The Southern Oscillation Index- Is it useful as a rainfall predictor for the Southern Mallee?

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Summary

The SOI phase signal for April-May (available on the last day of May) and subsequent monthly phases can provide useful information on the likelihood for rainfall for the rest of the season. It can be a very useful tool for assessing the risk of topdressing nitrogen fertiliser (especially if it is used in combination with other indicators such as potential of the crop; decile trend and stored soil moisture).

The indicator of whether it is going to be an El Nino or La Nina year is also a very good measure of the likelihood for rainfall in the southern Mallee for the latter part of the season. Unfortunately the proclamation of an El Nino or La Nina event usually occurs late in the season when most of the on-farm management decisions have been made.

Background

Farming systems across Australia are more refined than ever, yet still the greatest risk faced by farmers is exposure to an uncertain climate. Increased research into Seasonal Climatic Forecasting (SCF) tools has become a key area of investment by many of the agricultural R&D corporations across Australia. A reliable climate forecasting tool, particularly for rainfall, would have enormous implications for reducing the risk profile of primary production. Strategic crop selection, variety selection and use of inputs depending on the season would enable greater profitability in wet years and in dry years inputs could be reduced.

The Southern Oscillation Index (SOI) measures the difference in air pressure between Tahiti and Darwin and is an index, which has been investigated extensively as a SCF tool. The SOI index scale ranges from +30 to - 30. The SOI has an influence over seasonal weather conditions and there has been much interest from the farming community in its ability to predict the upcoming season.

Seasonal climate forecasting using the SOI has been used more extensively by grain farmers in Queensland and northern NSW than in northern Victoria. The SOI when compared to Queensland climate data over the past 100 years has established that the Southern Oscillation has a strong influence on cloud cover, temperature, humidity, evaporation, rainfall and number of wet days. For the northern region it has been possible to determine a correlation between a positive SOI and higher rainfall, and a negative SOI and lower rainfall. For this reason, many farmers in Queensland are using the SOI as a predictive tool for the coming season. A strongly negative or positive SOI can indicate whether the coming season is likely to be drier or wetter than normal.

Not as much analysis has been completed relating to the SOI and its predictive value in the southern cropping regions. There has been a common thought amongst many farmers that the SOI as a predictive tool for the southern grain belt of southern NSW or northern Victoria is not as effective. However more work has begun looking at the SOI phenomenon and the influence it has over the southern regions.

The BCG is investigating the SOI and its usefulness as a predictive tool for farmers in the southern region. As a preliminary analysis, work has focused only on the southern Mallee region, and forms the basis of this paper.

Methodology and Results

Analysis of long-term rainfall trends for Birchip

Initial analysis undertaken in this study was to determine any long term rainfall trends for Birchip. Trends specifically associated with annual rainfall, growing season rainfall and spring rainfall were of interest due to the large role rainfall during these periods has on winter crop production in the southern Mallee. The analysis used 104 years of historical rainfall data from 1899 to 2003.

Rainfall amounts (mm) for annual, growing season (April to October) and spring (September and October) periods were plotted over the one hundred years. Trend analysis was used to determine if there were any correlations between years and rainfall.

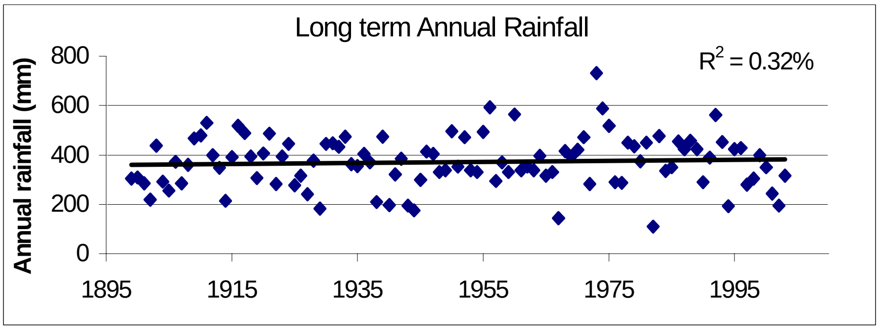

Figure 1. 104 years of Annual Rainfall (Jan-Dec). Long-term annual average annual rainfall for Birchip is 375mm

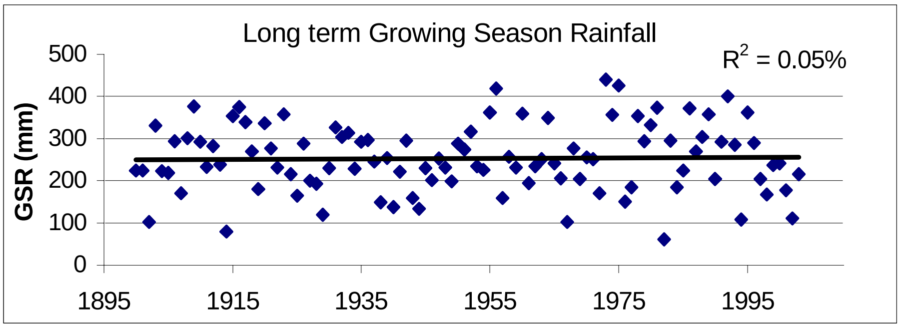

Figure 2. 104 years of Growing Season Rainfall (April-Oct). Long term average GSR for Birchip is 256mm.

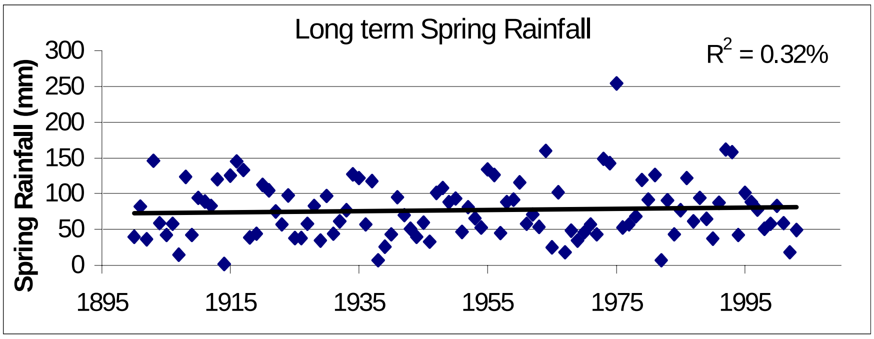

Figure 3. 104 years of Spring Rainfall (Sept - Oct). Long term average spring rainfall for Birchip is 76mm.

Over the 104 years of rainfall there was no increasing or decreasing rainfall trend in annual rainfall, GSR or spring rainfall as indicated by the R^2 of each trend line showing close to zero correlation between rainfall and year.

El Nino & La Nina Years and their influence on Birchip GSR and Spring Rainfall

Rapidly rising and positive SOI trends over the winter months are often associated with La Nina events. La Nina events are of interest, as in northern Australia they are associated with the occurrence of average to above average rainfall. El Nino events on the other hand are often associated with a rapidly falling or negative SOI and usually result in below average rainfall.

For the years classified as either El Nino or La Nina over the last 104 years, Birchip GSR and spring rainfall patterns were analysed to determine if there were any apparent trends or influences of the La Nina and El Nino events on rainfall.

A correlation between rainfall and an El Nino or La Nina event would give Birchip district farmers some idea of the likely rainfall outcome if such an event was declared by climatologists. The timeliness of such declaration would determine the usefulness of it as a Seasonal Forecasting Tool.

Australia over the last one hundred years has experienced 28 El Nino years. The influence of such years on Birchip's growing season and spring rainfall is represented in Figures 4 and 5.

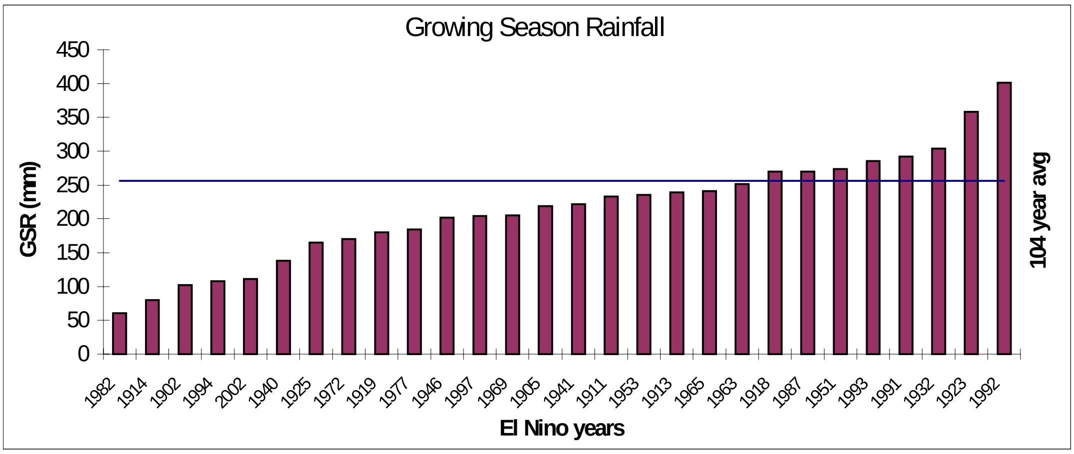

Figure 4. El Nino years and Growing Season Rainfall at Birchip (average 256mm)

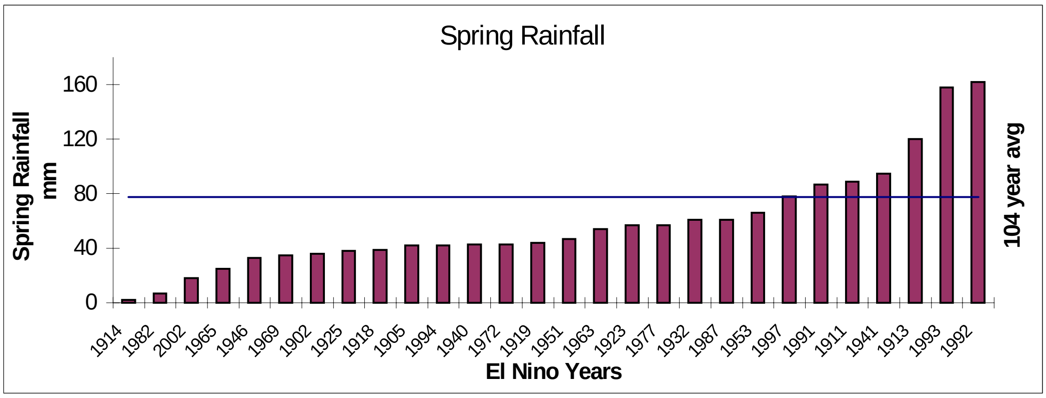

Figure 5. El Nino years and Spring Rainfall at Birchip (average 76mm)

70% (20/28) of El Nino classified years were below the long-term growing season average of 256mm. 75% (21/28) of El Nino classified years were below long-term spring rainfall average of 76mm.

Australia over the last one hundred years has experienced 21 La Nina years. The influence of such years on Birchip's growing season and spring rainfall is represented in Figures 6 and 7.

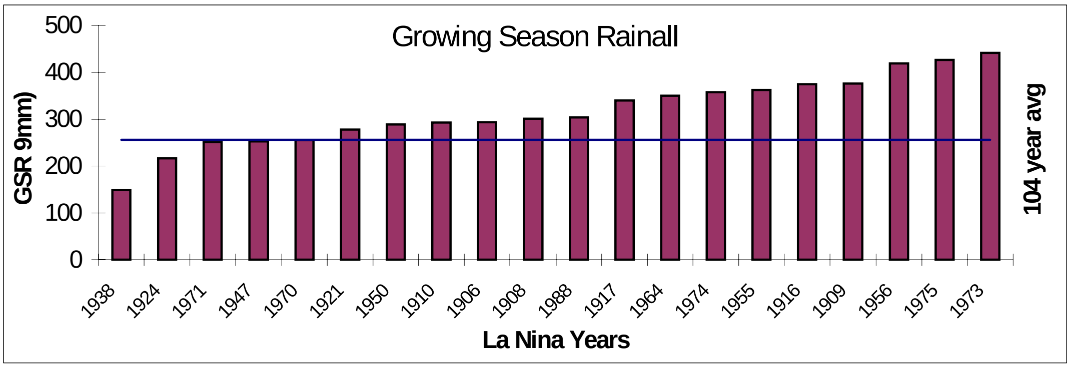

Figure 6. La Nina years and Growing Season Rainfall at Birchip (average 256mm)

95% of years classified as La Nina years have resulted in average to above average GSR rainfall in Birchip. Only two years experienced below average rainfall in La Nina years. 76% of years classified as La Nina years have resulted in above average spring rainfall.

Unfortunately El Nino or la Nina events are proclaimed late in the season (generally August or later) and generally too late for most on farm decisions (except possibly some late N applications). Even if they are proclaimed late in the season it is advisable for farmers to take note because of the strong correlation between an El Nino or La Nina event and rainfall received in the southern Mallee. Topdressing more N in a La Nina event should be considered because there is a high probability that it will be wet; conversely if it is likely to be an El Nino year than topdressing N would not be advisable.

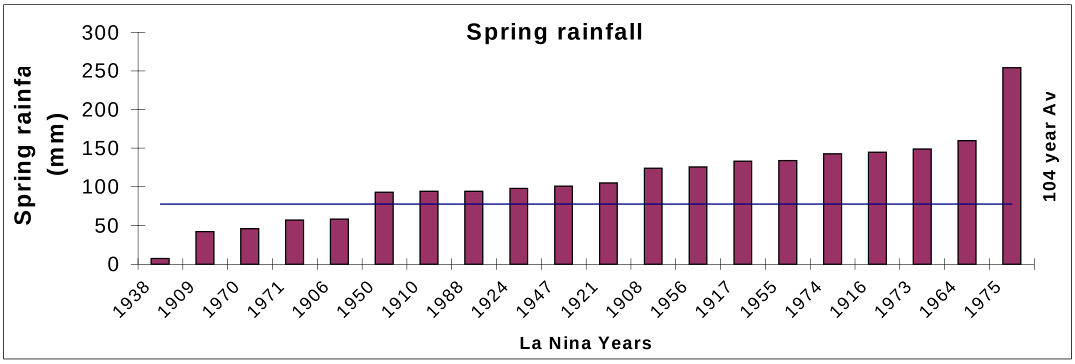

Figure 7. La Nina years and Spring Rainfall at Birchip (average 76mm)

SOI Phase classification versus GSR and Spring Rainfall for Wet, Dry or Average conditions

Further analysis was undertaken of SOI phase classification and its impact on Birchip GSR and spring rainfall. In the southern Mallee the growing season for the winter cropping program falls between April and October, consequently, the predicability of rainfall within that period is of key interest to farmers. Rainfall between September and October (spring rainfall) in the southern Mallee is critical to resultant crop yields and is therefore also of interest to farmers.

In this analysis, long-term rainfall data for the Birchip region was compared to long-term SOI phase data for the periods March-April, April-May, May-June and June-July, to establish any trends that could provide a seasonal predictive tool for southern Mallee farmers. These phase periods are the critical times for input decisions such as crop choice, variety and fertiliser inputs. It is at this point in the cropping cycle that decisions have a direct influence over the financial outcome of the cropping season.

There are five SOI phases as classified by the Bureau of Meteorology (BOM):

- Consistently negative
- Consistently positive
- Rapidly falling
- Rapidly rising
- Consistently near zero (neutral)

The SOI phases for the above periods were used to try to determine the probability of a particular rainfall outcome – wet, average or dry years.

Wet years were classified as the wettest 25% of years (or 27 years out of the 104 years of data analysed). These years recorded above 301mm GSR and above 101mm of spring rainfall.

Dry years were classified as the driest 25% of years (or 27 years out of the 104 years of data analysed). These years experienced less than 202mm GSR and less than 44mm of spring rainfall. The middle 50% of years were regarded as average.

Figure 8 shows the percentage chance of a dry, average or wet GSR occurring during each of the SOI phases during the critical months of (March-April; April-May; May-June; June-July).

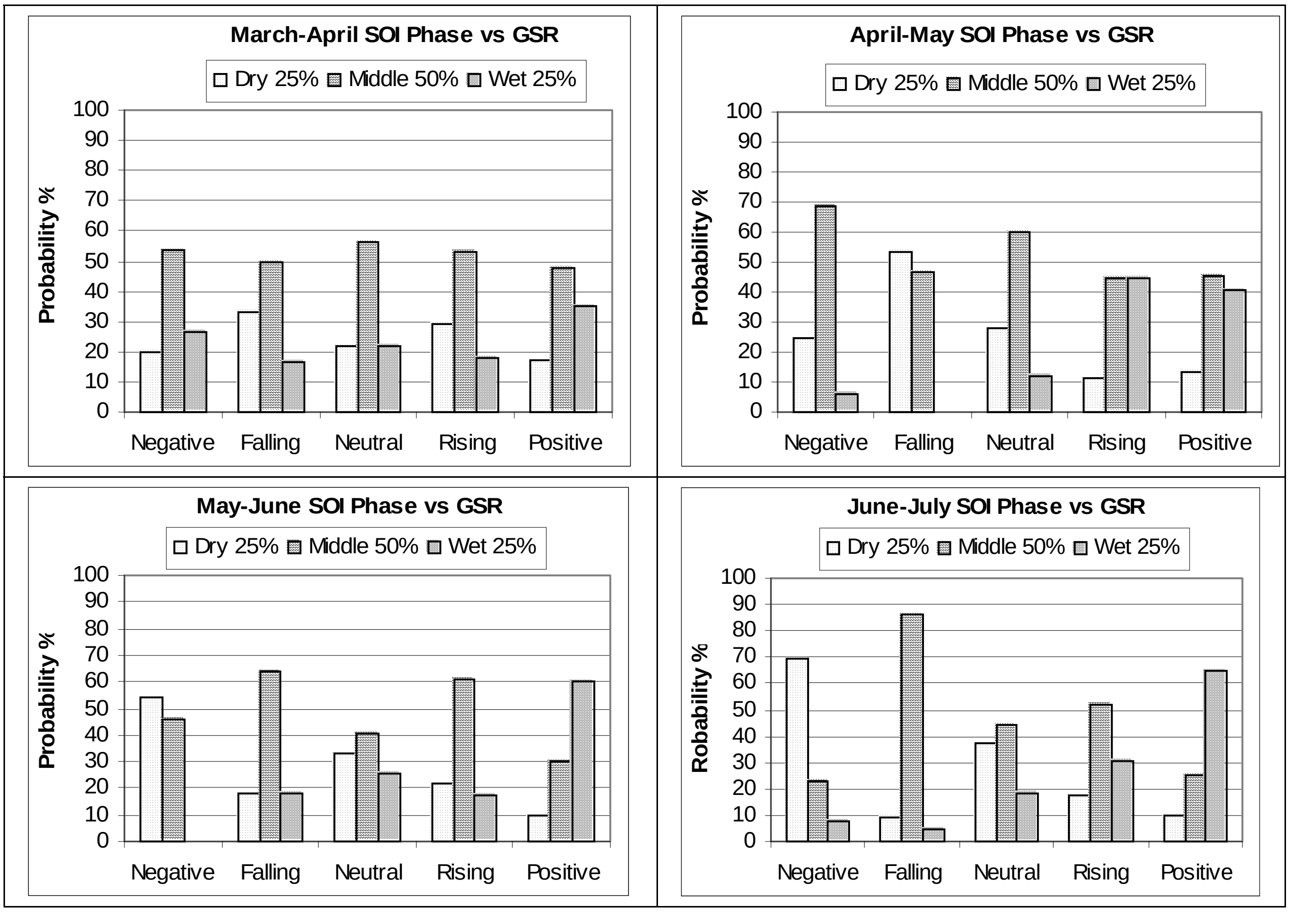

Figure 8. March- April; April-May; May-June; June-July SOI Phases SOI versus Growing Season Rainfall for Birchip (based on 105 years of rainfall data).

In the March-April phase there is no appreciable correlation between the SOI and whether it is going to be a wet, average or dry season (as based on Growing Season Rainfall). However, this pattern changes markedly during the April-May phase and continues for the May-June and June-July phases (the strength of the signal of whether it is going to be wet or dry actually continues to improve). Examples:

- During the April-May phase – a Negative SOI signal means there is a 94% chance of rainfall during the growing season being dry (25%) or average (69%); and only a 6% chance of rainfall being in the wet category.
- During the May-June phase – a Negative SOI signal means there is a 100% chance of the rainfall during the growing season being dry (54%) or average (46%) and no chance that it is going to be wet.
- During the June-July phase – a Positive SOI signal means there is a 90% chance that the rainfall during the growing season is going to be wet (65%) or average (25%) and only a 10% chance that it is going to be dry.

(The data presented was based on 105 years of rainfall and SOI data – the information is presented as probabilities, hence they are not certainties).

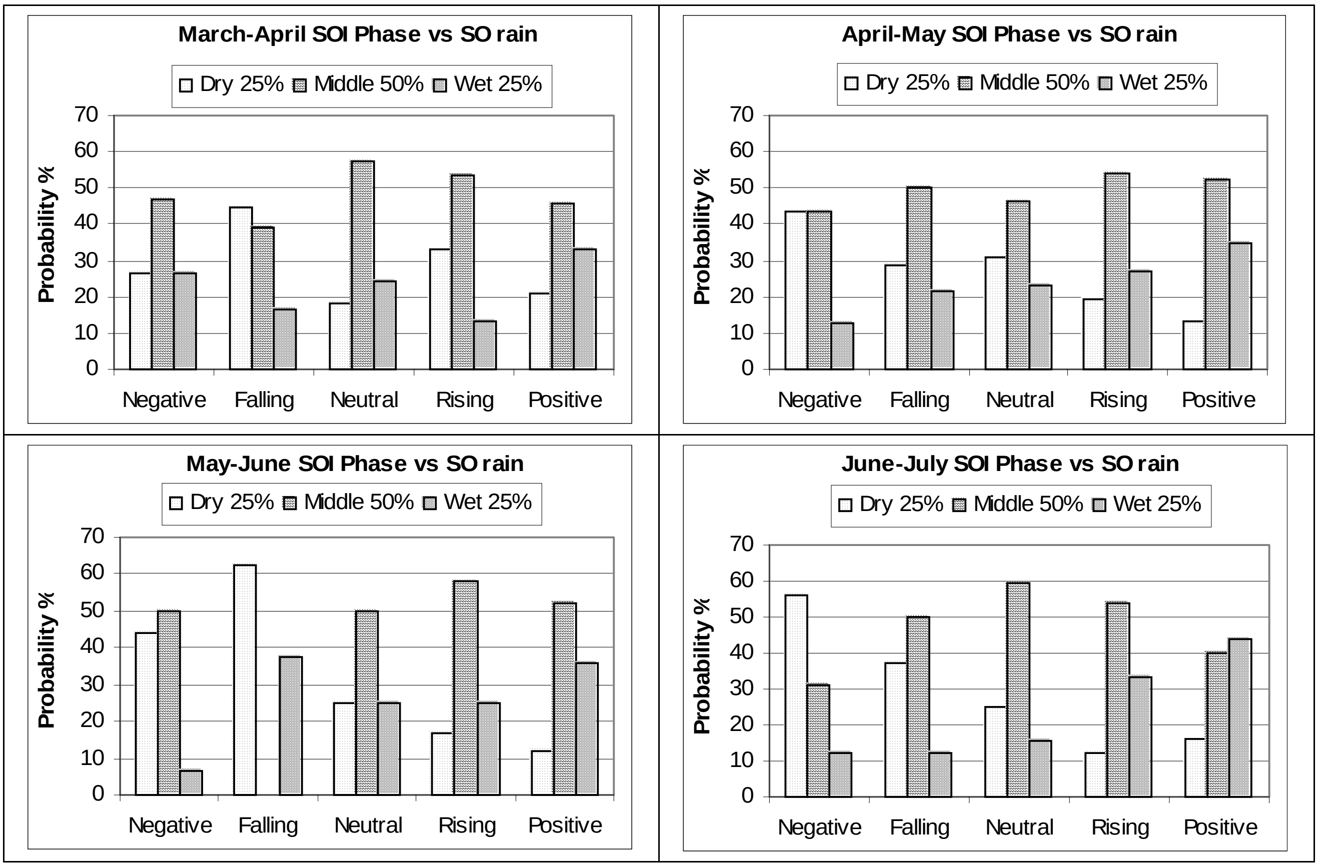

Figure 9. March- April; April-May; May-June; June-July SOI Phases SOI versus September-October rain for Birchip (based on 105 years of rainfall data).

Similarly to the SOI phase information provided in Figure 8 for Growing Season Rainfall, the SOI signal also works for estimating the probability of whether Spring rainfall (September-October) is going to be dry, average or wet (Figure 9). During the March-April phase the signal is weak and there is little indication of what the Spring rainfall is likely to be. However, the strength of the signal improves during the April-May phase and continues to improve in the May-June and June-July phases.

Interpretation

The classification of El Nino or La Nina year has resulted in at least a 95% chance of receiving above average rainfall in a La Nina year; or a 70% chance of below average rainfall in an El Nino year. Unfortunately for southern Mallee farmers these events are not proclaimed until later in the season when most management decisions have been made.

The SOI phase system can provide more useful information and much earlier in the season compared to whether an El Nino and La Nina event is likely to occur. The SOI signal in the March-April phase (determined on the last day of April) is unfortunately not a good indicator of what the likely rainfall is going to be for the rest of the season. Since farm management decisions such as crop choice and pre-drilling of urea are made in April and May, the SOI phase system during March-April cannot be used for these purposes.

However, the April-May phase (determined on the last day of May) and subsequent phases do provide good useful information with reasonable reliability. For example, if the SOI signal for the April-May phase is negative then there is a 94% chance that the season is going to be average (69%) or dry (25%) and only a 6% chance that it is going to be wet; the corollary is that if the signal is Positive then there is 86% chance that the season is going to be average (45%) or wet (41%) and only a 14% chance that it is going to be dry. Hence the indications can be useful for later sowing decisions and topdressing nitrogen.

By the time cereal crops in our region have reached late tillering (late July) the SOI signal can provide a useful indicator of whether there is a high or low probability of getting a dry, average or wet Spring. This together with how much stored water is present in the soil profile; the decile trend for the season and how well the crop is growing (ie. the effects of weeds, disease or lack of other nutrients) can provide an excellent indicator of whether the crop needs topdressing with N.

The Yield Prophet program initiated by the BCG in collaboration with CSIRO (APSRU – Toowoomba) uses the SOI phase signals in making yield forecasts during the season.

Acknowledgment

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