

# Grower Tools – Yield predictive devices for making in-season management decisions

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## Key messages

Estimating what a paddock will yield allows growers to manage herbicide and fertiliser inputs during the season; forward sell grain and accurately insure their crops. This is an important tool for managing gross margins and ensuring profitability.

## Introduction

This project investigated available technology tools for farmers to make in-season management decisions for grain farming in the Esperance Port Zone (EPZ). Until recently, Yield Prophet was the most well-known yield estimation tool, however there are now other options becoming available. SEPWA looked at how other in-season management tools measure up in a comparability study, looking predominately at five tools used to forecast yield and manage inputs.

## Method

Four focus paddocks were chosen: Condingup (-33.591566, 122.958710); Mt. Ney (-33.466148, 122.389909); Neridup (-33.640734, 122.035916) and Scaddan (-33.506420, 121.908752). All growers were set up with the following tools: Yield Prophet; iPaddockYield; Production Wise; PYCAL and N Rich Strips. These were all very different tools requiring different information. Set up requirements have been displayed in the table below.

**Table 1. In season management tools used within the Grower Tools project and their associated required information to set up as well as cost.**

In-season management tool	Information required to set up	Cost
<b>PYCAL</b>	Rainfall, soil moisture at sowing and soil evaporation value. PYCAL was used within the ProductionWise platform as it used actual soil moisture at sowing.	Free, however we used the one which was part of the ProductionWise package which costs \$550 for up to 5,000ha for 1 year.
<b>iPaddockYield</b>	Ten years of monthly rainfall and corresponding average farm crop yield.	\$179 – iPad/iPhone App
<b>ProductionWise</b>	Runs off the APSIM model which requires soil characterisation, soil test results, rainfall data from nearest weather station, last year's yield, and nitrogen, as well as NDVI from satellite imagery to produce its prediction.	Starting package is \$550 for up to 5,000ha for 1 year – web based platform.
<b>N Rich Strips</b>	High rate of nitrogen strip which is compared to the paddock standard using a GreenSeeker to measure NDVI. The NDVI values for both paddock and N Rich strip are then plugged into the N Calculator to give you various nitrogen rates to produce various protein levels.	Strip laid out for \$50/paddock GreenSeeker to read the strip \$600 N Calculator \$50/paddock
<b>Yield Prophet</b>	Runs off the APSIM model which requires soil characterisation, soil test results, rainfall data, last year's yield, crop rooting depth and nitrogen application.	\$180/paddock plus soil coring costs – web based platform.

Time required to set up each tool varied considerably, iPaddockYield, PYCAL and N-Rich Strips had a much shorter set up time than Yield Prophet and ProductionWise. Yield Prophet and ProductionWise required soil cores to be taken from the paddocks and analysed so that soil test and moisture results could be inputted into the tool as well as used to characterise the soil type of that paddock. There was a lack of suitable soil characterisations for the paddocks we looked at in the Esperance region. Because of this, soil test results had to be analysed by soil scientists to provide a characterisation, these were the following:

- Scaddan – Calcareous clay (Doodlakine No485),
- Neridup – Duplex sandy gravel (Jerdacuttup No450),
- Condingup – Deep sandy duplex (Condingup No456) and
- Mt. Ney – Alkaline shallow sandy duplex (Hopetoun No469).

Yield Prophet also requires a maximum crop rooting depth value and this was determined by looking at the soil sample results, specifically boron and aluminium levels.

In addition to this SEPWA also did a state-wide survey of growers to see how well the tools being tested were known to growers, whether growers had experience using the tools and how likely they would be to adjust seasonal inputs based on the information from an in-season prediction tool.

## Results

### Survey Results

Information on whether growers had heard of, have used and how likely they would be to adjust seasonal inputs based on information from seasonal prediction tools are detailed below.

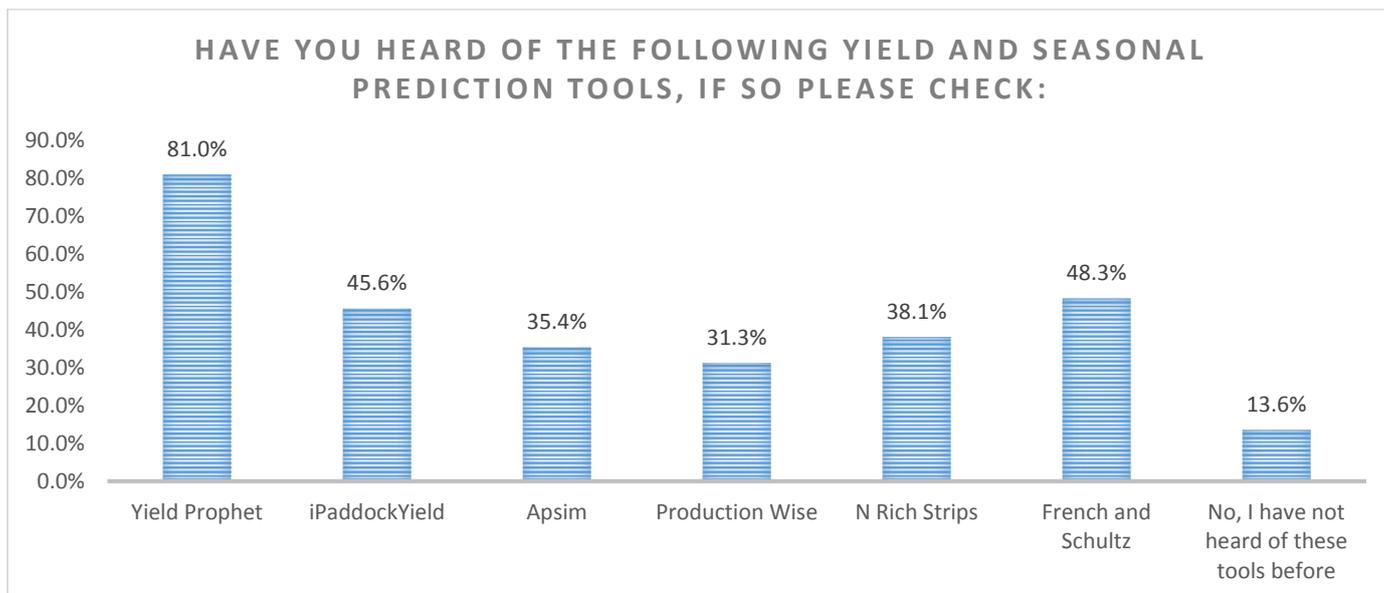


Figure 1. In-season prediction tools heard of by surveyed growers (n=81).

Results showed that out of the six yield predictive devices, Yield Prophet was the most known yield predictive device with 81% of respondents having heard of it. It was interesting to see that only 35.4% of respondents had heard of Apsim (Agricultural Production System Simulator), the model behind Yield Prophet and ProductionWise.

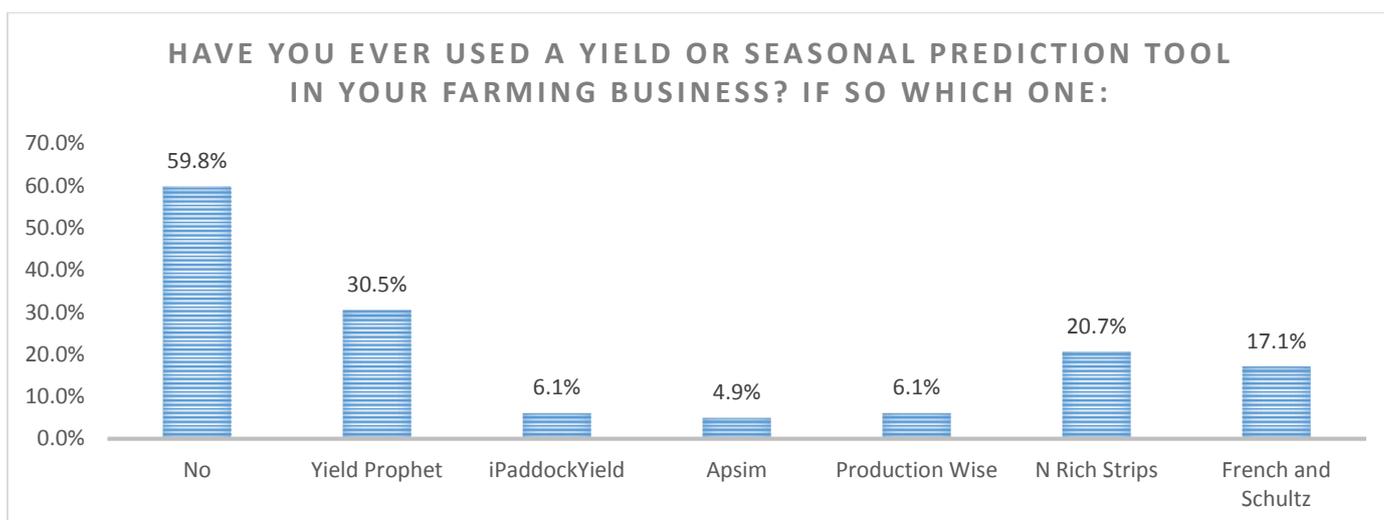
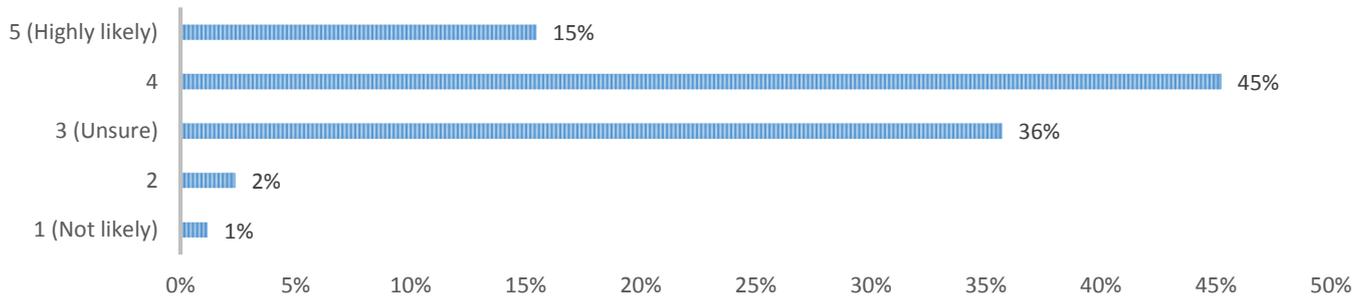


Figure 2. In-season prediction tools previously used by surveyed growers (n=82).

The most commonly tried yield predictive device from the pool of 82 grower respondents was Yield Prophet with 30.5% of the participants having tried it. French & Schultz was the second most tried yield predictive device with 17.1% of growers surveyed having tried it.

### LIKELINESS, RATED BY GROWERS, TO ADJUST SEASONAL INPUTS BASED ON THE INFORMATION FROM A YIELD OR SEASONAL PREDICTION TOOL

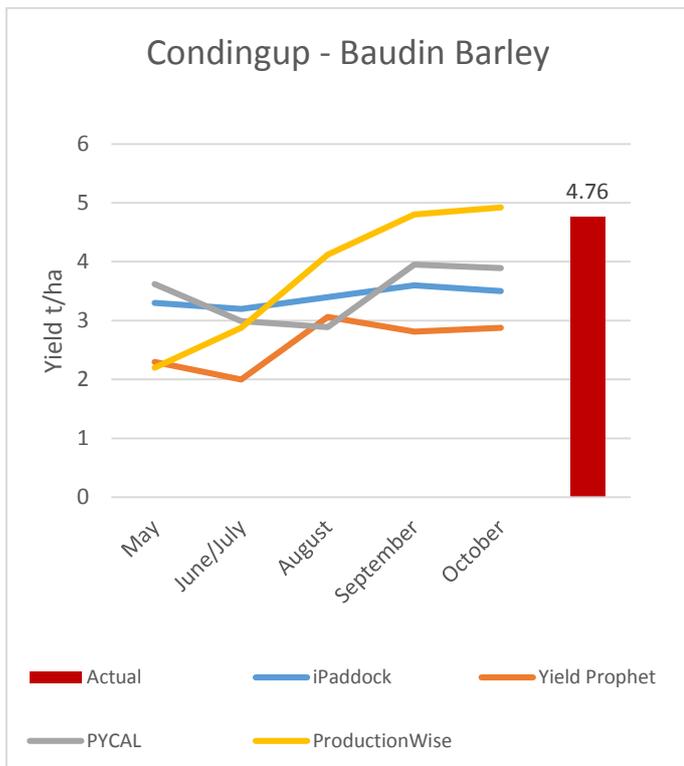


**Figure 3. Likelihood of surveyed growers to adjust seasonal inputs based on information from a seasonal prediction tool (n=84).**

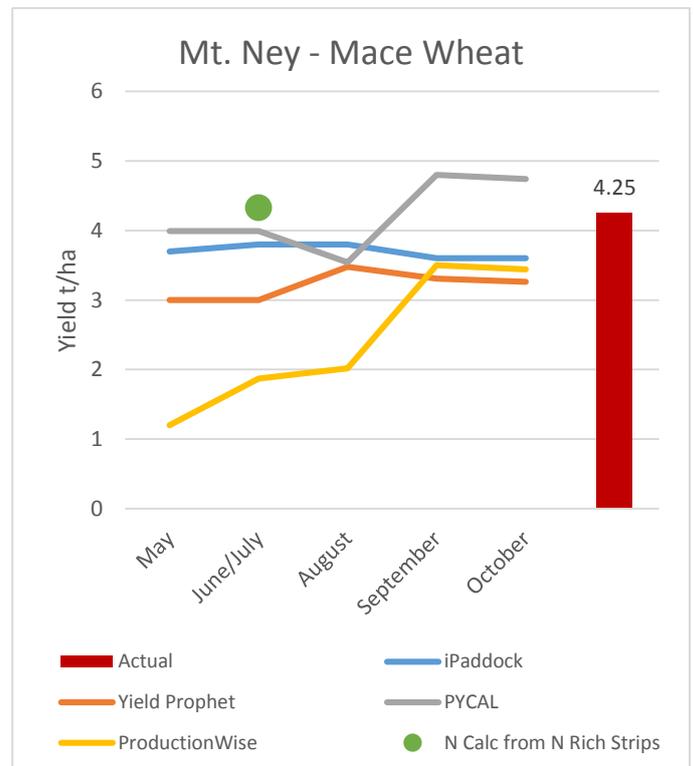
When asked to rate from 1 (low) to 5 (high) how willing the respondents would be to adjust inputs based on a yield or seasonal prediction tool, 1% said 1, 2% said 2, 36% were unsure, 45% said 4 and 15% rated it a 5, saying they would be very likely to adjust.

#### Prediction Tool Results

Throughout the season, predictions varied because of their differing models used. Consequently, different models were better at predicting yield for different sites.



**Figure 4. 2015 yield predictions of various tools compared to the actual result of 4.76t/ha with between 11.5-12% protein for Baudin Barley grown at Condungup. Condungup last iPaddockYield prediction was 3.5 +/- (0.5).**



**Figure 5. 2015 yield predictions of various tools compared to the actual result of 4.25t/ha with 9% protein for Mace Wheat grown at Mt. Ney. Mt. Ney last iPaddockYield prediction was 3.6 +/- (0.6).**

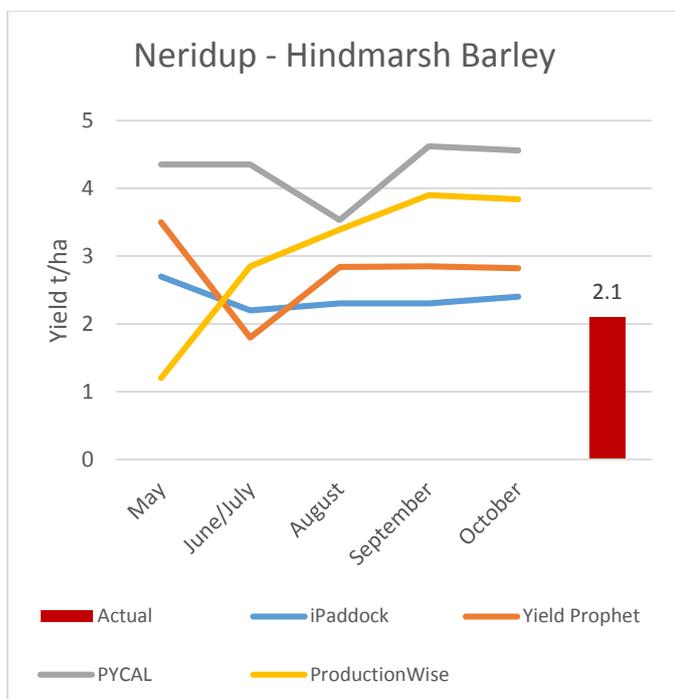


Figure 6. 2015 yield predictions of various tools compared to the actual result of 2.1t/ha with 9.8% protein for Hindmarsh Barley grown at Neridup. Neridup last iPaddockYield prediction was 2.4 +/- (0.4).

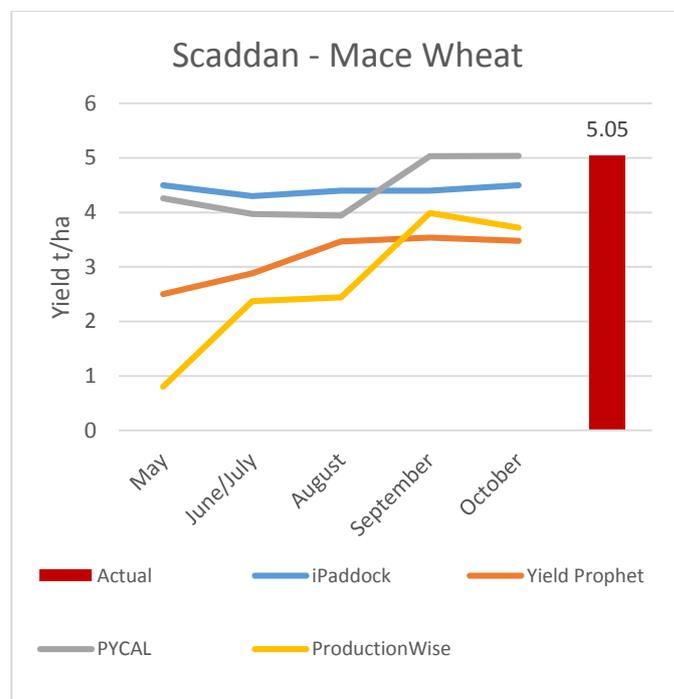


Figure 7. 2015 yield predictions of various tools compared to the actual result of 5.05t/ha with between 9.2%-9.5% protein for Mace Wheat grown at Scaddan. Scaddan last iPaddockYield prediction was 4.5 +/- (0.2).

### N-Rich Strips

Table 2. Nitrogen application and nitrogen rich strip reading at the four focus paddocks.

Location	Nitrogen sowing at	N-Rich Strip	Paddock Reading	N Calculator	Nitrogen Top Up	Second Top Up
Condingup	50 units (combination of Urea & Agstar Copper)	Not a significant difference prior to top up			29kg N/ha (90 L of Flexi NS)	
Mt. Ney	70kg of Maps, 40kg of Urea	0.7	0.6	Estimated yield with decile 5 spring – <b>4.455t/ha</b> Nitrogen fertiliser requirement <b>10.5% protein - 23kgN/ha</b> <b>11.5% protein – 58 kgN/ha</b>	20kg N/ha (70L of Maxam Flow)	
Neridup	24kg/ha ammonium sulfate, 7 units K till	Not a significant difference prior to top up			13kg N/ha (40L of Flexi N)	8kg N/ha (20L of Flexi N)
Scaddan	60L of Flexi-N, 100kg of Agstar	No difference prior to top up			17kg N/ha (40L of Flexi N)	8kg N/ha (20L of Flexi N)

### How did growers feel about the season?

The four growers were also asked to rate the season three times; before seeding in April; in June/July when they were topping up their nitrogen and after harvest in December/January. These ratings can be seen in figure 5 below. In April, all growers were very happy about the current season as there was good sub-soil moisture (the lowest rating received was 7/10). The June/July ratings were also very positive as they had received some good rainfall and were happy to top up nitrogen knowing the profile was still relatively full. After harvest, three out of the four growers were positive, rating the season 9/10, 9/10 and 10/10. The one grower who was unhappy with the season, rating it a 4/10 after harvest, had received too much rainfall and his paddock had been waterlogged leading to high rye grass pressure and consequently lower yields.

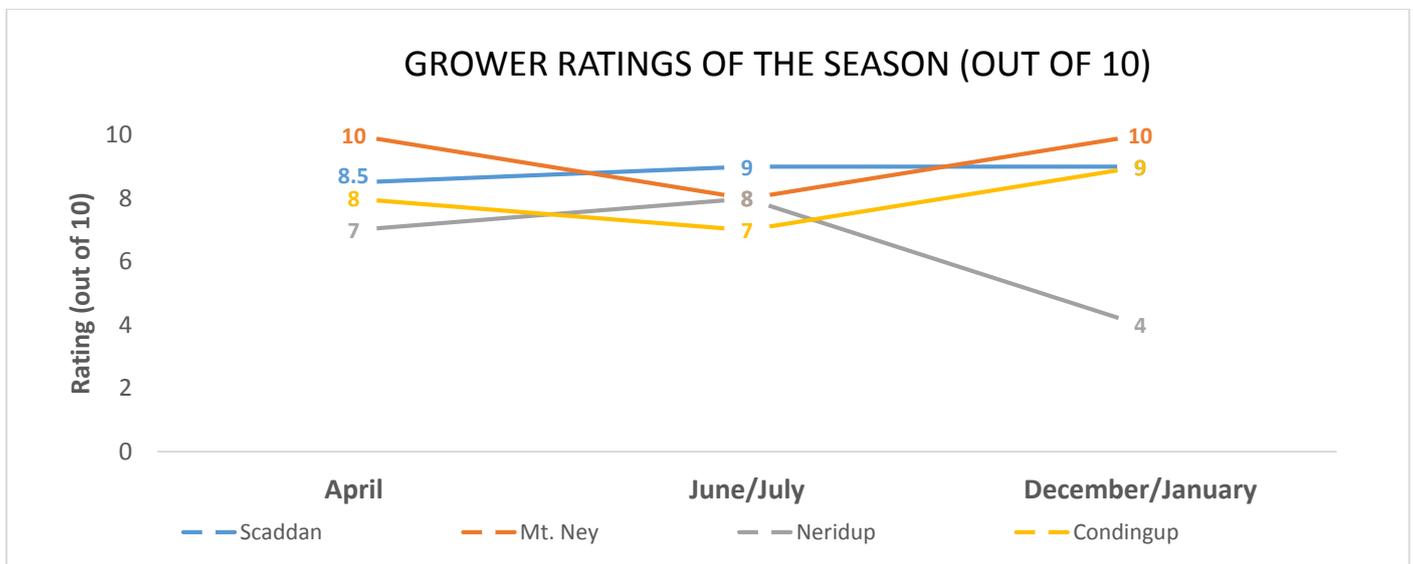


Figure 8. Host growers rating of the season taken in April, June/July and December.

## Discussion

### Survey Results

Survey results collected over the 2015 season display that Yield Prophet is the most widely known and tested tool among growers. This could potentially just show the age of the tool, as the newer tools ProductionWise and iPaddockYield have not been available for as long as Yield Prophet giving participants less time to be introduced to and try them.

Overall, 60% of growers rated their likeliness to adjust seasonal inputs based on information from a yield or seasonal prediction tool either a 4 or a 5 out of 5 (5 being highly likely). This demonstrates that there is a positive attitude towards using this information within farm businesses.

### Tool Results

The 2015 season brought above average yields to a lot of the port zone. The high rainfall caused waterlogging at the Neridup site as well as very high yields with diluted grain protein at Scaddan and Mt. Ney.

The tool which came the closest to predicting Baudin barley at Condingup was ProductionWise. PYCAL and iPaddockYield had the closest prediction for the Mace wheat at Scaddan and Mt. Ney. While iPaddockYield had the closest prediction for the Hindmarsh barley at Neridup. However, when asked which tool they liked the best and will continue to use, three growers said N-rich strips and one grower said iPaddockYield and N-rich strips, because of the simplicity.

One of the biggest factors to consider with all these tools is the level of human error they incur in set-up. The level of understanding the person setting up each tool has will directly impact on how accurately the model replicates the real world environment.

The simplicity of iPaddockYield, PYCAL and N-Rich Strips made their set-up process easy and growers had a good understanding of how these tools operated. All growers had calculated their potential yield using the PYCAL or the French and Shutz equation at some point in time and knew that this was based on rainfall being entered into an equation. N-Rich Strips were also used by all growers. These strips were implemented by their agronomist or fertiliser representative and used as an indicator for top-up nitrogen mid-season. iPaddockYield was also very simple to set up as the two requirements for the App were monthly rainfall data from the last ten years and corresponding average crop yield across the farm. All growers had readily available rainfall data and crop yields making the set-up time for iPaddockYield less than one hour. iPaddockYield graphs your crop yield with corresponding rainfall received to produce a curve that is unique to your management. However, some of the growers said their farm businesses had improved over the past decade, and therefore the curve was underestimating their potential yield in the current season.

Yield Prophet and ProductionWise required more information because they run off the APSIM model. Yield Prophet requires soil characterisation, soil test results, rainfall data, last year's yield, crop rooting depth and nitrogen, making it a much more sophisticated model. With this sophistication comes complexity. Precision Agronomics Australia (PAA), who have done extensive work using Yield Prophet, provided insight into the set-up process. They were currently running Yield Prophet on the same paddock we were setting-up and this allowed us to compare their inputted soil data

against ours. PAA had soil sample results as well as EM survey results allowing them to understand how certain characteristics of the soil varied spatially. Conversely, SEPWA only had four soil cores from 0-100cm which were averaged to get a general understanding of the entire paddock. Important decisions such as max rooting depth and soil characterisations were then decided on using the average of those four soil cores. Discrepancies in the soil cores being representative and determining actual rooting depth were possible sources in error for this.

ProductionWise did also contain the same level of complexity as Yield Prophet because of the APSIM model. Yet, the additional use of NDVI from satellite imagery was a positive for in-season updating. The Neridup paddock has a shallow sand over gravel over clay soil type which is prone to waterlogging and this was reflected in the ProductionWise Yield Forecast graph. As the soil profile filled up with moisture and water logged at the end of June, there was a decrease in biomass noted in the online prediction graph. By including the vegetation index from a NDVI calculation taken off satellite imagery, ProductionWise accounted for the water logging event via real time observations. It must also be noted that ProductionWise offered a lot more than a yield prediction service. ProductionWise offers the ability to not only predict yield throughout the season, but also create farm maps and run gross margin analysis. This combined package makes for quite a powerful tool. SEPWA ran the gross margin analysis using contractor rates and a fixed spraying rate over the four properties in 2015, appendix 1. Using the consistent rates allowed for easy comparison of the four properties as their varying factors are location, price and crop variety. This project was not looking for tools to analyse gross margins but the ProductionWise program has made for an easy end of season business comparison, which must be appreciated as extremely useful.

## **Conclusion**

The project has shown the complexity involved in trying to predict yield and these complexities can cause misunderstanding as well as lower confidence within the tools. The simple tools, iPaddockYield, N Rich Strips and PYCAL, are easy to set up and understand, while the more complex tools, ProductionWise and Yield Prophet, require assistance and a higher level of time investment. At the end of the project we found that the simple tools are grower tools while the more complex ones are consultant tools, or at least require consultant and grower collaboration for a reliable and robust set-up.

## **Key words**

iPaddockYield, Yield Prophet, ProductionWise, N Rich Strips, PYCAL

## **Acknowledgments**

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## Appendix 1. ProductionWise Gross Margin Analysis of 2015

The following four gross margins have been produced using contractor rates and fixed spraying rates of:

<i>Spray Detail</i>	<i>Cost</i>
Summer spray 1	\$18.95
Summer spray 2	\$17.08
Pre-EM Knock Down	\$15.98
Double Knock	\$21.25
Post emergence spray	\$13.37

### *Mt. Ney - Mace Wheat*

<i>Crop</i>	Mace Wheat	Start Date	14/01/2015					
<i>Sowing Area</i>	329.53 ha	End Date	2/11/2015					
<i>Income</i>	Date Occurred	Yield	Yield Source		Price	Per ha	Area (ha)	Total
<i>Grain Harvest</i>	2/11/2015	4.25 t/ha	My Paddocks		\$260.00 /t	\$1,105.00	329.53	\$364,135.07
<i>Forage Harvest</i>		0.00 t/ha			\$0.00 /t	\$0.00	329.53	\$0.00
<i>Grazing</i>		0.00 lwt kg/ha			\$0.00 /lwt kg	\$0.00	329.53	\$0.00
<i>Operation</i>	Date Occurred				Performed By	Cost Per ha	Area (ha)	Total Cost
<i>Spraying</i>	14/01/2015					\$18.95	329.53	\$6,244.67
<i>Spraying</i>	17/03/2015					\$17.08	329.53	\$5,628.44
<i>Spraying</i>	15/04/2015					\$15.98	329.53	\$5,265.95
<i>Soil Test</i>	17/04/2015				Contractor	\$0.00	329.53	\$0.00
<i>Spraying</i>	22/04/2015					\$21.25	329.53	\$7,002.60
<i>Sowing</i>	2/05/2015				Farm Employee	\$42.50	329.53	\$14,005.20
<i>Fertiliser Application</i>	27/06/2015				Farm Employee	\$10.00	329.53	\$3,295.34
<i>Spraying</i>	9/09/2015					\$13.37	329.53	\$4,405.87
<i>Grain Harvest</i>	2/11/2015				Farm Employee	\$50.00	329.53	\$16,476.70
<i>Input</i>	Date Occurred	Product	Rate/ha	Unit	Cost Per Unit	Cost Per ha	Area (ha)	Total Cost
<i>Fertiliser</i>	2/05/2015	Urea Granular	47	kg/ha	\$0.56	\$26.32	329.53	\$8,673.33
<i>Seed</i>	2/05/2015	Mace	70	kg/ha	\$0.30	\$21.00	329.53	\$6,920.21
<i>Fertiliser</i>	27/06/2015	Maxam-flo	70	L/ha	\$1.10	\$77.00	329.53	\$25,374.12
<i>Total Income</i>						\$1,105.00	329.53	\$364,135.07
<i>Cost of Production</i>						\$313.45	329.53	\$103,292.43
<i>Gross Margin</i>						\$791.55	329.53	\$260,842.64

**Condingup - Baudin Barley**

<i>Crop</i>	Baudin Barley	Start Date	14/01/2015					
<i>Sowing Area</i>	163.65 ha	End Date	5/12/2015					
<i>Income</i>	Date Occurred	Yield	Yield Source		Price	Per ha	Area (ha)	Total
<i>Grain Harvest</i>	5/12/2015	4.95 t/ha	My Paddocks		\$270.00 /t	\$1,336.50	163.65	\$218,711.54
<i>Forage Harvest</i>		0.00 t/ha			\$0.00 /t	\$0.00	163.65	\$0.00
<i>Grazing</i>		0.00 lwt kg/ha			\$0.00 /lwt kg	\$0.00	163.65	\$0.00
<i>Operation</i>	Date Occurred				Performed By	Cost Per ha	Area (ha)	Total Cost
<i>Spraying</i>	14/01/2015					\$18.95	163.65	\$3,101.07
<i>Spraying</i>	18/03/2015					\$17.08	163.65	\$2,795.06
<i>Spraying</i>	15/04/2015					\$15.98	163.65	\$2,615.05
<i>Spraying</i>	22/04/2015					\$21.25	163.65	\$3,477.46
<i>Soil Test</i>	23/04/2015				Contractor	\$0.00	163.65	\$0.00
<i>Sowing</i>	11/05/2015				Farm Employee	\$42.50	163.65	\$6,954.91
<i>Fertiliser Application</i>	2/07/2015				Farm Employee	\$10.00	163.65	\$1,636.45
<i>Spraying</i>	9/09/2015					\$13.37	163.65	\$2,187.93
<i>Grain Harvest</i>	5/12/2015				Contractor	\$50.00	163.65	\$8,182.25
<i>Input</i>	Date Occurred	Product	Rate/ha	Unit	Cost Per Unit	Cost Per ha	Area (ha)	Total Cost
<i>Fertiliser</i>	11/05/2015	Agstar Copper	92	kg/ha	\$0.86	\$79.12	163.65	\$12,947.59
<i>Fertiliser</i>	11/05/2015	Urea Granular	40	kg/ha	\$0.56	\$22.40	163.65	\$3,665.65
<i>Seed</i>	11/05/2015	Baudin	60	kg/ha	\$0.35	\$21.00	163.65	\$3,436.55
<i>Fertiliser</i>	2/07/2015	Flexi-Ns	90	L/ha	\$0.33	\$29.70	163.65	\$4,860.26
<i>Total Income</i>						\$1,336.50	163.65	\$218,711.54
<i>Cost of Production</i>						\$341.35	163.65	\$55,860.22
<i>Gross Margin</i>						\$995.15	163.65	\$162,851.32

**Neridup - Hindmarsh Barley**

<i>Crop</i>	Hindmarsh Barley	Start Date	14/01/2015					
<i>Sowing Area</i>	103.00 ha	End Date	11/11/2015					
<i>Income</i>	Date Occurred	Yield	Yield Source		Price	Per ha	Area (ha)	Total
<i>Grain Harvest</i>	11/11/2015	2.10 t/ha	My Paddocks		\$220.00 /t	\$462.00	103	\$47,585.08
<i>Forage Harvest</i>		0.00 t/ha			\$0.00 /t	\$0.00	103	\$0.00
<i>Grazing</i>		0.00 lwt kg/ha			\$0.00 /lwt kg	\$0.00	103	\$0.00
<i>Operation</i>	Date Occurred				Performed By	Cost Per ha	Area (ha)	Total Cost
<i>Spraying</i>	14/01/2015					\$18.95	103	\$1,951.81
<i>Spraying</i>	18/03/2015					\$17.08	103	\$1,759.21
<i>Spraying</i>	15/04/2015					\$15.98	103	\$1,645.91
<i>Soil Test</i>	17/04/2015				Contractor	\$0.00	103	\$0.00
<i>Spraying</i>	22/04/2015					\$21.25	103	\$2,188.71
<i>Sowing</i>	16/05/2015				Farm Employee	\$42.50	103	\$4,377.42
<i>Fertiliser Application</i>	22/07/2015				Farm Employee	\$10.00	103	\$1,029.98
<i>Fertiliser Application</i>	26/08/2015					\$9.00	103	\$926.98
<i>Spraying</i>	16/09/2015					\$13.37	103	\$1,377.08
<i>Grain Harvest</i>	11/11/2015					\$50.00	103	\$5,149.90
<i>Input</i>	Date Occurred	Product	Rate/ha	Unit	Cost Per Unit	Cost Per ha	Area (ha)	Total Cost
<i>Fertiliser</i>	16/05/2015	Urea Granular	30	kg/ha	\$0.56	\$16.80	103	\$1,730.37
<i>Seed</i>	16/05/2015	Hindmarsh	70	kg/ha	\$0.35	\$24.50	103	\$2,523.45
<i>Fertiliser</i>	22/07/2015	Flexi-N	40	L/ha	\$1.48	\$59.20	103	\$6,097.48
<i>Fertiliser</i>	26/08/2015	Flexi-N	20	L/ha	\$1.48	\$29.60	103	\$3,048.74
<i>Total Income</i>						\$462.00	103	\$47,585.08
<i>Cost of Production</i>						\$328.23	103	\$33,807.03
<i>Gross Margin</i>						\$133.77	103	\$13,778.04

**Scaddan - Mace Wheat**

<i>Crop</i>	Mace Wheat	Start Date	14/01/2015					
<i>Sowing Area</i>	322.91 ha	End Date	3/12/2015					
<i>Income</i>	Date Occurred	Yield	Yield Source	Price	Per ha	Area (ha)	Total	
<i>Grain Harvest</i>	3/12/2015	5.05 t/ha	My Paddocks	\$260.00 /t	\$1,313.00	322.91	\$423,978.20	
<i>Forage Harvest</i>		0.00 t/ha		\$0.00 /t	\$0.00	322.91	\$0.00	
<i>Grazing</i>		0.00 lwt kg/ha		\$0.00 /lwt kg	\$0.00	322.91	\$0.00	
<i>Operation</i>	Date Occurred			Performed By	Cost Per ha	Area (ha)	Total Cost	
<i>Spraying</i>	14/01/2015				\$18.95	322.91	\$6,119.11	
<i>Spraying</i>	18/03/2015				\$17.08	322.91	\$5,515.27	
<i>Soil Test</i>	14/04/2015			Contractor	\$0.00	322.91	\$0.00	
<i>Spraying</i>	15/04/2015				\$15.98	322.91	\$5,160.07	
<i>Spraying</i>	22/04/2015				\$21.25	322.91	\$6,861.80	
<i>Sowing</i>	8/05/2015				\$42.50	322.91	\$13,723.59	
<i>Fertiliser Application</i>	1/07/2015			Farm Employee	\$10.00	322.91	\$3,229.08	
<i>Spraying</i>	15/07/2015				\$13.37	322.91	\$4,317.28	
<i>Fertiliser Application</i>	12/08/2015				\$10.00	322.91	\$3,229.08	
<i>Grain Harvest</i>	3/12/2015			Farm Employee	\$50.00	322.91	\$16,145.40	
<i>Input</i>	Date Occurred	Product	Rate/ha	Unit	Cost Per Unit	Cost Per ha	Area (ha)	Total Cost
<i>Fertiliser</i>	8/05/2015	Flexi-N	60	L/ha	\$1.48	\$88.80	322.91	\$28,674.23
<i>Fertiliser</i>	8/05/2015	Agstar	100	kg/ha	\$0.86	\$86.00	322.91	\$27,770.09
<i>Seed</i>	8/05/2015	Mace	80	kg/ha	\$0.30	\$24.00	322.91	\$7,749.79
<i>Fertiliser</i>	1/07/2015	Flexi-N	40	L/ha	\$1.48	\$59.20	322.91	\$19,116.15
<i>Fertiliser</i>	12/08/2015	Flexi-N	20	L/ha	\$1.48	\$29.60	322.91	\$9,558.08
<i>Total Income</i>						\$1,313.00	322.91	\$423,978.20
<i>Cost of Production</i>						\$486.73	322.91	\$157,169.01
<i>Gross Margin</i>						\$826.27	322.91	\$266,809.19