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The Australian Wine Research Institute

Transitionary Activities

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FINAL REPORT to

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1. Abstract:

This report should be read as a supplement to previous final reports for the GWRDC-AWRI Investment Agreement 2006-2013 and in context with progress reports for project number AWR 1308.

All objectives have been achieved and the Transitionary Activities are complete. Specifically;

- extension activities were conducted and some capacity in AWRI nodes in Griffith, Hunter Valley and Tasmania was maintained;
- a proof of principle metagenomics study was successfully completed, demonstrating the effect of winemaking intervention on the genetic diversity of wild wine fermentations;
- work on the formation and fate of sulfidic off-aromas in bottled red wines has been completed; and
- the acquisition of approved capital items and small capital items has been completed.

2. Executive summary:

This report summarises utilisation of residual unspent monies attributed to the seven year Investment Agreement 2006-2013 for Transitionary Activities and purchase of capital items.

All objectives have been achieved and the Transitionary Activities are complete. Specifically;

- extension activities were conducted and some capacity in AWRI nodes in Griffith, Hunter Valley and Tasmania was maintained;
- following extensive industry consultations thirteen FPAs were completed and submitted to the GWRDC across the three Nodes, each with a separate detailed budget;
- a proof of principle metagenomics study was successfully completed, demonstrating the effect of winemaking intervention on the genetic diversity of wild wine fermentations;
- work on the formation and fate of sulfidic off-aromas in bottled red wines has been completed; and
- the acquisition of approved capital items and small capital items has been completed.

Practical outputs of benefit to the Australian grape and wine industry include presentations at the 2013 Australian Wine Industry Technical Conference (AWITC) and extension materials:

- at the 2013 AWITC one plenary presentation was delivered, four workshops were convened and presented, and 19 posters were presented;
- fact sheets, case studies and calculators relating to heat transfer and refrigeration, bioenergy, cellar storage temperature, and heat and cold stability have been made available via the AWRI website (www.awri.com.au);
- an article on bioenergy in WBM (August 2013: 39-41);
- an article on improving refrigeration efficiency and reducing electricity use in Technical Review (212/2014);
- an article on the impact of oak additions on the colour and phenolic profile of red wines in Technical Review (207/2013);
- enhancements to the RTP module on Refrigeration with the addition of case studies developed by the Riverina Node.

Research that will lead to enhanced economic returns and profitability:

New knowledge about copper additions and oxygen management in red wine ferments with rotary fermenters has highlighted the potential to positively impact on wine quality through reducing concentrations of undesirable volatile sulfur compounds; it may also improve the utilisation of existing winery fermentation assets.

3. Background:

The GWRDC has previously confirmed that residual unspent monies attributed to the seven year Investment Agreement 2006-2013 would be utilised "to support transitional expenditure under the new agreement (for 2013-14)". In response, the AWRI provided in 2013 an overview on 'transitionary activities' which would not be completed within the Investment Agreement period. These were discussed with GWRDC at the Joint Agreement Committee meeting held 18 June 2013 and the approved allocation of transition funds towards both 'transitionary activities' and capital expenditure was formalised through Project AWR 1308 in August 2014.

4. Project Aims and Performance Targets:

Project AWR 1308 has four main objectives:

- conduct extension activities and maintenance of capacity in AWRI nodes in Griffith, Hunter Valley and Tasmania;
- complete evaluation of the effect of winemaking intervention on the genetic diversity of wild wine fermentations;
- complete work on the formation and fate of sulfidic off-aromas in bottled red wines; and
- complete acquisition of approved capital items.

All objectives have been achieved and the Transitionary Activities are complete.

5. Method:

The Project was carried out as outlined in the original applications.

As approved by AGWA in the letter dated 19 December 2014, additional small capital items have been purchased from the residual $37,153 (see Appendix 5).

Linking sensory characteristics of iconic Hunter Valley Semillon wine to soil type

The juice from Semillon grapes which had been machine harvested from 31 vineyards for which the soils had previously been characterised, was collected from grape bins immediately post harvest. The samples were taken to the laboratory of a commercial winery (Bimbadgen Estate), and were spectrally analysed for pH, TA, Total Soluble Solids and YAN, using a Bruker Alpha spectrophotometer. Sub-samples of the juices were frozen and shipped to Adelaide, where they were thawed and their UV/Vis spectra obtained using a Varian and a Microdom spectrophotometer.

Six batches of the machine harvested grapes representing six different soil types were selected, and were all processed at a commercial winery using that producer's standard winemaking protocols. They were sampled periodically during fermentation, and at the end of fermentation while still on lees, and the lees were also sampled. The samples were frozen and no further analysis was performed on those samples.

- **Evolution of red wine phenolic profiles during barrel maturation**

  Wine from six new barrels which had been coopered to be as homogeneous as possible; and wine from six two year old barrels from the same cooper and of the same oak specification as the new barrels, and which had all previously contained exactly the same wine, were sampled monthly. The wine was analysed spectrally using the AWRI phenolics portal for colour (total pigments), tannin, and total phenolics, according to the method described by Dambergs (2012).

- **Metagenomics study as on the genetic diversity of wild wine fermentations**

  Internal transcribed spacer (ITS)-specific PCR was performed using degenerate ITS priming sequences as described by Bokulich and Mills (2013). Data analysis was completed using custom bioinformatics pipelines and the USEARCH (UPARSE) clustering package (Edgar 2013).

- **Formation and fate of sulfidic off-aromas in bottled red wines**

  Winemaking, gas treatments and bottling were as described in McRae et al. (2014). Volatile sulphur compounds were determined by gas chromatography with sulphur chemiluminescence detection GC-SCD (Siebert et al. 2010).

6. Results/Discussion:

- **Presentations at the 2013 Australian Wine Industry Technical Conference (AWITC) included**
  one plenary presentation: Creating value from by-products – an industry review and insights into practical case studies by R.A. Muhlack, K.K. Forsyth, N. Scrimgeour, and P.W. Godden; contributions to four workshops: Perfecting Pinot Noir, Practical applications of rapid analytical measurement tools for grapes and wine, The terroirs and tastes of Hunter Semillon, Influences on texture and in-mouth sensory properties of red and white wines;
  and 19 posters.

- Following extensive industry consultation thirteen FPAs were completed and submitted to the GWRDC across the three Nodes, each with a separate detailed budget.

- **Improving refrigeration efficiency to reduce electricity use**
  Refrigeration is by far the largest user of electricity in the majority of wineries which means that improvements to refrigeration efficiency can be expected to result in an immediate improvement to the financial bottom line. In response to this opportunity, a practical spreadsheet-based software tool, the AWRI Refrigeration Demand Calculator, was developed and made available to all Australian wine producers as a free download via the AWRI website. The calculator was developed using data accessed from three large wineries in the Riverina, and three medium-sized wineries in the Hunter Valley. Wine producers are able to enter grape intake and production data to simulate refrigeration demand across the entire annual production cycle, and assess the impact of factors such as cellar storage, cold stabilization temperatures, fermentation conditions, climate, brine temperature, tank size and insulation on refrigeration demand and associated energy costs.

- **Linking sensory characteristics of iconic Hunter Valley Semillon wine to soil type**
  There is a common belief amongst Hunter Valley winemakers that the four main soil types in the region (Red, Sandy Alluvial, Pale Orange with Ironstone and Alluvial Loam) produce fruit and wines with different flavour, style and phenolic profiles. Developing scientific understanding of any such relationships was identified as a regional priority, with broad applicability to other regions and wine types.
  During the 2013 vintage fruit samples were collected from more than 20 different vineyards, and the resultant juices were assessed using phenolically important UV-Vis wavelengths (265, 280 and 330 nm). This initial dataset indicated the existence of correlations between soil types and juice phenolics, and that hydroxycinnamates could potentially be a class of compounds responsible for the differences observed among the resultant wines. This preliminary work provides promise that an objective link between soil and wine characteristics might be made with further study.

- **Evolution of red wine phenolic profiles during barrel maturation**
  A study by the AWRI Hunter Valley node to examine the evolution of the phenolic profile of a 2013 vintage Hunter Valley Shiraz, stored in both old and new barrels. A commercial cooper supplied six new tightgrained, medium toast barriques for the trial, and a Hunter Valley wine producer supplied six four-year old barriques (with identical usage histories) of the same specifications and from the same cooper.

Measurements of tannins, total phenolics and colour (total pigments) were made three times in the grapes pre-harvest; daily during fermentation; at pressing; once during MLF; once at the completion of MLF; and then at least monthly for seven months. The results of this analysis revealed that in both treatments tannin and total phenolics tended to show a gradual increase over the length of the trial. While a more rapid increase in tannin, total phenolics and colour was seen in the wine stored in new oak (especially during the first six weeks after pressing), after six months there was no difference in these measurements between the wines stored in the two oak types.
The results have been summarized in an article in Technical Review (cf. Appendix 1).

- **Metagenomics study as on the genetic diversity of wild wine fermentations**
  Phylotyping metagenomic analysis of fungal composition has been completed on 27 winery samples from 2013 vintage Chardonnay wild ferments using two different markers for the Internal Transcribed Spacer (ITS) region. Both markers led to similar results. The dominant yeast species at the beginning of fermentation were shown to consist of Saccharomyces cerevisiae (multiple distinct strains), S. uvarum, Torulaspora delbrueckii and at least three species of Hanseniaspora. Non-Saccharomcyes yeast were shown to reduce in prevalence during fermentation, with S. cerevisiae being the sole species by mid-ferment. The use of sulfite was shown to also reduce the numbers of non-Saccharomyces yeast, with very high concentrations (150 ppm) totally removing non-Saccharomyces species, while appearing to favour one distinct strain of S. cerevisiae that was found as a minor representative in samples containing low or no sulfite. Lees addition to must prior to wild fermentations had no obvious effect on the ITS metagenomic profiling data.

- **Formation and fate of sulfidic off-aromas in bottled red wines**
  Wines were prepared in 2013 from a single batch of Shiraz fruit using seven different strategies to modify the volatile sulfur compounds (VSCs) in the packaged product. The impact of oxygen treatment during fermentation was studied by sparging triplicate rotary ferments with gas containing different oxygen concentrations (control=no sparging, 40% O2, 20% O2, and 100% N2). The control samples were not treated with any gas and were subjected to three remedial treatments (aerative racking, early and late copper (Cu) addition). The wines were bottled under two different closures, SaranTin and Saranex.
  Anaerobically treated ferments contained higher concentrations of VSCs associated with reductive aromas and lower concentrations of fermentation products. Early Cu addition succeeded in reducing the overall impact of VSCs on wine aroma; however, not to such an extent that their aromas were comparable with wines treated more oxidatively during fermentation. Aerative racking showed little difference compared to the control wines in terms of impact on VSCs, being less effective than both Cu remediation strategies. Wines which had been fermented aerobically showed significantly lower Cu concentrations at the end of fermentation than anaerobically treated analogues The results have been summarized in an article that has been submitted for publication (Viviers et al., cf. Appendix 1).
  After 12 months' bottle ageing, the colour measures and tannin characteristics of the control and N2–treated wines approximated those of the oxygen-treated wines at two months' bottle ageing. Early oxygen exposure resulted in wines with a phenolic composition characteristic of more mature wines, particularly with accelerated development of stable colour and lower tannin conversion. The results have been summarized in a publication in Tetrahedron (McRae et al., cf. Appendix 1).

7. Outcome/Conclusion:

All objectives have been achieved and the Transitionary Activities are complete. Practical outputs of benefit to the Australian grape and wine industry include presentations at the 2013 Australian Wine Industry Technical Conference (AWITC) and extension materials:

- at the 2013 AWITC one plenary presentation was delivered, four workshops were convened and presented, and 19 posters were presented;
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- enhancements to the RTP module on Refrigeration with the addition of case studies developed by the Riverina Node.

Enhanced economic returns and profitability:

New knowledge about copper additions and oxygen management in red wine ferments with rotary fermenters has the potential to positively impact on wine quality through reduced concentrations of undesirable VSC; it may also improve the utilisation of existing winery fermentation assets.

8. Recommendations:

- The successful completion of the metagenomics proof of principle study demonstrates the genetic diversity of wild wine fermentations; it highlights the potential of next generation sequencing and opportunities from metagenomics for characterising biological communities at a population level.

  An immediate opportunity exists for AGWA to co-invest into AWRI project 3.2.1 (Are there regional microorganisms, and can they be harnessed to produce regionally distinct wine styles?) as research to better understand Australia's unique terroirs and how they influence wine style expression has been identified as a key industry priority in AGWA's discussion paper for their 2015-2020 strategic plan. An important aspect of regional expression, particularly where spontaneous fermentations are performed, may be due to regional wine microorganisms. Metagenomics approaches provide a unique opportunity to identify if specific 'wild' strains of yeast and bacteria reside in specific vineyards, on grapes or in soils, or are linked to geographic or climatic zones.

  Futhermore, metagenomics analysis of DNA samples has the potential to spur the development of novel tools for quantifying genetic variation in grapevine diseases. Potentially, significant benefits for grapegrowers can be realized through improving the management of fungicide resistance through metagenomics based tools as proposed in projects AWRI 1.3.1 (Understanding genetic variation in grapevine diseases) and SARDI 1204 (Understanding fungicide resistance in powdery and downy mildew).

9. Appendix 1: Communication

Outcomes of this Project have been communicated through articles in peer-reviewed and industry journals, via the AWRI's Annual Report, website and Technical Review, and at the 2013 AWITC in Sydney.

Fact sheets, case studies and calculators relating to heat transfer and refrigeration, bioenergy, cellar storage temperature, and heat and cold stability were created or updated for the AWRI website (www.awri.com.au).

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10. Appendix 2: Intellectual Property:

Nothing additional to report.

11. Appendix 3: References

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12. Appendix 4: Staff

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