



# Yield Prophet 2014

VOLUME I REPORT I

JULY 2014

The Liebe Group would like to thank their Diamond sponsors for their ongoing support.



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## The sites being modelled in 2014 are:

- Red deep loamy duplex (Jibberding No. 956) - Keith Carter - east Wubin
- Acid sandy earth (Jibberding No. 955) - Keith Carter - east Wubin
- Red deep loamy duplex (Goodlands No. 147) - Doug Cail - Goodlands
- Yellow Deep Sand (Buntine No. 613-YP) - Mike Dodd - west Buntine

## KEY FINDINGS:

- Rainfall is currently limiting, need a big rain event to push the yield potential of the crops.
- All crops have sufficient nitrogen to support expected yields.
- On the red deep loamy duplex at East Wubin, salinity maybe a limiting factor for root depth.
- Dr Fiona Evan's (DAFWA) statistical seasonal forecast model is showing that July to September 2014, has a normal to below normal rainfall outlook for most of the south-west of WA, with decile 2 to 3 rainfall most probable over much of the Wheatbelt. See below link:- <https://www.agric.wa.gov.au/newsletters/sco>

## HOW IT WORKS

Yield Prophet is a web based interface for the agricultural production simulation model (APSIM). It uses real-time information from the paddock to simulate how the crop is growing. By using historical rainfall records it can determine probabilities of how a crop may yield.

This provides a forecast of the chance of achieving a certain yield at any point in time during the season. From this we can match inputs to these yield potentials. The accuracy of the forecasts depends highly on the soil type characterisation. The model does have limitations (it cant model weeds and diseases) and the information presented is designed to only be used as a guide to help understand soil water and Nitrogen dynamics.

The model is based on a well managed crop and therefore is a useful indicator of yield potential given soil water and inputs.

## TERMINOLOGY

The following terms are often used in the Yield Prophet reports:

**Plant Available Water (PAW)** - Amount of water that is potentially available to the plant (shaded area).

**Soil Plant Available Water (Soil PAW)** - Same as PAW.

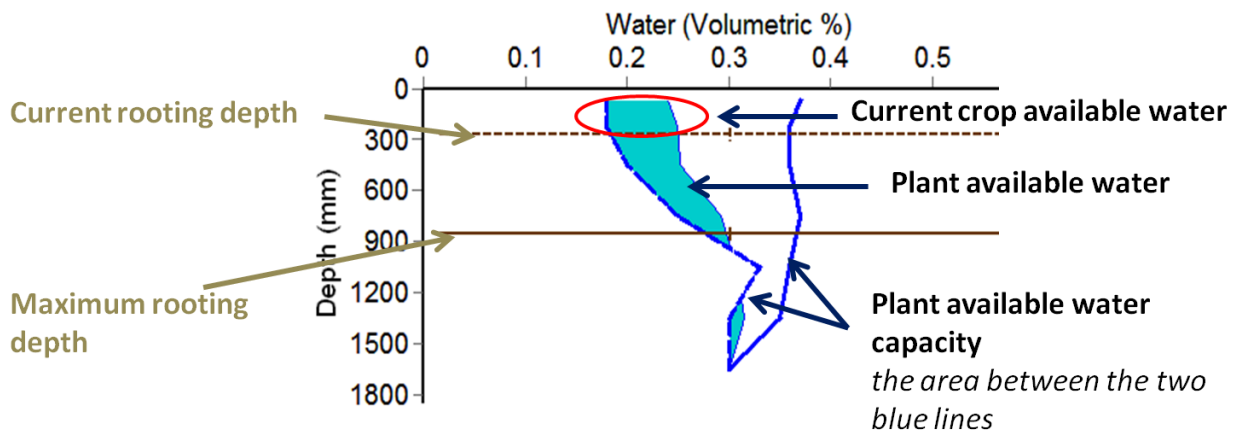
**Current Crop Plant Available Water (PAW)** - The soil water currently accessible to the roots determined by the current rooting depth.

**Crop Lower Limit (CLL)** - the amount of water remaining after a particular crop has extracted all the water available to it from the soil.

**Drained Upper Limit (DUL)** - Amount of water the soil is able to hold after drainage has finished.

**Plant Available Water Capacity (PAWC)** - The difference between the upper water storage limit of the soil (DUL) and the lower extraction limit of the crop, also know as the size of the bucket.

## EXAMPLE



## RAINFALL FOR YIELD PROPHET SITES 2014

Year	2014	2013	2014	2013	2014	2013	2014	2013	2014
Site	Year to Date	April	April	May	May	June	June	July	July
Keith Carter, Wubin (Red Deep Loamy Duplex)	122.5	0	36.5	31.5	38	2.5	28	39	36
Keith Carter, Wubin (Acid Sandy Earth )	122.5	0	36.5	31.5	38	2.5	28	39.5	36
Doug Cail, Goodlands	165.4	6	39	32.8	39.8	7.2	17	33	40.2
Mike Dodd, Buntine	122.5		22.5	44	43.5		24	30	29.5

## SITE DESCRIPTION

**Farmer:** Doug Cail

**Location:** Goodlands

### Soil

**Characterisation:**

Red deep loamy duplex

### Accumulated

**Rainfall 2014:**

187.8mm

### Plant Available

**Water Capacity (size of bucket):** 120mm

### Total water

**available:** 27mm

### Current water

**available to roots:** 25mm

### Total Nitrogen

**Status:** 125kg/ha

## CROP DETAILS

**Sowing date:** 11 May

**Crop Type:** Wheat

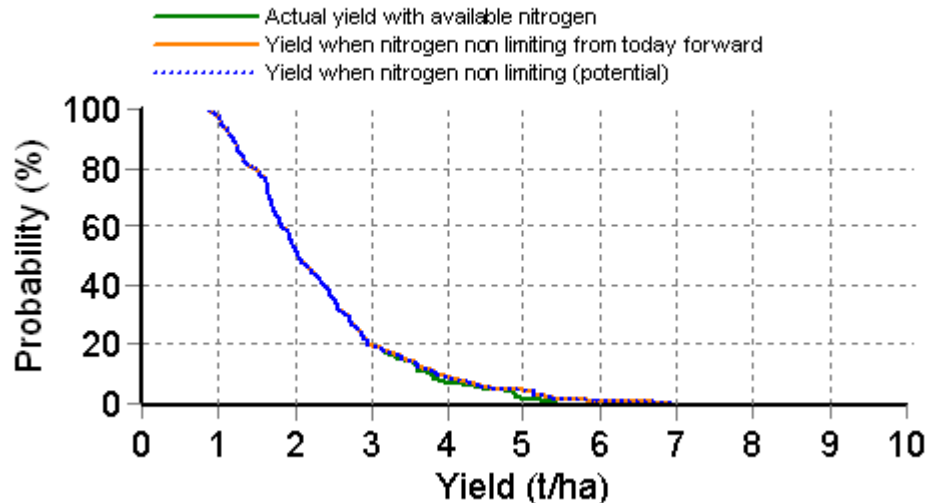
**Variety:** Mace

**Fertiliser:** 25 kg/ha  
MAPSZC & 20 kg/ha  
UREA

# RED DEEP LOAMY DUPLEX AT GOODLANDS

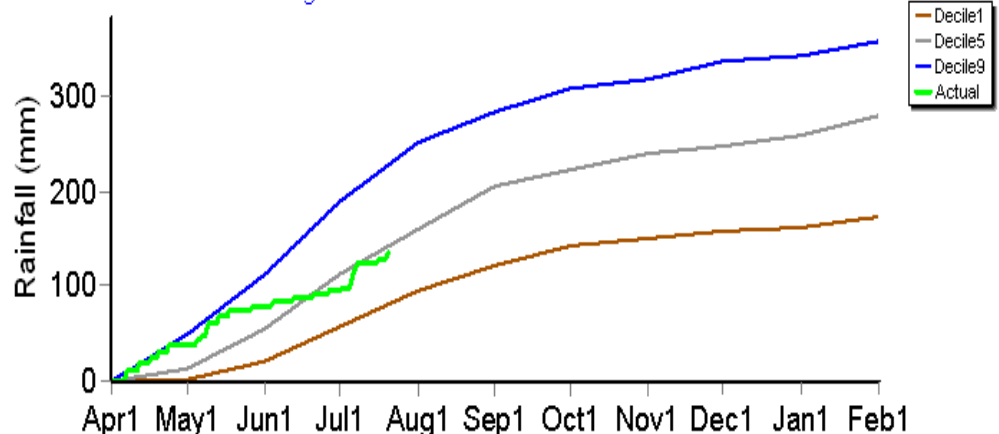
**How to interpret this graph:** Figure 1 shows the probability of achieving a particular yield. The green line is the achievable yield from current nitrogen in the soil whereas the blue line is achievable yield if nitrogen was not limiting. An 80% probability is the yield achieved in the last 20 lowest years out of the last 100 seasons. For the red deep loamy duplex at Goodland's there is an 80% chance of a 1.6 t/ha.

### Grain Yield Outcome



**Figure 1:** Predicted grain yield for red deep loamy duplex at Goodland's on 23rd of July depending on nitrogen. Predicted grain yield with the current available nitrogen (green), the predicted yield if nitrogen is non limiting from this day forward (orange) and the potential yield when nitrogen is completely non limiting (blue).

### The Season So Far - Growing Season Rainfall Deciles



**Figure 2:** Rainfall to date for Goodland's (green line) compared with historic records.

Decile 1 (brown line) is the lowest 10% of annual rainfalls ever recorded.

Decile 9 (blue line) is the highest 20% of annual rainfalls ever recorded.

Although the year's rain events started off well you can see in Figure 2 that there has been long periods between events which has influenced the models low yield predictions.

**RED DEEP LOAMY  
DUPLEX AT  
GOODLAND'S**

**Plant Available Water Capacity (size of bucket): 120mm**

**Total water available: 27mm**

**Current water available to roots: 25mm**

**Current rooting depth: 680mm**

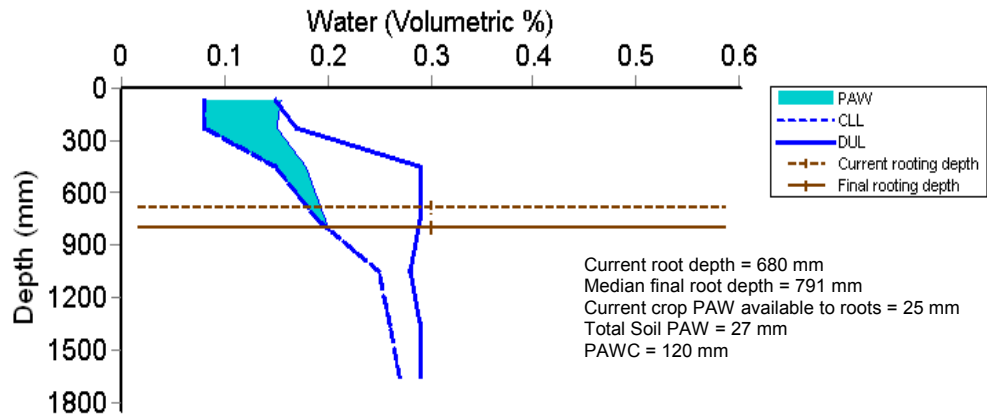
**Current Crop Available Nitrogen Status: 69kg/ha**

## SOIL WATER AT GOODLANDS

What is the water stress threshold? When the soil is holding less than one third of its capacity (the bucket is less than one third full) the roots find it difficult to extract water and start to become stressed. Our crop has 6mm available to it before the roots become stressed. The model tells us that the plant at the late tillering stage uses 1.4mm of water per day and 0.5mm of water evaporates in the sun (table not presented).

Using this calculation the plant will become stressed if it does not receive extra rain in 3 days.

Current Distribution of PAW



PAW= Plant Available Water  
CLL= Crop Lower Limit or Wilting Point  
DUL= Drained Upper Limit or Field Capacity  
PAWC= Plant Available Water Capacity  
Current Crop PAW= Soil water currently accessible to the roots down to the current rooting depth  
Soil PAW = Total accessible soil water in the soil profile.

**Figure 3:** Soil water budget on red deep loamy duplex at Goodland's as of 23rd of July.

## SOIL NITROGEN AT GOODLANDS

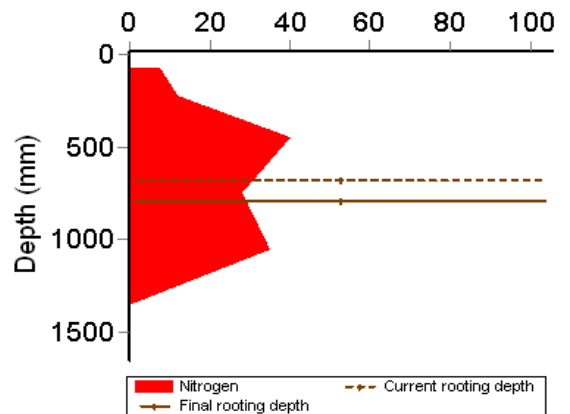
This soil has a total of 125 kg/ha of nitrogen present and the roots are currently accessing 69 kg/ha of nitrogen. A lot of nitrogen is located deep on the soil out of reach of the roots but even so nitrogen is not currently limiting on this site. Currently crop N use is 2.3 kg/ha per day, so there will be no N stress to the crop for another 30 days. Last year the paddock was in clover pasture which could account for the nitrogen fixing.

### Nitrogen Budget

Initial N status @ 15-May	229 kg/ha
N mineralisation since 15-May	0 kg/ha
N tie up since 15-May	8 kg/ha
N applications :	kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
Total N in plant	96 kg/ha
De-nitrification since 15-May	0 kg/ha
Leaching	0 kg/ha

**Current N status: 125kg/ha**

Current distribution of soil nitrogen (kg/ha)



**Current Crop Available N = 69 kg/ha**  
**Total Soil N = 125 kg/ha**

**Figure 4:** Soil nitrogen budget on red deep loamy duplex as of 23rd of July.

**SITE DESCRIPTION**

**Farmer:** Keith Carter

**Location:** East Wubin

**Soil**

**Characterisation:**

Red loamy duplex

**Accumulated**

**Rainfall 2014:**

138.5mm

**Plant Available**

**Water Capacity (size of bucket):** 138mm

**Total water**

**available:** 16mm

**Current water**

**available to roots:** 15mm

**Total Nitrogen**

**Status:** 389 kg/ha

**CROP DETAILS**

**Sowing date:** 8 June

**Crop type:** Wheat

**Variety:** Calingiri

**Fertiliser:** Agstar extra 40 kg/ha

Flexi N 50.9 L/ha

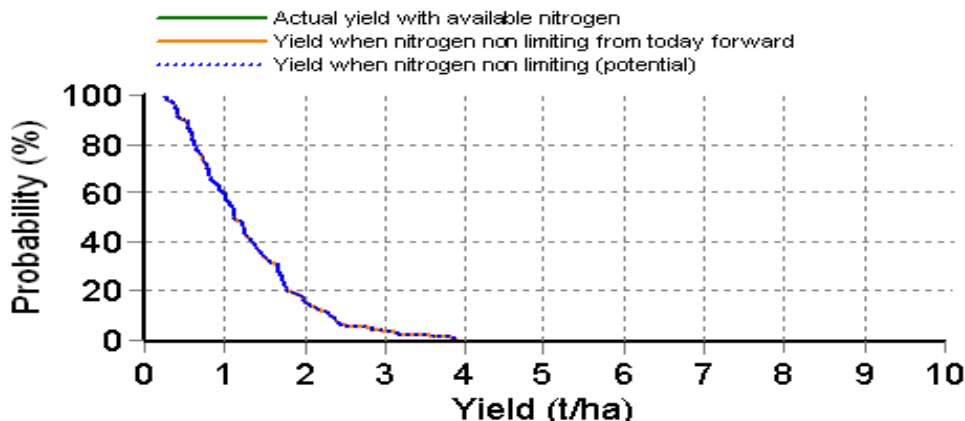
**Top up Fertiliser:**

Flexi N 40 L/ha

**RED LOAMY DUPLEX AT WUBIN**

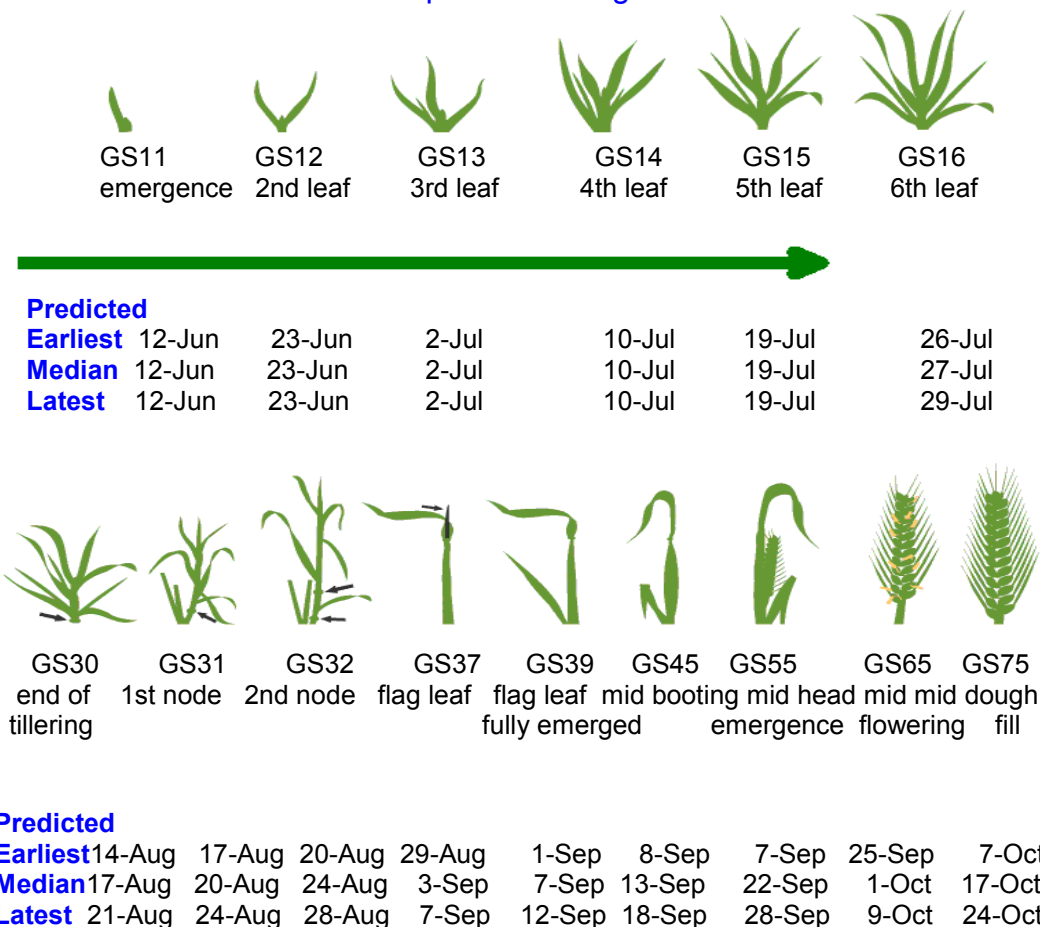
The graph below indicates there is a 80% chance of obtaining a 0.6 t/ha yield and as you can see in Figure 8 that nitrogen is not limiting. In the initial soil results from this paddock the Electrical Conductivity in the 40 - 120cm depth ranges from moderate to high which could suggest that one of the factors limiting the roots access to water and nitrogen is salinity.

**Grain Yield Outcome**



**Figure 5:** Predicted grain yield for a red loamy duplex at Wubin on 23rd July 2014. The green line is yield probabilities given current nitrogen applied where as the blue line in yield if nitrogen was unlimited.

**Simulated and Predicted Crop Growth Stage**



**Figure 6:** Predicted growth stage based on historical weather information for Wubin and growth patterns of a mid season wheat.

**RED LOAMY DUPLEX  
AT WUBIN**

**Plant Available Water  
Capacity (size of  
bucket): 138mm**

**Total water available:  
16mm**

**Current water  
available to roots:  
15mm**

**Current rooting  
depth: 394mm**

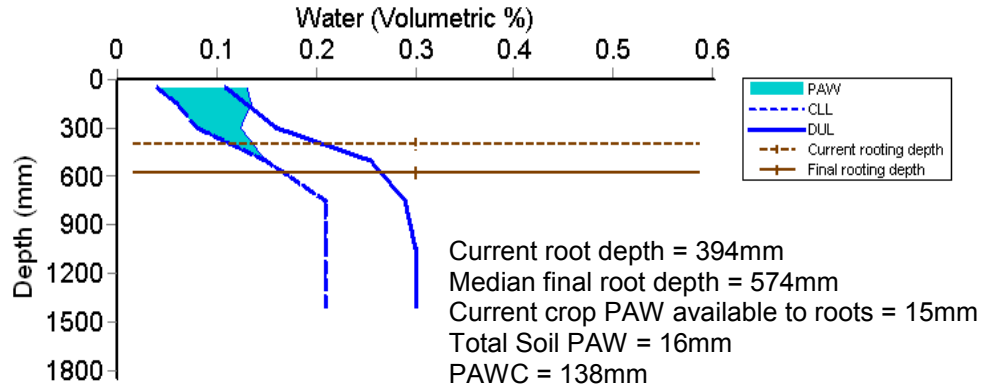
**Current Crop  
Available Nitrogen  
Status: 201 kg/ha**

**SOIL WATER AT WUBIN**

The roots currently have access to 15mm of water and are using 0.6mm of water per day. The model predicts that 1.1mm of water is evaporating per day due to the weather conditions.

The crop will soon grow into an area with little stored water as indicated by the shaded blue area in the graph below and unless we have further rain will become stressed due to lack of water.

Current Distribution of PAW



- PAW**= Plant Available Water
- CLL**= Crop Lower Limit or Wilting Point
- DUL**= Drained Upper Limit or Field Capacity
- PAWC**= Plant Available Water Capacity
- Current Crop PAW**= Soil water currently accessible to the roots down to the current rooting depth
- Soil PAW** = Total accessible soil water in the soil profile

**Figure 7:** Soil water budget on red loamy duplex at Wubin as of 23rd of July. The shaded blue area indicated water currently stored in the soil.

**SOIL NITROGEN AT WUBIN**

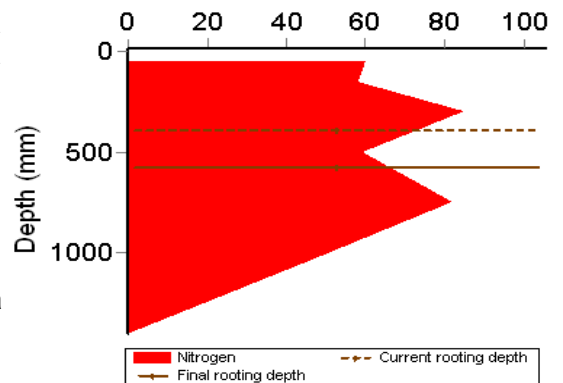
This soil has a total of 389kg/ha of nitrogen present and the roots are currently accessing 201 kg/ha of nitrogen.

At the beginning of the season the host farmer used 50.9 L/ha Flexi N and 40 kg/ha Agstar Extra. They have since added another 40 L/ha of Flexi N so nitrogen is not currently limiting at this site. No nitrogen tie up or leaching has occurred to date. Due to the rainfall to date there has been 3 kg/ha of N mineralisation adding to the nitrogen pool available to the crop.

**Nitrogen Budget**

Initial N status @ 19-May	328 kg/ha
N mineralisation since 19-May	3 kg/ha
N tie up since 19-May	0 kg/ha
N applications 8-Jun:	27 kg/ha
9-Jul:	53 kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
Total N in plant	23 kg/ha
De-nitrification since 19-May	0 kg/ha
Leaching	0 kg/ha

Current distribution of soil nitrogen (kg/ha)



**Current N status: 389 kg/ha**      **Current Crop Available N = 201 kg/ha**  
**Total Soil N = 389 kg/ha**

**Figure 8:** Soil nitrogen budget on red loamy duplex at Wubin as of 23rd of July. The shaded red area indicates nitrogen currently stored in the soil.

## SITE DESCRIPTION

**Farmer:** Keith Carter

**Location:** East Wubin

**Soil Characterisation:**  
Acid Sandy Earth

**Accumulated Rainfall  
2014:** 138.5mm

**Plant Available Water  
Capacity (Size of  
Bucket):** 142mm

**Total Water  
Available:** 29mm

**Current Water  
Available to Roots:**  
22mm

**Total Nitrogen  
Status:** 180 kg/ha

## Crop Details

**Sowing Date:** 28 May

**Crop Type:** Wheat

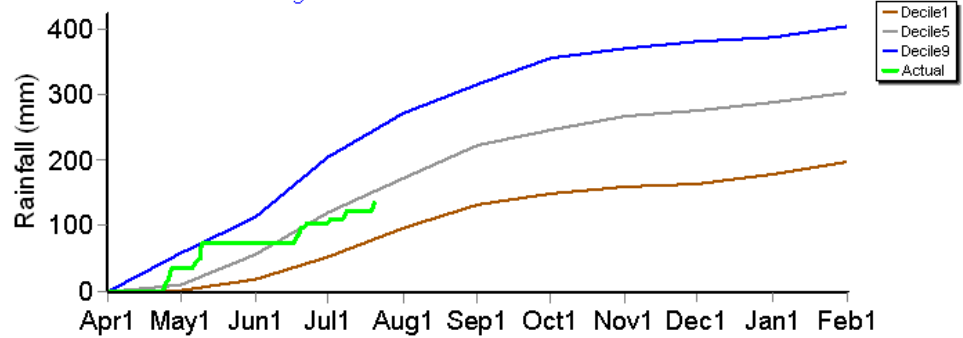
**Variety:** Corack

**Fertiliser:** 48.5 L/ha  
Flexi N & 40 kg/ha Ag  
Slow X-mop

# SOIL WATER AT EAST WUBIN

This site is tracking close to decile 5 at this stage.

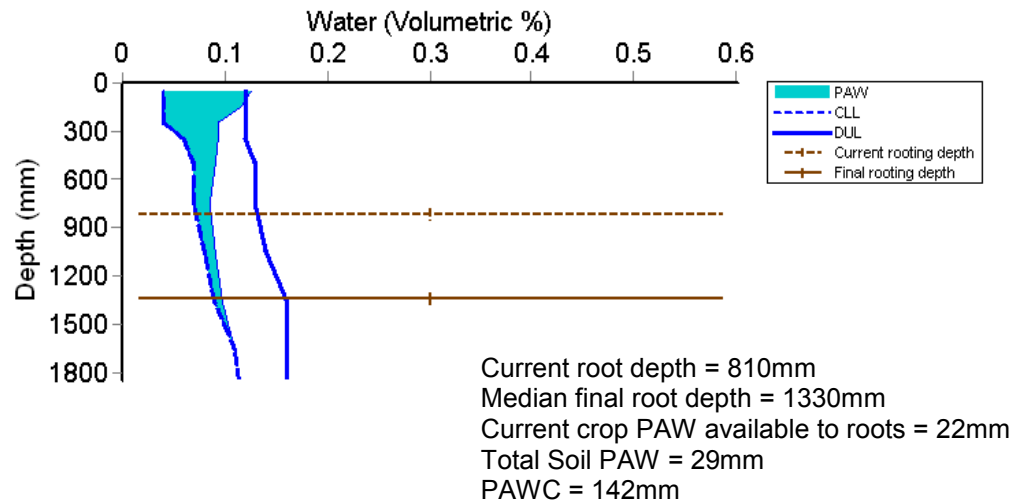
The Season So Far - Growing Season Rainfall Deciles



**Figure 9:** The rainfall to date for East Wubin (green line) compared to historic records. Decile 1 (brown line) is the lowest 10% of annual rains ever recorded. Decile 9 (blue line) is the highest 20% of annual rains ever recorded.

## Soil Water and Root Growth

Current Distribution of PAW



**Figure 10:** Soil water budget on acid sandy earth at Wubin as of 23rd of July. The shaded blue area indicated water currently stored in the soil.

According to the model the bucket is only 20% full. This is an acid sandy earth and so while the bucket fills up faster it also drains faster. This site requires a further 113mm of water to be considered full and currently has 22mm available to the crop.

# Soil Nitrogen at East Wubin

## ACID SANDY EARTH AT WUBIN

**Plant Available Water Capacity (size of bucket):** 142mm

**Total water available:** 29mm

**Current water available to roots:** 22mm

**Current rooting depth:** 810mm

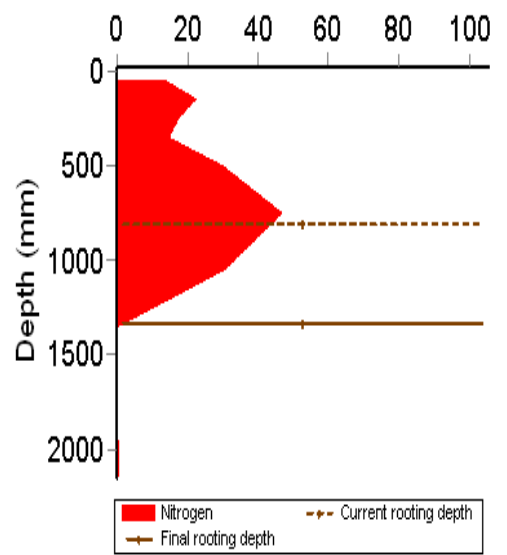
**Current Crop Available Nitrogen Status:** 132 kg/ha

## Nitrogen Budget

Initial N status @ 14-May	217 kg/ha
N mineralisation since 14-May	3 kg/ha
N tie up since 14-May	1 kg/ha
N applications 28-May:	20 kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
Total N in plant	59 kg/ha
De-nitrification since 14-May	0 kg/ha
Leaching	0 kg/ha

**Current N status:** 180 kg/ha

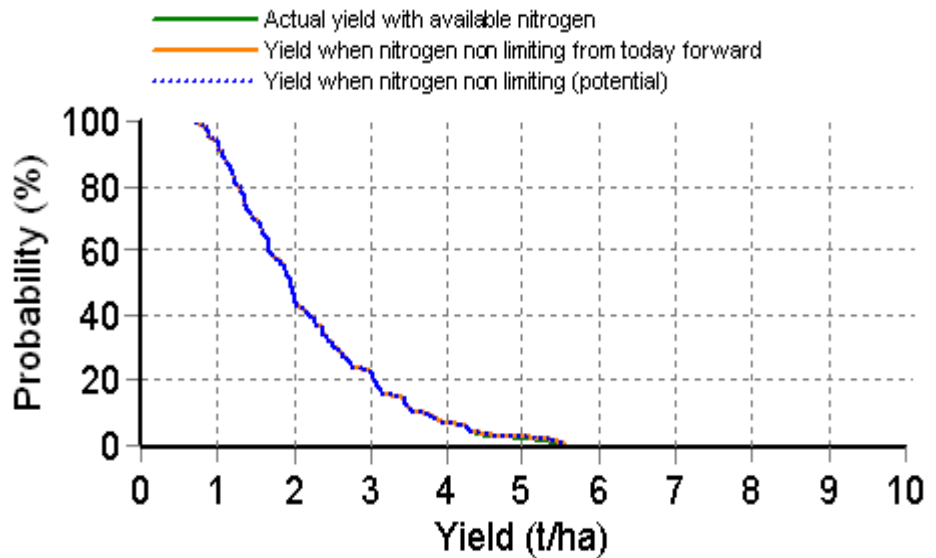
Current distribution of soil nitrogen (kg/ha)



**Current Crop Available N =** 132 kg/ha  
**Total Soil N =** 180 kg/ha

**Figure 11:** Soil nitrogen budget on acid sandy earth at East Wubin as of 23rd of July. The shaded red area indicates nitrogen currently stored in the soil.

## Grain Yield Outcome



**Figure 12:** Predicted grain yield for an acid sandy earth at East Wubin.



## SITE DESCRIPTION

**Farmer:** Mike Dodd

**Location:** Buntine  
Marchagee Rd, west  
Buntine

**Soil Characterisation:**  
Yellow deep sand

**Accumulated Rainfall  
2014:** 135.5mm

**Plant Available Water  
Capacity (size of  
bucket):** 136mm

**Total water  
available:** 29mm

**Current water available  
to roots:** 21mm

**Total Nitrogen Status:**  
101 kg/ha

## CROP DETAILS

**Sowing date:** 24 May

**Crop type:** Wheat

**Variety:** Corack

**Fertiliser Applications:**

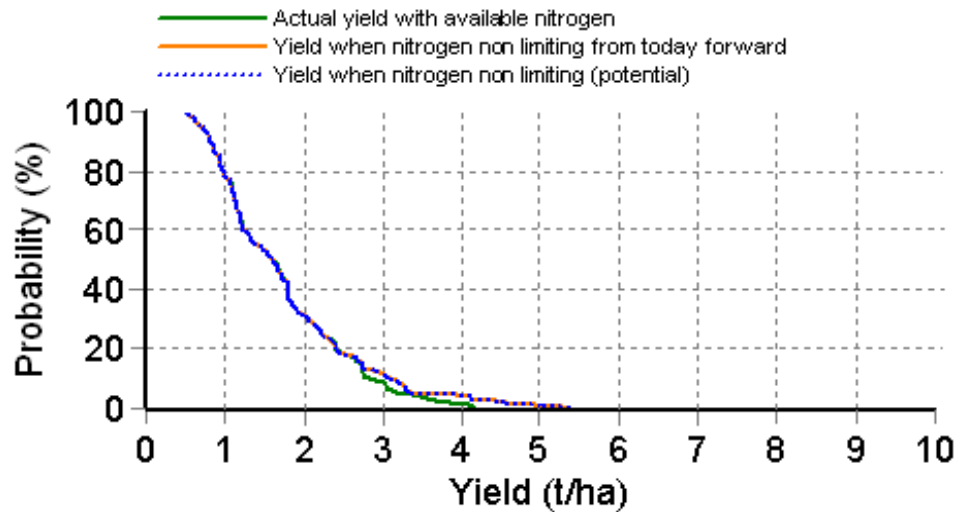
40 kg/ha Thumper Extra

20kg/ha muriate of  
potash

30 L/ha Flexi N

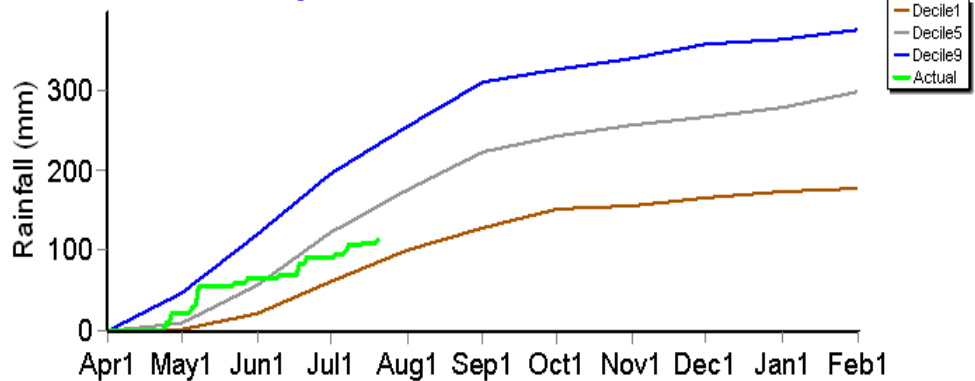
# YELLOW DEEP SAND AT BUNTINE

## Grain Yield Outcome



**Figure 13:** Yield outcome for unconstrained soil with rooting depth of 1.80m. Predicted grain yield with the current available nitrogen (green), the predicted yield if nitrogen is non limiting from this day forward (orange) and the potential yield when nitrogen is completely non limiting (blue). This graph shows the probability of exceeding a range of yield outcomes this season. It takes into account your pre-season soil moisture; the weather conditions so far; soil N and agronomic inputs. The long term record from your nominated weather station is then used to simulate what would have happened from this date on in each year of the climate record. The yield results are used to produce this graph.

## The Season So Far - Growing Season Rainfall Deciles



**Figure 14:** Rainfall to date for Buntine (green line) compared with historic records.

Decile 1 is the lowest 10% of annual rainfalls ever recorded.

Decile 9 is the highest 20% of annual rainfalls ever recorded.

As we can see from the above rainfall chart (Figure 14) the Buntine site has experienced no water stress, however it is lower than an average year (decile 5) and is currently tracking at a decile 3.

**YELLOW DEEP SAND AT BUNTINE**

**Plant Available Water Capacity (size of bucket): 136mm**

**Total water available: 29mm**

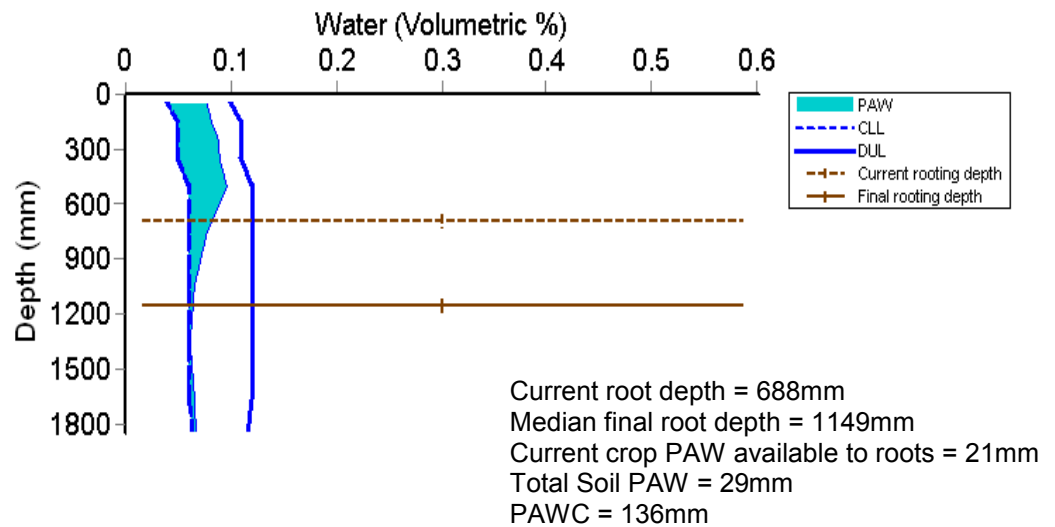
**Current water available to roots: 21mm**

**Current rooting depth: 688mm**

**Current Crop Available Nitrogen Status: 71 kg/ha**

**SOIL WATER AT BUNTINE**

Current Distribution of PAW



**Figure 15:** Brown line indicate maximum rooting depth. Dashed brown line indicated current rooting depth as of 23rd July. Shaded blue area is soil water.

Being a sand the profile fills the top first and then filters down. The rainfall to date has mostly filled the top of the profile to a rooting depth of 500mm but it drops off quite significantly lower down the profile. The crops roots are currently at a depth of 688mm and have 21mm of water available to them. The model predicts that 0.7mm of water is evaporating every day and that the crop is using 1.1mm of water per day.

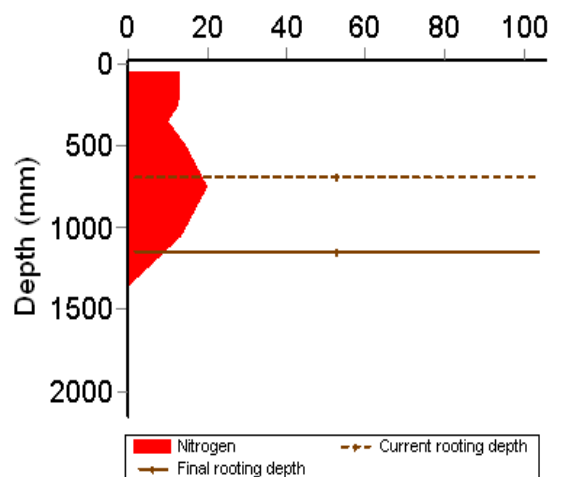
**Soil Nitrogen at Buntine**

**Nitrogen Budget**

Initial N status @ 14-May	166 kg/ha
N mineralisation since 14-May	1 kg/ha
N tie up since 14-May	15 kg/ha
N applications :	kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
	: kg/ha
Total N in plant	53 kg/ha
De-nitrification since 14-May	0 kg/ha
Leaching	0 kg/ha

**Current N status: 101 kg/ha**

Current distribution of soil nitrogen (kg/ha)



**Current Crop Available N = 71 kg/ha**  
**Total Soil N = 101 kg/ha**

**Figure 16:** Soil nitrogen budget on a yellow deep sand as of the 23rd July. Shaded red area is Nitrogen currently stored in the soil.

APSIM computer model created by



## CONCLUSION

The table below compares the daily water and nitrogen use of the plants given the current growth stage for the 23rd of July 2014. The difference in nitrogen use is likely to be due to the differences in crop growth. For example the yellow deep sand at Buntine will be at the end of tillering by the 9th of August while the red deep loamy duplex at Goodland's will be at flag leaf stage.

Soil/ Location	Growth stage	Daily evaporation (mm)	Daily water use (mm)	Daily N use (kg/ha)	N available to roots (kg/ha)
Red deep loamy duplex - Goodland's	32	0.5	1.5	2.3	60.9
Acid sandy earth - East Wubin	30	0.7	1.2	3.8	126.8
Red loamy duplex - East Wubin	16	1.1	0.6	2.6	194.1
Yellow sand - Buntine	16	0.7	1.1	3.9	61.7

With the season now into late July the rainfall is tracking from almost decile 9 to now being just below decile 5. The yield outcome will be determined by the follow up rains. Many of you will be making decisions on nitrogen based on your farms rainfall to date and is heavily influenced by your farms soil type as sandier soils are more forgiving with limited rainfall than clays. The heavier ground will not have a full a bucket of moisture and thus for the yields on this ground to be above those indicated we will need a very good finish to the season with no prolonged dry spells.

The soil type classification gives you a guide to plant available water and the plants rooting depth. There will be variation within many paddocks as soil type and subsoil constraints change. There are some major variations to stored soil nitrogen by soil type and rotation.

The availability of nitrogen to plants is finally determined by plant final rooting depth. Seasonal conditions will affect final plant root depth and the amount and timing of rainfall received over the length of the growing season. In the case of Doug Cail's red deep loamy duplex and Keith Carter's red loamy duplex a lot of nitrogen is stored below the final rooting depth.

Where your farm fits into the Yield Prophet sites and your local knowledge will still have a major affect on follow up nitrogen.

### ACKNOWLEDGEMENTS

CSIRO, the host farmers and Farmanco.