Water Use Efficiency to improve farm budgeting - a case study

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Key messages

1. A case study examining the trends in water use efficiency (WUE) for a farm located in a medium rainfall area in Western Australia demonstrated improved management, a higher expectation for long term yields, and better prospects for the business.
2. Thirty years after French and Schultz published their concept of WUE, is still not used as effectively as it could be. Perhaps partly, because the concept is not easily visualised.
3. By using data presented in WUE terms to clarify improved management, the bank offered more favourable terms for this business.
4. This case study shows a benefit for WUE as a benchmark, which it is hoped will encourage wider adoption and further development of the concept.

Aims

Industry-standard farm budgets use actual crop yield averages over five or ten year period to predict long term budget yield. This past performance has the advantage of being conservative, but will discouraged expenditure to improve productivity.

Alternatively, water use efficiency (WUE) could more accurately reflect management, based on the concept described some thirty years ago by French and Schultz (1984), where from a series of yield and water-use measurements made from 61 sites over a period of 11 years they conclude that in the Mediterranean–type environment of South Australia, the potential grain yield of wheat increased by 20 kg ha^{-1} mm^{-1} of water use (transpiration) above a minimum value of 110 mm, which is assumed to be the amount to water lost by soil evaporation. Therefore, the yield potential of 20 kg ha^{-1} mm^{-1} of growing-season rainfall (i.e. the rainfall-use efficiency) has provided a useful yardstick to farmers to compare the on-farm performance of their wheat crops. It has been validated by Oliver et al.(Oliver et al. 2009), incorporated into the Yield Prophet calculations, and demonstrated to be consistent indicator in consulting practice, at least along the South Coast of W.A.

A case study for a farm business in the medium rainfall area of Western Australia provided good opportunity to test this concept when presenting budgets to a bank. In this case, water use efficiency indicated better long term crop performance than long term average yields. Acceptance by the bank of the concept for budgeting to aim for long term yield indicated better prospects for the farm business, and therefore helped achieve more favourable bank lending based on a reduced level of risk.

Method

For budget purposes, crop yields are recorded as tonnes of grain produced on the farm, divided by the hectares planted for harvesting grain.

Farm rainfall recordings were used to calculate WUE, using approximations of the French and Schultz estimates -

- Evaporation and losses of moisture amounting to 100 mm.
- Subsoil moisture of 50 mm, retained from summer rain (December to the following April) in the clay subsoil typical of this farm, (potentially) by spraying of summer weeds.
- Conversion of effective moisture to grain yield of wheat and barley at 20 kg per mm of available moisture.

More precise estimates are available, for example from the Yield Prophet model, but with actual yields commonly only some 50 per cent of potential, this extra detail is trivial.

Also, in use of this concept, obvious problems such as frost, or particular weather extremes should be accommodated, though sometimes the use of the concept helps highlight problems that only become obvious after analysis.

For this case study, results have been modified to preserve anonymity of the farm business, while retaining the

conclusions from the data.

Results

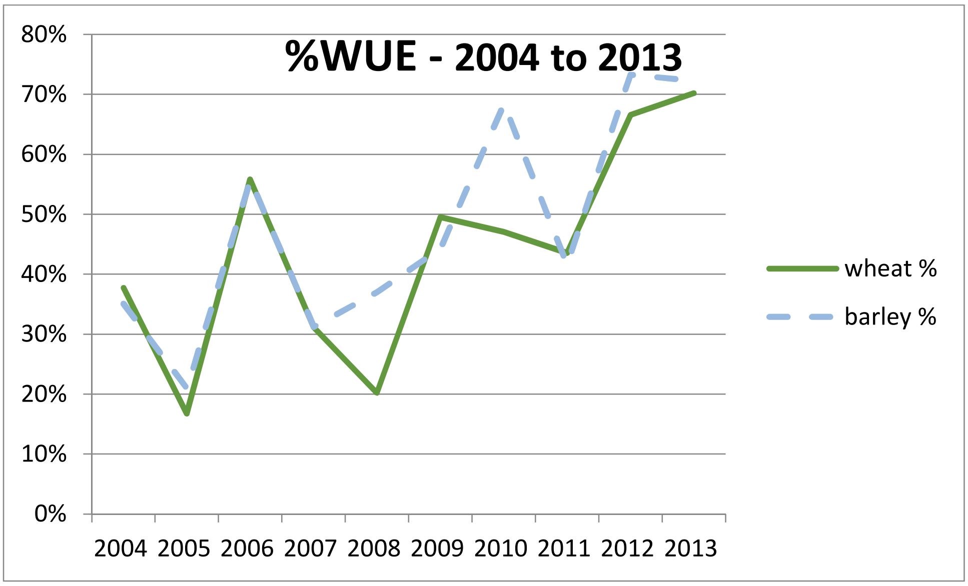
The history of farm yields were as follows -

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	10 yr Avg	5 yr Avg
Wheat	1.4	1.3	1.4	1.6	1.3	1.9	1.1	2.2	1.7	3.3	1.7	2.0
Barley	1.3	1.7	1.4	1.6	2.4	1.7	1.6	2.1	1.9	3.4	1.9	2.1

Rainfall figures (mm) are presented below. They were taken from farm records, but are not presented here in detail, because of potential to identify the particular farm business.

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	10 year Avg	5 year Avg
Growing Season Rainfall	236	445	172	299	374	242	167	303	176	285	243	230
Subsoil	50	50	50	50	50	50	50	50	50	50	50	50
Evaporation	100	100	100	100	100	100	100	100	100	100	100	100
Available mm	186	395	122	249	324	192	117	253	126	235	193	180
Potential yield	3.7	7.9	2.4	5.0	6.5	3.8	2.3	5.1	2.5	4.7	3.9	3.6
wheat %	38%	17%	56%	31%	20%	50%	47%	44%	67%	70%	44%	55%
barley %	35%	21%	56%	31%	37%	44%	68%	42%	73%	72%	48%	60%

And in graphical format -



Conclusion

The graph highlights the steady improvement in WUE, particularly over the last few years.

The graph also shows the distortions from very dry seasons (2006) and wet seasons (2005). For example, arguably, extra fertiliser in the wet years may improve WUE, or perhaps the calculations do not sufficiently account for runoff or

subsoil drainage. Certainly, blanket figures of 50 mm of subsoil moisture, and 100 mm of evaporation could be questioned.

However the general conclusion remains apparent. Compared to the five and ten year averages of around 2.0 tonne per hectare, a WUE of only 65 per cent of the five year potential cereal yield (3.6 tonne per hectare, for this farm) would be 2.4 tonne per hectare. This was the figure presented to the bank for the long term budget (Year-in, year-out). Obviously this would be a much stronger business outcome. This was recognised by the farmer's bank, resulting in an offer of more favourable lending terms, due to the lower risk margin. This has potential to be incorporated into future bank lending policy.

Adoption of measures of WUE by banks to assess management risk will benefit the farming industry by allowing wider comparison of crop performance. WUE reduces seasonal effects on crop performance, and therefore would highlight management effects. This would allow quicker assessment of practices such as new crop varieties, chemical treatments or fertiliser.

Details of this particular farm would therefore be of interest. In general terms, the improvement was partly achieved by managing weed burdens over the last five years, and newer herbicides such as Sakura have helped. However soil improvement, especially liming has also been aggressively implemented on this farm. Also, in a season such as 2014, a subjective adjustment for yield loss due to delayed harvest and weather damage would help.

The challenge still remains to further improve WUE, with figures across the farm as a whole still some 20 to 30 per cent below full potential. On the other hand, some paddocks and some soil types perform much better, which raises questions about what exactly constitutes soil fertility, and how might it be addressed.

Also, for the future, more accurate measurement of WUE might help hone management effects. For instance, more complex calculations are done by Yield Prophet, and better definition of subsoil moisture holding capacity might be informative.

Of course, the limitation of a single case study does not confirm the value of universal application of this concept, but shows potential benefit for individual farms, and the wider industry.

References

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Key words

Water use efficiency, farm budgeting,

Acknowledgments

This farm business has done the hard work. However farmer anonymity is acknowledged and preserved. Details have therefore been modified sufficiently to protect the anonymity of the business.

The idea for the paper was stimulated by interrogations by Marit Kragt and Michael Burton, of the University of W.A. during the process of another project.

GRDC Project Number: Self funded

Paper reviewed by: Peter Briscoe, AAAC, Albany and Lucy Anderton, DAFWA, Albany