Benchmarking Irrigation Performance

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A project on benchmarking of citrus and other crops is being conducted by Primary Industries SA, at Loxton, and is funded by the Murray-Darling Basin Commission, under their Natural Resources Management Strategy.

The benchmarking undertaken in this project is external benchmarking, by the definition given by the first speakers, and comes under the heading of industrial benchmarking, that is, comparisons were made between enterprises within the same industry, winegrape growing.

The project has two main aims:

- firstly to establish benchmark levels of performance with respect to appropriate indicators of irrigation success, and to use these indicators to compare the relative performance of the participating irrigators;
- the second aim was to identify best management practices for irrigation, which will assist irrigators to achieve the benchmark levels of irrigation performance. This lines up well with process benchmarking as defined by the first speakers.

The methodology of the project involved identifying a sample of winegrape irrigators from across the Riverland and Sunraysia, who were generally considered to be good irrigators. Irrigators' names were obtained from departmental extension officers, grower organisations, winery field officers and other irrigators. Data was collected from 36 sites, representing 34 irrigators.

The data that was collected from each site included:

- planting material and layout of plantings
- irrigation system and equipment
- irrigation scheduling tools used
- timing and depth of irrigations throughout a complete season
- yield and final Baume over three consecutive seasons

The irrigation systems included furrow, overhead and undervine sprinkler, and drip. The data was used to calculate various irrigation performance indicators, and sites were ranked according to their performance for each indicator.

Three irrigators who scored well on a number of the indicators were interviewed as case study subjects, and their practices form the basis of a series of best management practices for irrigation.

Benchmark indicators

Five of the indicators of irrigation performance are presented, although others were calculated in the project.

1. Yield (Figure 1), expressed as t/ha, is the standard production measure for any agricultural industry.
2. Water use efficiency (Figure 2), expressed as t/ML, is derived by dividing yield by the volume of water applied per hectare over the season.
3. Irrigation efficiency (Figure 3) is defined as total irrigation applied minus estimated drainage, divided by total irrigation applied, and is expressed as a percentage.
4. Return per megalitre (Figure 4) was calculated by assigning a standardised value to the yield at each site, and dividing this by irrigation volume.
5. Yield per volume of drainage (Figure 5), expressed in t/ML, relates the yield to the estimated volume of drainage produced in the course of the growing season. A high score for yield per drainage volume indicates both high yield and low drainage volume, both of which are desirable.

Figures 1–5 present the performance of all sites in relation to the indicators discussed above.

Two sites have been highlighted, the two best performing sites overall. These two sites, along with one other, were used as case studies for development of best management practices. Even the most cursory glance at the graphs immediately reveals that there is an enormous range in performance across the sites. Some sites containing young vines were included in the sample, to assess performance during vineyard development.

Yields from mature vines varied from 4 to 48.8 t/ha (Figure 1). Water use efficiency for mature vines within the sample ranged from 2.2 to 10.2 t/ML (Figure 2). This reflects the variation in the volume of water used over a season to produce the different yields of grapes. Sites 1 and 2 produced the highest yields, but they also did so using relatively little water, which made them efficient with respect to both land and water usage.

Irrigation efficiency in the sample varied between 43 and 95% (Figure 3), indicating that a small percentage of sites were creating very significant drainage volumes. Irrigation efficiency, whilst an important indicator, does not of itself
guarantee good overall performance. It is especially interesting to note that sites 1 and 2, the top two sites for every other indicator, do not score at the very top for this indicator. In addition, more than half of the irrigators within the sample achieved irrigation efficiencies greater than 85%, yet a much smaller percentage achieved high efficiency by the other indicators. Some of the sites which scored very highly for irrigation efficiency, scored quite poorly for some other indicators, possibly indicating a lack in some other areas of the total production system.

Return per megalitre shows a range for mature vines within the sample from $1,327 to $6,089/ML (Figure 4). The graph shows that, in terms of the value gained from water extracted from the Murray-Darling Basin system, there is a very wide variation just within this sample.

The value assigned to the yield was weighted according to the varieties of red and white grapes within the sample, and is therefore indicative, rather than the actual return gained. For red varieties, a bonus for quality is included.

As quality issues other than Baume become important, and wineries begin to pay according to these other factors, the relative values of the crops represented here could well change dramatically. Such payment schedules could have a significant impact on irrigation management within the winegrape industry if they give a significant advantage to crops that have been irrigated sparingly.

The final indicator, yield per drainage volume, shows the greatest range of values, from 5.4 up to 122.0 t/ML (Figure 5). This is perhaps the most disturbing finding, indicating that some sites are producing large volumes of drainage for very little positive outcome, that is yield. It should be remembered that a small amount of drainage is required in these irrigation areas to leach salt from the root zone. However, many of the sites at the low end of the sample are producing less yield per megalitre of drainage than some other sites are producing per megalitre of total irrigation.

It must be noted also that this indicator does not take account of all of the negative impacts of drainage.

Wastage of water is only one of a suite of impacts, which also include:

- development of saline perched water tables which can cause crop losses and plant death
- increased saline return flows to the river and subsequent high salinity irrigation water
- and a range of impacts on the ecology of the river system itself.

We have demonstrated problems amongst a group of good irrigators, and this begs the question as to the levels of unnecessary or low value drainage across the whole horticultural industry. This wasted water represents a whole untapped water resource which could be utilised if the efficiency of irrigation practices were improved across the industry.

In this regard, three of the best performing winegrape irrigators, along with five citrus irrigators from an earlier sample, were interviewed to identify the practices and management approaches which contributed to their high performance.

Best practices
A number of common threads were identified amongst the group of high performers. Significantly, two things that were not common amongst this group were the type of irrigation system and the monitoring and scheduling tools they were using.

Very similar irrigation systems, and sites using very similar scheduling tools were represented at both ends of the performance spectrum.

The common threads that did occur were extracted and analysed, to form an initial set of six irrigation best management practices (BMPs).

BMP 1: Irrigation as a high priority
All case study irrigators cited irrigation as either one of the most important factors in their production system, or the single most important factor, for example, ‘Irrigation is always number one’.

In addition, quotes such as:

- ‘There’s no point in doing second best, it’s a waste of money’, and
- ‘It’s worth the money we put into it, it’s worth the effort we put into it every day…’

indicate the willingness of these irrigators to put this priority into action.

When irrigation is seen as a low priority, it is no wonder if irrigation performance is low, and likewise it is not surpris-
ing that the best irrigators all place irrigation as a high priority in their growing system.

**BMP 2: Monitor all aspects of an irrigation event**
This is best described by a quote from one irrigator. ‘Monitoring is split into many things—before the irrigation, during the irrigation and after the irrigation.’

The simple decision of when to irrigate is only part of the whole story. Monitoring of where water is going, both during the irrigation, by measuring system performance and uniformity of application, and after the irrigation, by assessing under- and over-irrigation, is vital to efficient irrigation. Making decisions without sufficient information is like walking around in the dark, sooner or later you fall over something. Information is invaluable in the decision making process, and collecting that information is vital to making good management decisions.

**BMP 3: Use objective monitoring tools to schedule irrigation**
All case study irrigators used at least one objective monitoring tool, usually a soil based device, in determining the timing of irrigations. The tools varied widely, from tensiometers and hand assessment of soil water through to sophisticated tools such as the neutron probe and EnviroSCAN. However, the important thing is that they measured something, rather than relying on intuition, the calendar, or when the neighbours watered.

This is obviously related to the last point about monitoring, and refers to the quality of the information on which decisions are based. An important point about scheduling tools is that they must be appropriate, both to the crop and irrigation system they are used with, and also to the irrigator who must maintain them and interpret the data provided by the tool.

**BMP 4: Use more than one tool for scheduling irrigations**
All of the case study irrigators used a range of information sources in making the decision on when to irrigate, and how much to apply. Typically, much of the decision relied on one particular tool, but other factors were taken into account. The most common, and simplest were:

- digging holes to check soil water
- observation of the appearance of plants
- checking of test wells or drain flows after irrigation, and subsequent adjustment in practice at the next irrigation.

A gain, this impacts on the quality and reliability of the information on which management decisions are based. It is a case of not putting all the eggs in one basket. If a particular tool has a fault, or the irrigator's interpretation of the tool is flawed, cross checking against another source of information will soon show up that a problem exists.

**BMP 5: Retain control of irrigation scheduling**
With modern technology, it is possible to set up irrigation systems to operate entirely automatically, based on the readings from a probe or a set of probes. This is tempting, as it certainly takes care of a large item of work for the irrigator. A long the same lines, it is easy to allow a consultant to dictate the irrigation schedule, based on his or her measurements, or to blindly irrigate because the tool being used indicates that it is time to.

The case study irrigators all firmly held onto control of irrigation scheduling, that is, they took into account the data from the scheduling tool or the recommendation of the consultant, but retained the power to vary the schedule using their own judgement, and the use of other tools.

Finally, it is the management skill of the individual manager which determines how well the site performs, and good managers back their own judgement, based on their knowledge of their property, rather than blindly following the advice of a machine or an outsider.

**BMP 6: Multiple sources of information**
The case study irrigators cited a range of different ways in which they obtained access to information about irrigation. All of them saw this process as important, and were willing to talk to anyone with something to offer, even if they later discarded it as not applicable to their situation. In the case of larger, corporate operations, employee education was seen as important, as was encouraging the employees to make a meaningful contribution toward management decisions.

One extremely interesting observation was that the top performing irrigator in the citrus sample, and the top performing irrigator in the winegrape sample have both been in the horticultural industry for only a short time (around five years). Both came into the industry with no prior knowledge, and learned by asking others and seeking out information from any source available.

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This contrasts with the apparent closed-mindedness of some who have been in the industry all of their lives, and do not believe they can learn anything from anyone else. There is always more to learn, and better ways to do things.

**Use of benchmarking as an extension tool**
The major shortcoming of this project to date is that only 36 winegrape irrigators have had the opportunity to participate in a benchmarking exercise. While that exercise has been invaluable in determining appropriate performance indicators for irrigation, and has resulted in a suite of useful best practices, it has gone only part way.

What do we do with the benchmarks and best management practices that have come out of the project? Do we simply insist that they should be followed, or can this project provide a framework and methodology for benchmarking, that irrigators can use for themselves?

Encouraging irrigators to conduct their own benchmarking studies is an attractive proposition for two reasons. Firstly, people like to look over the fence, to see how they compare with their neighbours. Irrigators are no exception. This methodology merely taps into that desire, and provides a legitimate means by which meaningful comparisons between properties can be made. Irrigators then get an indication of where they lie relative to other irrigators, and this in itself can provide a strong incentive to improve.

Secondly, by encouraging the irrigator to spend time and energy going through the benchmarking process, there is a far greater likelihood that the irrigator will actually make changes as a result. Information is often valued according to the cost involved in obtaining it, and handing out free information is not always the most effective way to bring about a change in behaviour. The effort put into benchmarking by the irrigator is a large incentive to make meaningful changes in management practices, so as not to waste the effort already expended.

The role of government agencies such as PISA is to facilitate this process.

Therefore, funding will be sought from appropriate bodies to further develop the benchmarking methodology to this end.