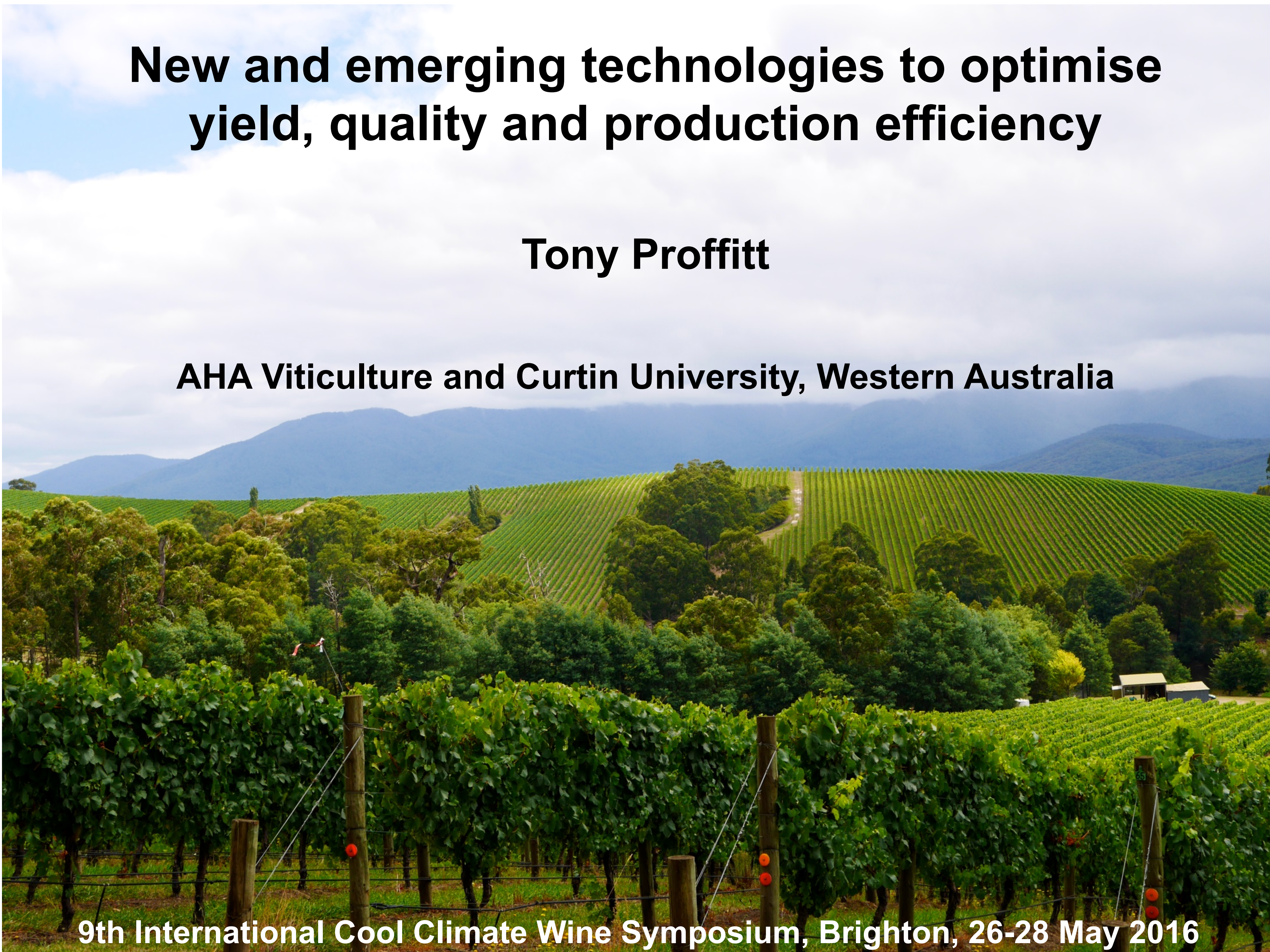


New and emerging technologies to optimise yield, quality and production efficiency

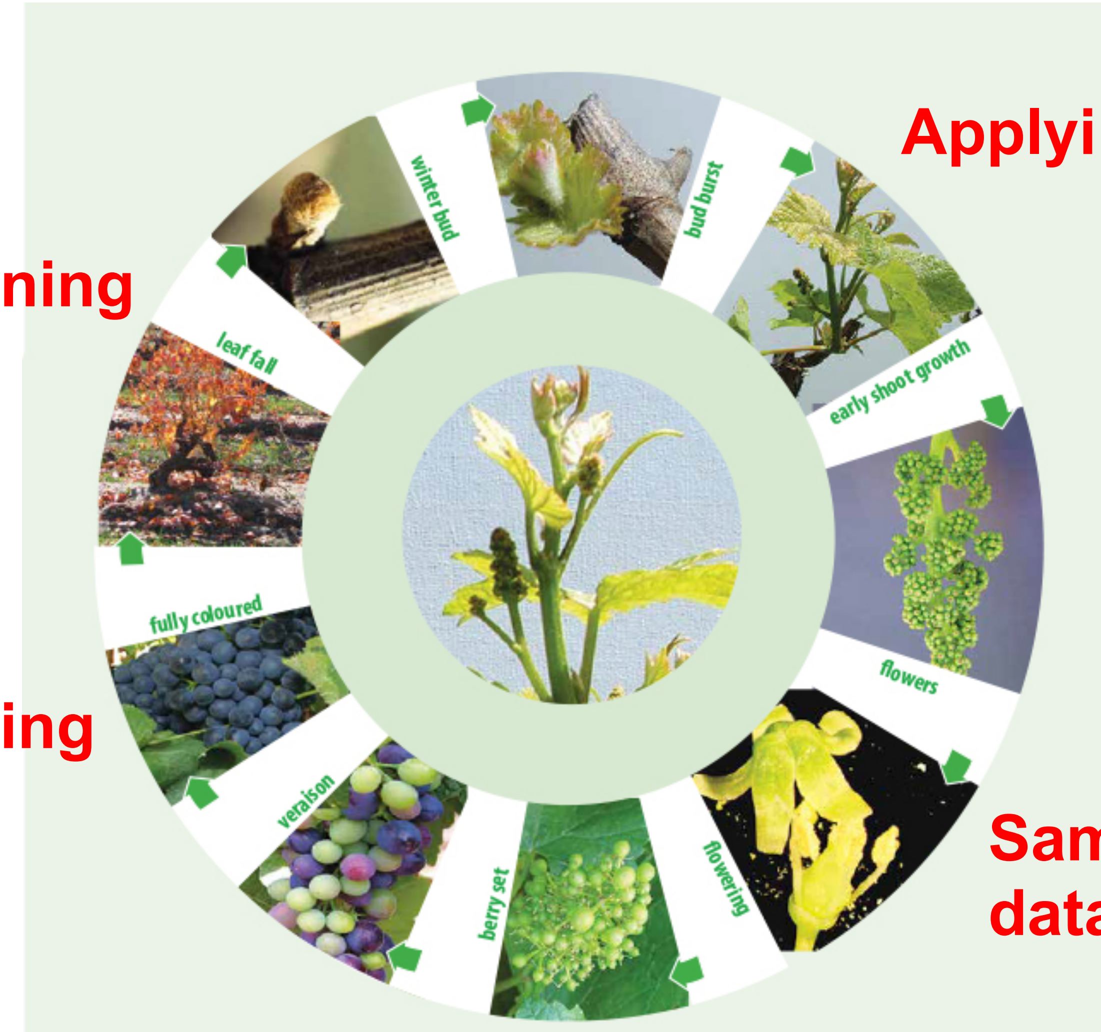
Tony Proffitt

AHA Viticulture and Curtin University, Western Australia

9th International Cool Climate Wine Symposium, Brighton, 26-28 May 2016

Pruning

Applying inputs



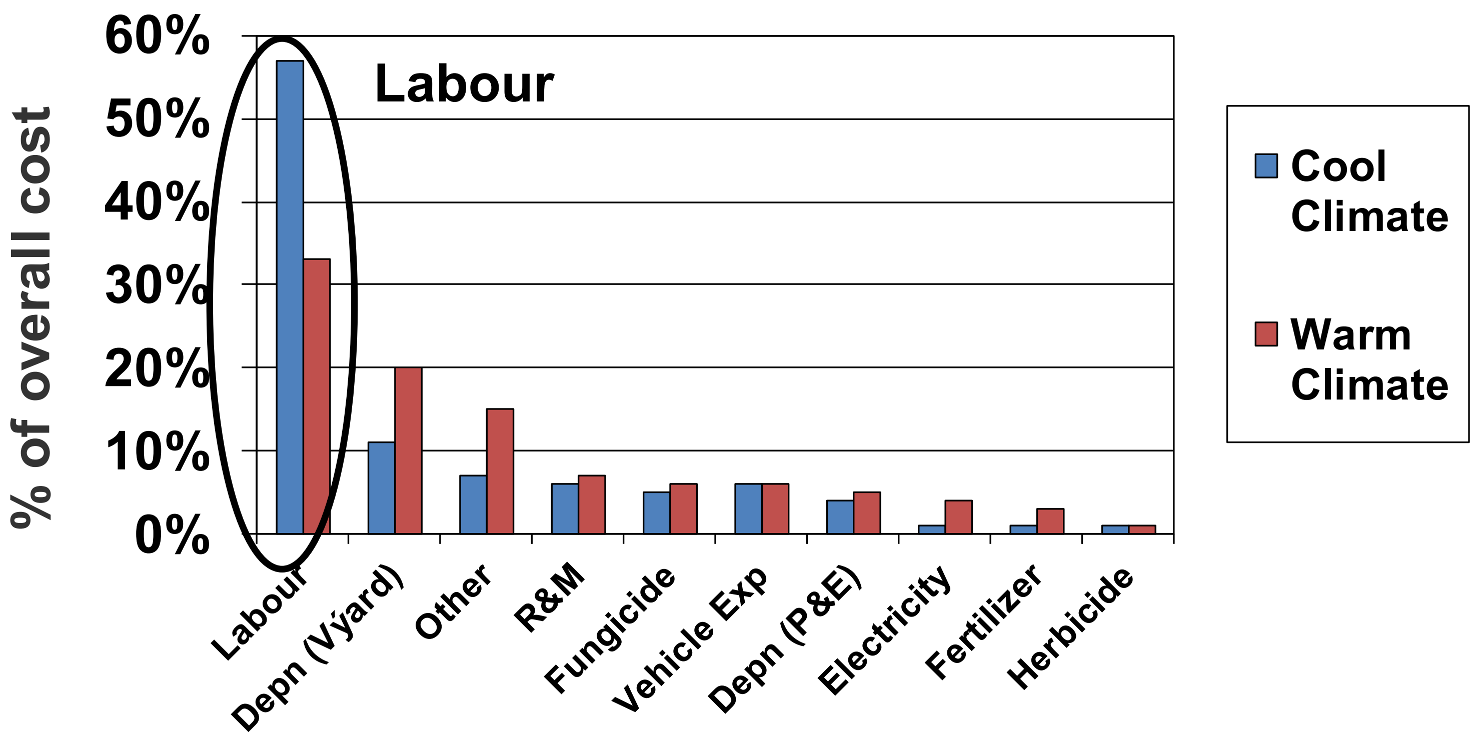
Harvesting

Sampling and data acquisition

Winter pruning

•Generally the most expensive and important seasonal activity

•High cost is related to the labour input
Australia: labour represents ≈ 60% of annual budget in cool climate vineyards compared to ≈ 30% in warmer regions. Mechanisation and automation helps to reduce this cost



Courtesy of B. McClen, Brown Brothers

BROWN BROTHERS Est. 1889

KLIMA mechanical cane-stripper – a New Zealand innovation

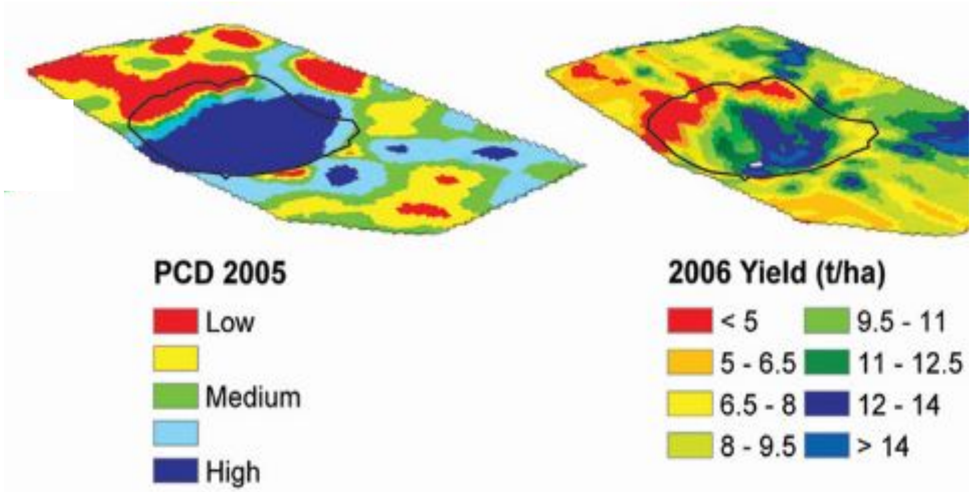
•Fruiting wire lifted and unwanted vine material cut, stripped and mulched
Wire is re-attached by hand and replacement canes wrapped down

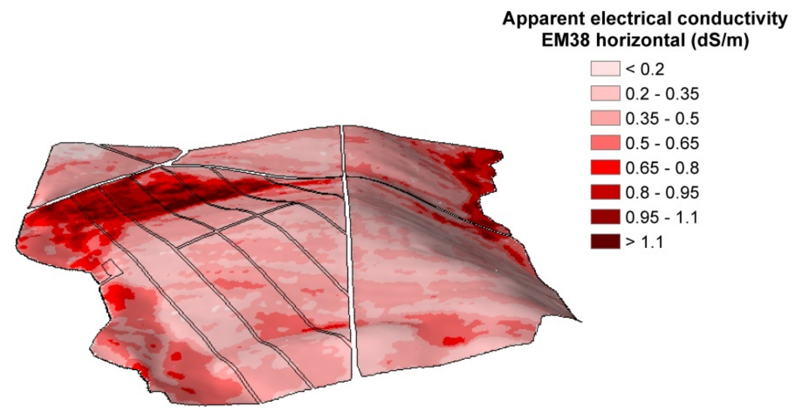
•Cane pruning has become more affordable:
In Australia and New Zealand, costs have been reduced by 30-40%

Applying inputs during the season

Targeted management

- Variation in canopy size, yield, soil characteristics and elevation can be mapped at high spatial resolution

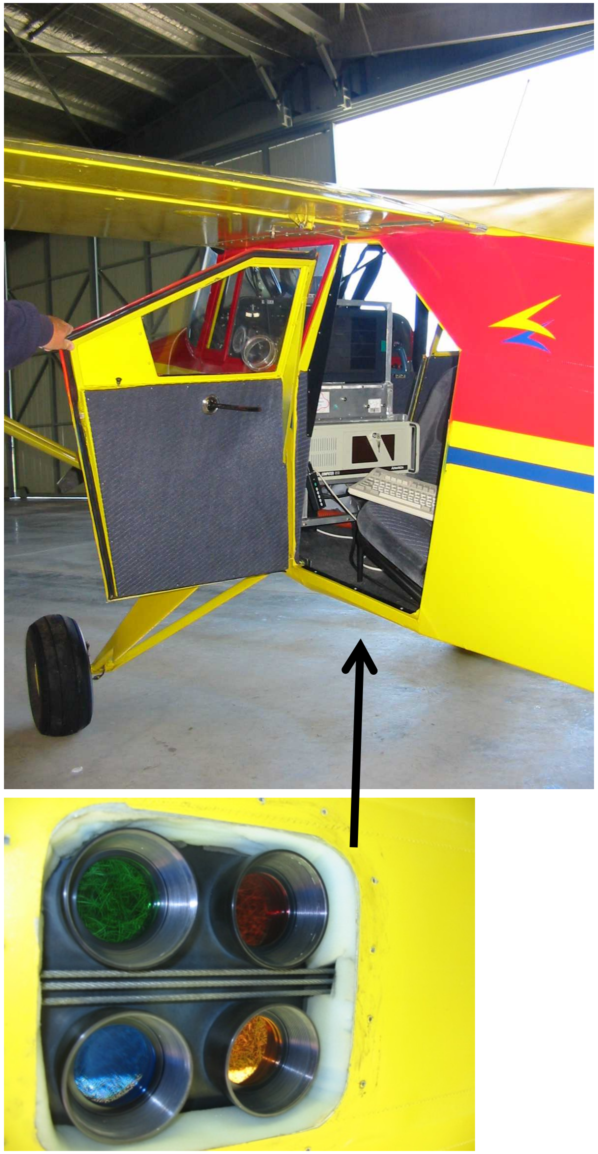




- This information allows inputs (e.g. irrigation water, fertilizers, soil amendments, sprays, labour) to be applied to discrete areas where they are required (i.e. targeted vs uniform management)

Courtesy of R. Bramley, CSIRO

Variation in canopy growth and size can be determined from the air or from the ground using sensors

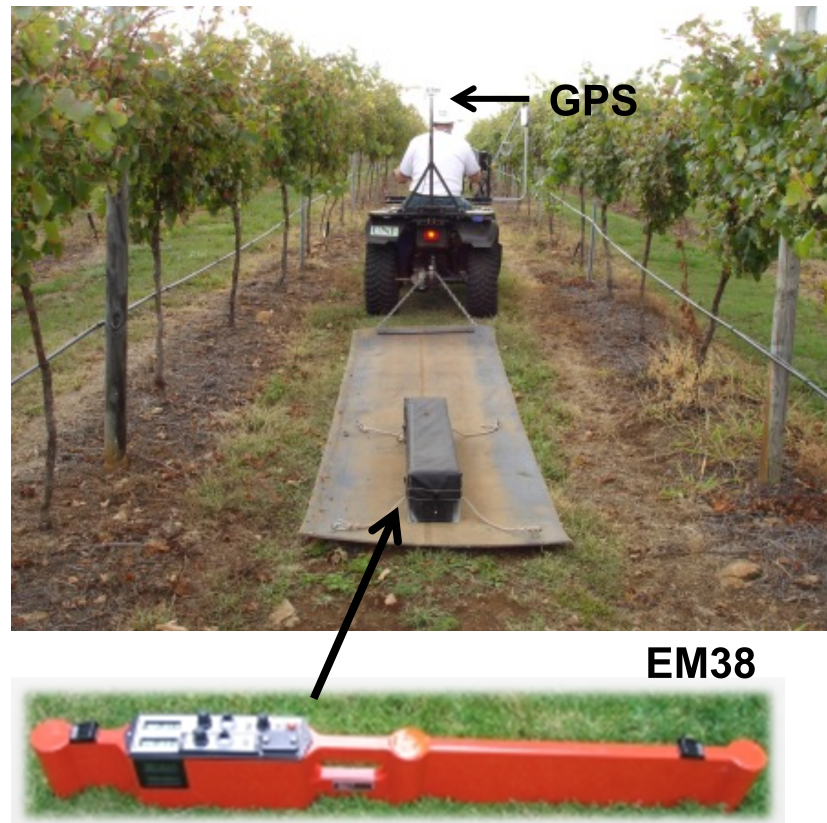


Multispectral camera system and GPS fitted to light aircraft

Sensors attached to a quad bike

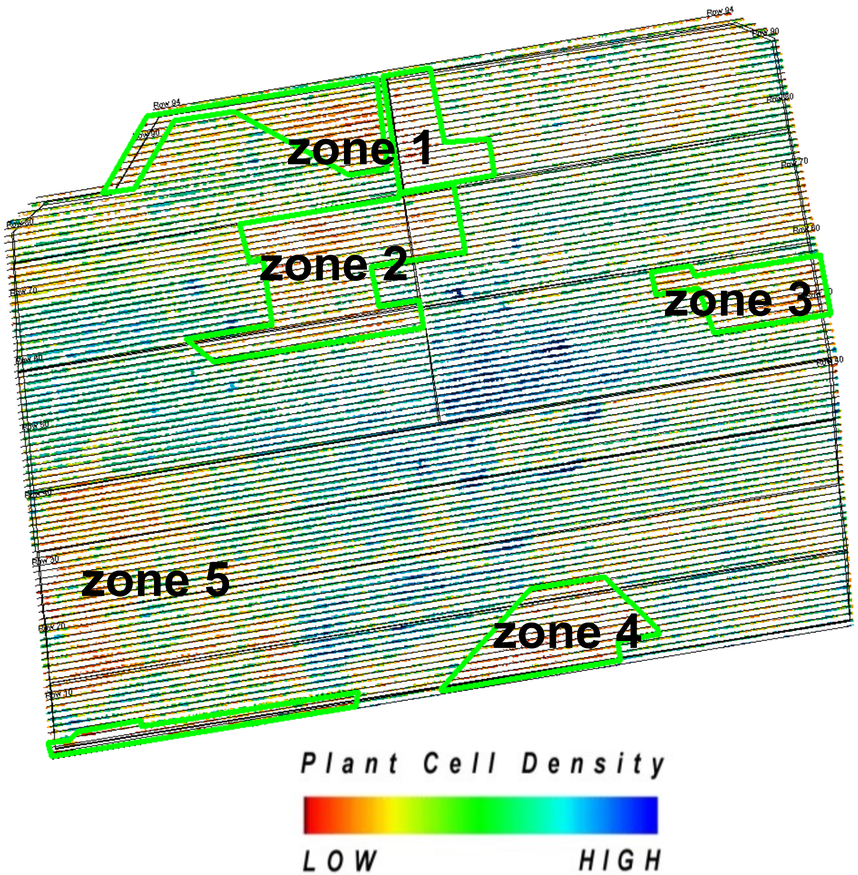
- Variation in yield can be mapped using sensors fitted to mechanical harvesters
- Variation in soil can be mapped using sensors such as the EM38

Weighing platform fitted to mechanical harvester



Targeted mulching

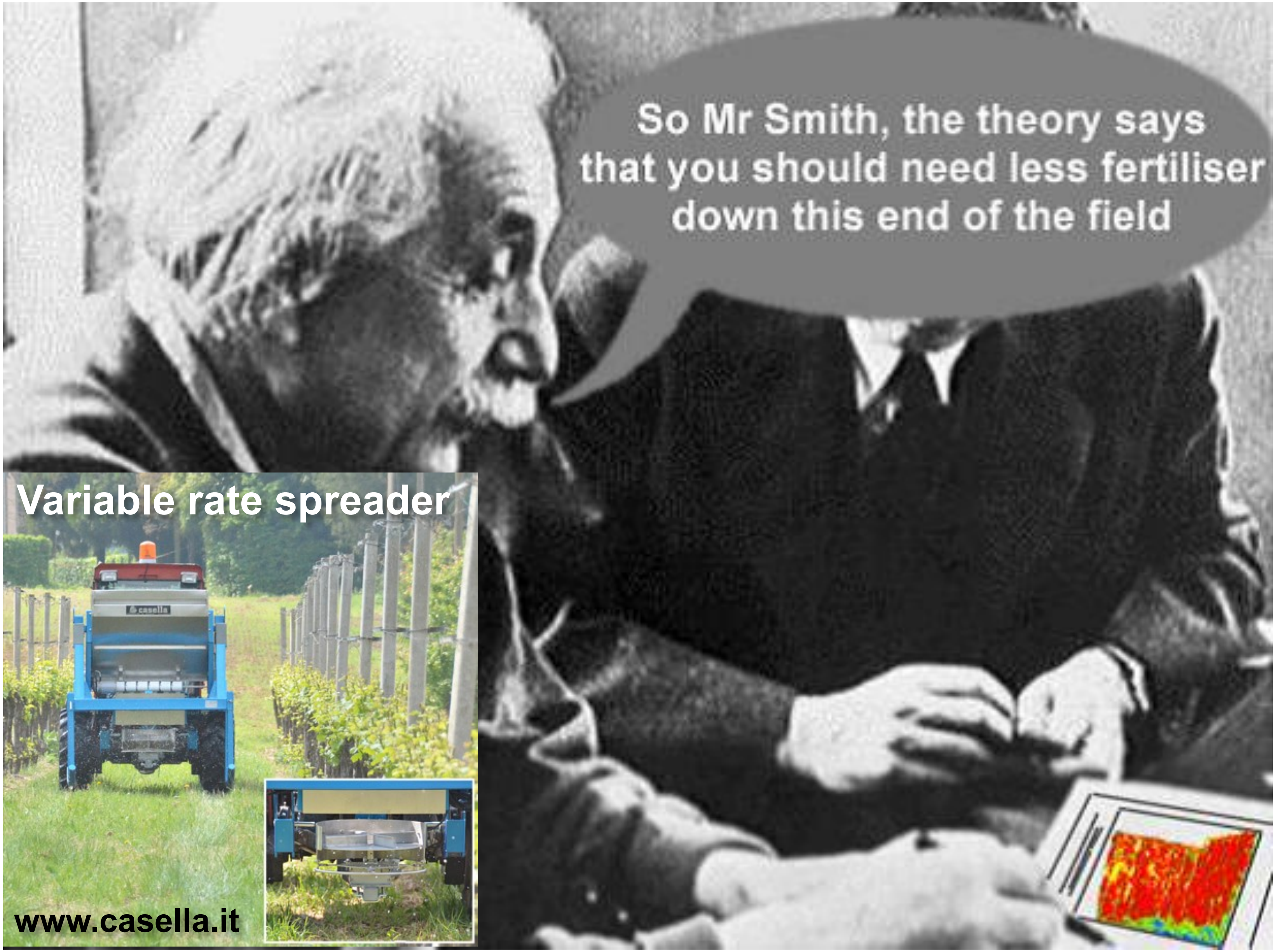
Remotely acquired imagery used to delineate areas with weak vine growth (15% of vineyard)



Maps can be displayed on devices with GPS capability

Mulch is only applied where it is required (e.g. weak vines)

Targeted fertiliser using variable rate technology



Spray technology

Incorrect applications of chemical sprays can result in pest and disease resistance, poor control, high costs and environmental contamination

Research at the Universitat Politècnica de Catalunya (Spain)

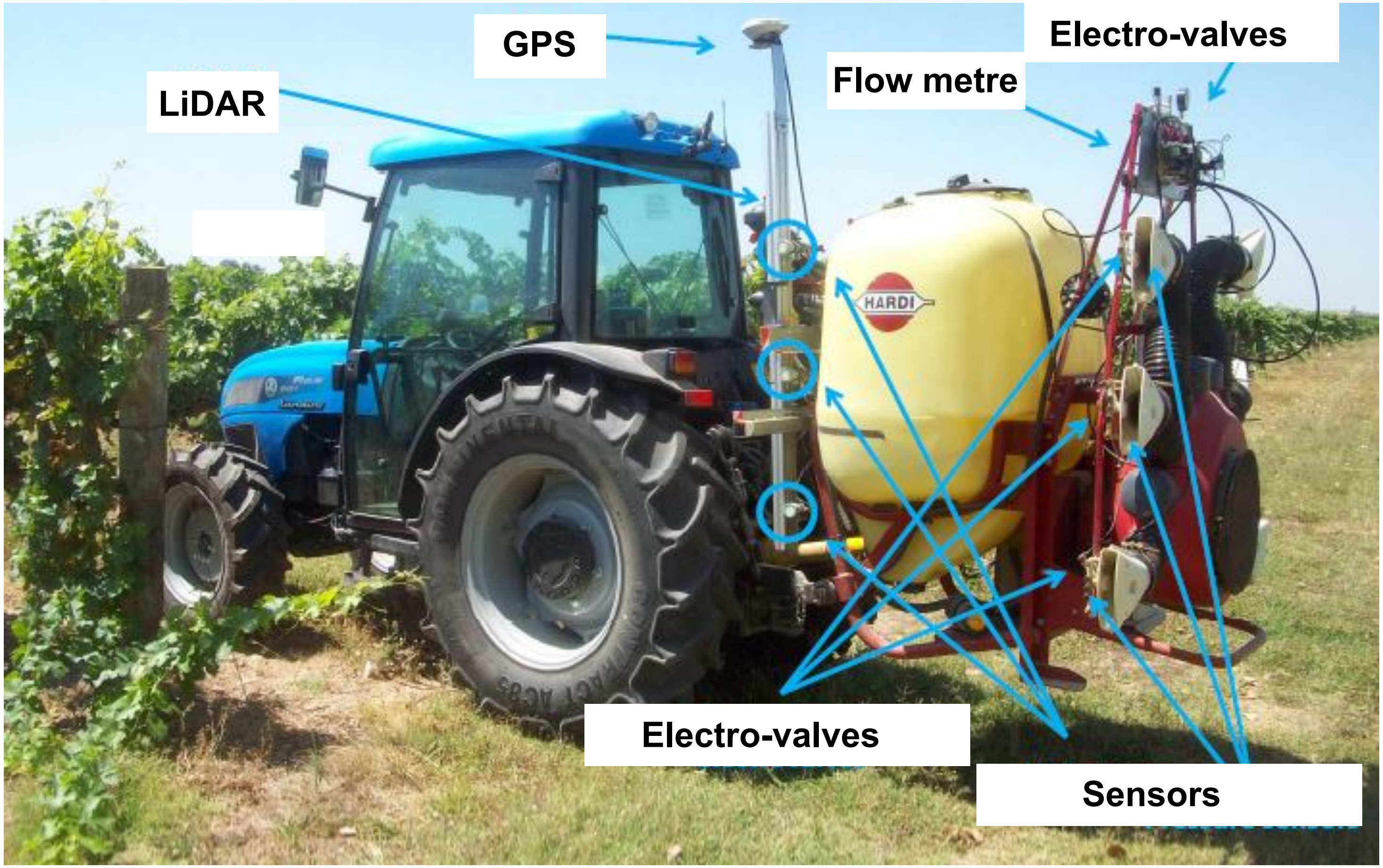
Aim: to adapt the volume of water and chemical dose applied to suit variations in canopy characteristics

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Courtesy of E. Gil, Universitat Politècnica de Catalunya

LiDAR scanners characterise the canopy

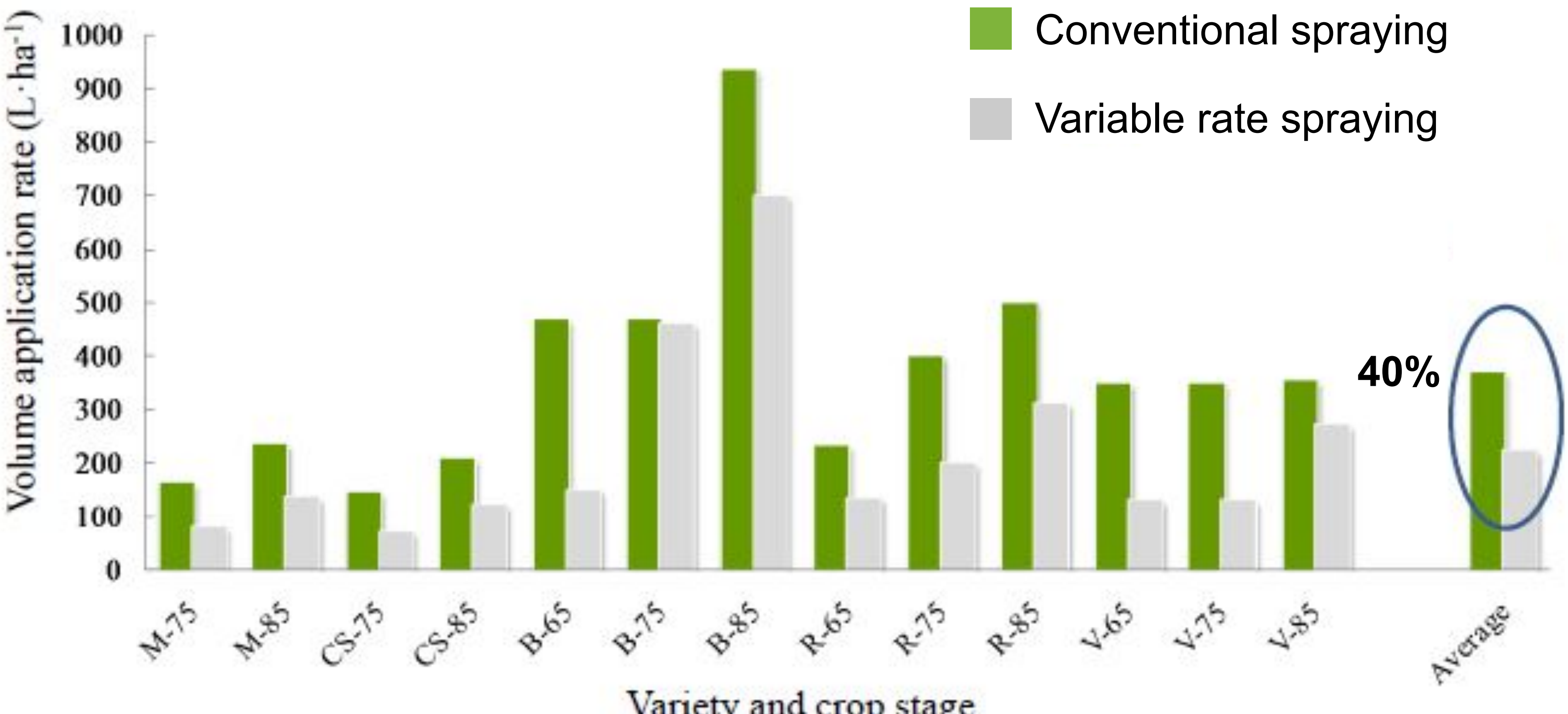
GPS provides positional coordinates



Courtesy of E. Gil, Universitat Politècnica de Catalunya

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

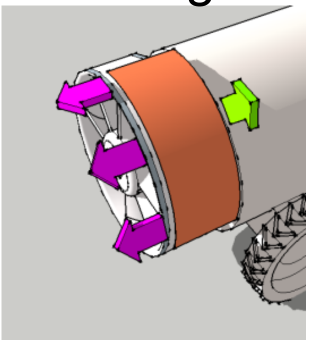
- Technology used satisfactorily in Spain and USA
- On average, for a number of varieties and growth stages, a 40% reduction in spray volume has been achieved (savings in chemical and time)



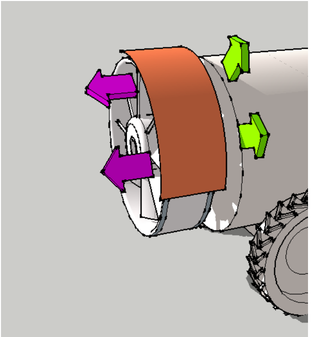
Gil et al. 2011

Research and application at Cornell University (USA)

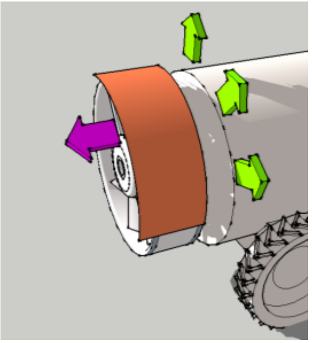
Development of the ‘louvre’ system which adjusts or re-directs airflow according to canopy architecture and size



Small air flow opening (25 mm)



Intermediate air flow opening



Fully open (100 mm)

	Early season		Mid season		Late season	
Louvre position	Fully open	Adjusted	Fully open	Adjusted	Fully open	Adjusted
Drift reduction (%)	0	71	0	37	0	18
Deposition increase (%)	0	82	0	55	14	0

Courtesy of A. Landers, Cornell University

Research and application at Cornell University

Infrared sensors are used to control the opening and closing of nozzles via solenoids – spray is only emitted when canopy is detected

2009 season	Reduction in chemical use
Early season	40%
Mid-season	18%
Full canopy	0.3%

Courtesy of A. Landers, Cornell University

Recycling spray machines

- Manufacturers have refined their recycling spray machines to minimise drift and reduce chemical usage

- Chemical usage has been reduced by up to 70% in early season sprays

Sampling and data acquisition during the season

Random vs zonal sampling

Mapping spatial variability in vine and soil characteristics allows growers to move from a ‘random sampling’ approach to a ‘zonal sampling’ approach

•Yield forecasts: ≈ 6-12% improvement in accuracy
•Pest and disease scouting: ≈ 30% saving in time during peak periods
•Berry maturity: ≈ 6-10% improvement in accuracy

Average Bè = 13.4°

High vine vigour

Bè = 12.8°

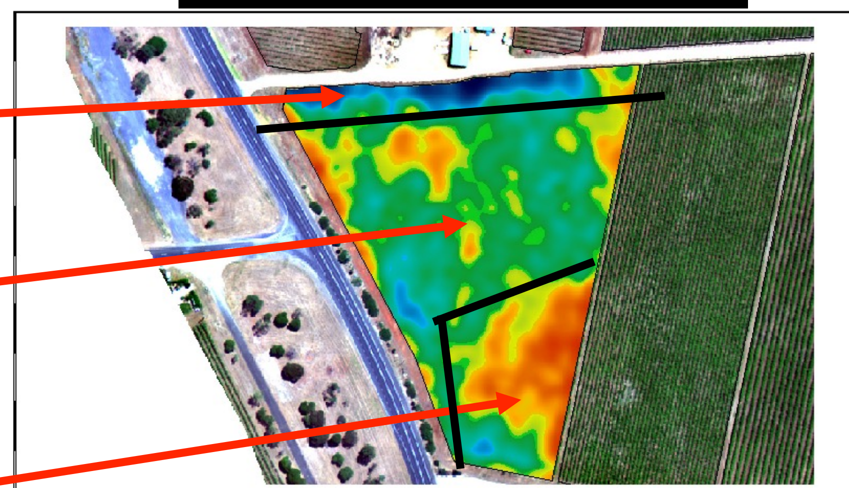
Medium vine vigour

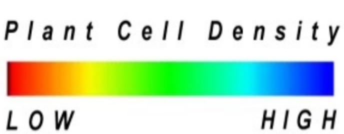
Bè = 13.7°

Low vine vigour

Bè = 14.1°

Berry maturity example





Unmanned aerial vehicles (drones)

Can be used to acquire imagery at ultra-high resolutions (1 cm/pixel) in near real-time using multi-spectral camera systems

Fixed-winged UAV

Rotary-winged UAV

Proffitt 2015

- Dispersing predatory insects (currently used in horticulture)

Dispensing unit in action

- Bird control

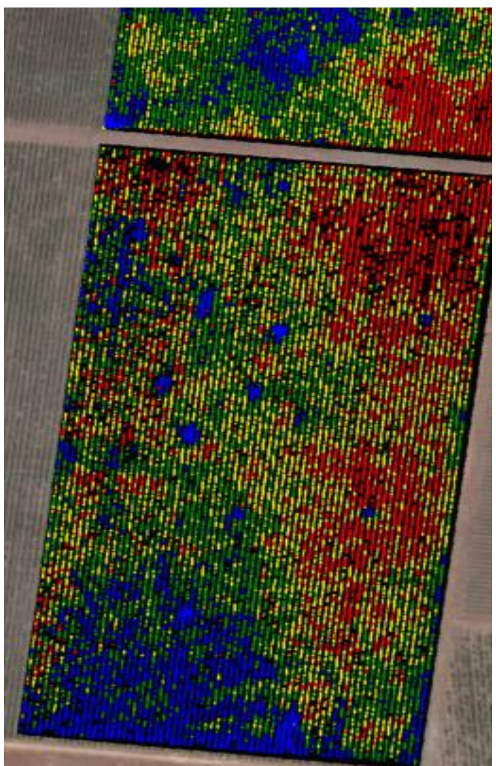
Semi-autonomous 'Robird'

Thermography (infrared thermal imaging)

- Assessing vine water status using canopy temperature has the potential to improve irrigation management decisions (and therefore water use efficiency and fruit quality)

- May also be useful for detecting irrigation water leaks and disease

Infrared thermal image



Shiraz, 5.4 ha

35 to 36.25°C

36.25 to 37.5°C

37.5 to 38.75°C

38.75 to 40°C

On-the-ground measurement of vine water status

Courtesy of PIRSA

Government of South Australia
Primary Industries and Regions SA

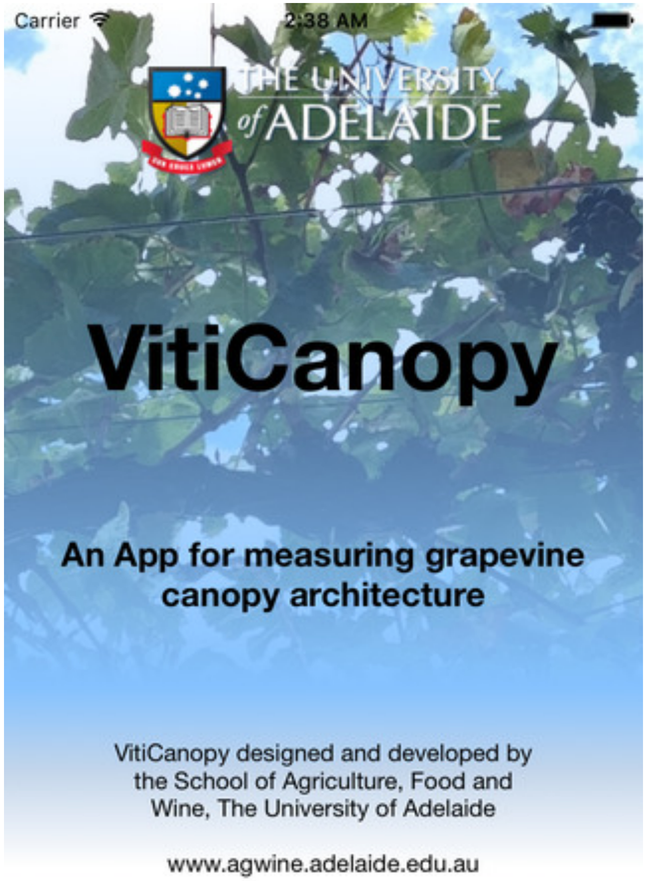
Apps and training tools

Smartphones / tablets have transformed the way that growers can access information and use device-enabled tools in the vineyard

Apps / training tools are being developed to provide easier ways to measure vine performance and to more accurately assess pest and disease problems

- **VitiCanopy**
- **PMapp**
- **BRAT and RotBot**
- **MyPest Guide Grapes**

VitiCanopy Achieving the correct vine balance is important



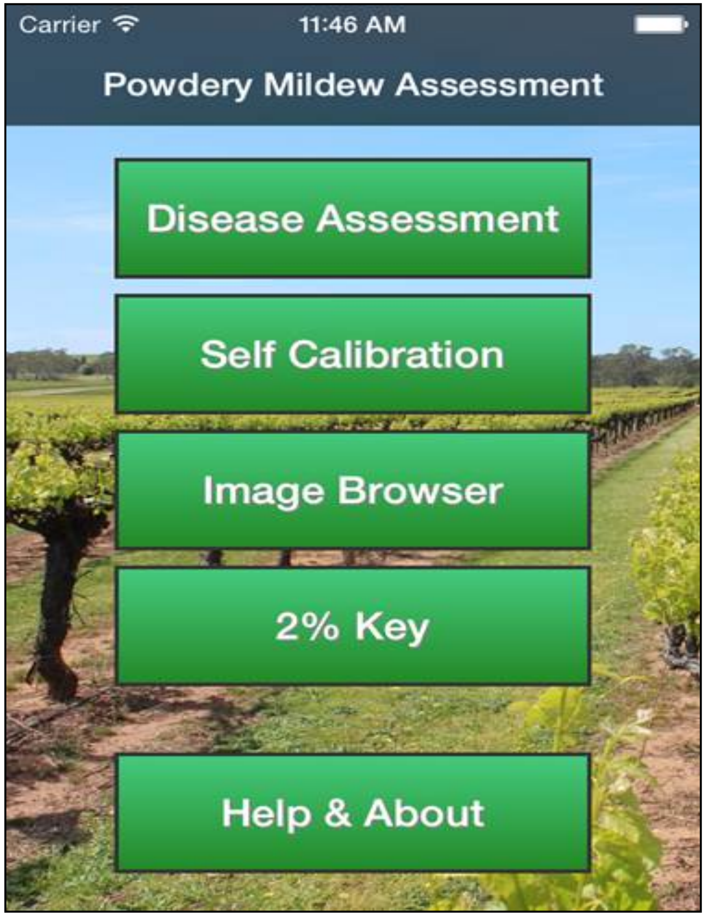
- Estimates leaf area index and canopy porosity using cover photography and image analysis
- Provides a quick and inexpensive tool to assess canopy architecture

Upward-looking image of a canopy taken by a smartphone/tablet - ready to be analysed by App

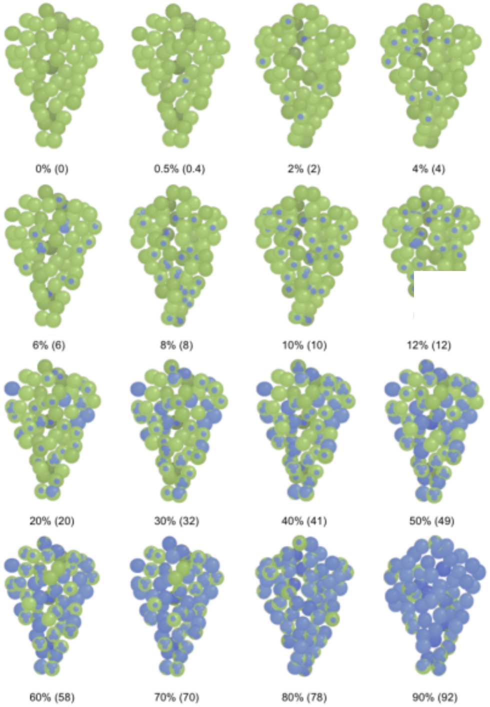
Fuentes et al. 2012

THE UNIVERSITY OF ADELAIDE

PMapp There are tolerance levels for powdery mildew-infected grapes



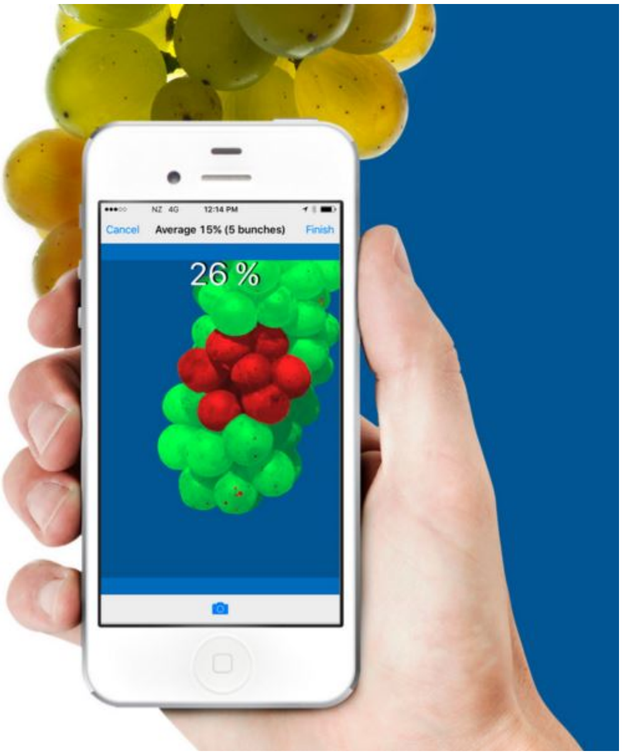
- Calculates % incidence and % severity, records date, geo-reference position
- Facilitates the standardised assessment of powdery mildew in the vineyard



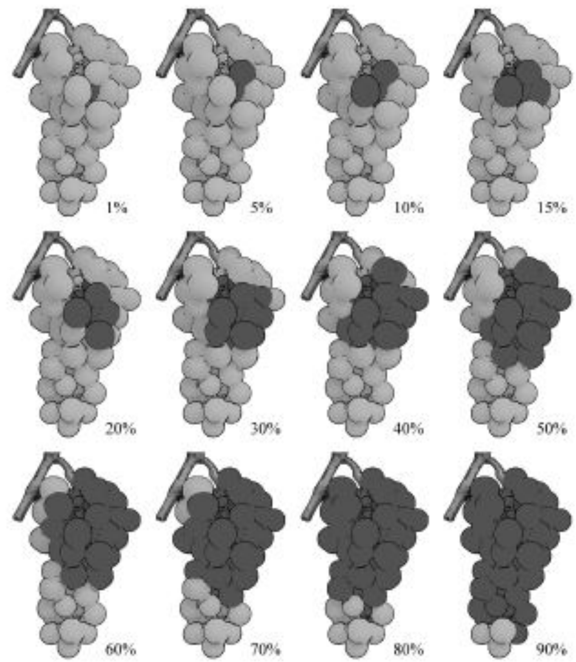
THE UNIVERSITY OF ADELAIDE

Birchmore et al. 2012

BRAT / RotBot There are tolerance levels for botrytis bunch rot



- BRAT facilitates the standardised assessment of botrytis bunch rot in vineyards and grape loads
- RotBot assesses photos of white grape bunches for the disease

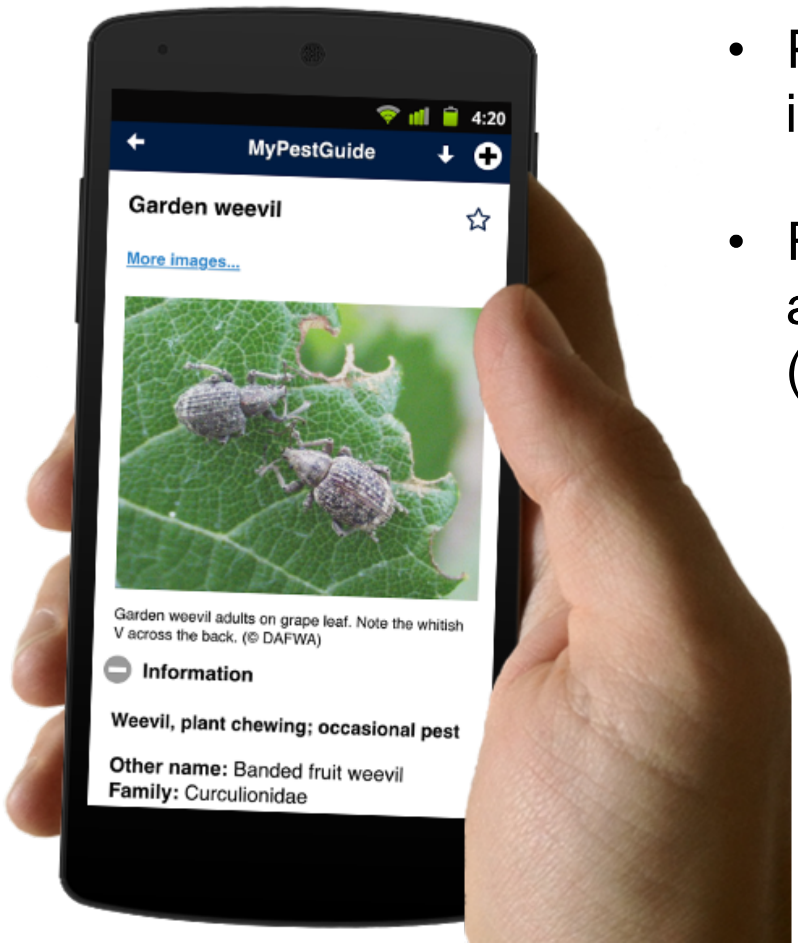


Plant & Food RESEARCH
RANGAHAU AHUMĀRA KAI

hortplus

Hill et al. 2014

MyPest Guide Identifying pests in the vineyard is important



- Provides growers with a tool to quickly identify common pests in the vineyard
- Records date, time, geo-reference position and reports any species considered exotic (i.e. possible biosecurity threat)

Department of Agriculture and Food

GOVERNMENT OF WESTERN AUSTRALIA

Harvesting

Selective harvesting

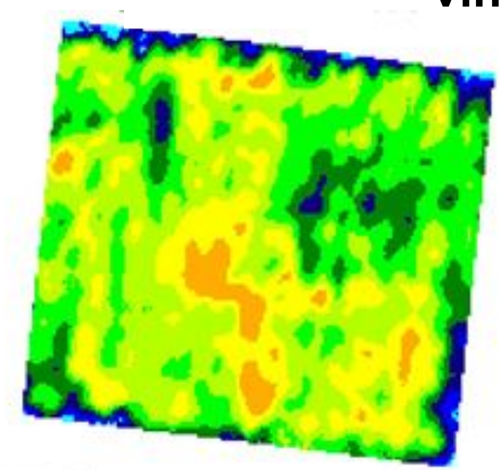
Mapping variation in vine performance allows growers and winemakers to harvest parcels of fruit ‘selectively’ according to different yield / quality criteria and product streams

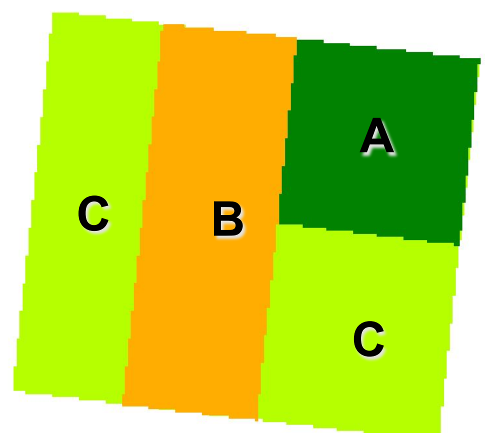
Potential income benefits

•Grape production: ≈ 6%

•Bottled wine: ≈ 20%

Patches of vines / fruit identified as being different and then harvested and vinified separately





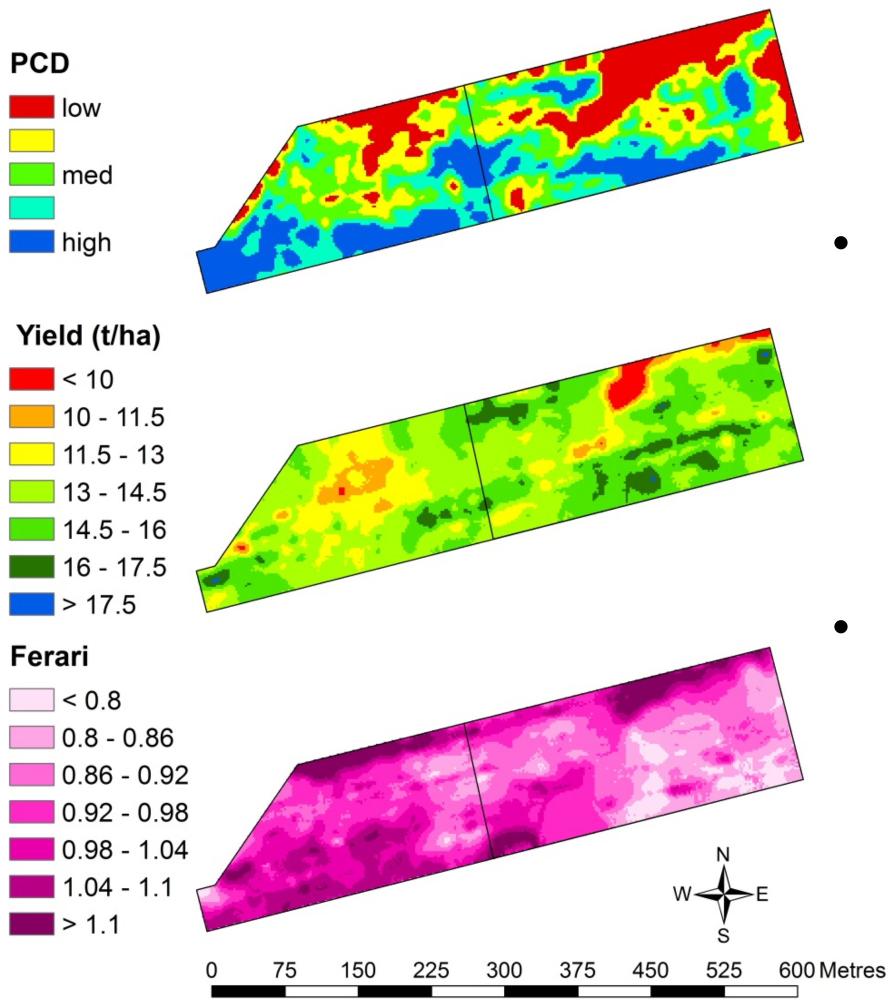
Courtesy of R. Bramley, CSIRO

On-the-go fruit quality assessment

Force-A (France) have developed the MULTIPLEX® optical sensor which can provide real-time measures of polyphenols, including anthocyanin which is a recognised index of quality in red wine grapes

Courtesy of R. Bramley, CSIRO

Shiraz, 8.2 ha, Clare Valley (Australia)



- Marked spatial structure in:
  - Vine vigour (PCD)
  - Yield (t/ha)
  - Anthocyanin concentration ('Ferari' index)

- The Multiplex sensor has potential for on-the-go measurement of colour (an index of quality in red grapes)

Bramley et al. 2011

Destemming and sorting equipment

Example: Pellenc Selectiv' Process uses a vibrating de-stemmer and roller sorting-table

- Improved removal of green berries, late-season senescing leaves, petioles and shrivelling berries

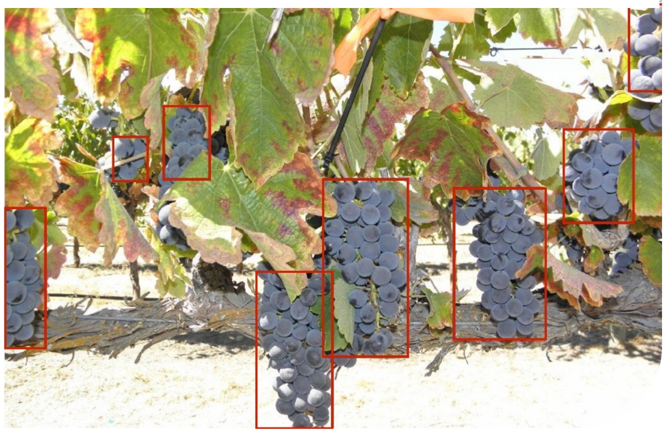
- Lower harvest costs due to reduced need for staff and supporting machinery / equipment

Robotics and technologies under development

- Intelligent, vision-based robots for winter pruning – project work underway in New Zealand, France and the USA
- Robots equipped with non-invasive sensing technologies to monitor in real-time parameters such as yield, nitrogen and vine water status, berry composition - e.g. VineRobot Project (European Union)
- Automated, non-destructive technologies for improving yield forecasts – project work underway in Australia, Spain and the USA

Image data collection

Bunch detection



Courtesy of M. Whitty, University of New South Wales

UNSW
THE UNIVERSITY OF NEW SOUTH WALES

Technology	Yield	Quality	Production efficiency
Cane-stripper			✓
High resolution maps for targeted management	✓	✓	✓
Soil sensing	✓	✓	✓
Spraying		✓	✓
High resolution maps for zonal sampling			✓
Unmanned aerial vehicles			✓
Thermography	✓	✓	✓
Apps and training tools			✓
High resolution maps for selective harvesting		✓	
On-the-go fruit quality sensing		✓	
Destemming / sorting		✓	

References

Birchmore, W., Scott, E., Emmett, B., Zanker, T. and Perry, W. (2015). Smart-phone app field assessment of powdery mildew. The Australian and New Zealand Grapegrower & Winemaker Journal. 622: 46-47.

Bramley, R., Le Moigne, M., Evain, S., Ouzman, J., Florin, L., Fadaili, E., Hinze, C. and Cerovic, Z. (2011). On-the-go sensing of grape berry anthocyanins during commercial harvest: developments and prospects. Australian Journal of Grape and Wine Research, 17(3): 316-326.

Fuentes, S., De Bei, R., Pozo, C. and Tyerman, S. (2012). Development of a smartphone application to characterise temporal and spatial canopy architecture and leaf area index for grapevines. Wine & Viticulture Journal, 27(6): 56-60.

Gil, E., Llorens, J., Landers, A., Llop, J. and Giralt, L. (2011). Field validation of DOSAVINA, a decision support system to determine the optimal volume rate for pesticide application in vineyards. European Journal of Agronomy, 35(1); 33-46.

Hill, G.N, Evans, K.J., Beresford, R.M. and Dambergs, R.G. (2014). Comparison of methods for the quantification of botrytis bunch rot in white wine grapes. Australian Journal of Grape and Wine Research, 20: 432-441.

Proffitt, T. (2015). Do Unmanned Aerial Vehicles (drones) offer new opportunities to viticulture? The Australian and New Zealand Grapegrower & Winemaker Journal, 615: 38-43.

Acknowledgements

- The ICCWS organising committee for the invitation to give this presentation
- The sponsors for funding the ICCWS
- Colleagues for allowing me to use information from their work

Thank you!

INTERNATIONAL COOL CLIMATE WINE SYMPOSIUM

ENGLAND 2016