# Assessing the Water Use Efficiencies of high and low input wheat production systems

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**Aim**

In this project we aim to compare the water use efficiency (WUE) and profitability of high *versus* low input cropping systems. We have established trials in collaboration with three grower groups: The Liebe Group, the Mingenew-Irwin Group and North-East Farming Futures. The exact treatments differ between the three trials based on input from the grower groups. The treatments were designed to compare logical "packages" that may include deep ripping, fertilizer application rates, sowing rate, genotype and rotation. Supplementary treatments were included to allow the effects of some of the factors to be separated.

**Background**

Water is the ultimate limiting resource in our dryland cropping systems and yet little is known about how effectively we can manipulate water use and productivity in cropping systems beyond just the single crop. This project is part of a suite of activities funded by the GRDC to explore how we can optimize WUE. In this project, our approach is to compare treatments with high and low input levels and to monitor summer water storage and water carry over between seasons as well as WUE of the crops in the short (two year) rotations.

## Trial Details

| | |
|---|---|
| **Property** | Liebe Long Term Trial Site, West Buntine |
| **Plot size & replication** | 10m x 12m x 4 replicates |
| **Soil type** | Deep Yellow Sand |
| **Soil pH** (1:5 water) | 5.8 (10cm); 5.8 (60cm) |
| **EC** | 157 (10cm); 71 (60cm) |
| **Sowing date** | For wheat 2009: 12/6/09 |
| **Seeding rate** | As per treatment |
| **Fertiliser** | As per treatment |
| **Paddock rotation** | As per treatment |
| **Growing Season Rainfall** | 166mm (Buntine) |

**Treatments (Buntine)**

The Buntine trial has eight treatments; four 'systems' and four supplementary treatments. The systems are: lupin/wheat rotation with high inputs for the wheat (ripping, high fertilizer and high plant density), canola/wheat high input, lupin/wheat low input and volunteer pasture/wheat low input. These are shown in Table 1.

**Table 1:** Treatments for wheat cropping systems at Buntine:

| Treat | Rotation crop (2008 & 2010) | Wheat management (2009 & 2011) | | |
|---|---|---|---|---|
| No. | | Ripping | N rate (kg/ha) | Sowing rate (kg/ha) |
| | *Monitored for water use:* | | | |
| 1 | Lupin | Yes | 60 | 90 |
| 2 | Canola | Yes | 60 | 90 |
| 3 | Lupin | No | 20 | 50 |
| 4 | Volunteer pasture | No | 20 | 50 |
| | *Supplementary treatments:* | | | |
| 5 | Volunteer pasture | No | 60 | 90 |
| 6 | Lupin | No | 60 | 90 |
| 7 | Lupin | Yes | 20 | 50 |
| 8 | Canola | Yes | 20 | 50 |

**Results so far**

***Water use efficiency:*** The trial has been running for three seasons. In 2008 and 2010 the treatments were sown to a range of rotations. 2009 was the first season in which wheat was grown across all the treatments. The water balance for the wheat crops is presented in Table 2. Transpiration was estimated by subtracting 30% of in-season rainfall as an estimate of soil evaporation. Transpiration efficiency was then calculated as the yield divided by transpiration.

Total water use was very similar for high or low input systems and variation in transpiration efficiency was related to the yield of the different treatments. This is typical of crops in Mediterranean climates. Water use efficiency was low after the pasture, but was higher where N was supplied either as fertilizer or from the previous lupin crop.

**Table 2:** Water balance and water use efficiency for wheat grown under 'high' and 'low' input systems in the 2009 season at Buntine.

| **Rotation in 2008** | **Pasture** | **Lupin** | **Canola** | **Lupin** |
|---|---|---|---|---|
| **Wheat inputs 2009** | **Low** | **High** | **High** | **Low** |
| **Rainfall (mm)** | 227.0 | 227.0 | 227.0 | 227.0 |
| **Soil water depletion (mm)** | 27.3 | 39.9 | 37.1 | 36.9 |
| **Total water use (mm)** | 244.9 | 257.5 | 254.7 | 254.5 |
| **Yield (t/ha)** | 1.7 | 2.9 | 2.9 | 2.7 |
| **Transpiration efficiency (kg/ha/mm)** | 9.7 | 15.5 | 15.4 | 14.3 |

***Summer fallow efficiency:*** Out of season rainfall was 112mm between November 2009 and June 2010. Monthly rainfall is shown in Fig 1. Fallow efficiency was 38% which contrasted to the Morawa and Mingenew trials where fallow efficiency was 0%.

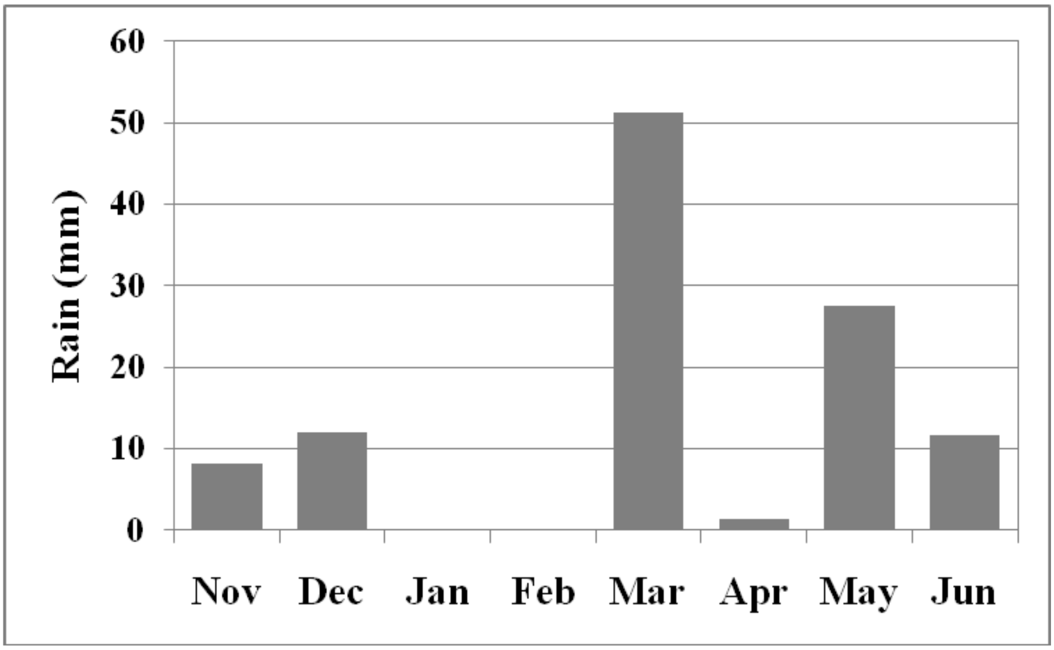


**Figure 1:** Out of season rainfall between the harvest (November 09) and sowing (June 10).

**Comments**

Crop water use in 2009 was dominated by in-season rainfall, with soil water depletion contributing 10-20% across locations and treatments. Variation between the treatments in the amount of soil water depletion was small relative to total water use, being in the vicinity of 5-10%.

Typical of Mediterranean-type climates, total water usage did not vary much between the treatments, even when deep ripping was included, with differences in WUE mainly being caused by the differences in yield.

Looking across the three sites, summer fallow efficiency did not differ between the treatments within each trial, but Buntine had an efficiency of 38% compared with 0% at Morawa and Mingenew. At the latter two sites, the rainfall was received in smaller events and was concentrated before Christmas. In addition, the soil was heavier at those sites. All these factors are known to reduce fallow efficiency.

These results are for the first cycle of the rotations. They will be supplemented with a repeated cycle and with simulation analysis to capture the year-to-year variation in rainfall patterns.

The economics of the systems will be calculated over the crop sequence.

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**Paper reviewed by** Phil Ward (CSIRO Plant Industry)

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