



Yield Prophet[®] 2005

End of Season Report for Subscribers

Introduction

This report is a summary of in-season delivery of the Yield Prophet on-line simulation service in 2005. It is intended to provide a review of the service for the season, and an indication and discussion of model accuracy and performance. Anyone who has any questions or wishes to discuss the topics raised in this report may do so by contacting any member of the Yield Prophet team, or by posting on the Yield Prophet forum.

Subscribers

2005 was the third year of Yield Prophet's commercial delivery, and 338 paddocks were subscribed to the service. Subscriptions directly involved 236 growers, 38 agronomic consultants, 8 government extension and research officers and 8 grower groups. Compared to the first two years of commercial delivery, there were many more subscribers (27 in 2003, 48 in 2004) and they were much more geographically spread (Figure 1).

The deadline for subscriptions in 2005 was initially 25 March, however by this date only nine users had subscribed! Consequently, the deadline was extended pretty much indefinitely, with the last subscription arriving on 27 September 2005. Whilst it is probably good to have some flexibility in subscription timing, in the future we will encourage users to register early (i.e. March). Early registration provides the Yield Prophet team with a greater chance to organise soil types and met stations. It also allows subscribers to use Yield Prophet as an aid to pre-sowing decisions, such as crop type, variety and inputs.

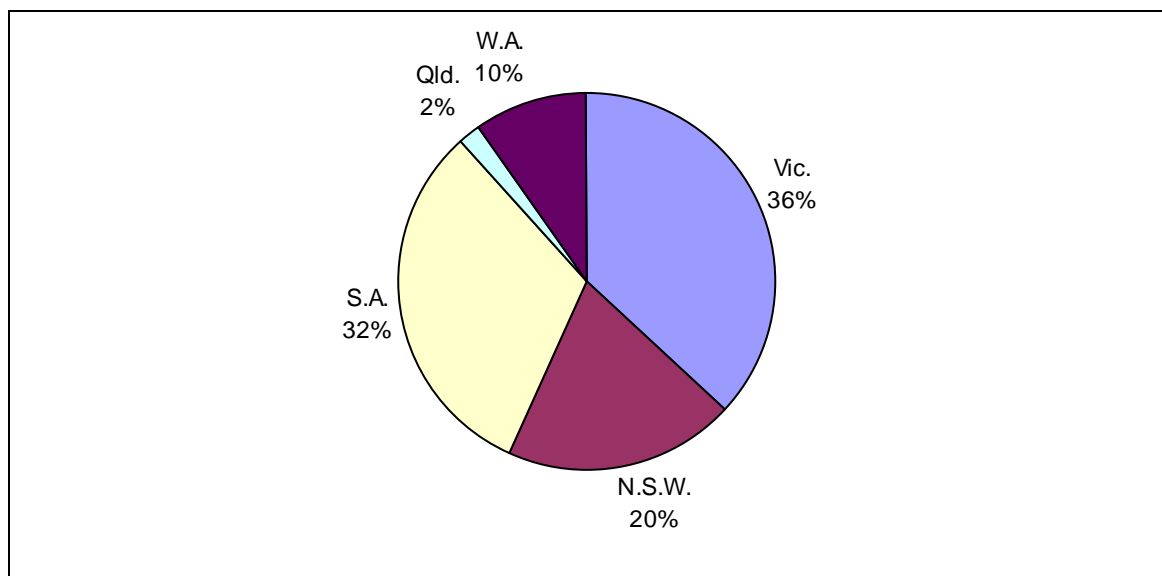


Figure 1. The geographic distribution of Yield Prophet paddocks in 2005.

Usage Statistics

Users generated 6813 reports from 5 April to 1 December 2005, with most demand experienced during August and September (Figure 2), the decision making time for nitrogen top-dressing. For most of the season, most users were getting their reports within 7 minutes of requesting them. However, during the August peak, the time taken for a report to be available after a subscriber had generated it was very long (many hours). To prevent this from happening in the future, the Yield Prophet team have upgraded the single computer used to run simulations for much of 2005 to a 'cluster' of 26 dual-processor computers. This has increased the computing power of Yield Prophet by over fifty times, and will avoid long queues for reports in 2006 and beyond.

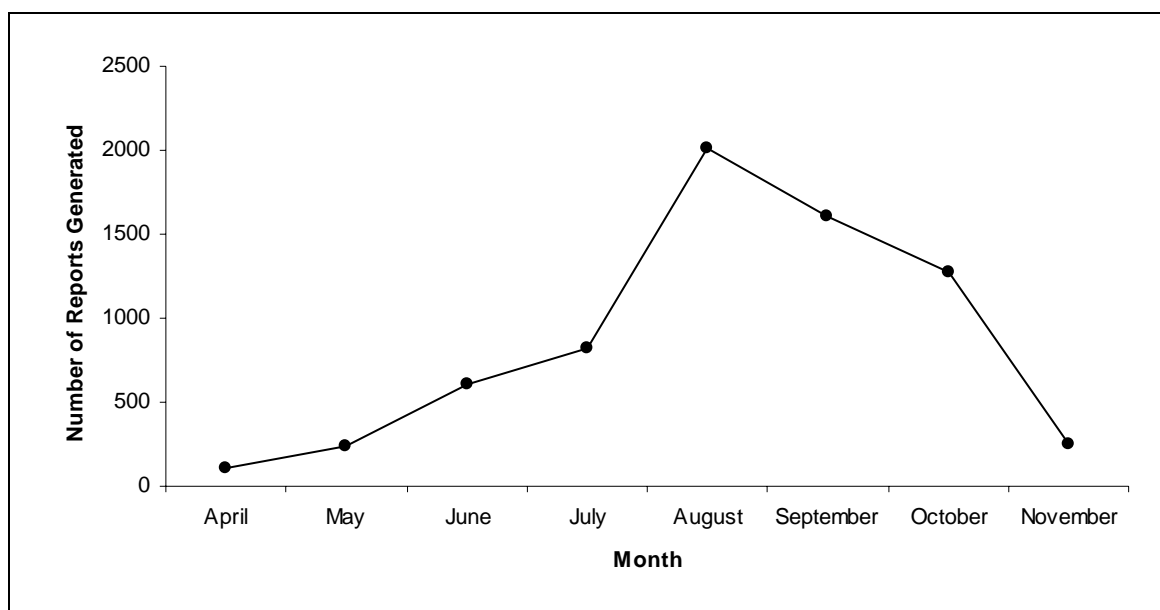


Figure 2. The number of Yield Prophet reports generated by subscribers each month in 2005.

Soil Characterisation and Input Data

An appropriately measured soil characterisation is essential 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 water and nitrogen within that soil is available to the crop for growth during the season (see www.farmscape.cse.csiro.au/farmscape/SoilMatters for discussion of these terms). The Yield Prophet team have 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, in 2005 many subscribed paddocks 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 growers, and any information available from existing soil surveys. This process is referred to as 'estimated soil characterisation'.

Users were required to provide segmented soil analysis data (soil water content, nitrate, EC and pH of samples taken from 0-10, 10-40, 40-70, 70-100 cm soil depth) for their paddocks prior to sowing. Some subscribers opted to use 'Deep N' soil test results (nitrate and sometimes soil water content from 0-60 cm soil depth).

Crops

One of the major new features of Yield Prophet in 2005 was its ability to simulate barley production. In order to achieve this, parameters in the APSIM wheat module were modified to represent the growth and development of different barley cultivars based on the 2004 data from BCG's variety trial at Lubeck and DPI Victoria phenology observations from Horsham and Walpeup over a number of seasons and varieties. Many new wheat varieties were also added to Yield Prophet in 2005 based on the phenology of different varieties as stated in State Department planting guides, and there were some inconsistency in grouping of varieties by different state departments! Yield Prophet's simulation of wheat and barley development was validated at the end of 2005 using detailed data collected at the main BCG trial sites.

Canola was also trialled in southern NSW where growers had previously used APSIM runs in conjunction with CSIRO Plant Industries for crop management. However, results from this trial were mixed, mainly as a result of differences between wheat and canola crop lower limits in the presence of subsoil constraints. Canola will be trialled again in 2006 at BCG field day sites to evaluate a potential commercial release in 2007.

Model Performance

The observed yields of 176 paddocks and proteins of 131 paddocks were returned at the time of writing. Figure 3 shows a plot of simulated versus observed yields and proteins for all paddocks for which observations were reported, excluding 9 paddocks which were seriously affected by disease or weeds. It shows that while Yield Prophet can account for 54% of the variation observed in yield ($R^2=0.54$), there are many simulated yields that deviate significantly from those observed. Table 1 shows that in 51% of returned yields, there was a greater than 0.5 t/ha difference between simulated and observed values. Compared with Yield Prophet results for previous years (an $R^2=0.88$ in 2004, $R^2=0.72$ in 2003), this is a disappointing result. However, there are several good reasons for the level of error observed, mostly to do with inputs, which are discussed below. Simulation of grain protein was not as accurate as that of yield (Figure 3, Table 2). This is because in APSIM an accurate estimate of grain protein requires accurate simulation of more processes than does yield (mineralisation, nitrogen uptake, partitioning etc.). Consequently, simulation of protein is less accurate than simulation of yield.

Table 1. The number of simulated yields within 0.5 and 1.0 t/ha of observed results for paddocks of different input data quality.

Data	Number of Returned Yields	Percentage of simulated yields within 0.5 t/ha (%)	Percentage of simulated yields within 1.0 t/ha (%)
All results (wheat and barley)	176	49	78
Measured soil characterisations and segmented soil input data (wheat and barley)	67	69	96
Measured soil characterisations and segmented soil input data (wheat)	53	70	98

Table 2. The number of simulated grain protein contents within 1 and 2 % of observed results for paddocks of different input data quality.

Data	Number of returned protein contents	Percentage of simulated protein contents within 1% (%)	Percentage of simulated protein contents within 2% (%)
All results (wheat and barley)	131	31	43
Measured soil characterisations and segmented soil input data (wheat and barley)	44	36	59
Measured soil characterisations and segmented soil input data (wheat)	32	37	62

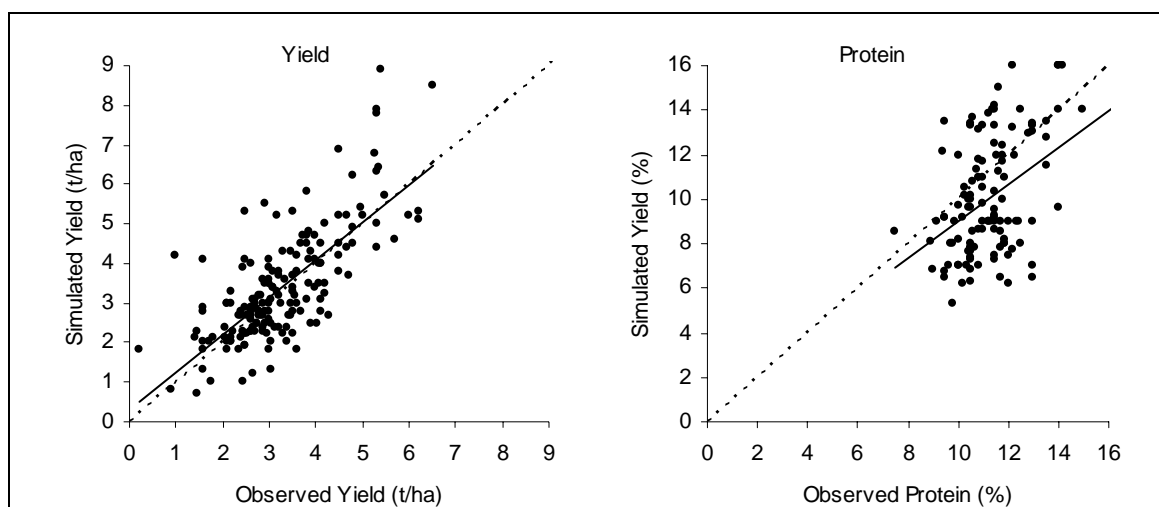
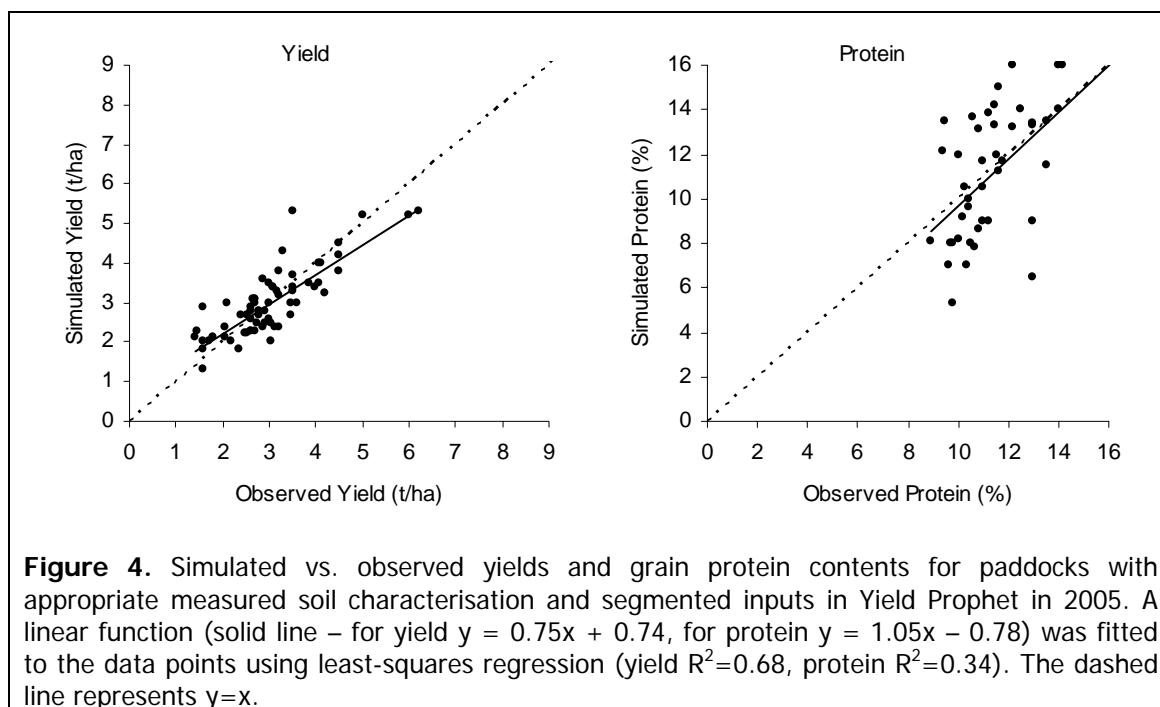


Figure 3. All returned simulated vs. observed yields and grain protein contents for Yield Prophet in 2005. A linear function (solid line - for yield $y = 0.95x + 0.31$, for protein $y = 0.84x + 0.61$) was fitted to the data points using least-squares regression (for yield $R^2=0.54$, for protein $R^2=0.21$). The dashed line represents $y=x$, or where all data points would lie if the both the simulation and observed data were perfectly accurate.

A frustrating source of error in 2005 was the selection of an incorrect soil type for a paddock at the start of the season. Discrepancies between observed and simulated yields at the end of the season showed that the soil type was clearly inappropriate. This was judged to have occurred in 9% of paddocks for which observed yields were returned in 2005. About half of these paddocks were Deep N sampled (a single sample used to determine water and nitrogen in the 0-60 cm zone). The results of Deep N samples provide far less information on which to base soil type selection than the recommended segmented sampling. In many of these cases a more appropriate soil characterisation existed in the Yield Prophet soil-library and could have been used.

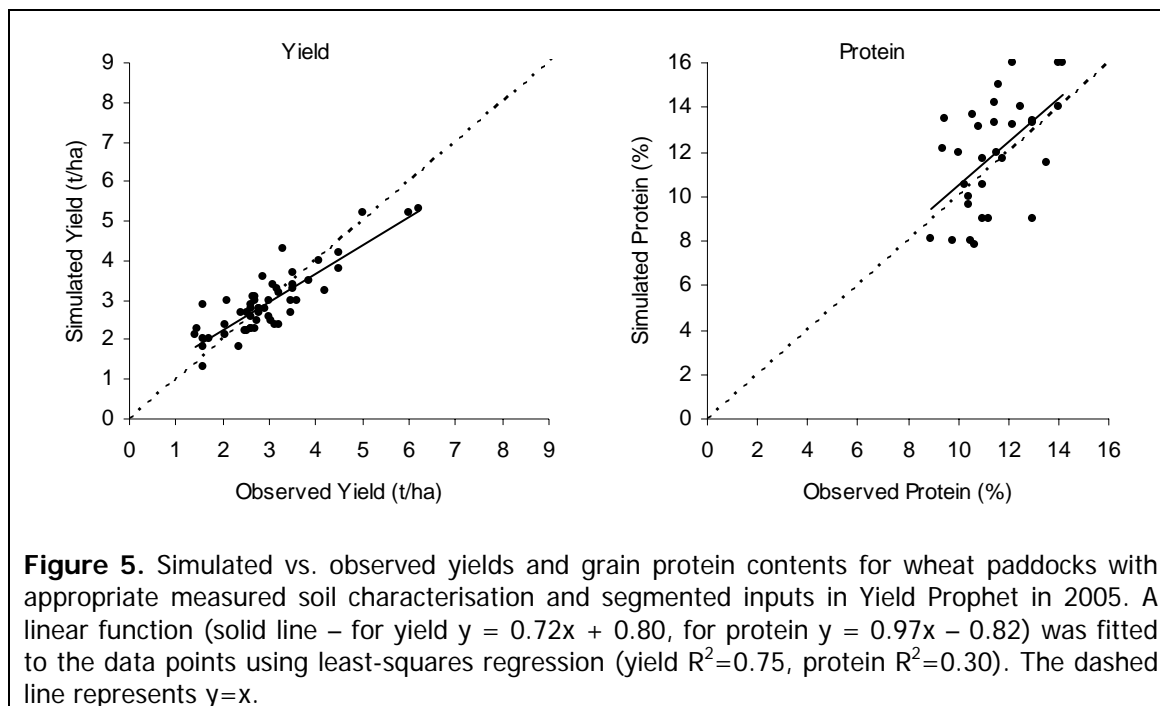
Another disadvantage of Deep N samples as an input for Yield Prophet was clearly illustrated this season. Deep N samples are somewhat misleading in name being only taken typically to depth of 60 cm. With the soft finish experienced in many regions, crop roots have been observed growing to a depth of 1 m or more. The default Yield Prophet set up assumes that there is no available moisture or nitrogen below the sampling zone, which is why subscribers are encouraged to take initial samples to maximum rooting depth. This means that plants probably had access to soil water and nitrogen which was not measured at the start of the season. This obviously provides crops with a considerable source of water and nitrogen that is not accounted for by Yield Prophet, and which resulted in Yield Prophet under-predicting yield and protein in many paddocks that were not sampled to full rooting depth.

One of the major differences between Yield Prophet in 2005 and previous years was the greater geographical distribution of paddocks. Yield Prophet paddocks in 2003 and 2004 were all largely within BCG's catchment area and other study regions where soils had been characterised over time. In 2005, Yield Prophet paddocks came from all over Australia, and whilst some subscribers or their consultants could provide measured characterisations for their soil type, the majority could not. To enable these new subscribers to use Yield Prophet in 2005, the Yield Prophet team estimated soil characteristics as described in the 'Soil Characterisation and Input Data' section above. An estimated characterisation will never be as good as measured data, and this is reflected in the increase in accuracy of yield simulation for paddocks with appropriate measured characterisations (Figure 4), where the R^2 value increases to 0.68 for yield and 0.34 for protein.



Barley was trialled in Yield Prophet for the first time in 2005, and varieties were parameterised using data from BCG's 2004 Lubeck variety trial. One serious limitation of these data was that in 2004, barley varieties suffered terminal drought stress during grain fill. This meant that it was very difficult to estimate correct parameters for rate of potential grain-fill. Also, obtaining phenology parameterisation data from a small number of geographically close sites made it difficult to have confidence in simulations for crops in regions a long way from the parameterisation sites.

In order to genuinely compare the results of 2005 with those from 2004 and 2003, and provide a true indication of Yield Prophet's performance without the noise created by input error, the results from wheat paddocks alone on appropriate, measured soil characterisations and with segmented initial soil samples taken at depth are presented in Figure 5 (30% of all paddocks with returned yield data). This shows that given appropriate inputs, Yield Prophet can account for 75% of the variation observed in yield, with 70% of yields falling within 0.5 t/ha of observed yields, and 98% within 1.0 t/ha.



Model Improvement for 2006

The results from 2005 have provided a good data set for the Yield Prophet team to review the science of the configuration of the APSIM model behind Yield Prophet, and to suggest and assess improvements where necessary.

Based on this, the Yield Prophet team have made adjustments to three parameters of the barley module - root density (it is well documented that barley roots more vigorously than wheat), the number of degree days taken for barley to complete grain-filling, and a parameter limiting crop soil water demand to a fraction of atmospheric potential. Overall, optimisation of these parameters improved the 2005 simulation of barley yield and protein considerably. With the changes, in paddocks with measured soil characterisations and segmented input data, 65% of simulated yields were within 0.5% t/ha of observed yields and 80% of protein measurements were within 1.0% of measured protein values. These improvements give us more confidence in the performance of the barley module heading into the 2006 season.

A review of the wheat module and general parameter assumptions is currently underway to ensure that the APSIM configuration is optimised for simulation accuracy. However, it is unlikely that there will be many significant changes as performance of these components of Yield Prophet has previously been demonstrated to be high over a number of seasons.

Conclusions

In 2005, Yield Prophet expanded a lot, both in capabilities and area of delivery. This came at a cost, with overall accuracy disappointing in comparison to previous years. The accuracy of the barley module has been improved for 2006 using 2005 yield data from around Australia, possible improvements for the wheat module and general configurations are currently being considered.

To be confident of obtaining accurate simulations, subscribers should provide Yield Prophet with appropriate inputs i.e. measured soil characterisations and segmented initial soil data including recommended analyses.

The amount of water available to a crop is a function of rainfall and soil type (particularly PAWC) of a soil. An awful lot of attention gets paid to rainfall (everyone knows their seasonal average, keeps a rain gauge and records etc.), but very little to PAWC. Without accurate measurements of PAWC, you will never know how much of the water that is in your soil, and which may subsequently arrive as rainfall, will be available to your crop. In other words, your capacity to confidently calculate a potential yield for your crops is limited without knowing the PAWC of your soil. For the information that it provides you with, measuring your PAWC isn't that difficult or expensive, and CSIRO and BCG are able to help. If you are interested in characterising your soil (measuring PAWC), contact Neal Dalgliesh on 07 46881376, mobile 0427 725955 or e-mail Neal.Dalgliesh@csiro.au

Yield Prophet 2006

Yield Prophet in 2006 will see improvement and consolidation of the features introduced in 2005 rather than expansion of capability. The web-interface is currently undergoing extensive re-design based on subscriber feedback in order to make it more intuitive, and to reduce the time and effort required to use it. New features available in 2006 are;

- 'Batch' and 'Favourite' reports, which will enable users, particularly consultants, to create reports much more quickly and easily
- The outputs available on the Agronomic, Climate and Irrigation Scheduling Reports will be combined into the one 'Crop Monitoring' report. This will require users to only generate one report instead of three. Additional outputs will include a visual growth scale, current and forecast root depth, growth stage forecast, current distribution of water and nitrogen in the soil profile, water and nitrogen accounting and SOI and BoM rainfall forecast.
- User memory; users don't need to provide password during each session
- User selection of customised home page upon log-in

Pricing & 2006 Subscription

2006 Yield Prophet[®] subscriptions and costs are outlined below. These prices do not include sampling and analysis for initial soil conditions. Collection of initial soil data are the responsibility of the subscriber

To subscribe to Yield Prophet[®] 2006, go to www.yieldprophet.com.au and select the subscription type of your choice. Fill out the on-line registration form, and click the 'subscribe' button at the bottom of this form. Confirmation of your subscription will be e-mailed to you along with soil sampling information. You will be provided with a user-name and password by 1 May 2006.

Please note that the crops available in Yield Prophet[®] 2006 are wheat, barley, sorghum and fallow (nitrogen and water balance).

All prices include GST, invoices are sent in September. Subscribers do not have to use the full compliment of paddocks in each subscription type.

Trial - \$220

1 paddock with log-in details and full help-line support to 1 grower who can nominate a consultant to work with. For first-time users who want to try one paddock, with minimal outlay on soil sampling etc.

Grower - \$550

Up to 6 paddocks with log-in details and full help-line support to 1 grower who can nominate a consultant to work with. Additional paddocks are \$55 each. For competent and independent growers who use Yield Prophet for regular management of many paddocks.

Consultant - \$550

Up to 6 paddocks with log-in details and full help-line support to 1 consultant, with corporate branding provided on web-pages and reports. Additional paddocks \$55 each. For consultants who will use the service on behalf of growers, with little or no grower input. Consultant will have to update rainfall, management etc and send reports to growers. No help-line support offered to growers.

Premium Consultant - \$1100

Up to 6 paddocks with log-in details and full help-line support to 1 consultant plus 3 growers, with corporate branding on web-pages and reports. Additional paddocks are \$55 each, additional growers \$110 each. For consultants who will use the service in conjunction with growers, with grower use and input. Both consultant and grower can update rainfall and management details and simultaneously generate and view reports.

If you have any questions regarding Yield Prophet[®] subscription, please contact;

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