Australian Government

Australian Grape and Wine Authority

Wine Australia

Gaps analysis for 2015–16 investment priority of digital viticulture

The Australian Grape and Wine Authority Strategic Plan 2015–20 identifies digital viticulture as a priority research and development (R&D) topic for the Australian wine sector

Background

'Digital viticulture' is a term used to describe the development and deployment of digital technologies in viticultural research and their delivery to end users. It includes approaches that use remote sensing, decision support systems (and associated input and output data), technologies to sense and control the vineyard environment and the use of various 'omics' in plant and microbial biology. The concept extends from pre farm-gate, through to supply and logistics, consumer tracking of products and environmental and sustainability reporting at vineyard, region, and national scales.

Within Strategy 3: *Building Australian vine and wine excellence* in the *Australian Grape and Wine Authority Strategic Plan 2015-20*, digital viticulture initiatives are a component of the *Grapegrowing for Excellence* program. Measures of success for the program include:

- The availability of new viticultural approaches or tools to help growers optimise grape production towards desired quality targets, preferred wine styles and premium price points.
- Development of digital tools to capture and interpret the information in large data sets to drive quality improvements.
- Quality improvements driven by new tools that draw on the benefits of recognition technologies, robotics and/or systems engineering.

Situation analysis

This paper is drawn from consultations with industry practitioners and from a workshop held at the Wine Innovation Cluster (Urrbrae, South Australia) in December 2014, to review current knowledge, identify practices that are currently being employed within the wine sector and to identify industry needs. A key aim was to identify high priority areas for future R&D investment. This paper seeks to guide potential research providers on where R&D can deliver best gains in decision-making effectiveness and profitability in the vineyard.

Accurate measurements of key crop parameters in the vineyard and rapid delivery of information to growers and wineries will provide better decision making tools to maximise fruit quality, control input costs, facilitate management of fruit yield and enable better harvest logistics and fruit grading decisions at the winery. There has been a rapid increase in capacity to obtain information from within vineyards on a wide range of factors important to managing inputs such as labour, water, chemicals and fertiliser, and to achieve desired fruit composition. In addition to advances in Precision Viticulture, new and developing technologies provide opportunities to establish image based accurate yield forecasts, measures of fruit ripeness and disease damage and sensors for water management.

Broader advances in sensing technologies, vision systems and image analysis, and their eventual integration with mechatronic platforms provides a pathway to the development of automated (robotic) systems suitable for use in the vineyard. Intelligent robotic systems of this kind will offer alternatives to current labour-intensive vineyard tasks, such as pruning, shoot positioning / thinning, harvesting, spray applications etc. in the future.

The ability to stream information from sensor-based systems brings with it the issue of storage and analysis of large data sets and, importantly for industry, the delivery of this information in simple, smart ways to assist management decisions and improve profitability.

Priority areas for investment

Two priority areas for immediate investment have been identified:

1. **Simultaneous yield, crop condition and quality estimation and forecasting**
2. **Dynamic canopy, disease and water management**

Current research efforts nationally and internationally within these areas tend to have a single focus e.g. yield estimation or autonomous system (robot) development etc. There are potential advantages in developing simultaneous yield, crop quality and condition estimation and forecasting, and to develop dynamic measures to manage canopy size and structure, water and disease control.

Potential project activities within these two priority areas are described below. There is already activity in some of these areas; in this case, we are looking for projects to extend existing work.

1. Simultaneous yield, crop condition and quality estimation and forecasting

- Develop high-resolution proximal sensing tools, mountable on vineyard vehicles, or potentially using an aerial platform, to provide rapid and representative estimates of:

  (a) Fruit load at various stages in the crop cycle
  - Non-destructively separate fruit, canopy and wood at all stages of development
  - Estimate bunch number and berry number

  (b) Fruit maturity/composition assessment late season (pre-harvest)
  - Focus on non-destructive sugar and colour measurements for maturity variability assessment, but where possible, augment by addition of other objective chemical measures of quality.

  (c) Fruit condition assessment late season (pre-harvest)
  - Utilise non-destructive sensing systems to quantify fruit disease incidence e.g. mildew, botrytis, and physical defects, e.g. sunburn and fruit shrivel.

  In each case:
  - Providing a basis for a desktop and mobile tool that combines proximal sensing data including vineyard spatial variability information with mathematical approaches to provide a robust estimate of yield, fruit quality and fruit condition for the block, utilising minimum data inputs.
  - Including validation using sampling protocols proven to provide near real-time estimates of yield, fruit maturity/composition and fruit condition for the block.
- Develop non-destructive techniques to measure bud fruitfulness and hence estimate the potential fruit load well in advance of the season. This will require research to non-destructively identify buds with inflorescence primordia to provide a basis for quantitative assessment of bud fruitfulness.
- Develop a spatially astute economic modelling tool to address the question of how much within-block variability in yield, fruit quality and fruit condition is required to justify separate treatment at harvest on an enterprise-specific basis or adoption of other precision management practices to minimise variability.
- Model and project crop condition decline as a result of defined adverse weather events and the trade-off between meeting ‘preferred / ideal’ fruit condition and earlier harvest, interventions or crop rejection; similar analysis in seasons of compressed harvest can be used to evaluate potential impacts of delayed harvest, including excessive maturity and higher than desirable wine alcohol contents.
- Combine remote and proximal data with desktop modelling and predict crop yield at the enterprise, regional and industry wide scales.
- Adapt technologies for within-vineyard assessment of fruit condition to assessment at the weighbridge e.g. extent of diseased or shrivelled fruit, material other than grapes (MOG) and pre-fermenting fruit by detection of volatiles.

2. Dynamic canopy, disease and water management

Canopy and disease management

- Develop a ground-based proximal sensing method for estimating canopy leaf area and structure at regular intervals during a season that is superior to remote sensing methods.
- Develop a computer based method that converts canopy leaf area and structure data to a form that can be compared with benchmark desired values for specific time points during a season as a prompt for intervention decisions.
- Integrate dynamic canopy leaf area and structure monitoring data with climate data and disease forecasting models to assist with timing of spraying decisions.
- Investigate potential induced volatile or other chemical or reflectance signals indicative of early fungal infection or pest incidence that can be detected non-destructively by sensors.

Water management

- Establish whether variation in crop stress (e.g. canopy temperature and allied environmental measurements) can be quantified in the context of variable ability of the soil to provide water; determine spatial variability in vine water status as a basis for devising management options for greater uniformity.
- Develop a dynamic plant-based measure of vine water status, using non-contact sensing, to integrate the range of vineyard variables that affect vine performance through water use and provide an index-based system to assist vineyard irrigation management, with the level of precision and control required to be based on desired product outcomes.
- Identify crop physiological indicators that can be determined by proximal or remote sensing, to be used as an early warning system for preventing catastrophic canopy senescence and fruit death (shrivel) due to water stress.
- Assess the potential for low frequency use of EM38 or other sensors e.g. non-destructive plant water status sensors, to calibrate individual, fixed position soil moisture sensors recording at high frequency for application in making informed decisions in regard to whole blocks or blocks at other locations on the farm.
- Liaise with water supply organisations and commercial entities to assess potential for development of secure computerised (desktop and mobile) control of water pumps and irrigation scheduling that accurately measures water and electrical inputs that may provide a basis for water and electricity trading between enterprises in a region.

Next steps

Wine Australia is looking for R&D proposals that address industry priorities and satisfy the following criteria:

- lead to industry relevant outcomes in a timely manner
- involve appropriate collaboration
- represent good value for money, including appropriate co-contribution
- are novel and feasible

Key dates

Preliminary Project Applications (PPAs) due	Friday 14 August 2015
Final Project Applications (FPAs) invited	Friday 4 September 2015
FPAs due	Friday 2 October 2015
Applicants advised	late November 2015
Contracting	December 2015
Projects start	January 2016