



IRRIGATION RESEARCH & EXTENSION COMMITTEE

2006



FOR IRRIGATION CROPPERS

**Managing irrigation and nitrogen in
grain crops with yield prophet®**

JAMES HUNT

Birchip Cropping Group

Ph: 03 9354 1654

Email: james.hunt@aanet.com.au

IREC

C/- CSIRO Land and Water, Griffith

Private mail bag 3 Griffith NSW 2680

Tel: 02 69601550 **Fax:** 02 69601562 **Email:** irec@irec.org.au

Introduction

Yield Prophet (www.yieldprophet.com.au) is a web interface for the crop production model APSIM (www.apsim.info). It simulates crop growth based on paddock-specific inputs of soil type, pre-sowing soil water and nitrogen, rainfall, irrigation and nitrogen fertiliser applications, and climate data. Yield Prophet was developed by BCG (Birchip Cropping Group) in collaboration with CSIRO as a risk management tool for dryland farming systems in the Victorian Wimmera and Mallee, with an emphasis on decision support for nitrogen fertiliser inputs. It was first used for wheat at BCG trial sites in 2002, and its early predictions of the failure of that season generated sufficient interest and credibility to allow a commercial release to BCG members in 2003 as a monthly fax-out service. Continuing demand resulted in the development of the Yield Prophet web-interface, which allowed a larger number of subscribers to receive up-to-date crop information and forecasts on demand in 2004.

In 2004, Yield Prophet was used to schedule irrigation and nitrogen top-dressing for a pivot-irrigated wheat crop near Serpentine in northern Victoria. Under management guided by Yield Prophet, this crop yielded 7.1 t/ha, and BCG and CSIRO decided to invest in developing Yield Prophet as a tool for irrigation scheduling.

In 2005 Murray Irrigation offered to assist growers with the costs of subscription and soil testing. Eight growers initially took up the offer and members of the Yield Prophet team met with them in August 2005. Through discussion a set of tools for irrigation crop monitoring and scheduling was developed, which came on-line in September 2005. As the season progressed six of the eight growers involved in the initial meeting proceeded with their involvement in the program.

HOW YIELD PROPHET WORKS

Subscription

Farmers or consultants subscribe to the service in autumn and provide the Yield Prophet team with their paddock names, planned crop and variety and their closest Bureau of Meteorology (BOM) weather station. Subscribers are then given a user name and password with which they can log onto the Yield Prophet website. Growers are also able to nominate a consultant with whom they wish to access Yield Prophet, and this consultant is also given access to data on that grower's paddocks.

Soil sampling

Growers sample their paddocks at different depth intervals down to the maximum rooting depth of their crop (e.g. 0–10, 10–40, 40–70, 70–100 cm). These samples are analysed for water content, nitrate concentration, organic carbon, electrical conductivity, chloride and pH. These data are entered by growers into the Yield Prophet web interface, and are also used by the grower and Yield Prophet team to select a suitable soil characterisation.

Soil characterisation

An appropriately measured soil characterisation is an essential input for Yield Prophet to simulate crop growth, yield and protein accurately. The plant available water capacity (PAWC) and bulk density of a specific soil type determine how much of the measured water and nitrogen is available to the crop for growth during the season. PAWC is determined by a soil's 'drained upper limit' (DUL, or field capacity) and its 'crop lower limit' (CLL, similar to permanent wilting point). The Yield Prophet team has a 'library' of soil characterisations measured for many of the major cropping soil types found within BCG's membership catchment and other regions Australia-wide. However, most of the paddocks subscribed by the Murray Irrigation growers had soil types for which there were no available measured characterisation data. In these circumstances, a soil characterisation was estimated by the Yield Prophet team based on soil type and previous rainfall and crop yields provided by the growers, and any information available from existing soil surveys.

Crop growth simulation and prediction

During the season, subscribers enter paddock management details (sowing date, crop type, variety, nitrogen fertiliser and irrigation). When growers wish to find out how much water and nitrogen is currently available to a crop, the likely yield of their crop, or what the likely impact of management events will be, they generate a report. When a report is generated, Yield Prophet simulates daily crop growth from sowing up to the present using the paddock specific rainfall and management data entered by the subscriber, and climate data (maximum and minimum temperature, radiation, evaporation and air pressure) from the nominated BOM weather station. At every daily time step Yield Prophet calculates the amount of water and nitrogen available to the crop, and the water and nitrogen demand of the crop. This is used to determine if the crop is suffering stress from lack of either of these resources, and any subsequent reduction in growth and yield potential.

Yield prediction

In order to make predictions about crop yield, Yield Prophet uses the last one hundred years of climate data taken from the nominated BOM station to continue the simulation from the date of report generation to the end of the season. The model simulates one hundred different crop yields and proteins, based on the current season up until the day the report is generated, and on the season finishes of the past one hundred years. These yields are then plotted as a probability curve (Figure 1b), which provides growers with an estimate of the probabilities of obtaining different yields. This range of probabilities narrows as the season progresses and components of yield become more certain.

This is the main output of Yield Prophet. The likely impact of different irrigation and nitrogen applications can then be determined by simulating different nitrogen and irrigation ‘scenarios’. Yield Prophet calculates a probability curve for each scenario, and subscribers use this to determine the likelihood of achieving a yield or protein response from the addition of water or nitrogen (Figure 1b).

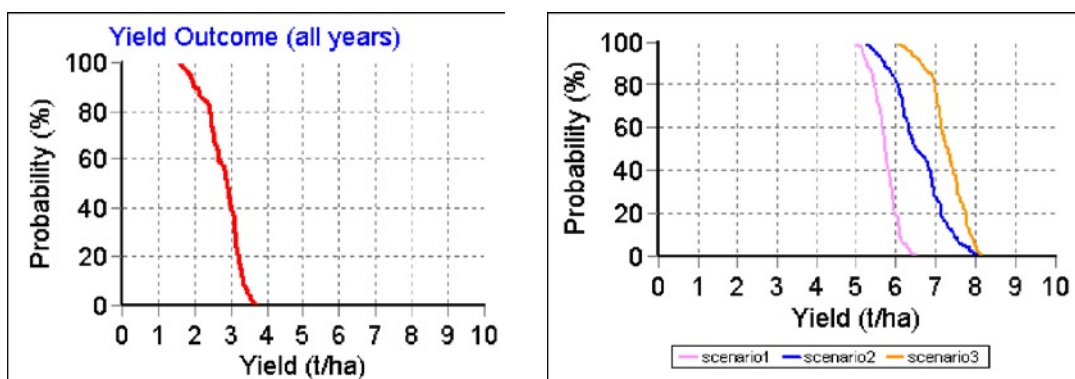


Figure 1 a) A yield probability curve, the main output from Yield Prophet. **b)** Yield probability curves for three different nitrogen and irrigation scenarios generated for an irrigated wheat crop on 3 October 2005. Scenario 1 (pink line) is the yield probability adding no further water or nitrogen, Scenario 2 (blue line) is the yield probability with an additional 50 kg/ha of nitrogen top-dressed on 3 October, Scenario 3 is the yield probability with 50 kg/ha of nitrogen top-dressed on 3 October and two additional 25 mm irrigations on 3 and 17 October.

Figure 1 a) A yield probability curve, the main output from Yield Prophet. b) Yield probability curves for three different nitrogen and irrigation scenarios generated for an irrigated wheat crop on 3 October 2005. Scenario 1 (pink line) is the yield probability adding no further water or nitrogen, Scenario 2 (blue line) is the yield probability with an additional 50 kg/ha of nitrogen top-dressed on 3 October, Scenario 3 is the yield probability with 50 kg/ha of nitrogen top-dressed on 3 October and two additional 25 mm irrigations on 3 and 17 October.

Irrigation scheduling

Because Yield Prophet calculates the amount of water available to a crop, and average evaporation and transpiration based on 100 years of data, it has the potential to be a very effective tool for irrigation scheduling. Figure 2 shows the Irrigation Scheduling report from Yield Prophet. The graph shows the PAWC of the soil that is being accessed by the crop as roots grow, and the amount of PAW calculated from initial measured soil water plus rainfall and irrigation, subtract evaporation and transpiration. The red section of the line is a projection of PAW over the future two weeks assuming no rain, and growers can use this to determine when to water, and how much water to apply. The impact of any irrigation can be calculated from the probability curves in the irrigation comparison report described above (Figure 1b).

Conclusions

Yield Prophet has the potential to be a very useful tool for scheduling irrigation and managing nitrogen in grain crops. Accuracy in the Murray Irrigation region, and indeed much of the country, is currently limited by the quality of available soil characterisation data. Yield Prophet is 'data hungry' and requires an investment in time to set up and learn to use properly. However, the information that it is capable of providing for farm managers and their consultants makes this a worthy investment.