



Economic returns from high & low input irrigated wheat

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- Pre-irrigation (with no spring irrigation) resulted in a yield of 4.6 t/ha in the drought years and 6.2 t/ha in good years, demonstrating the importance of pre-irrigation for irrigated wheat.
- Soil moisture sensors should be used in autumn to determine subsoil moisture and whether or not pre-irrigation is needed.
- If irrigation water is limited, eg 400 ML available for the crop, profitability per megalitre in drought and good years is maximised with pre-irrigation only.
- If land is limited, profitability per hectare is maximised with pre-irrigation + full spring irrigations in the drought seasons or pre-irrigation + 1–2 spring irrigations in the good seasons.

The large 'irrigated cereal project' is yielding a wide range of interesting and useful results. Beyond identifying high yielding varieties and lines for future breeding programs, the project is also providing the means to compare and put figures on the impact of different crop management systems.

The aim of the GRDC-funded evaluation of irrigated cereals for eastern Australia was to identify cereal genotypes to provide cereal breeding programs with a selection framework of high yield-potential lines grown under irrigation to maximise yield.

Trials were conducted between 2007 and 2010 at Yanco, Coleambally, Griffith, Hillston, Deniliquin and Kerang.

In 2008, project leader Andrew Milgate obtained additional NSW government funding from Biofirst to compare wheat variety performance between a full irrigation, high input, 10-tonne yield potential system and a pre-irrigation, lower input system.

This article takes the field results from the comparison of the high input and lower input systems in the two drought seasons 2008 and 2009, and compares production and returns against a theoretical dryland cropping system and a system of pre-irrigation and one spring. The range of management options is then analysed using growing season rainfall and water use figures for two good seasons.

Field work

The high and low input systems were located alongside each other in the 2008 and 2009 seasons, at the Yanco and Coleambally sites of the irrigated cereal evaluation trial.

The high input system involved:

- pre-irrigation and full irrigations in spring to avoid moisture stress

- a total nitrogen budget of 300 kg N/ha including soil nitrogen, sowing nitrogen, first node and booting nitrogen.

The lower input system involved:

- pre-irrigation, only
- soil nitrogen and starter nitrogen at sowing.

There were two replicates of each system and an entire irrigation bay was allocated to each replicate. The trial area at each site was approximately four hectares.

The genotype evaluation was superimposed over the management systems, and all replicates were sown on the same day, with the same 1000 genotypes. The results for each replicate were averaged across all genotypes.



Trial site in 2008, showing lower input system (pre-irrigation) left, and high input system (pre-irrigation and spring irrigation) right.

Returns on irrigation

The water use, yield and financial returns from the high input and lower input systems in the drought seasons of 2008 and 2009 are presented in Table 1.

These field-based systems were also compared to two other theoretical situations:

- a dryland system with a yield of 1.5 t/ha and water use efficiency (WUE) of 14 kg/mm
- a system with pre-irrigation and one spring irrigation – a WUE of 14 kg/mm assumed.

The results for the theoretical systems are also presented in Table 1.

Table 2 presents outcomes for the same four systems in good seasons. The growing season rainfall underlying the calculations in Table 2 is based on actual figures for the good seasons of 2000 and 2010. Yield has been calculated assuming a WUE 15 kg/mm. Pre-irrigation water use figures in Table 2 are from the 2008 and 2009 trial, and spring irrigation water use is assumed to be 1.0 ML/ha for the first spring irrigation and 0.9 ML/ha for the second.

Drought season results

Any level of irrigation of wheat was considerably more profitable than dryland wheat in the drought seasons.

The high input system, pre-irrigation plus full spring irrigations, was the highest yielding system at 8.2 t/ha and gave the highest gross margin per hectare, \$1061/ha.

The lower input system, pre-irrigation only, yielded 4.6 t/ha and gave highest gross margin per megalitre, \$372/ML

If the area for cropping was limited to 100 ha, pre-irrigation and full spring irrigations gave the highest return, with a gross margin for the 100 ha area \$106,100.

If irrigation water was limited to 400 ML, pre-irrigation is the most profitable system, returning \$149,000 for the 400 ML available.

Good season results

The difference in profitability between a dryland crop and an irrigated crop is much less than in a dry season.

Pre-irrigation plus two spring irrigations yielded 9.1 t/ha and gave the highest gross margin per hectare of \$1370/ha.

Table 1. Economic returns in drought seasons – 2008 & 2009

Average Growing Season Rainfall – 161 mm. Wheat price – \$250/tonne				
	Theoretical dryland crop WUE of 14 kg/mm	Trial results for low input system Pre-irrigation	Theoretical irrigation system Pre-irrigation (1.6 ML/ha) + 1 spring (1.0 ML/ha) WUE of 14 kg/mm	Trial results for high input system Pre-irrigation + full spring irrigation (2-5)
Water use (ML/ha)	106 mm	1.6	2.6	5.4
Yield (t/ha)	1.5	4.6	6.0	8.2
Gross margin (\$/ha)	\$121	\$596	\$838	\$1061
Gross margin (\$/ML)	\$114	\$372	\$322	\$196
Land-limited gross margin (\$/100 ha)	\$12,100	\$59,600	\$83,800	\$106,100
Area that could be grown with 400 ML (ha)		250	154	74
Water-limited gross margin (\$/400 ML)		\$149,000	\$129,052	\$78,514

Table 2. Economic returns in good seasons – based on 2000 & 2010 rainfall

Average Growing Season Rainfall – 345 mm. Wheat price- \$250/tonne				
	Theoretical dryland crop WUE of 15 kg/mm assuming no waterlogging yield loss	Theoretical results for low input system Pre-irrigation	Theoretical irrigation system Pre-irrigation (1.6 ML/ha) + 1 spring (1.0 ML/ha) WUE of 15 kg/mm	Theoretical results for high input system Pre-irrigation + full spring irrigation (2)
Water use (ML/ha)	252 mm	1.6	2.6	3.5
Yield (t/ha)	3.8	6.2	7.7	9.1
Gross margin (\$/ha)	\$629	\$952	\$1211	\$1370
Gross margin (\$/ML)	\$250	\$595	\$466	\$391
Land-limited gross margin (\$/100 ha)	\$62,900	\$95,200	\$121,000	\$137,000
Area that could be grown with 400 ML (ha)		250	154	114
Water-limited gross margin (\$/400 ML)		\$238,000	\$186,494	\$156,189

Pre-irrigation only (using the trial-based water use of 1.6 ML/ha) yielded 6.2 t/ha and gave highest gross margin per megalitre of \$595/ML.

If area is limited to 100 ha the pre-irrigation and two spring irrigations gave the highest gross margin for the 100 ha of \$137,000.

If the volume of irrigation water is limited (say 400 ML), pre-irrigation over an area of 205 ha is most profitable at \$238,000.

Achieving high yielding crops

Good average yields from pre-irrigation of 4.6 t/ha in the drought years and 6.2 t/ha in good years (assuming no waterlogging) were achievable in the lower input systems. The results are in fact pleasing, exceeding general expectations for dry conditions and experiences in good seasons (where 3–4 t/ha has been welcomed).

The lower input system of pre-irrigation and no spring watering resulted in the highest gross margins per megalitre.

Over almost a decade of drought and low water allocations, the importance of pre-irrigation has to some extent been forgotten. These results show how important pre-irrigation is for irrigated wheat to produce good yields, just as weed-free fallows have been for moisture retention for dryland crops.

If summer/autumn rainfall is high soil moisture sensors should be used to determine subsoil moisture down to a depth of one metre, and decide whether or not a pre-irrigation is needed. In a dry autumn soil moisture sensors should still be used to confirm if subsoil moisture is lacking. If soil moisture readings are 50–75 kPa (kilopascals), pre-irrigation is recommended.

It is expected that moisture monitoring will become more important in the future, as climate change is predicted to bring about drier autumns and hence it is anticipated farmers will be pre-irrigating much more.

Pre-irrigation critical for good yield

Although not investigated in the trial or documented in tables 1 and 2, the experience of growers and agronomists has been that crops not pre-irrigated in the dry seasons lost yield potential in winter from moisture stress and delayed spring irrigation compounded the lost yield potential. Delayed spring irrigations had a high water use of 1.2–1.5 ML/ha, resulting in temporary waterlogging on top of the moisture stress.



This study and the results of the high yielding irrigated cereal project further refine the formula for growing 8-10 t/ha of irrigated wheat.

The results of the work reported here show that irrigation of wheat in dry seasons can be profitable. Pre-irrigation, even if it is the only irrigation for the season, is critical for profit; and timely spring irrigations are profitable if water is not limiting.

If irrigation water is limited and using the example of a 400 ML limit for the wheat crop, pre-irrigation will be the most profitable system. This conclusion is arrived at by determining the gross margin per megalitre.

Even though the higher input system yields very well (8.2 t/ha), more water is required (5.4 ML/ha) to achieve that yield and gross margin (\$1061/ha). The resulting gross margin per megalitre is \$196/ML (\$1061/ha ÷ 5.4 ML/ha); compared with \$372/ML for pre-irrigation.

Even though the irrigation system is lower yielding than others, more land (250 ha) can be used on the basis of water supply, so overall production is greater.

If land is limiting, the most profitable system will be based on the gross margin per hectare. The highest gross margin was from pre-irrigation plus full spring irrigations in the drought seasons or pre-irrigation plus 1 or 2 spring irrigations in the good seasons.

In reality, on a farm there may be a mixture of pre-irrigated crops maximising gross margin per megalitre; and other crops which are spring irrigated where GM/ha is maximised.

Yield expectations lifting


We have been pleasantly surprised with higher yielding commercial varieties and lines that have yielded 9–11 t/ha in the evaluation project. The yields are well above expectations set by earlier research and systems such as Siragcrop, which aimed for 8.0 t/ha in the early 1980s; and more recent work in the early 2000s, again with Maarten Stapper from CSIRO, where 8.0 t/ha was the target yield.

Results and calculations from the comparison of different irrigation systems reported here, enable further refinement of crop management recommendations for irrigated wheat.

Confident that irrigated wheat has the potential to be high yielding, fertiliser and sowing inputs at sowing can be based on the 8–10 Tonne Irrigated Wheat Club program.

A decision about spring irrigation can be made at the DC30 (1st node) stage. If the decision is to irrigate and shoot numbers are 500–800 shoots/m²:

- in a drought year, 8–10 tonnes can be obtained from 3–4 ML/ha
- in a good year, 8–10 tonnes can be obtained from 1–2 ML/ha.

This work has provided a meaningful insight into managing irrigation in good years, and not so good years; as well as determining the impact of land and water limitations of returns on a per megalitre and per hectare basis. 

Further information

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