# Can seasonal forecasting improve grower profitability?

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## Key messages

- The Department of Primary Industries and Regional Development's Statistical Seasonal Forecast (SSF) and the Bureau of Meteorology's Predictive Ocean Atmosphere Model for Australia (POAMA) produce three month outlooks throughout the year. Analysis of six years of data (2012 to 2017) indicates that SSF had some success in indicating whether May to July rainfall was above or below median particularly in the north and central regions.
- SSF also produces growing season outlooks in April for the following May to October. Six years of analysis (2012 to 2017) found that the SSF correctly indicated the growing season in 5 years in the northern and central agricultural regions, four years in Esperance and only two years in the southern agricultural region. SSF correctly indicated the below median years 2015 and 2017 for the entire grainbelt. SSF incorrectly forecast 2012 as being above median in the northern and southern region.
- Rainfall outlooks produced in June for the July-September period can be used to refine N rates for top dressing. However, this study over thirty seven years (1981 to 2017) found that there was little economic benefit from using forecast July-September rainfall rather than historic median rainfall to estimate potential yield when determining N rates. This is because the outlooks had only minor success at indicating July-September rainfall. Other studies indicate that the outlooks may provide value at seeding times, when they have relatively more skill at indicating May rainfall.

## Aims

The aims of this research were to:

1. Determine how successful SSF and POAMA outlooks were at indicating above or below median three month periods for the years 2012 to 2017 in four different regions of the grainbelt.
2. Determine how successful the SSF growing season outlooks have been at indicating below or above median seasons since 2012
3. Investigate whether potential yield calculated using July–September seasonal outlooks can give better guidance for in-season N decisions than using long-term median rainfall for four locations in the grainbelt.

## Methods/Assumptions

*Determining seasonal forecast models success rates*

The SSF uses historical relationships between global sea surface temperature and sea level pressure with rainfall in south-west Australia to produce forecasts of rainfall for the coming months. The SSF has been operating since 2012, but it was modified in 2013 from a grid-based system to its current form whereby forecasts are made for each weather station and then interpolated. Statistical models are fitted each year to data from 1975 until the most recent year, so that forecasts in 2013 are made using data from 1975 to 2012, forecasts for 2014 are made using data from 1975 to 2013 and so on.

The POAMA model is a dynamical (physics based) climate model used for monthly and seasonal climate outlooks. It is a long-range forecast system that uses current ocean, atmosphere, ice and land data observations to initiate outlooks up to nine months ahead. POAMA seasonal outlooks are based on the last three weeks of forecasts, i.e. five separate model runs combining to make a 165-member ensemble.

Forecasts are probabilistic and are given as the percentage chance of exceeding median rainfall (from 0 to 100%); therefore the outlook provides information about the chance of above or below median rainfall for a given period. SSF and POAMA three month outlooks and SSF growing season outlooks (May to October), were assessed for four agricultural regions (north, central, southern and Esperance) (Figure 1). The probability of exceeding median maps of each outlook (three month outlooks of SSF and POAMA and the six month growing season outlooks of SSF), were determined as being correct by comparing the outlook to three month rainfall and six month rainfall decile maps produced by the Bureau of Meteorology (available from http://www.bom.gov.au/jsp/awap/rain/index.jsp.

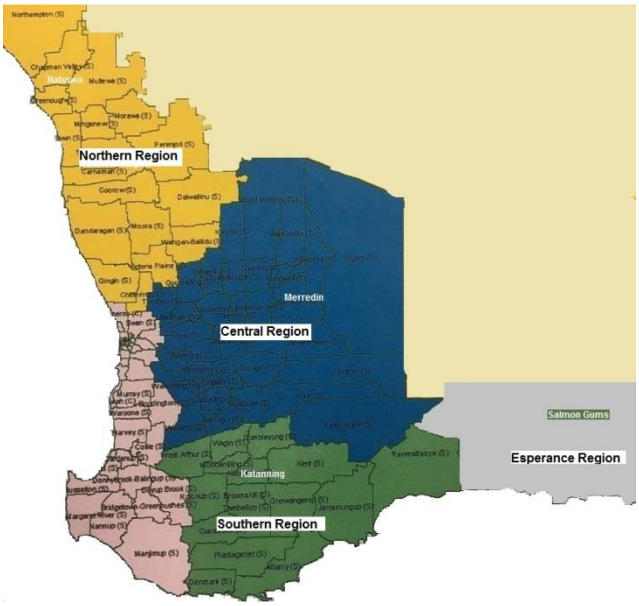


**Figure 1.** Map showing locations of the four grainbelt regions and four locations used in this study.

*July to September outlooks and N decisions*

By using yield forecasting systems in conjunction with nitrogen decision tools, the chances of matching fertiliser rates to yield potential should increase. Nitrogen can be effectively applied to cereal crops at any stage up to booting if sufficient rainfall follows the application to wash the fertiliser into the root zone (Lemon, 2006). Top dressing fertiliser six weeks after sowing is a common practice in the grainbelt, so in this study in-season N adjustments were assessed. For this study, four locations in the grainbelt were chosen: Nabawa, Merredin, Katanning and Salmon Gums.

July to September rainfall forecasts were obtained from each of the SSF and POAMA outlooks from the years 1981 to 2017. As the SSF has only been in operation since 2012, for the years 1981-2011 the July-September rainfall forecasts were done retrospectively as part of a cross-validation procedure. POAMA hindcast data were obtained from www.agforecast.com.au based on the research of McIntosh and Brown (2016). POAMA hindcasts are composed of predictions for each year from 1981 to 2017 made using data until the most recent year. POAMA hindcasts give 33 (and not the 165 as the operational model) different outcomes for a single event. Therefore, the median of the 33 runs was used in the model assessment.

Potential yields were calculated using one third of observed summer (November to March) rainfall, observed April-June rainfall and median October rainfall (French and Shultz, 1984). Four potential yields (calculated for all years and all locations) were then calculated using:

1. Observed July–September rainfall, to give an "observed" potential yield (i.e. full knowledge of July-September rainfall).
2. Median July-September rainfall.
3. SSF July-September cross validation rainfall.
4. POAMA ensemble median July-September forecast rainfall.

Select Your Nitrogen (SYN) was used to calculate N top-dressing in July required to maximize net return using each of the four potential yields for each year for each of the four locations. The per annum net of N over the 37 years was calculated for each of the four potential yields to determine whether forecasts are valuable for N top-dressing decisions. Fertiliser price (CSBP prices from 2015, MAP at $872/tonne and Flexi N (32% N) at $483/tonne) and wheat price (Australian Hard $217 with protein adjustment from the 2015/16 AWB Harvest Pool Golden Rewards Quality Matrix) where used in SYN.

**Results**

*Three month seasonal forecast models*

Each of the four regions was assessed in terms of the comparison between both outlooks and actual rainfall observed, and correct forecasts (as described previously) were tallied in Figure 2. For the outlook to be of any value, a minimal score of four out of six years needs to be reached (as three out of six is no better than guessing). The SSF has correctly indicated whether May-July was below or above median in all 6 years in the northern region (Figure 2A), 5 out of 6 in the central region (Figure 2B) and 4 out of 6 years in the southern region (Figure 2C) and Esperance (Figure 2D). Winter rainfall (June to August) was correctly indicated in 4 out of the 6 years in the northern, central and Esperance regions by the SSF. POAMA correctly indicated winter rainfall in 4 out of 6 years in the central and Esperance region. Both models had no success at indicating January to April (apart from March to May by the SSF in Esperance) and July to December rainfall (except September to November by the SSF in Esperance).

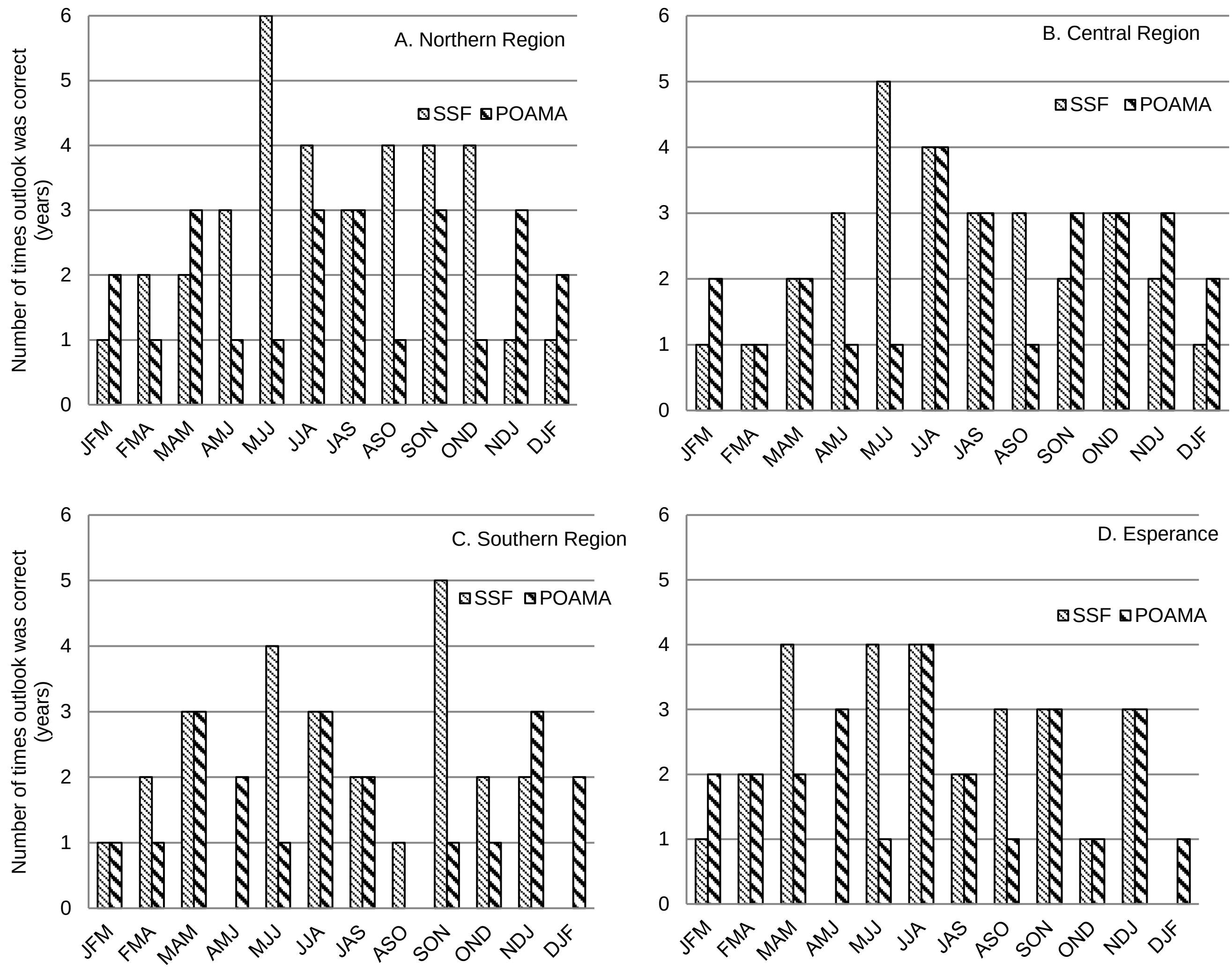


**Figure 2.** Success rates of three month outlooks of SSF and POAMA for the six years (2012-2017) in the A. northern agricultural region, B. central agricultural region, C. southern agricultural region and D. Esperance region. Letters indicate start of the month (e.g. JFM is January, February and March outlook).

*Growing season outlook*

The SSF May to October outlook produced in April, correctly indicated whether May to October rainfall would be above or below median in the Northern Agricultural Region and Central Agricultural Region in 5 years out of 6 (Table 2), the Southern Agricultural Region in 2 years out of 6 and Esperance region in 4 out of 6 years. The SSF correctly indicated two below median seasons 2015 and 2017 in the data series for the entire grainbelt (but not 2012), which suggests that the SSF is better at identifying below median growing seasons.

**Table 2** Growing seasons (May to October) where the SSF correctly indicated an above or below growing season in the grainbelt. Grainbelt regions are the same as used in Figure 1.

| Growing season year | Northern region | Central region | Southern region | Esperance |
|---|---|---|---|---|
| 2012 | | ✓ | | ✓ |
| 2013 | ✓ | | | |
| 2014 | ✓ | ✓ | | ✓ |
| 2015 | ✓ | ✓ | ✓ | ✓ |
| 2016 | ✓ | ✓ | | |
| 2017 | ✓ | ✓ | ✓ | ✓ |

*Nitrogen decisions*

There was little difference between the net return per annum of the median and outlooks over the 37 years at all locations (Table 3). Data was further analyzed to indicate if value was obtained when the forecasts indicated either above or below median for July to September. No clear trend in value was apparent.

**Table 3.** Per annum net return using optimal top-dressed N ($/ha) over 37years (1981-2017) using potential yields based on observed July-September rainfall, median July-September rainfall, SSF and POAMA July-September forecasts.

| | Nabawa | Merredin | Katanning | Salmon Gums |
|---|---|---|---|---|
| Observed | 643 | 389 | 563 | 480 |
| Median Rainfall | 563 | 337 | 505 | 408 |
| SSF | 558 | 340 | 501 | 410 |
| POAMA | 564 | 329 | 503 | 409 |

## Conclusion

The SSF and POAMA three month outlooks had varying success in the grainbelt. The SSF had some success at indicating May to July rainfall in northern and central regions. In other months, including summer both models had low or no success. This is because summer rainfall is more often driven by short term weather systems (thunderstorms) not slow developing climate systems that the models are following.

The SSF growing season outlooks (May to October) had higher rates of success in the northern and central regions because the SSF is more correlated to winter-spring rainfall patterns originating from the Indian Ocean, than those rainfall patterns that originate in the Southern Ocean which drive the climate patterns influencing the southern and Esperance regions. The SSF growing season outlooks provided in April of each year correctly indicated the dry seasons of 2015 and 2017 for the entire grainbelt.

As N fertiliser application can cost as much as $80/ha or more, accounting for up to 25% of farmers input costs (Lemon, 2007), seasonal forecasting can be of considerable value when benefits are averaged over a number of years if the skill of the forecasts is high. Seasonal forecasts give probabilistic information about the seasonal bias and are therefore potentially valuable in the long-run rather than in any given year (McIntosh et al, 2015). This report showed that there was little or no benefit in using either outlook in determining in-season N rates in four grainbelt locations. This is largely due to the outlooks having relatively low skill in indicating July-September rainfall. However, the outlooks could be of benefit at providing N decisions at seeding (May), as they have more success at indicating May to July rainfall. This is supported by the findings of Asseng (et al, 2012) and McIntosh (et al, 2015) who found that the value of seasonal forecasts was between $31/ha and $66/ha when using the POAMA model to determine the amount of nitrogen fertiliser at seeding.

Although the seasonal forecasts were found to be of little benefit in making in-season N decisions, they maybe of considerable benefit at the start of the season when skill of the models is high. Potential value of outlooks may be in the; calculation of crop choice and area sown, pasture growth, stocking rate decisions, N decisions at seeding, and buying and selling of livestock.

**Key words**: seasonal forecasts, in-season N application, WA grainbelt

**Acknowledgements**: Thank you to Rebecca O'Leary and Jeremy Lemon, DPIRD for help with SYN, Alexandra Edward for Mace prices. Meredith is part funded by the National R for R Project funded by AgriFutures Australia "Improved Use of Seasonal Forecasting to Increase Farmer Profitability".

**Paper reviewed by**: Art Diggle, DPIRD; Glenn Cook, Bureau of Meteorology: Rebecca Darbyshire, DPI NSW.

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