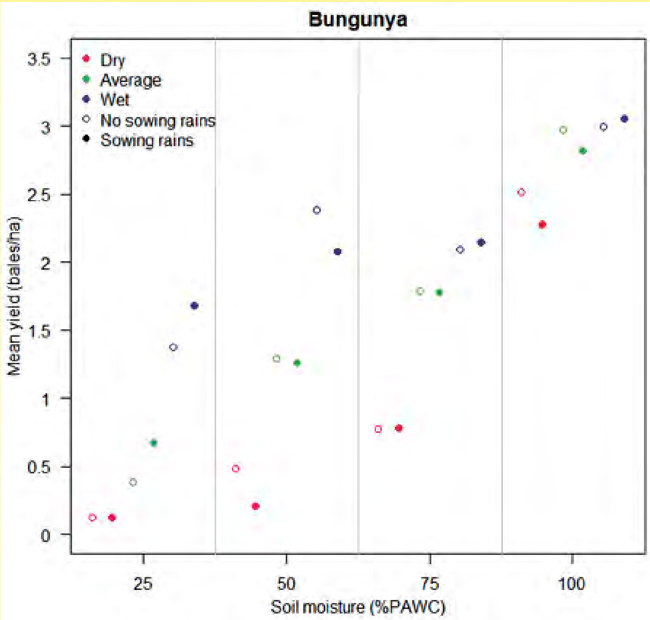
We treated the forecast as a theoretical forecast, to classify likely dry, average or wet conditions (tercile forecast). We did not evaluate a particular forecasting system (eg. SOI phase, BoM outlooks) as we wanted flexibility in terms of industry direction regarding the characteristics of the forecast (type and length) and to allow us to consider the characteristics of the forecast (skillfulness) needed to provide value back to growers. For the dryland cotton case study, total rainfall received between November and February as a forecast in October was identified as useful for sowing decisions.

We are evaluating different starting soil moisture conditions and whether planting rains were received in relation to historical November-February rainfall split into 'dry', 'average' and 'wet' terciles defined in Table 1. This allows us to see how influential these different rainfall categories are in determining final yields compared with the prior conditions. The initial results indicate

TABLE 1: Summary of variables tested – terciles are the upper, middle and bottom third of total rainfall received from November-February

Terciles		Plant Available Water Content (PAWC)		Sowing rains	
Dry	0–186 mm	25%	55.7 mm	Sowing rains	10 mm during the week of sowing
Average	186–271 mm	50%	111.5 mm		
Wet	>271 mm	75%	167.2 mm	No sowing rains	Nil rain during the week of sowing
		100%	222.8 mm		

FIGURE 1: Mean yield for dryland cotton planted at double skip at Bungunya (1889–2015) for each tercile group and four starting soil moisture percentages



PAWC is plant available water content.

that starting soil moisture is the major driving factor behind yield followed by November-February rainfall and then whether sowing rains were received or not (Figure 1).

The greater the starting soil moisture the greater the yields. If cotton is only planted on 25 per cent starting soil moisture poor yields will likely result with the average maximum yield 1.7 bales per hectare only achieved if sowing rains are received and the season evolves in the wet tercile. But if planting occurs on a full moisture profile at least 2.3 bales per hectare can be expected on average even with a dry tercile rainfall season. So a dry season on a full soil moisture profile is much better than a wet season planted on a low soil moisture profile.

In relation to sowing rains, mixed results were found. Rains tended to provide a yield boost in situations with 25 per cent starting soil moisture, likely providing key moisture to assist with emergence. Conversely, with 50 per cent starting soil moisture, sowing rains had minimal or negative influence on yield. This result indicates that the additional moisture encouraged greater biomass growth early in the season but this additional growth was unsupported by stored soil moisture and the plant cannot sustain the biomass through the season. Note, this was variable between years and a notable yield bump was found with sowing rains in years when the sequence of in-season rain coincided with key reproductive phases. Limited impact of sowing rains was found with 75 per cent starting soil moisture and a small negative influence was found with 100 per cent starting soil water.

These findings may be self-evident to many growers, with the mantra to plant on good starting moisture often repeated. Indeed, if planted on a full profile it is likely a reasonable dryland cotton yield will be obtained, regardless of the season. This illustrates that with a full soil profile, the value of a seasonal forecast may be reduced, and the decision will likely be to plant a crop.

Equally, with low starting soil moisture, it is likely poor yields will be obtained unless a particularly good wet season occurs with middling yields possible. Under these circumstances, a forecast may have some value if it is skillful in predicting seasonal rainfall.

For middle range starting soil moisture (50 and 75 per cent), meaningful improved yields were observed, particularly for dry years compared with average or wet years. For these starting soil moisture conditions, the forecast may have some value. Assessing forecast value economically rather than based on potential yield differences is the next phase of the project.

[1]Research Officer, NSW Department of Primary Industries.
[2]Senior Research Scientist, NSW Department of Primary Industries.

Further information:
Dr Rebecca Darbyshire, E: rebecca.darbyshire@dpi.nsw.gov.au M: 0448 185 605

http://www.rirdc.gov.au/news/2015/05/06/government-grant-gives-green-light-for-seasonal-forecasting-r-d-project

'Using the forecast' component and the associated Community of Practice: Jemma.Pearl@bcg.org.au