Challenging climatic, market and economic conditions have been front and centre for the Australian grape and wine industry over the past year, with many producers across Australia feeling the strain. Impacts of the supply/demand imbalance are being felt across our industry, with effects across different regions and business scales. As the industry's own R&D organisation, the AWRI's purpose is to support producers in dealing with current and future challenges.

At the AWRI this year we continued to develop and implement actions under our strategy, which has the overall goal of transforming our organisation to ensure it has a sustainable future. Industry engagement was deepened through activities such as consulting with different parts of industry for 'impact' projects, collaborating with diverse grower communities, and developing case studies from sustainable growers and winemakers. We are making improvements to our knowledge transfer activities based on insights from psychology and behavioural science. Our scientists continue to make advances in grape and wine science and to publish the outcomes of their research in high-impact peer-reviewed journals. The research team is also challenging itself to push into new areas, always with a focus on solving industry problems or supporting improvements in profitability or sustainability across the Australian wine sector.

WINE AUSTRALIA INVESTMENT AGREEMENT

This year was the first year of a new four-year investment agreement with Wine Australia (2022-2026), signed in June 2022. Projects under this new agreement fall into three categories: 'extension & adoption', 'insights' and 'impact'. The first two categories are similar to earlier projects, and progressed well during the year. The impact category is new and requires a different way of working, to co-design projects with industry. During the year, AWRI teams worked on the co-design process for three impact project areas: no- and low-alcohol (NOLO) wine production, sustainability, and wine production and quality.

BOARD CHANGES

This year saw the completion of Louisa Rose's maximum term of twelve years on the AWRI Board, eight of which were spent as Chair. Louisa's contribution to the AWRI over that period cannot be overstated. After six years on the Board, Prof. Kiaran Kirk was re-appointed as a Director and elected to the role of Chair following the end of Louisa's term. Kiaran is Dean of the College of Science at the Australian National University in Canberra and Chair of the Board of Clonakilla Wines, his family's winery in the Canberra District wine region.

SUSTAINABILITY AND ESG IN FOCUS

Sustainable Winegrowing Australia saw substantial membership growth in 2022/23, reaching 1,227 members, up from 933 in 2021/22 and 479 in 2020/21. The proportion of certified members also grew significantly to almost 50% of the overall membership. During the year the AWRI increased its own focus on Environmental, Social and Governance (ESG) priorities, with the launch of an ESG committee and inclusion for the first time of ESG reporting in the Annual Report.

AFFINITY LABS

Affinity Labs continued to develop new services, new partnerships and new ways of reaching customers across Australia during the year. A strategic partnership with Campden BRI in the UK, signed in March 2023, is supporting the expansion of food and beverage testing in Australia and wine testing in the UK.

Across Australia, Affinity Labs is building a network of sample drop-off points that will make it easier for customers in regional areas to get their samples to our laboratories, improving turnaround times and access to services.

NOLO ADVANCES

This year the NOLO trial-scale research facility, featuring a research-scale spinning cone column, opened at the Hickinbotham Roseworthy Wine Science Laboratory on the Waite Campus. The facility was funded by a $1.98 million grant from the Government of South Australia, through the Department of Primary Industries and Regions, and is operated by the University of Adelaide and AWRI through WIC Winemaking Services. In addition, the AWRI and the University of Adelaide were research partners in a successful CRC-P bid that brings Australian Government funds to support a consortium of industry stakeholders to undertake industry-focused NOLO research.

TECHNICAL TRENDS FROM THE AWRI HELPDESK

As in previous years, the queries received by the AWRI helpdesk were strongly influenced by weather conditions during the growing season and vintage. The cooler and wetter weather conditions, along with high soil moisture content, delayed flowering in many regions, resulting in a late harvest. Pest and disease pressures were also increased during spring and early summer. Growers in several regions requested information and assistance regarding 'mothballing' or 'resting' vineyards, as a way of addressing the impacts of oversupply pressures.

LOOKING TOWARDS VINTAGE 2024

Winter 2023 was much drier than normal for Queensland and the east coast, and wetter throughout South Australia and Victoria. Water reserves are still high following three years of wetter conditions. It seems likely that the upcoming season will see drier and hotter conditions than have been experienced over the past three seasons. Concerns about water availability and bushfires are likely to take over from more recent issues of flooding and disease pressures. While the smaller 2023 vintage may have lessened some of the oversupply issues our industry is grappling with, profitability concerns remain very real. AWRI is committed to continuing to support producers in dealing with the challenges they are facing.

CUSTOMERS, CONSUMERS AND MARKETS

CONSUMER RESPONSE TO HIGH-PROLINE WINE BLENDS

Wines from a structured blending experiment combining a low-flavour Cabernet Sauvignon, a high-proline Cabernet Sauvignon (both from a warm inland region) and a high-colour, high-tannin Lagrein were assessed by 126 regular red wine consumers. Blends of the low-flavour wine with the high-proline wine were more liked than the blends with the high colour, tannin and flavour blend component. This highlights the potential for wine producers, particularly in warm inland regions, to target proline-rich grapes and wine for enhancing perceived sweetness, viscosity and flavour intensity, while masking unwanted bitterness and excessive astringency.

NEW AGROCHEMICAL OPTIONS

Project staff worked with chemical suppliers to identify active constituents that are not currently registered for use in viticulture, but which might be useful if registration could be obtained. This resulted in three chemical companies identifying an active constituent that might be applicable in viticulture to control a pest or disease problem.

DELEGATION TO INDIA

The AWRI participated in an Australian trade delegation to India to attend the first India-Australia Wine Regulatory Forum. The delegation focused on building technical links and understanding between the two countries' wine industries and developing a common regulatory framework. The group also participated in the first Australia-India inter-governmental joint dialogue on wine, where two working groups were launched. The first will review the barriers to wine trade between the two nations and the second will work towards developing an Indian Wine Research Institute on similar lines to the AWRI and promote other opportunities for knowledge sharing.

EXPANSION OF SMOKE ANALYSIS RING TEST

A pilot study testing the variation between international laboratories measuring smoke markers in grape material was completed, demonstrating the effectiveness of using freeze-dried homogenate as a stand-in for fresh grape material. The success of this pilot study has led to the funding of a major proficiency testing round for 20 international laboratories, across four continents, comparing their analysis of smoke markers in grape material.

EXTENSION, ADOPTION AND EDUCATION

NEW BEHAVIOURAL SCIENCE CAPABILITY

The AWRI now has a behavioural scientist on staff to support the design, evaluation and monitoring of projects, drawing on insights from education, psychology and cognitive neuroscience. This new capability is enhancing the quality of extension, adoption and practice change programs, ensuring they achieve the greatest possible impact in industry.

FOLIAR SPRAYING PRACTICE CHANGE PRIORITY

A third practice change priority, on the use of foliar sprays to increase flavour potential in grapes, commenced this year. Four producers participated in vintage trials, resulting in wines from different regions that will be used in workshops in the second half of 2023.

EVENTS AND WEBINARS

Five roadshow seminars and four workshops were delivered in 2022/23. Three workshops provided practical training on spray application and the fourth covered content from two current practice change themes: aeration of ferments and foliar spraying to boost tropical flavours. Twenty webinars were presented to a total of 1,667 attendees, with the most popular webinar topic being regenerative viticulture. There were also 13,400 views of this year's webinar recordings on the AWRI YouTube channel.

AWRI AND AFFINITY LABS WEBSITES

More than 228,750 visitors accessed the AWRI website during the year (5,000 more than previous year) resulting in 631,560 page-views. New and updated technical content on the AWRI website covered topics including managing waterlogged vineyards, grapevine viruses, yeast propagation, vineyard disease assessment, *Brettanomyces* and NOLO winemaking. A total of 16,720 users visited the new Affinity Labs website and it received 190,210 pageviews.

PODCASTS

The second series of 'AWRI decanted' was completed during the year, with six episodes released between July and September 2022. Episodes covered topics in viticultural research and highlighted practitioners who were putting the research into practice in their businesses. All episodes of the first two series of 'AWRI decanted' are freely available via podcast apps.

HELPDESK SUPPORT

During 2022/23, the AWRI helpdesk responded to 1,976 wine and viticulture enquiries and conducted 153 investigations. Viticulture query numbers were higher than average for the second year in a row, in part due to the cool and wet conditions driving queries on the control of pests and diseases. Queries on winemaking practices were also elevated, covering a wide range of topics including skin contact for white wines, yeast culture propagation, aeration of ferments and production of NOLO wines.

LIBRARY SERVICES

In 2022/23 the library responded to 1,321 reference and information requests, and provided a total of 2,592 non-open access articles, an increase of 54% from the previous year. Ongoing efforts to provide direct links to articles available from publishers' websites resulted in users accessing 2,739 open access articles from various online tools on the AWRI website. In total, 5,331 articles were provided or accessed in 2022/23.

SHOWRUNNER

Forty shows totalling approximately 17,000 entries used the ShowRunner platform in 2022/23. The system now operates as a web-based platform with options for shows to self-run the software and for the ShowRunner team to deliver support remotely.

NEW WAYS TO INFLUENCE 'FLINT' OR 'STRUCK MATCH' AROMAS

Phenylmethanethiol (PMT) and 2-furylmethanethiol (2-FMT) have been shown in previous work to contribute to 'flint' or 'struck match' aromas in wine. Small-scale trials in Chardonnay confirmed that diammonium phosphate (DAP) additions and choice of commercial wine yeast strains affected the formation of PMT. This work is now being expanded to large-scale trials including an industry trial. The effects of post-fermentation treatments on PMT and 2-FMT concentrations were also assessed in Chardonnay. American and French oak chips significantly increased the concentration of 2-FMT, and high levels of SO_2 addition at bottling produced the greatest PMT concentration.

SURVEY OF OAK-RELATED AROMA COMPOUNDS IN PREMIUM WINES

A survey of barrel-fermented and/or barrel-aged commercial premium Australian Shiraz, Cabernet Sauvignon, Pinot Noir and Chardonnay wines assessed the prevalence of compounds that have been proposed as barrel-ageing markers: oak lactones, volatile phenols, furanones, aldehydes, thiazoles, PMT and 2-FMT. Several new methods were developed or improved to help produce accurate quantitative data. This work is providing insights on under-studied positive characteristics in wine (e.g. 'caramel', 'red berry' and barrel fermentation-related flavours) and will help direct future projects, based on industry priorities.

SMOKE TAINT PUBLICATIONS

Two key papers from earlier smoke taint research were published this year. The first links results from grape analysis to the likelihood of perceptible smoke characters in wine and confirmed that the current suite of 13 smoke exposure markers in grapes can predict smoky flavour in wine. This is particularly valuable as the results allow the risk of smoky characters developing in wine made from smoke-exposed grapes to be assessed. The second paper reported on three consumer studies which clearly showed that smoke characters in wine negatively affected consumer liking, across different wine styles.

'RAISIN'/'JAMMY' FLAVOUR IN SHIRAZ AND OTHER RED GRAPES

Chemical markers associated with overripe flavours in Shiraz were found to be increased in Shiraz grapes with later harvest dates, but not necessarily related to temperature or extent of shrivel.

With the focus previously being on shrivel, which is particularly observed in Shiraz grapes, this study was expanded in vintage 2023 to understand the presence of overripe-related compounds in non-Shiraz red grapes, including Cabernet Sauvignon, Merlot and Durif.

GENETIC ANALYSIS OF VINEYARD SCALE INFESTATIONS

Metagenomic techniques were applied to understand the ecosystem of scale insects, parasitoids and other insect species present in vineyards. Scrapings of scale-infested vines were collected from eight vineyards across South Australia and subjected to whole-genome sequencing. The species *Parthenolecanium corni* was found to be a significant member of the scale infestations, confirming empirical observations of scale with two or more cycles of offspring per year within Australian vineyards. This will have significant implications for the development of control strategies for this group of pests.

UNDERSTANDING COLD STABILITY IN RED WINES

Studies of cold stability during fermentation and ageing showed that red wines invariably lose a significant quantity of unstable potassium bitartrate early in fermentation, and naturally cold stabilise. Losses of monomeric anthocyanin with ageing may contribute to minor changes in cold stability over time.

PLASMA TECHNOLOGY TO IMPROVE MEMBRANES

Plasma technology offers the capability to alter the characteristics of filtration membranes, including their charge, roughness and hydrophobicity/hydrophilicity, enabling precise control of their surface properties. This opens up avenues for the development of innovative and improved membranes for use in beverage processing.

APPLYING CRISPR TO IMPROVE YEAST TRAITS

CRISPR technology represents a significant advancement in genome editing that, under specific conditions, can be used under a non-GMO framework. CRISPR was successfully applied in commercial wine yeast strains to introduce novel biochemical pathways allowing production of high amounts of desirable flavour and aroma compounds during fermentation.

NEW FACTOR IN DIACETYL PRODUCTION DURING CO-INOCULATED MLF

Elevated concentrations of the 'buttery' compound diacetyl were produced when *Oenococcus oeni* was co-inoculated with high SO_2-producing strains of *Saccharomyces cerevisiae*, suggesting that SO_2 may be a potential mediating factor in diacetyl production. The wines with high diacetyl concentrations were found to exhibit 'buttery' characters by a sensory panel.

GENETIC LINKS BETWEEN SO_2 TOLERANCE AND COPPER SENSITIVITY IN WINE YEAST

Previous work identified a negative association between SO_2 tolerance and copper tolerance in *Saccharomyces cerevisiae* wine yeasts, meaning that many SO_2-tolerant wine yeasts tended to be sensitive to elevated copper concentrations. A gene that mediates SO_2 tolerance in wine yeast was identified as contributing to sensitivity of yeast to elevated copper concentrations. It also suggests that selection for moderate SO_2 tolerance might be a preferred strategy for breeding yeast strains with broad stress-tolerance traits.

ENVIRONMENT, SUSTAINABILITY AND NATURAL CAPITAL

NATIONAL PICTURE OF AUSTRALIA'S SUSTAINABLE WINE PRODUCTION

The sustainability team provided nationally aggregated data and worked with Wine Australia to deliver the second annual Sustainable Winegrowing Australia Impact Report.

UPDATED LIFE CYCLE ANALYSIS FOR AUSTRALIAN WINE

Aggregated and de-identified data from Sustainable Winegrowing Australia was used to update the life cycle analysis for Australian wine originally conducted by the AWRI in 2016. This analysis, published in the *Wine & Viticulture Journal*, also informed the wine industry's Emissions Reduction Roadmap developed by Wine Australia.

REFERENCE GENOME FOR SHIRAZ

A reference genome for Shiraz, the most-planted grapevine variety in Australia, has been produced. This has provided a detailed view of the genetics that underpin this cultivar, including the discovery of a specific combination of genetic variants linked to the production of the 'peppery' compound rotundone.

GENOME SEQUENCING OF AUSTRALIAN GRAPEVINE GERMPLASM

Genome sequencing has been performed for more than 800 grapevine samples across 23 varieties. This represents the majority of clones from the main suppliers of grapevine germplasm in Australia. Clustering of samples using unique DNA fingerprints has produced detailed maps of clonal-specific DNA variation that can be used to identify specific clones within each cultivar.

FURTHER OPTIMISATION OF AUTONOMOUS VEHICLES FOR VINEYARD WEED CONTROL

Testing of autonomous vehicles for weed control in vineyards continued. The tractor fitted with an autonomy kit last year was successfully tested on longer runs (~50 km). Additional sensors on implements and a camera system that detects people and obstacles boosted overall performance and safety. An autonomous weeding robot and autonomous lawnmowers were also trialled, but both were found unsuitable for use in Australian vineyards.

FOUNDATIONAL DATA AND SUPPORT SERVICES

AFFINITY LABS

Affinity Labs had a strong year despite the wine industry facing difficult market conditions. Total sample numbers for 2022/23 (23,094) were 15% lower than the three-year (2020 to 2022) average (27,166), reflecting the overall reduction in the Australian crush, which was around 26% lower than the long-term average. Customer numbers grew by 136, a 20% greater increase than last year.

SPIRITS BENCHMARKING

Affinity Labs delivered a benchmarking study comparing the sensory and chemical make-up of a range of commercial whiskeys from around the world. This program grouped the various products by their sensory and analytical characteristics, giving an understanding of how they differed and which compounds were responsible for these differences. Going forward this will be an important tool for local producers as it will enable them to benchmark their own products as well as modify production practices to target specific market segments and product outcomes.

NEW LIPIDOMICS CAPABILITY

Metabolomics SA now offers a lipid profiling service, thanks to the commissioning of a new high resolution mass spectrometer. The analysis targets 21 different classes of lipids and is applicable to multiple matrices. Lipids are an important component of plants, food and animals, and cover a variety of functions such as energy storage, nutrient transport, regulation and signalling, making their analysis an important part of understanding any biological system.

CITIZEN SCIENCE IDENTIFYING NEW YEAST STRAINS

At the end of its second year, AWRI's citizen science project 'Yeast catchers' has worked with more than 2,000 student scientists from more than 50 schools in six states and territories. Over 6,000 individual yeast isolates were assessed to determine their species using DNA-based microbial profiling techniques. At least 89 species of yeast were identified across 32 genera.

Readers are encouraged to read the annual report in detail rather than relying on the brief details provided here. The full report can be found on the AWRI website: **www.awri.com.au**.

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Extracts of artwork 'kaaruyarta – vineyard' by Allan Sumner – Kaurna Ngarrindjeri Yankunytjatjara Artist, April 2023.

Photography: Jacqui Way Photography

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