Winegrape irrigation benchmarking
Murray-Darling and Swan Hill 1998-2002

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Introduction
In 1998 the Murray Valley Winegrape Industry Development Committee initiated an irrigation benchmarking survey for the Sunraysia region. The aims of the survey were to:

- determine the irrigation performance of local winegrape irrigators,
- monitor the change in irrigation performance over a number of seasons, and
- allow participating winegrape irrigators to compare their own performance with others.

The format of the benchmarking survey was adapted from a previous study (Skewes and Meissner 1997).

In the first year 22 irrigators nominated for the survey, providing information on seven winegrape varieties over 42 sites. These irrigators have been benchmarked for the last four seasons. In the second year 14 additional irrigators joined the study, including nine from the Swan Hill region. This resulted in 64 sites which have been benchmarked for the last three seasons. The winegrape varieties included in the survey were Sultana, Colombard, Chardonnay, Ruby Cabernet, Shiraz, Cabernet Sauvignon and Merlot.

A range of performance measures were obtained from participating growers and ranked. Some of these measures are presented below.

1. Yield (t/ha) and Irrigation Applied (ML/ha) — 1999-00

White varieties
Average yield for white varieties in 1999–2000 was 26.3 t/ha, ranging from 12.4 to 55.9 t/ha. From irrigation records collected, irrigations applied between 15 August 1999 and 31 May 2000 were totalled. Average irrigation applied was 5.1 ML/ha, ranging from 2.0 to 7.9 ML/ha. Rainfall is not included in any irrigation-applied figures throughout the report.

A relatively strong variety effect was seen in 1999–00, with Colombard ranked to the right of the graph. The amount of water applied was not strongly related to the yield produced. Enormous variation in water application existed across sites producing similar yields. Colombard site 17C, for example, produced 33.0 t/ha using 7.6 ML/ha, while sites 06A, 06B and 03B produced around 35 t/ha, but applied only 4.1 ML/ha (circled). This suggests that there is potential to reduce annual water applications with no detriment to production in some instances. Irrigation system has a strong effect in this example, as site 17C is irrigated using overhead sprinklers, while 06A, 06B and 03B are all drip irrigated.

Figure 1. Yield (coloured bars) and Irrigation Applied (line) to white winegrape varieties in 1999–2000.

Red varieties
Average yield for red varieties in 1999-00 was 18.6 t/ha, ranging from 11.0 to 26.1 t/ha. From irrigation records collected, irrigations applied between 15 August 1999 and 31 May 2000 were totalled. Average irrigation applied was 6.8 ML/ha, ranging from 3.8 to 12.2 ML/ha. Rainfall is not included in any irrigation-applied figures throughout the report.

A relatively strong variety effect was seen in 1999–00, with Shiraz ranked to the right of the graph. The amount of water applied was not strongly related to the yield produced. Enormous variation in water application existed across sites producing similar yields. Shiraz site 17G, for example, produced 28.8 t/ha using 15.6 ML/ha, while sites 06A, 06B and 03B produced around 25 t/ha, but applied only 9.7 ML/ha (circled). This suggests that there is potential to reduce annual water applications with no detriment to production in some instances. Irrigation system has a strong effect in this example, as site 17G is drip irrigated, while 06A is overhead sprinklers.

Figure 2. Yield (coloured bars) and Irrigation Applied (line) to red winegrape varieties in 1999–2000.
Red varieties
Average yield in 1999–2000 was 20.0 t/ha, ranging from 12.2 to 34.6 t/ha. Average irrigation applied was 4.6 ML/ha, ranging from 2.1 to 7.9 ML/ha.

While reasonable conclusions from the Colombard example can be drawn in relation to the irrigation system used, this result is not consistent throughout the study. Cabernet Sauvignon sites 29A and 15B (Figure 2) are similar to the Colombard example: the overhead (OH) irrigated site (15B) had 70% more irrigation applied than the drip irrigated site 29A, with similar yields produced. However the Shiraz sites identified (21A and 17E) produced similar yields, but were the reverse of the previous two examples with the overhead irrigated site applying approximately 50% less water than the drip-irrigated site. There are numerous examples of this ‘inconsistency’ in each season of the survey.

It is obvious that irrigation performance (in terms of ML/ha) is not strictly driven by the irrigation system alone. No significant relationships were found in the survey between irrigation volumes applied or yield with irrigation system, scheduling tool or rootstock. The lack of significant relationships is understandable considering that the survey includes irrigators who adopt different management practices with regard to pruning, nutrition and crop thinning, etc. Irrigation is only one of the many management practices which contribute to production. The survey is not a controlled experiment in any way. The data is of more use in comparing sites and looking for trends over time, which were the original aims of the survey.

2. Application Efficiency %
A plication efficiency was estimated from the amount of irrigation applied and the estimated drainage over the season. Drainage was estimated from irrigators’ records using the Right Amount Right Time computer-aided irrigation scheduling program. A cumulation of soil moisture deficit between irrigation events was estimated from weather data collected at the Agriculture Research and Advisory Station (ARA S), Dareton.

An application efficiency benchmark of 85–90% results in a leaching fraction of 10–15%. This is considered sufficient to remove harmful salts from the rootzone in the Lower Murray-Darling without creating excessive amounts of drainage. An application efficiency of 100% may not be recommended in the long term.

Figure 3 shows that in 1998–99 (coloured bars) only 11 of the original 40 participating sites (28%) produced an application efficiency greater than 85%. A nother 11 sites were relatively inefficient being less than 70%. In 1998–99, drip irrigation was strongly correlated to higher application efficiencies (drip sites concentrated to the top of the graph), however, irrigation management still is the strongest determinant of irrigation performance. Two drip sites produced poor application efficiencies below 60%, and two overhead and one low-level site produced good application efficiencies of approximately 85%.

Thirty-eight of the original 40 sites participated in the project in the following three seasons. Overall application efficiency improved from 77.7% in the first year, to 86% in the fourth year of the study (Table 1). The standard deviation has consistently dropped each year, meaning that the variation in the survey has reduced. Irrigators who were very efficient in the first year are tending to lower their application efficiency, and likewise the irrigators who were initially poor have improved their performance. This results in a general ‘flattening’ of the line, and a lower standard deviation. In the final year of the survey 27 of the 40 participants (67%) produced an application efficiency of greater than 85%.

Drip irrigation had a consistently higher application efficiency (87.0% over four seasons) than both overhead (74.8%) and low-level sprinkler irrigation (77.9%). Drip and low-level sprinkler systems have generally improved their average application efficiency over the four years of the study, while the trend with overhead sprinklers has been
inconsistent, possibly due to the wide range in water requirements over the four seasons, and overhead sprinklers expressing a greater response to this variation (Table 1).

The biggest improvement in application efficiency occurred between the first and second year of the survey (77.7% in 1998–99 to 83.9% in 1999–00). One reason for this may be that significant rainfall occurred in the early part of season 1999–2000. As well as reducing the amount of irrigation applied, this rainfall provided good leaching of the profile. For the remainder of the season growers could confidently apply irrigation efficiently with little concern about leaching irrigations. This results in higher application efficiencies.

Application efficiencies have continued to improve throughout the survey, with very little rainfall recorded (Table 2). If the dry conditions continue next season (2002–03), irrigators may choose to apply more leaching irrigations, resulting in lower application efficiencies than have been produced previously.

4. Irrigation Applied (ML/ha)

The irrigation applied was reduced by 21% in the second year of the survey (from 6.6 ML/ha in 1998–99 to 5.2 ML/ha in 1999–00, Table 2). This was due to the milder first half of the 1999–2000 season, as well as higher seasonal rainfall. At the Agriculture Research and Advisory Station (ARAS), Dareton, 295 mm of rainfall fell from September to May in 1999–2000 compared to 166 mm in 1998–99 (Table 2).

Although overall water use decreased in the second year, the ranked performance is similar in both years. The irrigators who applied higher volumes of water in the first year remain the highest, and vice versa.

The third and fourth years of the study showed an average application of approximately 6 ML/ha (Table 2). These seasons were both very low in rainfall, however, the average application did not reach the average measured in 1998–99, which was also a very dry season. This offers further proof that irrigation practices are improving and that irrigation volumes are dropping. Irrigation system has a strong effect on the irrigation volumes applied, with drip irrigation drip applying 15–20% less water than overheads and low levels over the four seasons of the survey.

5. Regulated Deficit Irrigation

Regulated Deficit Irrigation (RDI) is becoming a more common management practice for red grape growers in Sunraysia. As discussed it is difficult to determine relationships between any irrigation practices and production or irrigation applied. An interesting trend, however, has been the irrigation volumes applied in relation to RDI over the last three seasons. Table 3 describes the irrigation volumes and average yields produced from 1999–00 to 2001–02.

Irrigators adopting RDI have consistently applied less water over all seasons than irrigators allowing unrestricted growth of their red varieties. This is expected as RDI involves restricting the amount of irrigation applied for four to six weeks in the middle of the season. In addition, for RDI to be successful irrigation must be closely monitored over the whole season, and this will also help to reduce irrigation volumes.

It appears that the irrigators adopting RDI have been progressively applying greater stress over each season. The differences in the average amount of irrigation applied between RDI and unrestricted growth has progressed from 0.6 to 0.9 to 1.8 ML/ha over three seasons. Average yield is not significantly different between RDI and unrestricted growth over any of the seasons; however, it has taken until the final year of the survey for the average yield under RDI to fall below the average yield under unrestricted growth.

Conclusion

The annual volume of irrigation applied provides a reasonable indication of irrigation management, but does not accurately show how the irrigation was applied throughout the season. For example 03B applied only 4.2 ML/ha in 1999–00 (Figure 4), but had a relatively low application efficiency of 68.4% (Figure 3). Vine vigour, crop end use, row spacing and other location effects are not taken into account when comparing the volume of irrigation applied. Location of the property in particular appears to influence irrigation volumes. Private diverters in isolated areas on the Murray and Darling rivers appear to have a greater water demand than irrigators inside community schemes, regardless of system type. Therefore applying a benchmark standard for irrigation volumes to which irrigators should aim does not seem appropriate. To do this would be an oversimplification.
Application efficiency percentage is a more accurate indicator of how efficiently irrigators are applying water, and standard benchmarks do exist. Many irrigators are now consistently applying less than traditionally recommended irrigation volumes. Some irrigators are managing their irrigation so that very little or no leaching occurs. Soil and leaf analyses on these sites so far suggest that there are no immediate salinity concerns.

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References