GRAPE & WINE ROADSHOW

Barossa Valley Seminar

Thursday, 3rd October, 2013

Welcome and introduction / overview of the AWRI
Con Simos

Issues for discussion at today's Interactive session
Con Simos

Vine balance – how does it affect yield and quality?
Mardi Longbottom

How can irrigation management strategies be used to manipulate wine quality?
Marcel Essling

Morning Tea

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Barossa Valley Seminar

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Does soil and vine nutrient status affect wine quality?
Marcel Essling

Great wine from grafted vines
Mardi Longbottom

Improving water use efficiency with rootstocks
Everard Edwards

Lunch

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Barossa Valley Seminar

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Interactive session
Con Simos

Winery cost reduction strategies
Neil Scrimgeour

Afternoon Tea

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Causes and management of slow and stuck fermentations
Paul Henschke

How to significantly reduce your carbon footprint without spending any money
Neil Scrimgeour

Features of the AWRI website and closing comments
Con Simos

A W R I

The Australian Wine
Research Institute

Vine balance – how does it affect yield and wine quality?

Mardi Longbottom

Vine balance & wine quality

- What is vine balance?
- How do we measure vine balance?
- What is the best way to achieve vine balance?

What determines wine quality?

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Yield/ha?

Berry size?

Shoot vigour?

Canopy density?

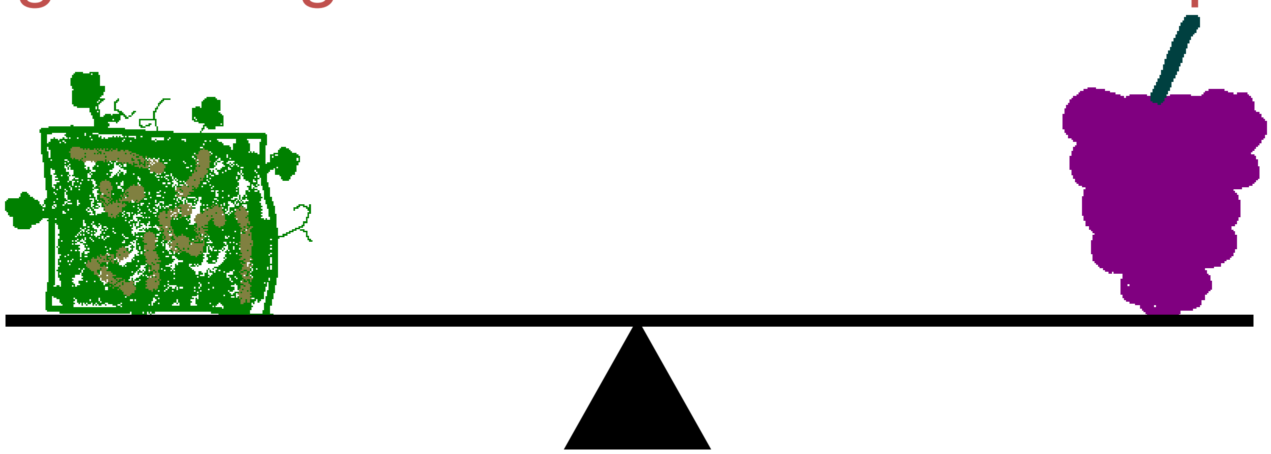
Bunch exposure?

for a given variety x location

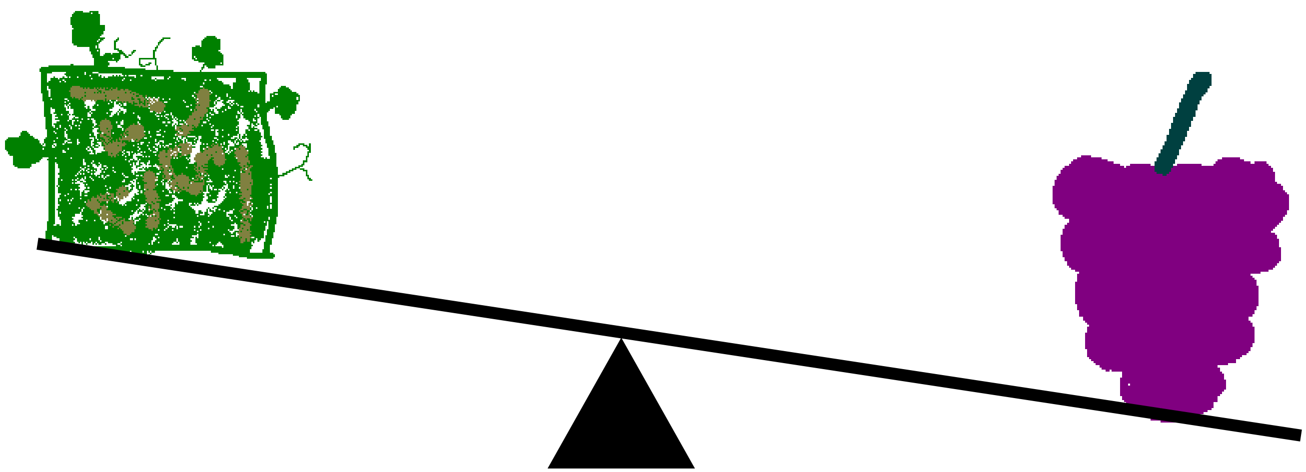
The Australian Wine Research Institute

‘Balance is achieved when vegetative vigour and fruit load are in equilibrium and consistent with high fruit quality’

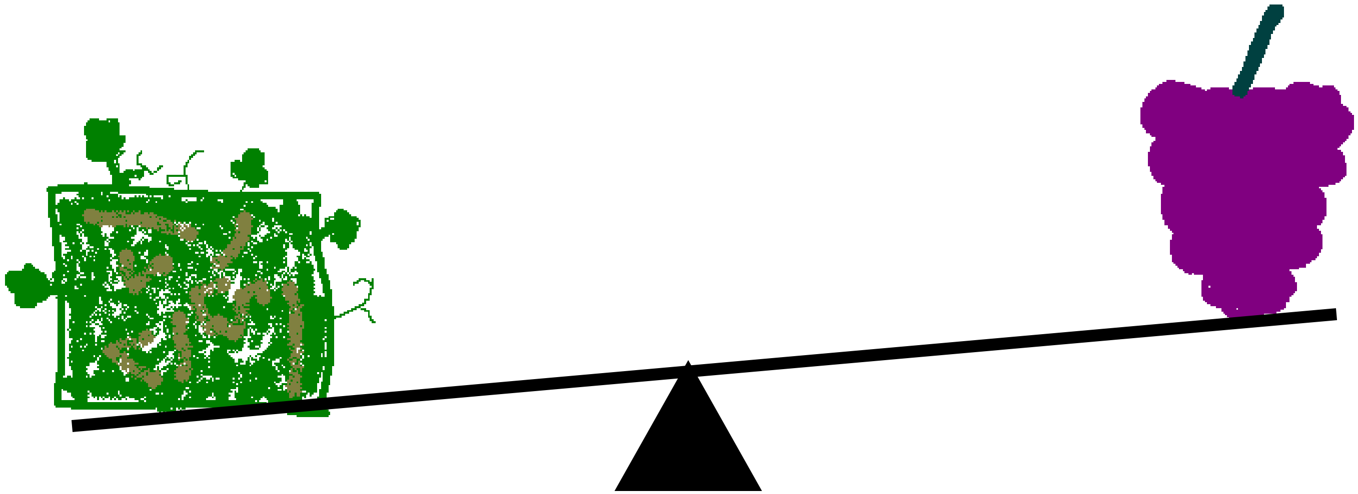
Gladstones (1992) Viticulture and Environment



‘overcropping’



excessive vigour; undercropping



The indices of vine balance

1. Fruit yield to pruning weight (Y/P, Ravaz Index)

recommended range for Y/P is generally between
5 and 10

Cool climates (5)

Hot climates (10)

Yield to pruning weight contd

The Australian Wine Research Institute

Y/P = 6

Y/P = 2

Does FW/PW correlate with wine quality?

The Australian Wine Research Institute

- Cab Sauv, single vineyard, Calif (Dokoozlian et al. 2011)
- Bunch thinning 3 weeks after fruitset

Treatment	Yield t/ha	FW/PW	Days to reach 24° Brix (relative to BA)
'Undercropped' UC	4	3	-12
'Balanced' BA	15	8	0
'Overcropped' OC	30	14	+11

Does FW/PW correlate with wine quality?

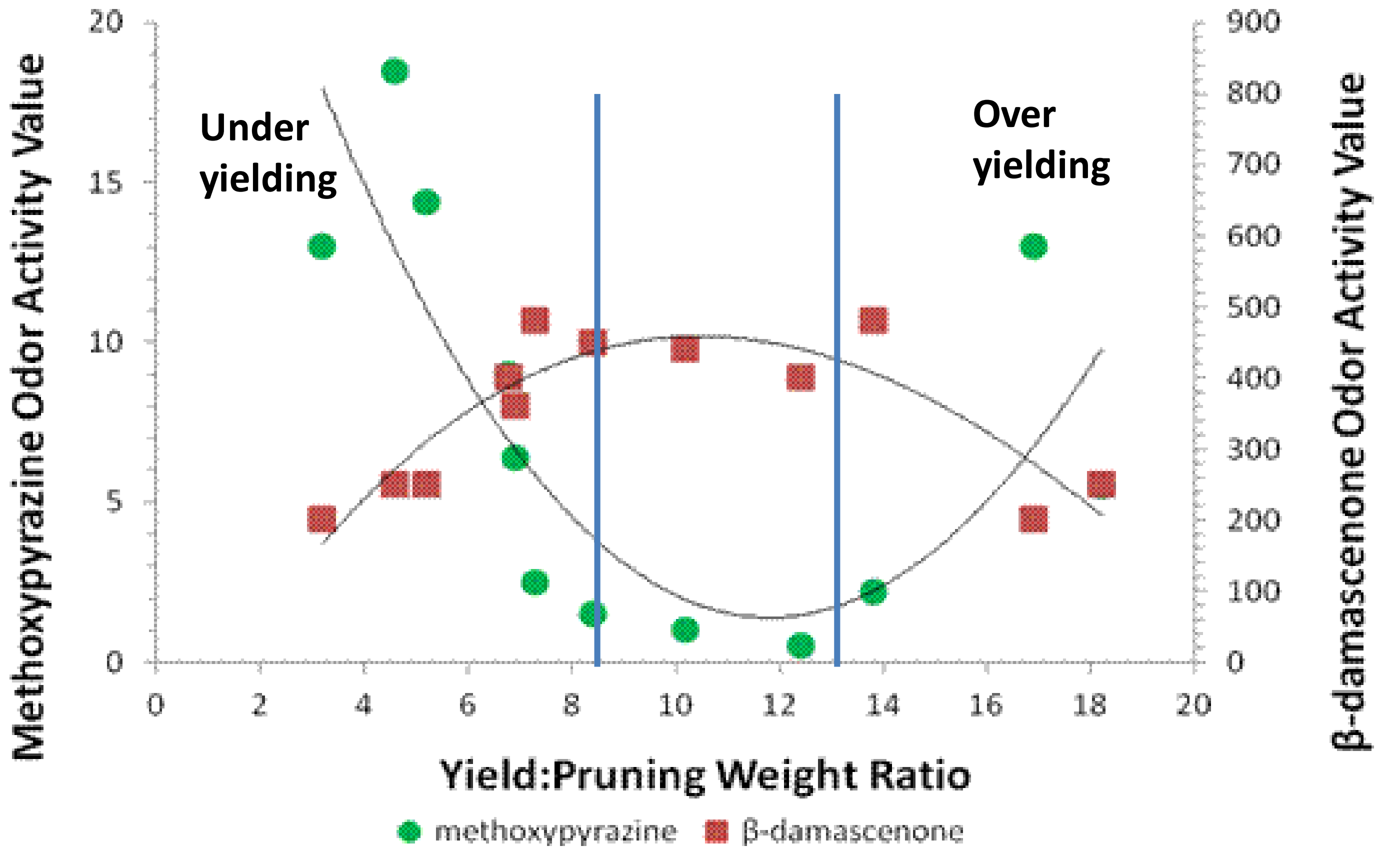
The Australian Wine Research Institute

- Cab Sauv, single vineyard, Calif (Dokoozlian et al. 2011)
- Bunch thinning 3 weeks after fruitset

Treatment	Yield t/ha	FW/PW	Days to reach 24° Brix	OAV damascenone at 24° Brix
‘Undercropped’	4	3	-12	200
‘Balanced’	15	8	0	380
‘Overcropped’	30	14	+11	160

Does Y/P correlate with wine quality?

The Australian Wine Research Institute



redrawn from Dokoozlian et al. 2011 with permission from authors

The indices of vine balance

The Australian Wine Research Institute

2. Leaf Area to Fruit Yield ratio (LA/Y)

recommended range:

0.5 to 1.5 m^2/kg

Hot climates

Cool climates

Divided canopies

Single canopies

Barossa

Yield

- low yielding vineyards MAY produce better wine than high yielding

- However, it is not necessarily the low yield *per se* — rather it is where the vines are grown and the way that they are managed that determines the quality.

Yield

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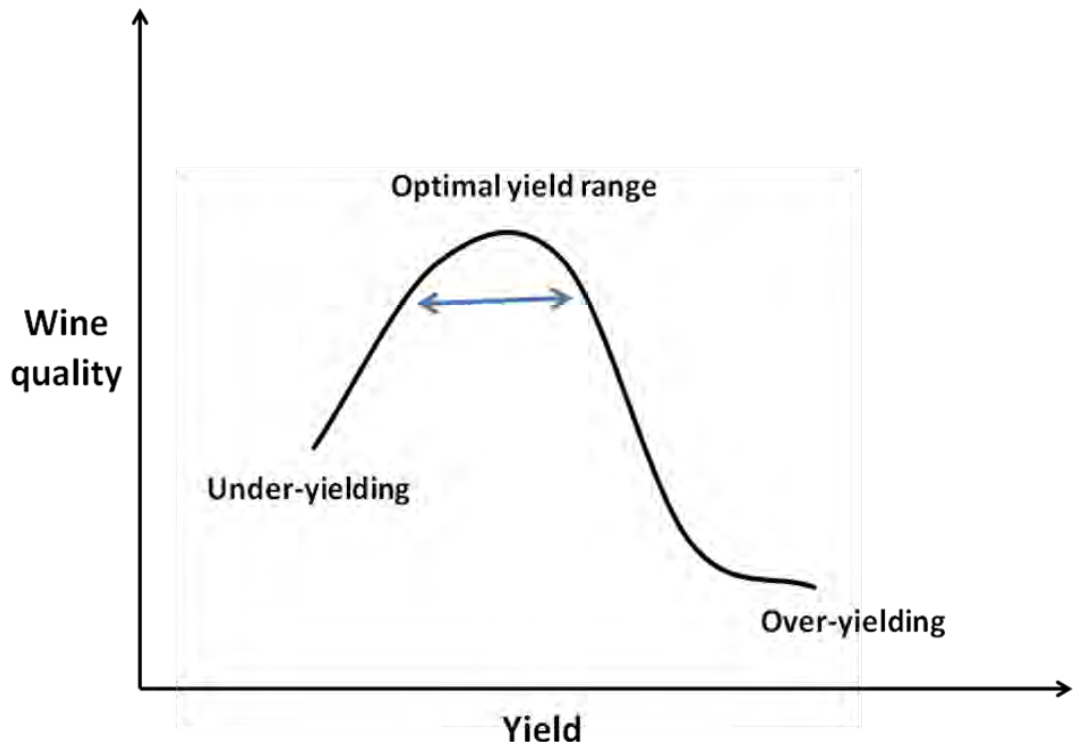

Generalised relationship between grape yield and wine quality.

A diversion to Bordeaux

Source: van Leeuwen et al. (2004)

Terroir study

- 3 soil types
  - ‘dry’ = gravelly
  - ‘moist’ = clay subsoil
  - ‘wet’ = sandy + roots in contact with high water table

- Cab Sauv, Cab Franc, Merlot

Insert Bordeaux photo

A diversion to Bordeaux

Source: van Leeuwen et al. (2004)

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What were the seasonal factors most closely associated with vintage rating?

- ~~Yield?~~
- ~~Berry size?~~
- ~~Sunshine?~~
- ~~Temperature?~~
- ~~Length of ripening period?~~
- Rainfall? – flowering to harvest

yes

A diversion to Bordeaux

Source: van Leeuwen et al. (2004)

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- Best vintages when water supply to vine from flowering to harvest was most limiting
- Either soil effect or seasonal effect or both
- Water deficit prior to veraison → early cessation of shoot growth

Other indices of vine balance

Cessation of shoot growth by veraison

Can this be quantified?

Other indices of vine balance

Cessation of shoot growth by veraison

Why is this significant?

- Diversion of resources to fruit?
  - Or some other factor?
- Diversion of resources to roots?
  - → increased supply of hormones from roots to ripening fruit?

Other indices of vine balance

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Periderm development

poor shoot periderm development after leaf fall

Other indices of vine balance

The Australian Wine Research Institute

Early maturity/harvest

The first vineyards to be harvested for given variety within a particular climatic zone will produce the best wine. Is this true?

Early harvest

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Riverland Shiraz (1995)

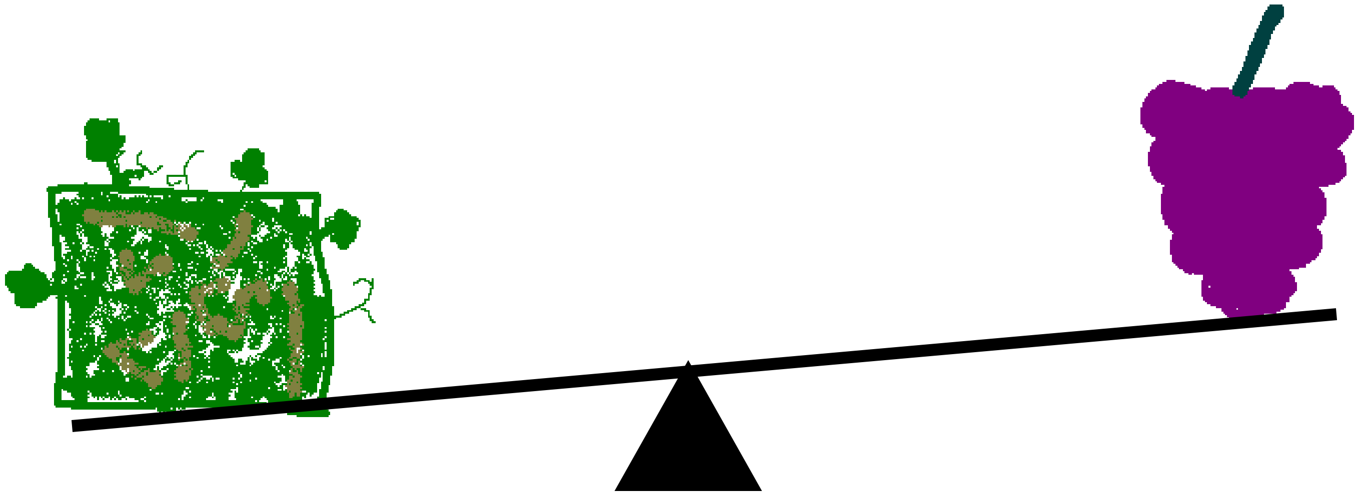
- 40 vineyards studied within same region/macroclimate
- different vineyards harvested at the same maturity, ie. 23.0 ± 0.5 °Brix
- difference of 37 days between the first vineyard to reach this target maturity and the last

→ the earlier the harvest, the better the wine score.

How to achieve vine balance: some principles

- Need to achieve balance prior to veraison
- Need to develop adequate LA for ripening
- Avoid excessive shoot vigour

What do you do if vineyard is like this?



How to achieve vine balance

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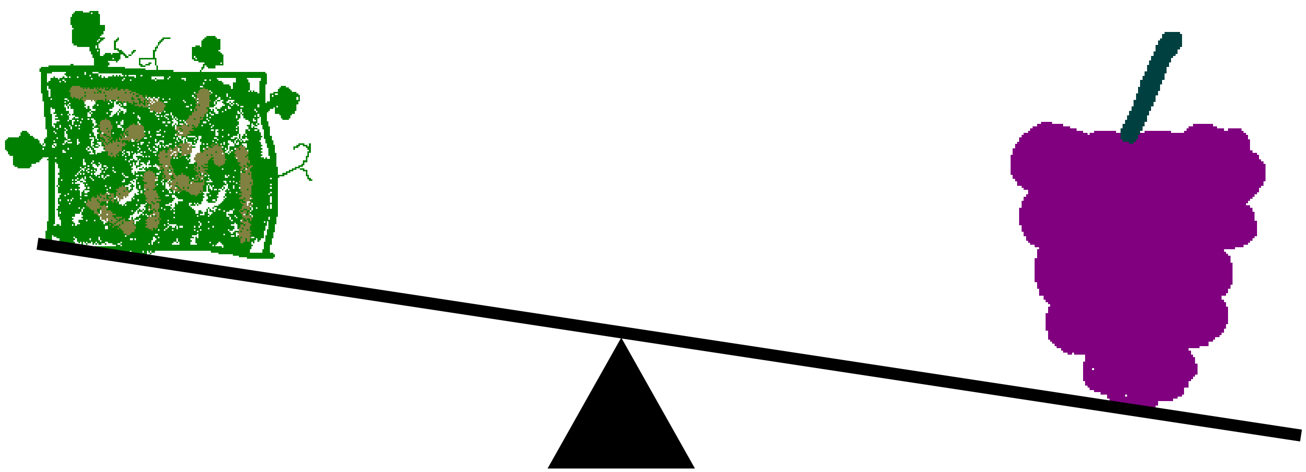
Control vegetative growth by inducing mild to moderate water stress

Irrigation management

Soil management

What do you do if vineyard is like this?



How to achieve vine balance

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Yield control

- Pruning level
- Bunch thinning

How to achieve vine balance

Does yield regulation lead to improved wine quality?

Perhaps – but it depends on:

- The starting point
- How and when it is done
- May only be effective if it improves vine balance
  - It will be ineffective if it disrupts vine balance
  - and causes sugar ripening to be too advanced relative to flavour ripening

Early vs late bunch thinning?

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- Early is more economical than later
- If too early may stimulate shoot vigour
- In a high rainfall climate,
  - leave high bud number to reduce shoot vigour
  - then bunch thin relatively late e
- In dry climate can use severe pr
  load knowing that water stress v

A novel method of yield control

The Australian Wine Research Institute

Leaf removal in bunch zone just before flowering (E-L 19)

- Approx 8 basal leaves
- Manual or mechanical
- No lateral shoots removed

- Yield reduced by 20 to 70% mainly due to fewer berries/bunch
- Varieties used: Semillon, Tempranillo, Graciano, Carignan, Sangiovese, Barbera, Trebbiano, Ciliegiolo
  - Mostly warm climates

Poni et al (2009), Scheiner et al. (2010)

A novel method of yield control

Positive effects:

- Reduced bunch compactness
- Reduced Botrytis
- No detrimental effect on Brix
- Increased concentration anthocyanin and other phenolics
- Partial recovery of LA to give later bunch protection

Why does it work?

Take home messages

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- Indices of vine balance are useful guide but use other indicators as well
- Low yield does not mean good balance
- Control of shoot growth before veraison is important
  - It is better to achieve vine balance earlier in season rather than later
- The timing and method of yield control must be appropriate for the site

Further reading

The Australian Wine Research Institute

- Bindon et al. (2008a) Aust J Grape and Wine Res. 14, 91-103
- Dokoozlian, N. et al. (2011) Some new perspectives on the impact of vine balance on grape and wine flavour. Proc. 17th GIESCO meeting, Asti-Alba Italy: 407-409
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- Scheiner et al. (2010) Amer. J Enol. Vitic. 61(3), 358-64
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The Australian Wine Research Institute

mardi.longbottom@awri.com.au

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How can irrigation management strategies be used to manipulate wine quality?

Marcel Essling

Prepared by Peter Dry

Contents

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Winegrape quality can be defined as:
the suitability of a batch of grapes to produce a wine of the highest quality for a targeted style.

❖Irrigation options

❖When deficit irrigation is appropriate

❖When DI won't work

❖How it works

❖Why it works

Irrigation scheduling

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- Maintain RAW range for ‘no stress’
- Sustained deficit irrigation (SDI)/ deficit irrigation (DI)
  e.g. 70% ET_V
- Regulated deficit irrigation (RDI)

When is deficit irrigation appropriate?

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When is deficit irrigation appropriate?

The Australian Wine Research Institute

Cabernet Sauvignon, Sunraysia: after 2 seasons of deficit Irrigation. Photo taken at end of January

When won't it work?

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RDI: How do you do it?

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Does it work?

Effect of irrigation strategy on sensory attributes:

Cabernet Sauvignon, Napa Valley
Chapman et al (2005)

- Standard Irrigation (SI) = 32 L/vine/week
- "Minimal" Irrigation (MI) = 'deficit 32 L/vine/week applied when midday LWP < -1.6 MPa

Does it work?

Effect of irrigation strategy on sensory attributes:

- ‘Deficit wine’ was rated much higher than standard wine with more desirable fruity aromas and flavours
- ‘Standard wine’ had more undesirable herbaceous/vegetal aromas and flavours

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Why does it work?

Water deficit: why does it work?

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- Lower yield ?
- Smaller berries ?
- Reduced vegetative growth ?
- More open canopy and better bunch exposure ?
- ………?

If it is lower yield …?

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- What is the possible mechanism?

Lower yield…?

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- Often not large yield decrease for deficit irrigation relative to “well-watered” control
  - e.g. 15 to 20%

Standard = 17.6 t/ha
Deficit = 15.0 t/ha
(Chapman et al. 2005)

Lower yield…?

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- Deficit imposed at 'right' time (e.g. pre-veraison) has much greater effect on vegetative growth than on yield.
- Some deficit irrigation studies show no yield change but still increased wine quality
  - e.g. PRD (Dry et al. 2001)

Lower yield…?

Does yield reduction by any means necessarily improve quality?

- No
- In fact, yield reduction may reduce quality
  - e.g. by bunch thinning (Chapman et al. 2004, Reiger 2009)

Why does it work?

The Australian Wine Research Institute

- ~~Lower yield ?~~
- Smaller berries ?
- Reduced vegetative growth ?
- More open canopy and better bunch exposure ?
- ………?

Is it the result of smaller berries?

Small berries have larger skin surface area relative to volume of juice than large berries

TRUE

But do they have a larger weight of skin relative to volume of juice than large berries?

NOT NECESSARILY

Is it the result of smaller berries?

The Australian Wine Research Institute

Small berries have larger skin surface area relative to volume of juice than large berries

TRUE

But do they have a larger weight of skin relative to volume of juice than large berries?

NOT NECESSARILY

Concentration of wine components

Is it the result of smaller berries?

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- Irrigation deficit produces berries with more skin and seed tissues relative to whole berry mass than well-irrigated controls

- INDEPENDENTLY OF ANY CHANGE IN BERRY SIZE (Roby and Matthews 2004; Roby et al. 2004)

Is it the result of smaller berries?

The Australian Wine Research Institute

Berry size – the evidence against:

- Wines made from different berry size classes of Shiraz found characteristics including colour are similar from small and large berries (Walker et al. 2005)
- PRD increases anthocyanin concentration without any change in berry size (Bindon et al. 2008a)
- Leaf removal in bunch zone just before flowering increases anthocyanin concentration without any change in berry size (Poni et al. 2009)

Water deficit: why does it work?

The Australian Wine Research Institute

- ~~Lower yield ?~~
- ~~Smaller berries ?~~
- Reduced vegetative growth ?
- More open canopy and better bunch exposure ?
- ………?

Reduced vegetative growth?

The Australian Wine Research Institute

Reduced vegetative growth?

The Australian Wine Research Institute

Bordeaux study (van Leeuwen et al. 2004)

- Best vintages where water supply to vine from flowering to harvest was most limiting
- Either soil effect or seasonal effect or both
- Water deficit prior to veraison → early cessation of shoot growth → highest vintage rating

Reduced vegetative growth?

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- Reduced shoot vigour by veraison…but can this be related to wine composition?

Reduced vegetative growth?

Cessation of shoot growth by veraison

- Relationship between shoot vigour and concentration of methoxypyrazines (MP) in Cabernet Sauvignon fruit

- MP strongly correlated with pre-veraison shoot vigour
  - Independent of bunch exposure

Lakso and Sacks (2010) Pract Winery and V'yard May/June 35-49, 73

Reduced vegetative growth?

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Cessation of shoot growth by veraison

- Diversion of resources to fruit or roots?
- Or is something happening to roots?
  - $\rightarrow$ increased supply of hormones from roots to ripening fruit? e.g. ABA

Lakso and Sacks (2010) Pract Winery and V'yard May/June 35-49, 73

Reduced vegetative growth?

ABA and grape ripening

- ABA known to be involved in:
  - in initiation of ripening
  - and promotes partitioning of resources to fruit after veraison
- Ripening depends on constant supply of ABA external to bunches
- Main source = roots
  - Mild to moderate water stress is key to maintenance of ABA supply

Water deficit: why does it work?

The Australian Wine Research Institute

- ~~Lower yield ?~~
- ~~Smaller berries ?~~
- Reduced vegetative growth ? - perhaps
- More open canopy and better bunch exposure ?
- ………?

More open canopy?

- **Reduced canopy density?**
  - Better bunch exposure
  - Less leaf shading
  - Less disease

More open canopy?

Bunch exposure:

- Good evidence that bunch exposure is associated with wine quality

Several possible explanations:

- **Direct effect** of light and/or temperature on primary and secondary metabolites
- **Indirect effect**
  - e.g. bunch exposure effect on skin thickness

More open canopy?

Bunch exposure and skin thickness

- Pre-flowering defoliation of Barbera and Lambrusco salamino (Poni et al. 2009)
  - Increased bunch exposure
  - Increased relative skin weight
  - Increased anthocyanins
  - (**Increased** berry size)

More open canopy?

Bunch exposure

- Only moderate light is required for colour development
- Flavour compounds (eg isoprenoids) form more in exposed bunches – however, degradation is also greatest in exposed bunches
- Therefore, greatest aromatic intensity and varietal typicity is achieved in **partial or reduced intensity sunlight** plus **moderate air temperatures**.

Is it possible to have too much bunch exposure?

The Australian Wine Research Institute

Water deficit: why does it work?

The Australian Wine Research Institute

- Lower yield ?
- Smaller berries ?
- Reduced vegetative growth ? - perhaps
- More open canopy and better bunch exposure ? - perhaps
- ………?

Water deficit: why does it work?

The Australian Wine Research Institute

- Or is it the effect of water deficit on plant metabolism directly?
  - e.g. biosynthesis of amino acids, carotenoids
  - Bindon et al 2008 (Barossa shiraz and cabernet sauvignon under PRD) suggested that stress-related signalling may directly affect the isoprenoid metabolic pathway.

Hypothetical effect of water deficit on aroma and flavour compounds in grape berries

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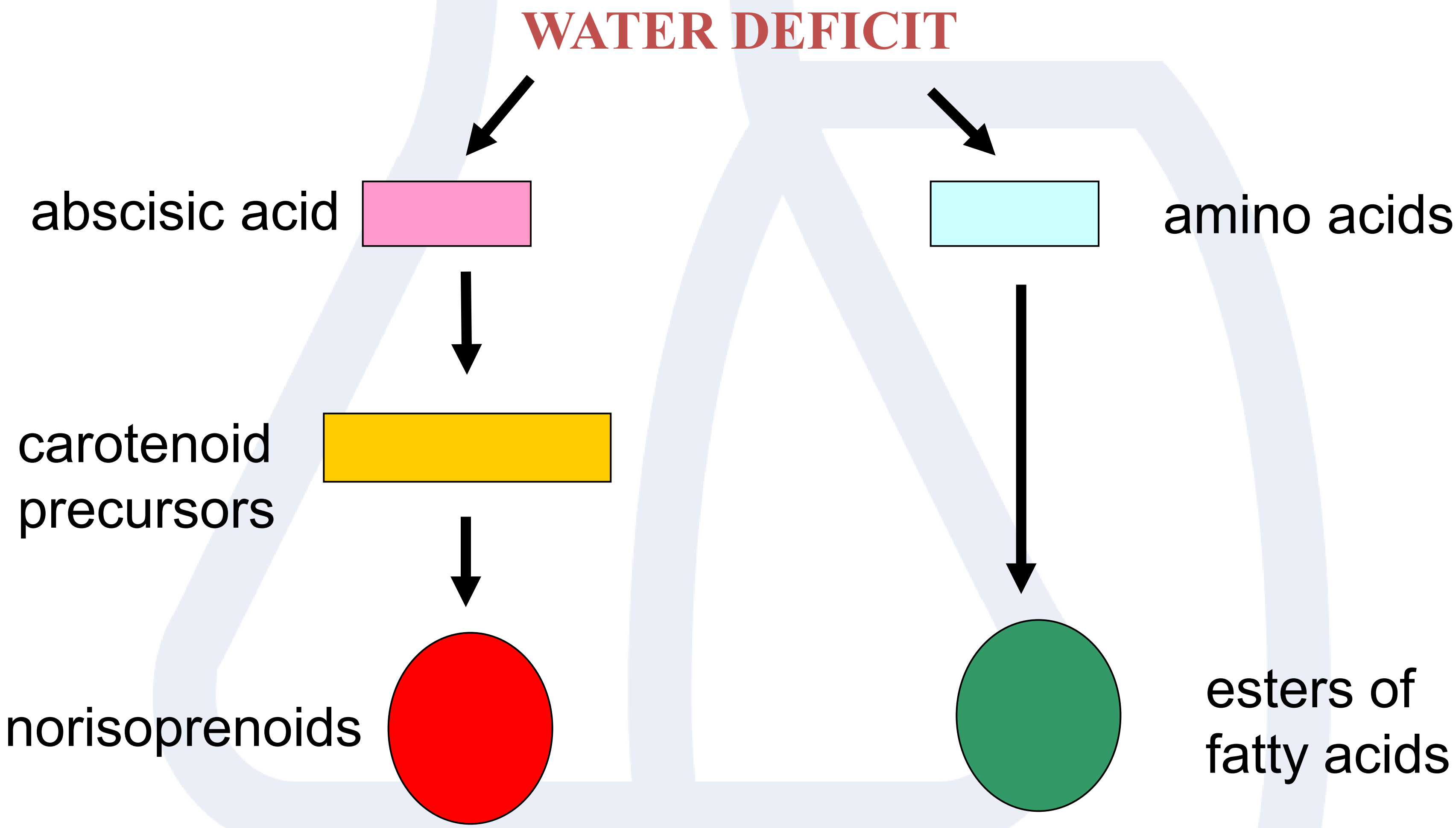

Water deficit: why does it work?

The Australian Wine Research Institute

- ~~Lower yield ?~~
- ~~Smaller berries ?~~
- Reduced vegetative growth ? - perhaps
- More open canopy and better bunch exposure ? - perhaps
- Direct effect on metabolism ? - **probably**

Take home messages

- It is likely that the “physiological effect” of the deficit irrigation that is often used to control yield is more important in determining the sensory properties of the resulting wine than any yield or berry size effects.

Take home messages

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- Therefore, a water deficit (achieved by irrigation management or otherwise) may not have to result in a significant decrease in either yield or berry size in order to affect wine quality in a positive manner

Take home messages

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- The successful imposition of a water deficit via irrigation management will be dependent on many environmental factors, and conditions that lead to mild or moderate water stress are preferable to severe stress – which should always be avoided

- The timing of a deficit will vary from site to site
  - e.g. it may be difficult to impose a deficit before veraison in some locations

Take home messages

- While an effect on vegetative growth —achieved by pre-veraison deficit—appears to be important, perhaps a post-veraison deficit may still have some positive effect on quality

Take home messages

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- Be prepared to change your strategy if a heat-wave is predicted

Further reading

The Australian Wine Research Institute

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- Walker, R. et al. (2005) Aust J Grape Wine Res. 11, 2-8

AWRI

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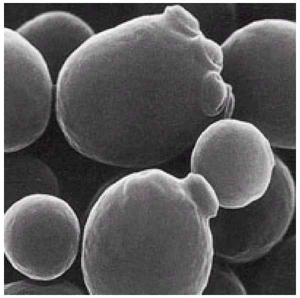
Does soil and vine nutrient status affect wine quality?

Marcel Essling

Prepared by Peter Dry



Does soil nutrient status affect wine aroma and flavour?

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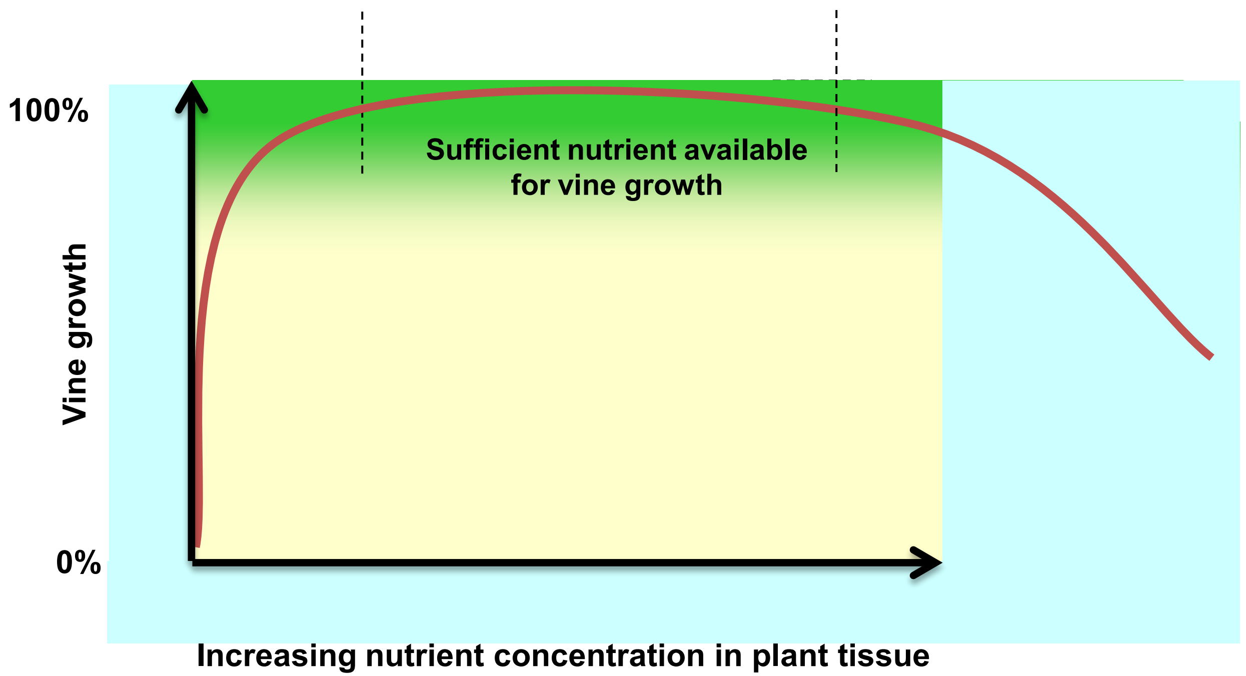
- Wine quality is not easily manipulated by fertiliser practices.
- Many studies – no correlation between wine quality and soil content of any nutritive element with exception of N (and salt)



Response to N: summary

Red wine quality: negatively correlated with vine N

- particularly when water not limiting

❖ Low soil N best for red wine quality

White wine: moderate soil N best for quality

❖ Low N → decreased aromatic precursors and increased tannin

❖ High N → increased Botrytis

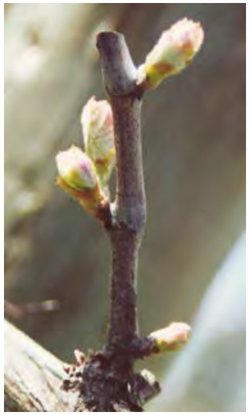
NITROGEN

- Of all mineral nutrients, N has greatest effect on growth, yield and fruit composition
  - ↑ soil N → ↑ photosynthesis → ↑ sugar
- As for water, excess N can have negative effect
  - e.g. increased canopy size

NITROGEN

The Australian Wine Research Institute

- Demand for N greatest from budburst to flowering
  - But most uptake from soil after flowering
  - Overwintering reserves thus very important
- Storage reserves are lowest at flowering
  - Therefore plant is vulnerable to deficiency if insufficient N in soil after flowering



Total berry NITROGEN

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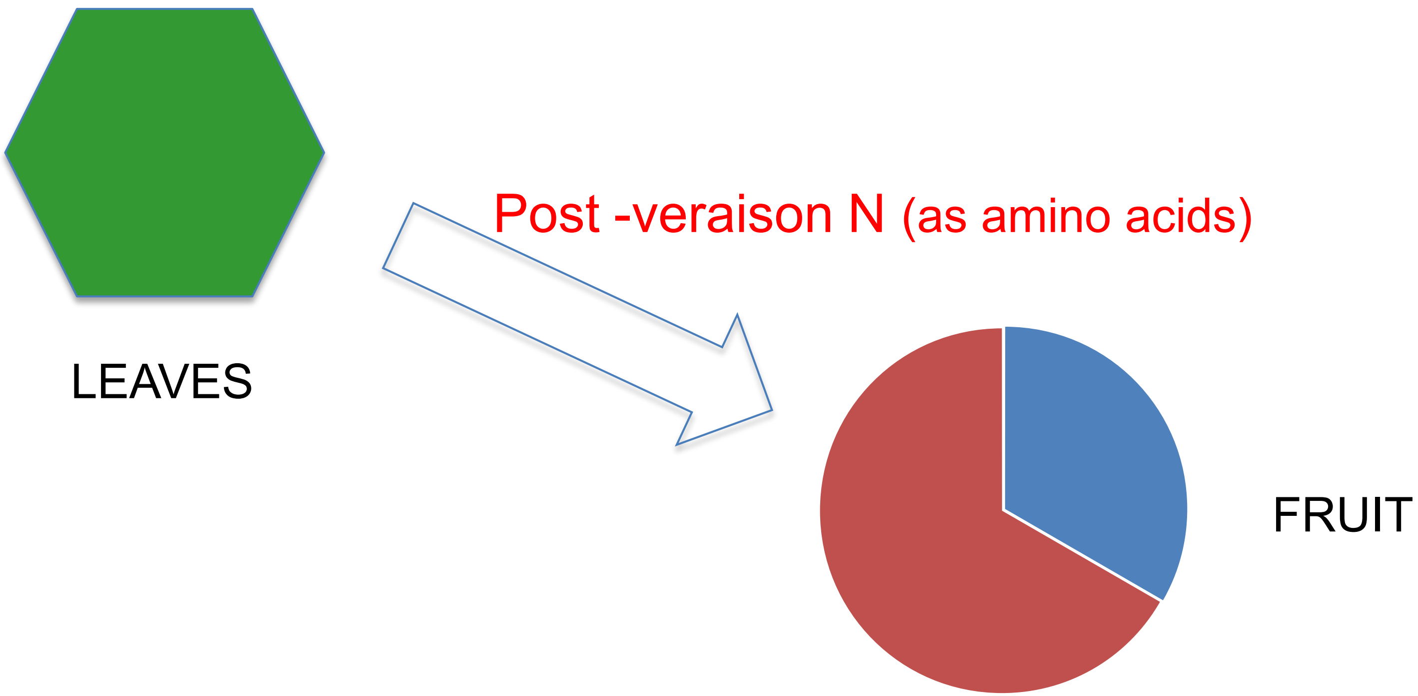

What is effect of N fertilisation on vine performance?

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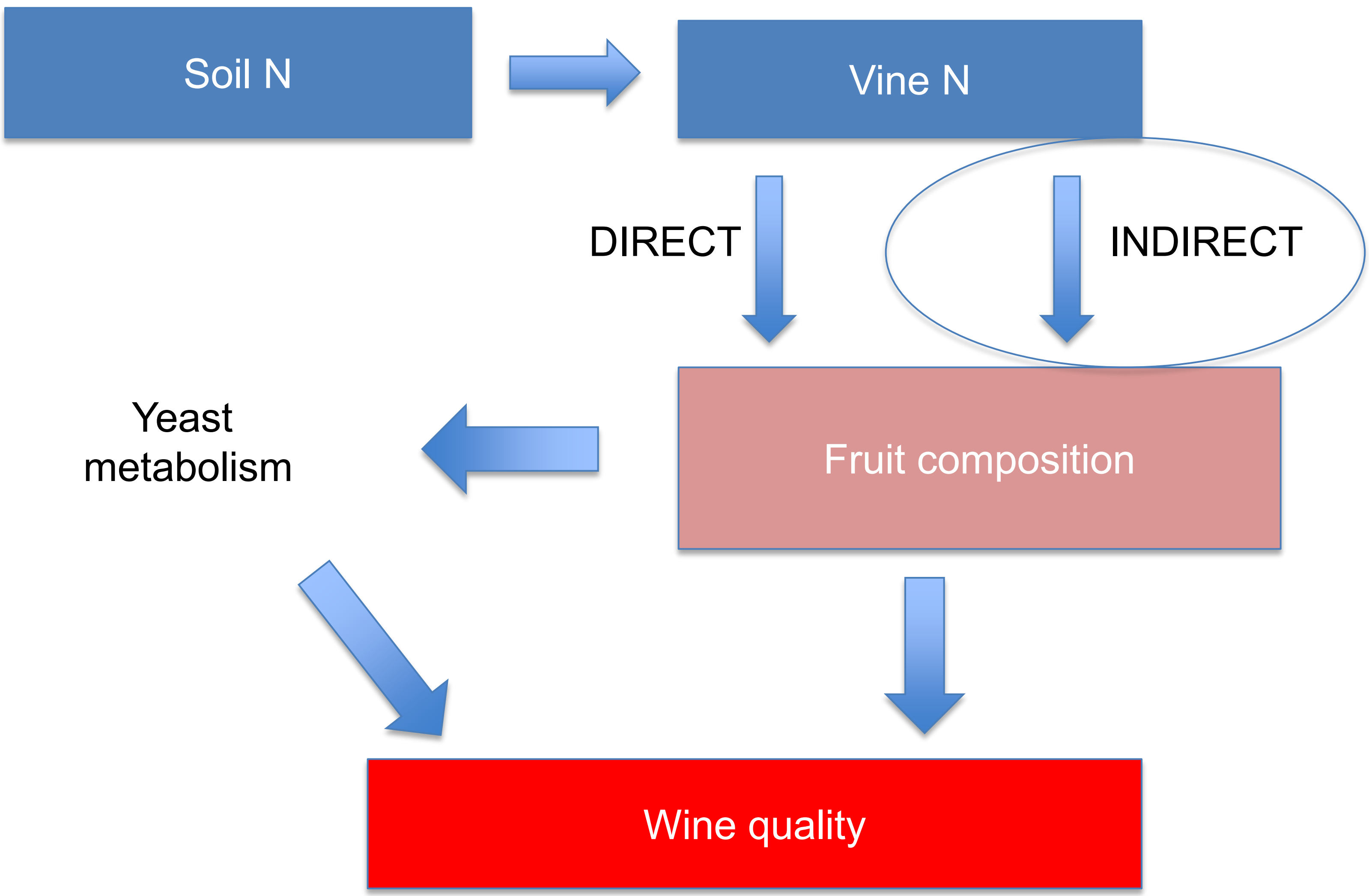
- Deficit to marginal status (based on tissue analysis)
  - N fert. generally has a positive effect
- Adequate to high status (based on tissue analysis)
  - N fert. may have negative effect
    - Disrupt balance
    - Increases vegetative growth
    - Increases shading
    - Decreases net photosynthesis
    - Assimilates diverted from fruit to shoots

Nitrogen effect on fruit composition and wine quality

The Australian Wine Research Institute



N impact on wine quality: Indirect effect

The Australian Wine Research Institute

- Excess → ↑ vegetative growth ↑ canopy density
  - More bunch zone shading → fruit composition
    - e.g. increased methoxypyrazine concentration in Cab Sauv in response to N fertilization

N impact on wine quality: Indirect effect

The Australian Wine Research Institute

- Excess → ↑ vegetative growth ↑ canopy density
  - More bunch zone shading → fruit composition
    - generally decreased monoterpenes in response to N fertilisation.
  - More disease
  - Growing tips compete with fruit for assimilate

Nitrogen effect on fruit composition and wine quality

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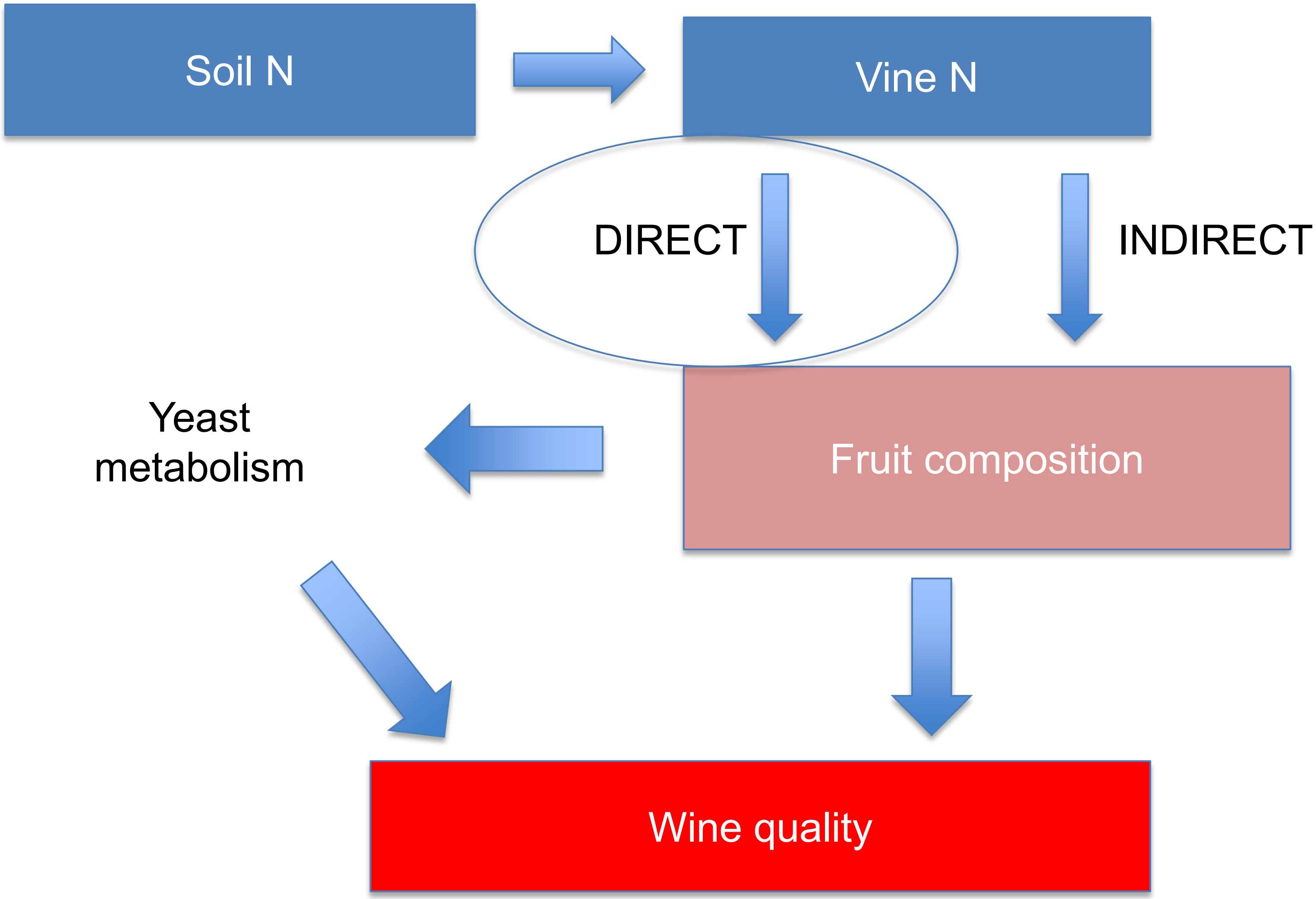


N impact on wine quality: Direct effect

Nitrate uptake → reprogramming of gene expression

- High nitrate suppresses genes involved in phenolic production
  - Delayed accumulation of phenolics and flavonols
- Low N at flowering stimulated sugar and phenolics
- High nitrate → ↑ organic acid production

  ↑ amino acid

Overall effect is decreased phenolics

N impact on wine quality: Direct effect?

Impact on organic acids:

- Increased N fertilisation
  - Often no change in malic and tartaric acids
  - Some studies found higher acid, lower pH (with significant yield increase). Keller 2001
  - Increased TA Christensen 1994

N fertilisation and grape anthocyanins

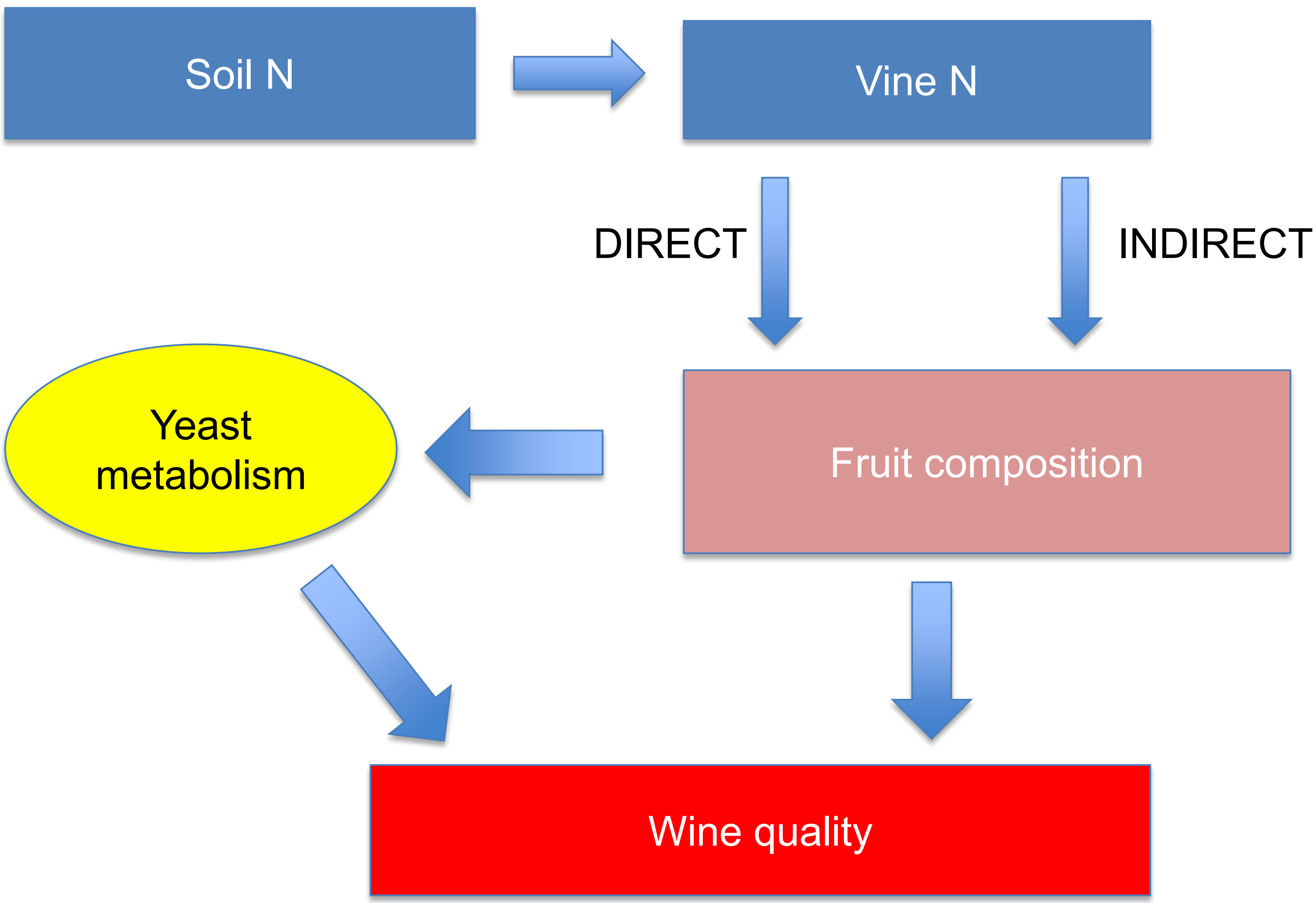
- Response to N fertilisation depends on starting point
  - Less than adequate level:
    - may increase anthocyanins
  - Adequate or more:
    - may decrease anthocyanins
  - High N → lowest colour density in wine
  - Low N → highest total anthocyanins and phenolics

N impact on wine quality

- Can the negative effect of shading caused by high N be overcome by leaf removal in bunch zone etc?
  - Not necessarily – high N and low flavonol make berries more susceptible to sunburn
- Or hedging?
  - This may waste resources because removes young leaves and retains old inefficient leaves
  - Also diversion of assimilates away from fruit

Nitrogen effect on fruit composition and wine quality

The Australian Wine Research Institute



N and fermentation

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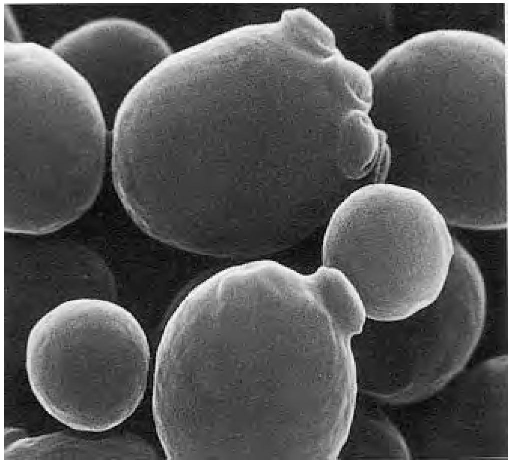
Nitrogen affects



- Yeast growth
- Metabolic activity
  - Fermentation rate
  - Flavour active compounds (fermentation bouquet)

Grape nitrogen: effect on yeast

The Australian Wine Research Institute

- Total Nitrogen in juice is mainly
  - Ammonium
  - Free Amino Acids
- Yeast assimilable N (YAN)

  = free amino N (FAN) + ammonium N (NH_4+)
- Yeast will use ammonium N initially, then most assimilable amino acids
- If YAN too low → stuck or slow ferments
- Low N → lower total amino acids (and more proline)
- High N → higher total amino acids (and more arginine)

Does N fertilization affect YAN in grapes?

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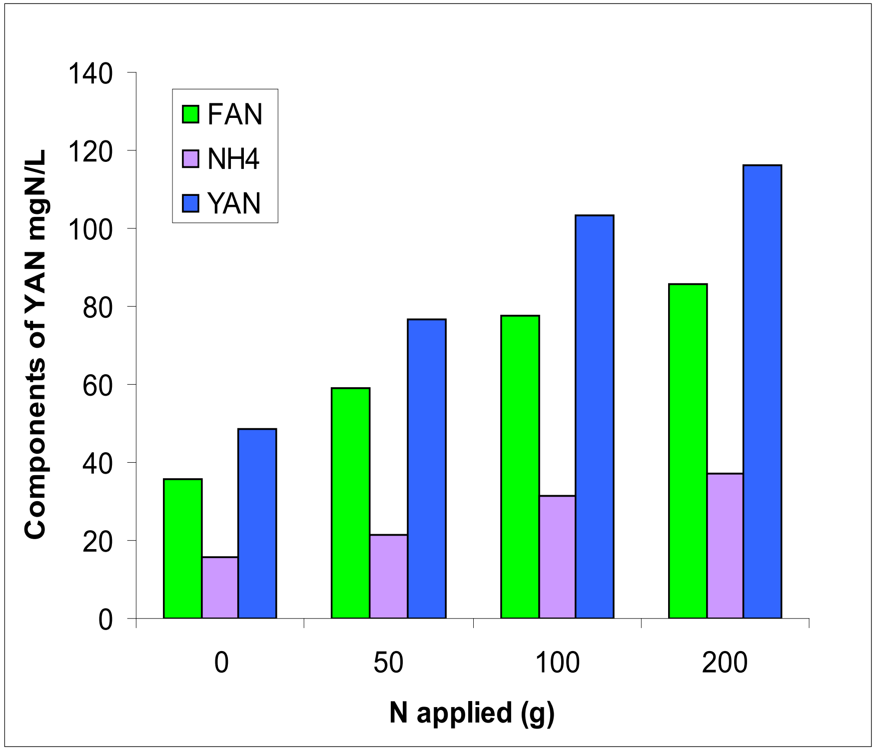


Grape N that yeast can use

Fermentation and sensory

The Australian Wine Research Institute

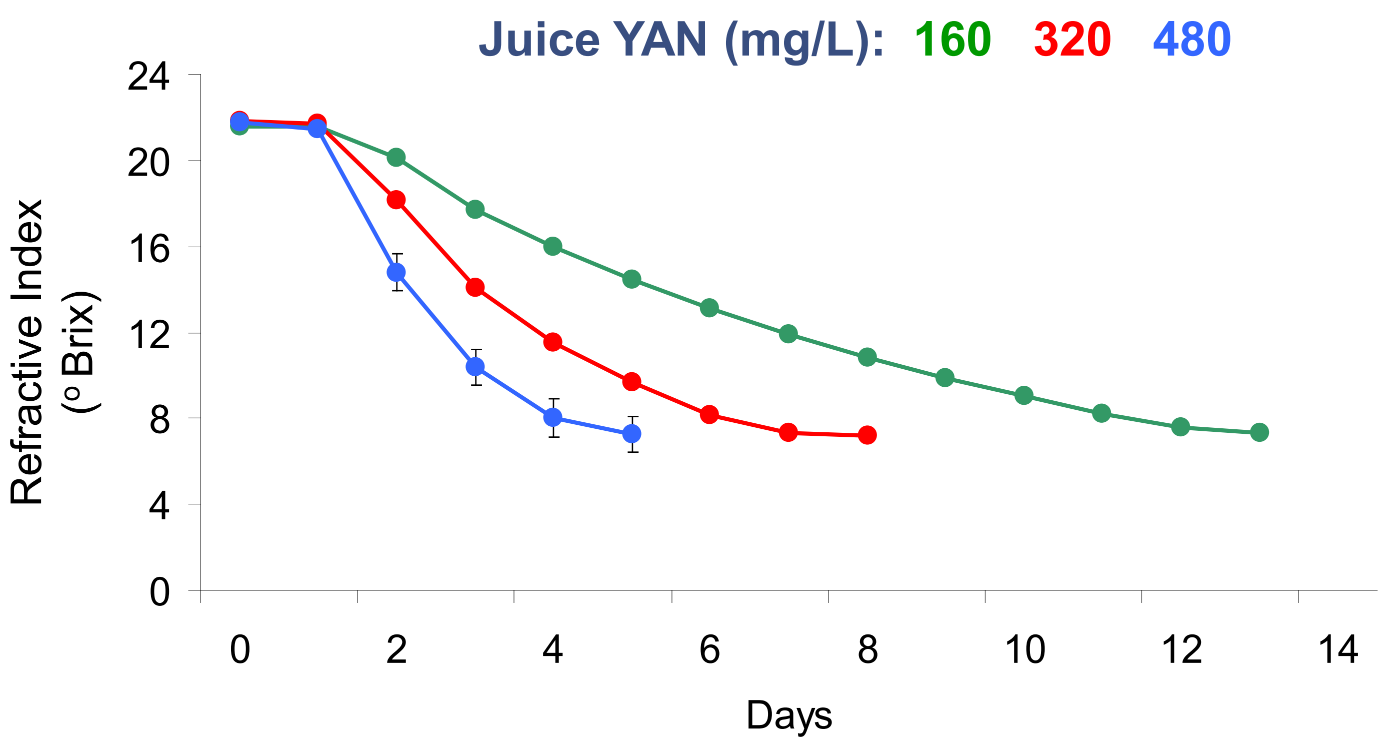
AWRI fermentation study

- Filtered Chardonnay juice
- Low N (YAN = 160 mg/L)
- High N demand yeast (AWRI 796)
- Wine analysis and descriptive sensory analysis


Diego Torrea

Effect of Juice N on Fermentation

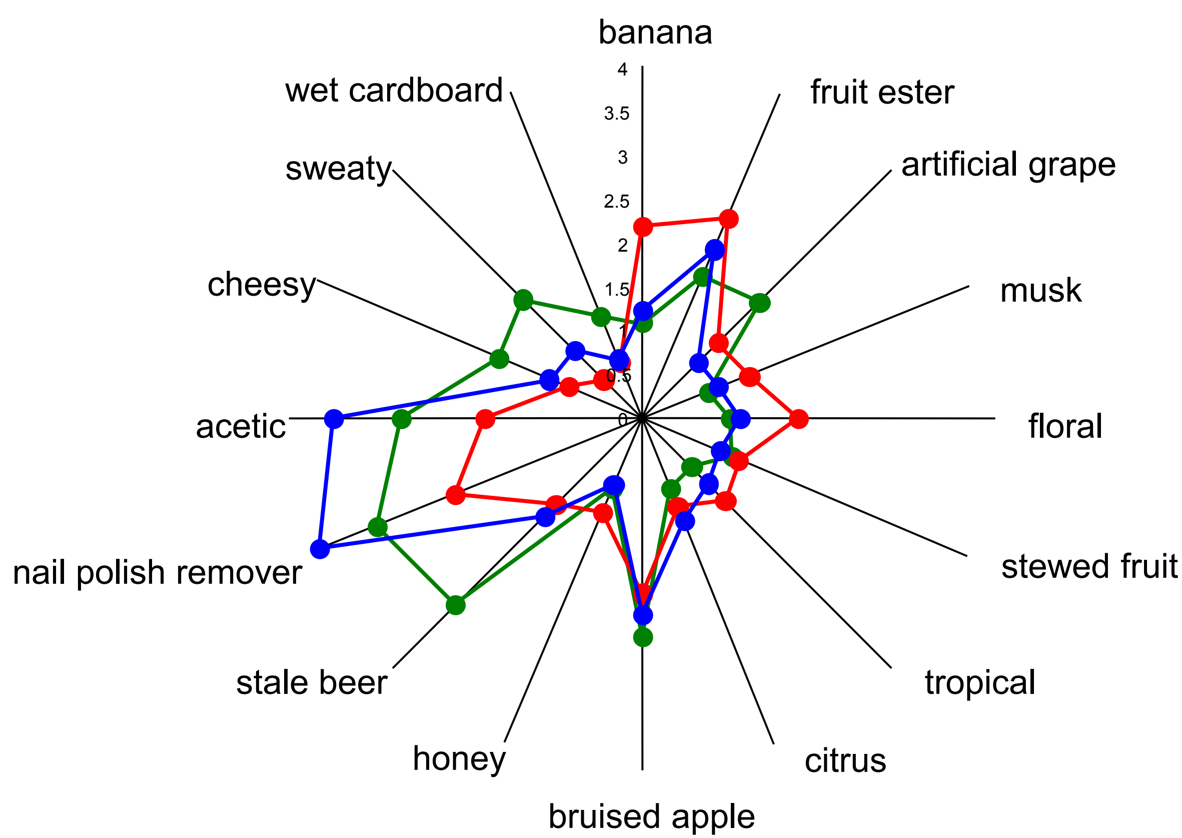
The Australian Wine Research Institute



Juice YAN affects: i) yeast growth,
ii) fermentation, and
iii) fermentation duration

Effect of juice N concentration on wine aroma profile

The Australian Wine Research Institute



Low & High N: Negative effects
Moderate N: Positive effects

Juice YAN (mg/L): **160** **320** **480**

NITROGEN

The Australian Wine Research Institute

- Increased PR proteins with increased plant N
  - → haze and increased need for bentonite fining

Potassium

- No evidence for direct effect of soil K on wine quality
  - Except K deficiency may impair sugar accumulation
- K fertilisation effect on juice K concentration?
  - No consistent results
- Factors such as rootstock type, irrigation, canopy management etc much more influential than K status of soil
  - Reduced irrigation → reduced juice K concn
  - Shoot trimming → increased leaf blade K concn

Potassium

- High K in juice
  - → decreased concentration of free acids particularly tartaric (and ↑ pH)
  - → may decrease rate of degradation of malic acid
  - Reduced colour intensity
  - Lack of acidity in flavour
  - Poor wine stability

What factors determine how much K ends up in juice?

Impact of K movement from leaves to fruit

The Australian Wine Research Institute

EXPOSED CANOPY
Less potassium moves from leaves to the berries

Shading→ ↑ K in leaves at veraison
→ ↑ K in berries at maturity
Therefore more K in wine, higher pH

SHADED CANOPY

More potassium moves from leaves to the berries

Potassium: rootstock effect

The Australian Wine Research Institute

- Direct or indirect effect?

- Direct
  - Rootstock type affects:
    - a) uptake by roots √
    - b) transport from roots to shoots √
    - c) transport from leaves to fruit ?
- Indirect
  - Rootstock type affects shoot vigour, canopy shading

Mg and Ca

The Australian Wine Research Institute

- Mg deficiency may decrease export of sugar and amino acids to fruit
- No direct effect of Ca
  - High Ca soils usually well drained so may be indirect effect
- High soil Mg or Ca may decrease K uptake by roots → lower juice/wine pH
  - Therefore high soil pH (associated with high soil Ca) may be coupled with low wine pH

Take home messages

- Know the nutrient status of your vines so you can correct a deficiency if there is one
- Wine quality is not easily manipulated by fertiliser practices – if nutrient status is adequate
- N is the only soil nutrient that has a significant impact on wine quality
- N has both direct and indirect effects on fruit composition and wine quality
- Only use N fertiliser to correct a deficiency or to maintain adequate levels (timing is important)
- Measure must YAN before fermentation

The AWRI is a member of the Wine Innovation Cluster and is supported by Australia's grapegrowers and winemakers through their investment agency, the Grape and Wine Research and Development Corporation, with matching funds from the Australian Government.

AWRI
The Australian Wine Research Institute

Can great wines come from grafted vines?

Mardi Longbottom

Barossa 2011

The Australian Wine Research Institute

- What is the rootstock mix in the Barossa?
- Why the bad rap? - historical use / evaluation of rootstocks & progress
- Can great wines come from grafted vines?

Barossa stats

In 2010:

- 11,029 ha of vines, 6631 blocks
- Area on rootstock?

2725 ha or 25%

- What is the most common rootstock in the Barossa?

Ramsey

- Of those vines on rootstock, what is the most common scion variety?

Pre 1990

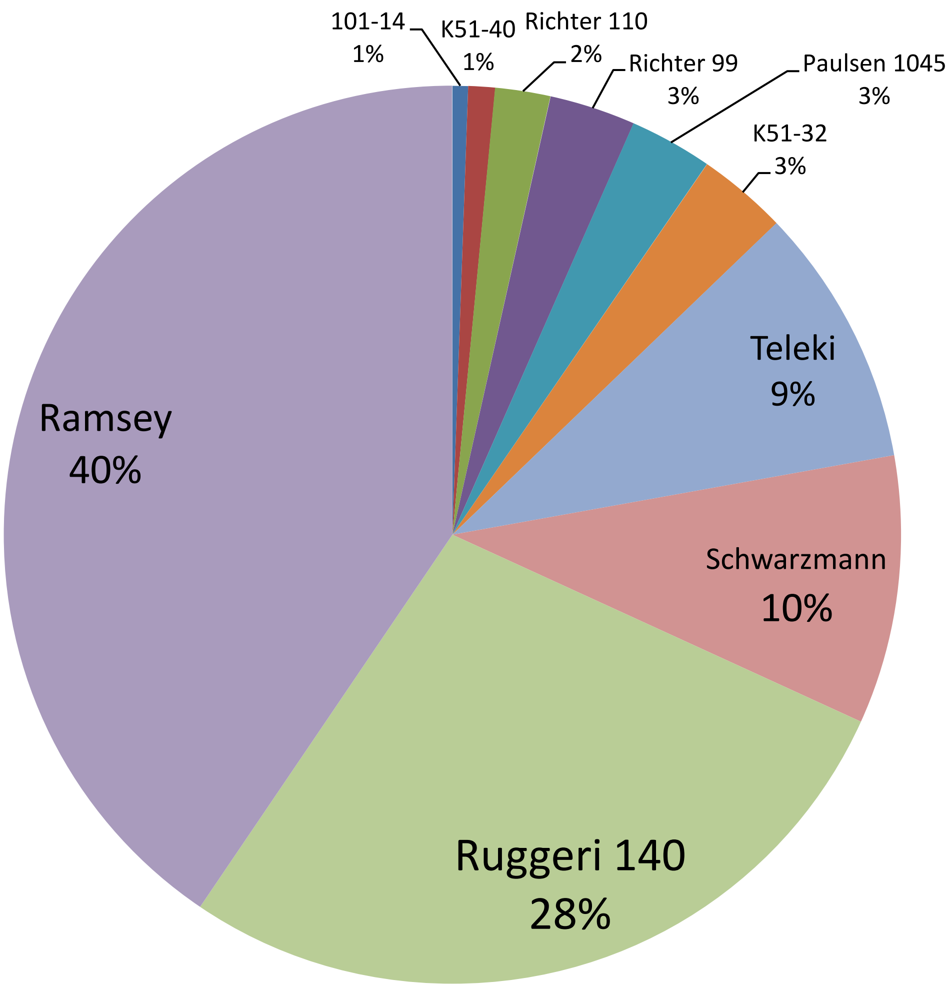
The Australian Wine Research Institute

Year	Area (ha)	Scion variety	Rootstock variety
1928	0.3	Semillon	Ramsey
1964	0.4	Semillon	Unknown
1966	0.6	Riesling	K51-32
1975	1.6	Shiraz	101-14
1977	0.5	Cabernet Sauv.	Ramsey
1980	0.34	Riesling	Schwarzmann
1980	1	Semillon	Ramsey

1980-1990 – Ramsey dominated
1990-1995 – Schwarzmann, Ramsey, 140 Ruggeri, 5A Teleki
1995 + - Increased mix but still dominated by the above rootstocks

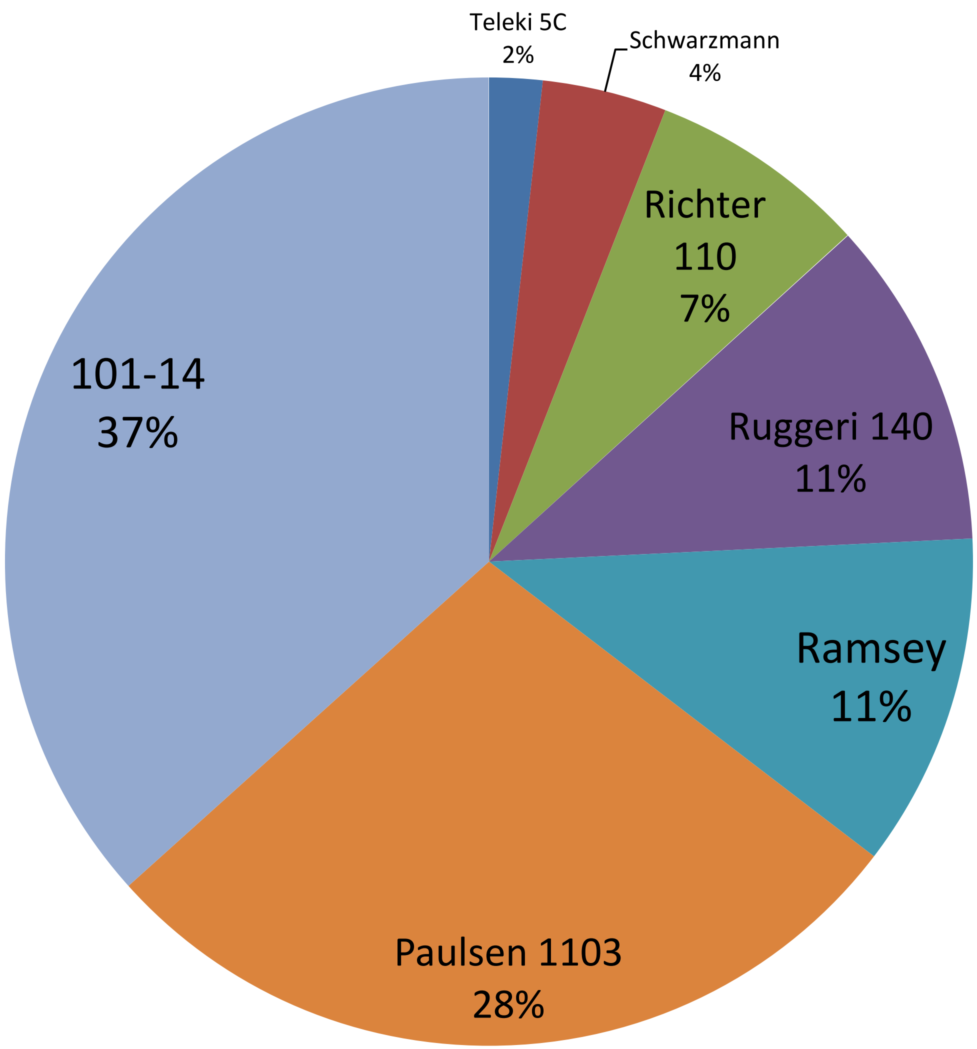
1990-1999

The Australian Wine Research Institute



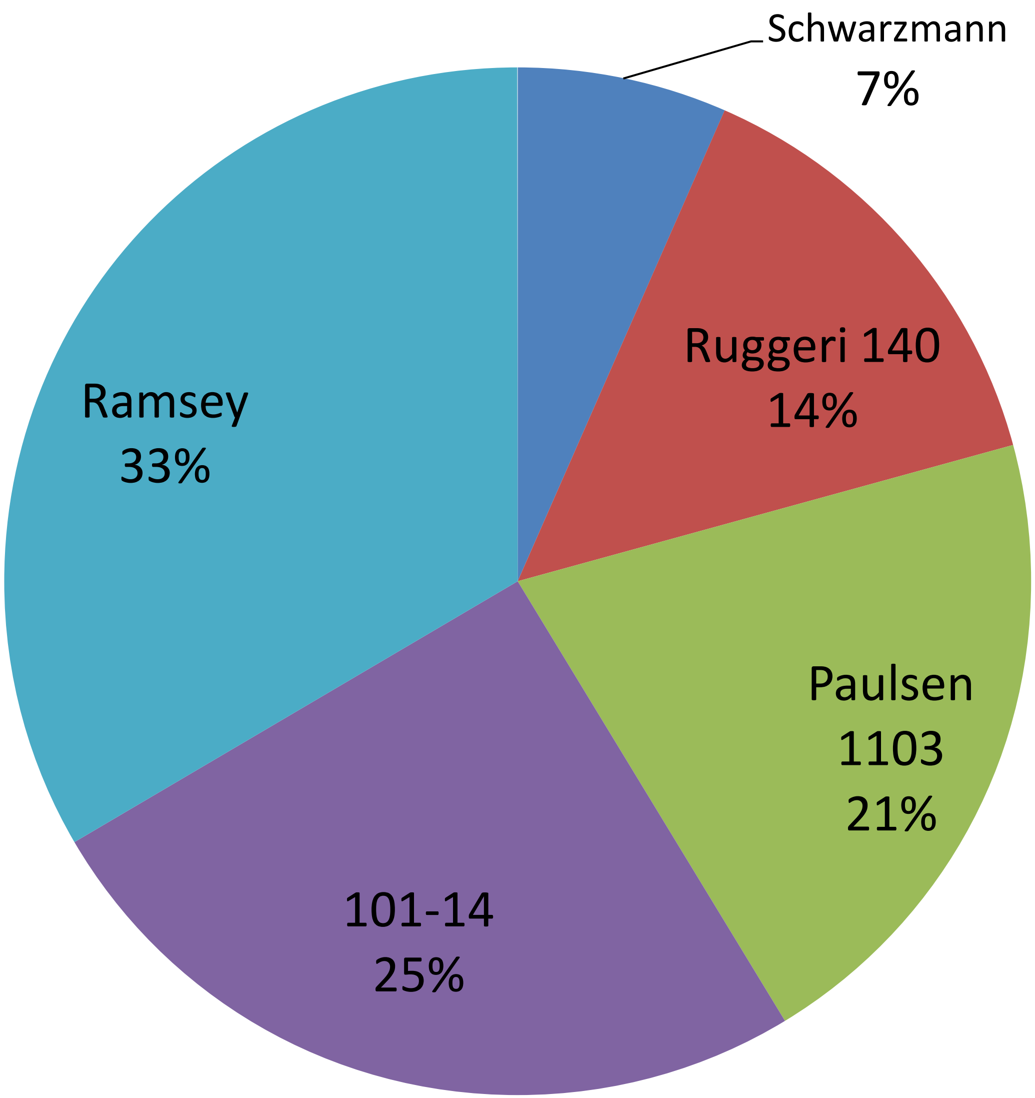
2000-2010

The Australian Wine Research Institute



Barossa 2010

The Australian Wine Research Institute



% of variety on rootstock

The Australian Wine Research Institute

	% var on rtsk
Grenache	4%
Cabernet Franc	16%
Riesling	17%
Semillon	20%
Shiraz	24%
Cabernet Sauvignon	27%
Viognier	41%
Chardonnay	42%
Sauvignon Blanc	47%
Merlot	52%

Cheval Blanc

Isole e Olena

What do these vineyards have in common?

Romaneé-Conti

Vega Sicilia

Do grafted vines have a bad reputation with some winemakers in Australia?

The Australian Wine Research Institute

- Not in Rutherglen, Corowa, Alpine Valleys, King Valley, Goulburn Valley, Glenrowan, Yarra Valley…….


OWN ROOTS
ungrafted


A X R
grafted

If not for phylloxera-resistant rootstocks, then …?

- Perhaps reputation mainly applies to nematode-resistant rootstocks?
  - but many of phylloxera-resistant stocks also nematode-resistant

History of nematode-resistant rootstocks in Australia

The Australian Wine Research Institute

- Commercial evaluation from 1970s

- Main focus on nematode resistance
  - Vigour
  - Yield

- Problems with some high ‘vigour’ stocks
  - wine with high K, high pH, low colour
    - direct or indirect effect?

Was the 'problem' exaggerated by some winemakers?

The Australian Wine Research Institute

Shiraz, Riverina (1986)

- Wine pH*:
  - Ramsey 3.82
  - Own roots 3.70
- Ramsey 46% higher yield*
  - * Average over 4 years

Hedberg P. et al. Aust J Exp Agric 26, 511-16 (1986)

Do all rootstocks produce wines with high pH?

The Australian Wine Research Institute

Related to potassium accumulation in fruit

- High K
  - champinii parentage
    - eg Ramsey, Freedom, Harmony, K51-32, K51-40
- Moderate K
    - Schwarzmann, 140 Ru, 99 R, 101-14
- Low K
    - 1103 P, 5C Teleki, SO4, 420A, 110 R, 5BB, own roots

What about the wine quality rating?

The Australian Wine
Research Institute

History of nematode resistant rootstocks in Aust

The Australian Wine Research Institute

McLaren Vale: Chardonnay (3 years) (1993)

- Ramsey
- 5C Teleki
- 140 Ruggeri
- Schwarzmann
- own roots (OR)

Grafted higher yield than OR

Wine quality rating: no difference

Source: Ewart, A. et al. (1993) ANZ Wine Ind. J. 8, 270-74

History of nematode resistant rootstocks in Aust.

The Australian Wine Research Institute

Langhorne Creek: Cabernet Sauvignon (3 years) (2000)

- Ramsey,
- 5C Teleki,
- 110 R,
- Schwarzmann,
- own roots

Colour and phenols = ns

- Wine (final year only)
  - 5C Teleki better than own roots
  - 5C Teleki higher yield "   "

Source: Gawel, R. et al. (2000) ANZ Wine Ind. J. 15(1) 67–63

What has changed in past 25 years?

- Some high vigour stocks discarded
  - eg Dog Ridge, Freedom
- Better matching of scion and stock
- More rootstocks now available that can produce good wine
- Better management of grafted vines
  - eg Yalumba Ramsey story

What has changed in past 25 years?

The Australian Wine Research Institute

- Not only nematode resistance that is important
  - Salt tolerance
  - Drought tolerance (avoidance)
  - etc

New CSIRO nematode resistant rootstocks

- Low to moderate ‘vigour’
- Lower K and pH and better wine than Ramsey, 1103 P or 140 Ru
- Good water-use efficiency
- Good salt tolerance
- Tolerant of phylloxera

The Australian Wine Research Institute

Grafted vines can produce better wine than own roots when:

- Avoidance of excessive water stress
- More tolera
- Less salt u
- Better N co
- Earlier or l
- Less within-block variability

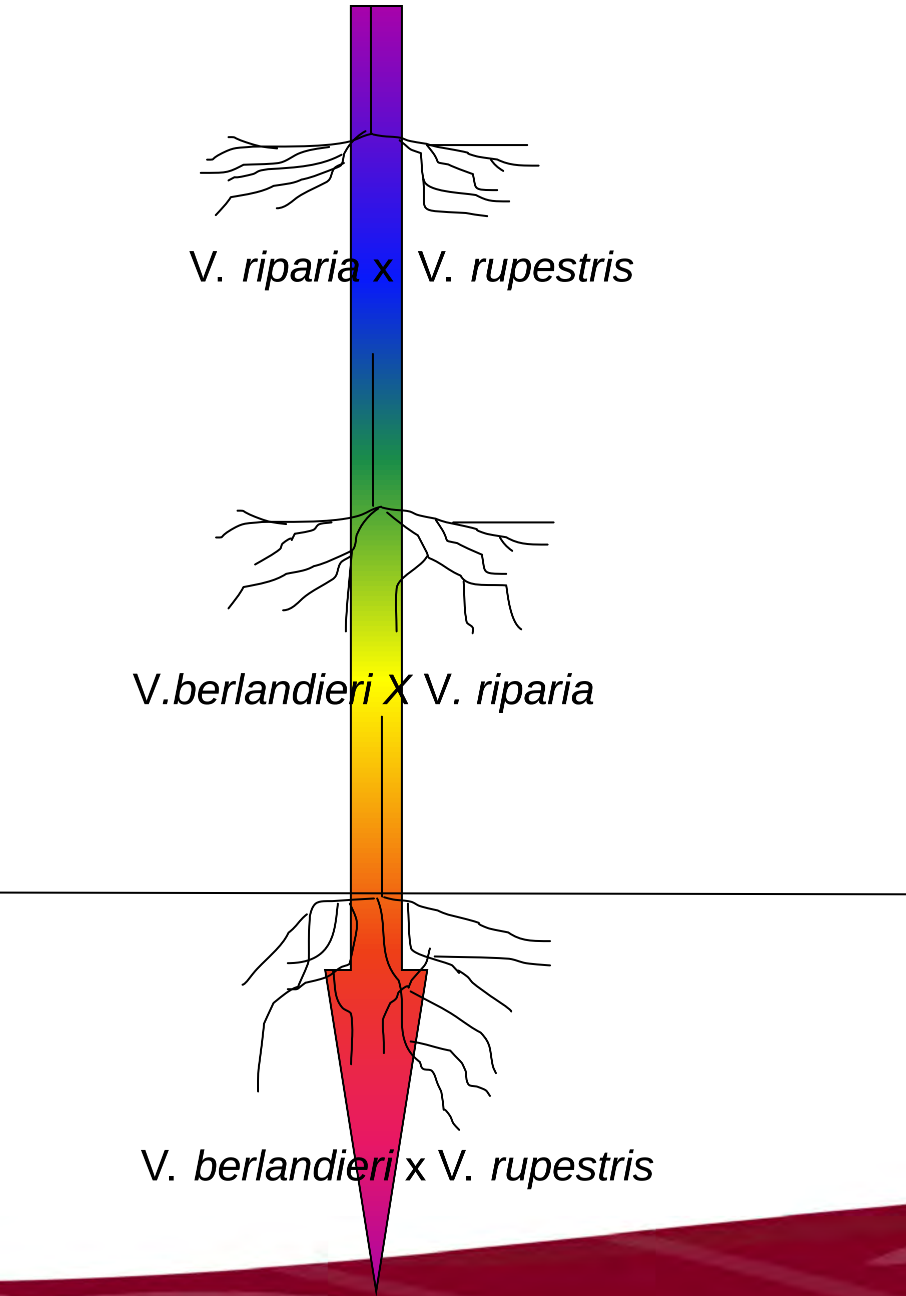
Avoidance of excessive water stress / drought tolerance

Rootstock genotype can influence:

- Root biomass and architecture
- Hydraulic conductivity
(water uptake/movement into roots & shoots)
- Canopy leaf area
- Stomatal conductance
- Canopy transpiration
- Yield
- Drought tolerance
- Salinity tolerance

Drought avoidance

Source: Dry, N. (2007)



Salinity tolerance

- Tolerant
  - 1103 P
- Moderately tolerant
  - 140 Ru, Schw., Ramsey, 101-14
- Moderately sensitive
  - 5BB, 5C Teleki, 110 R, 99 R, K51-32
- Sensitive
  - Own roots, 3309, 1202, K51-40

Better N composition - effect on YAN

Merlot, Napa:

- 1103 P and 101-14

Rootstock	Nitrogen Fertiliser	YAN (mg/L)
1103 P	None	430
101-14	high	290

Maturity advance/delay

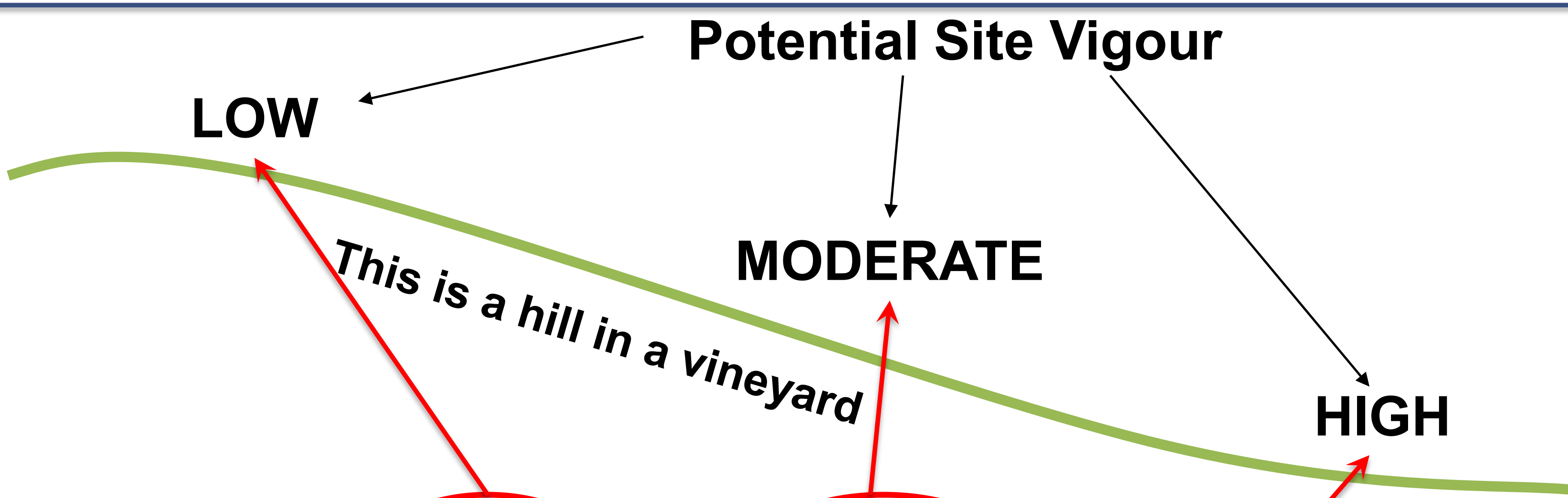
The Australian Wine
Research Institute

- Advance
  - 101-14, Schw., 3309, 420A, 5C Teleki
- Delay
  - Ramsey, 140 Ru, 1103 P, 110 R, 99 R

But the differences are only minor

Less within-block variability

The Australian Wine Research Institute



Rootstock	5C Teleki	Schwarzmann	101-14
Relative Vigour	moderate	low-moderate	low
PWt (kg/vine)	0.7	0.6	0.6
Yield (kg/vine)	1.3	0.8	1.1

Source: Phylloxera and Grape Industry Board of SA

Rootstock characteristics

The Australian Wine Research Institute

Take home message:

If you are dealing with these issues in the vineyard, consider the use of rootstocks as a tool to improve fruit and wine quality

Consider available information in your region

Case study: effect of rootstock on wine quality rating

The Australian Wine Research Institute

Source: Phylloxera and Grape Industry Board of SA

Quality classification used in case studies

The Australian Wine Research Institute

Classification	**Price $/bottle**
Super-premium	> 35
Premuim	18 - 35
Semi-premium	12 – 18
Commercial	< 12

(PGIBSA)

McLaren Vale Chardonnay, Coonawarra Cabernet S., Barossa Shiraz

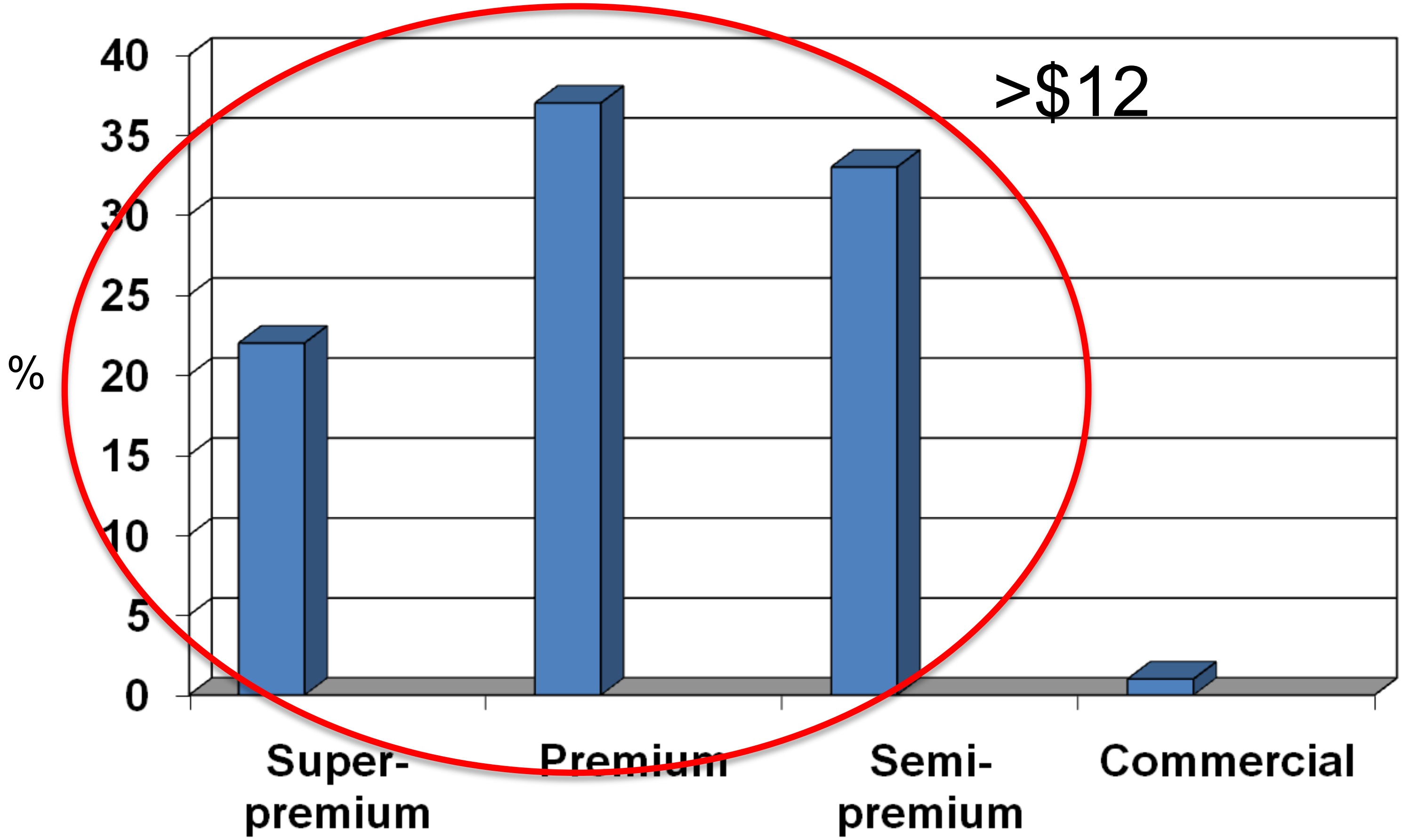
Out of all grafted vineyards in study, what % super-premium and premium?

- > 50?
- > 30?
- < 30?

Quality grading of wines from grafted vines (2005)

The Australian Wine Research Institute

McLaren Vale Chardonnay, Coonawarra Cabernet S., Barossa Shiraz



Similar story in 2006

Source: Phylloxera and Grape Industry Board of SA

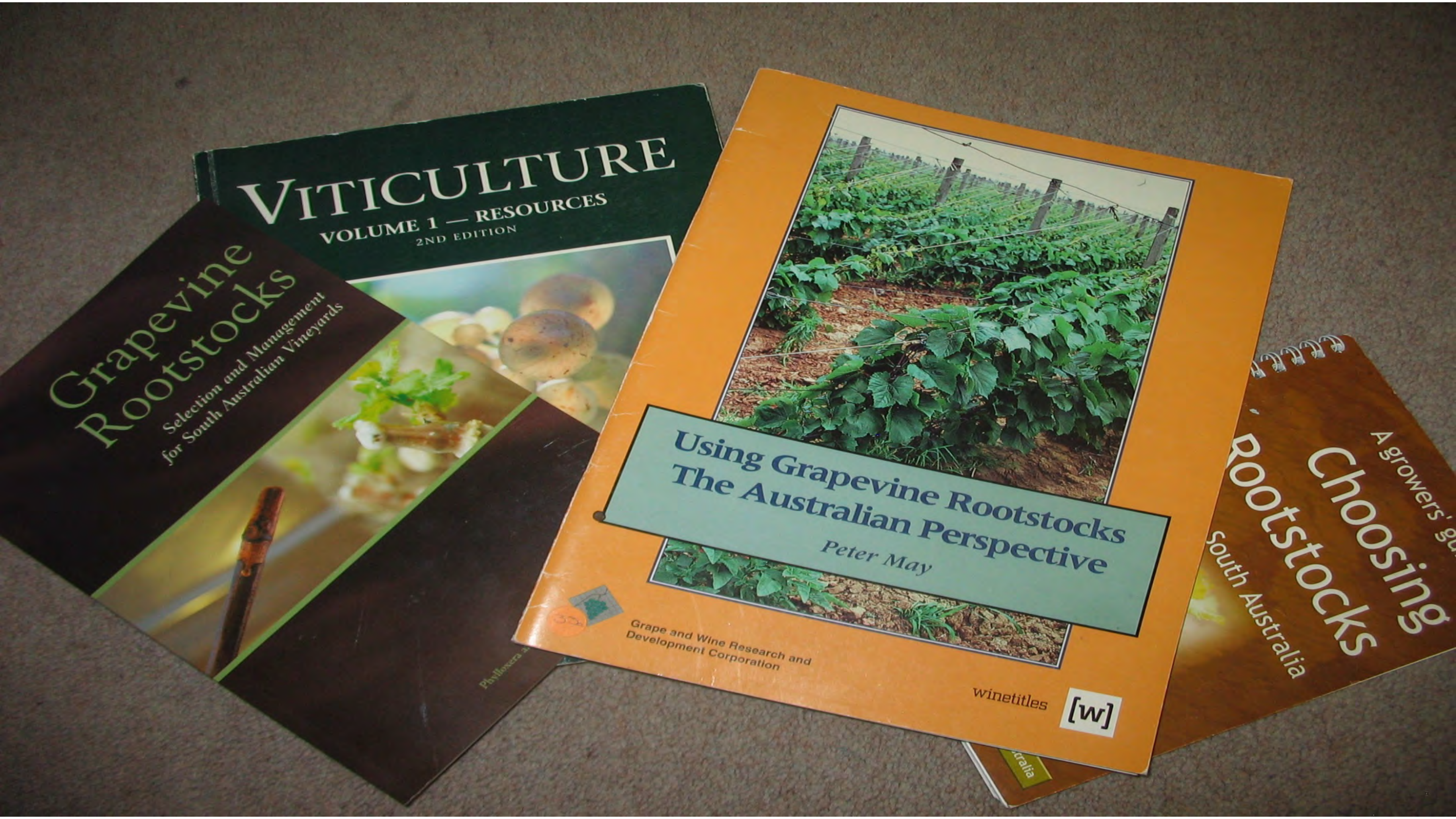
Conclusions

- Most great wines of world are from grafted vines
- The bad reputation of a **few** nematode-resistant rootstocks for wine quality in the past may have been deserved
- But now the situation is different
  - Better management
  - Better rootstocks

Conclusions

- Grafted vines can produce better wine quality than own-roots in many situations due to a combination of traits

For further information



Acknowledgements

The Australian Wine Research Institute

- PGIBSA
- Catherine Cox, TWE (formerly PGIBSA)
- Nick Dry, Yalumba (formerly PGIBSA)

Questions?

The Australian Wine Research Institute

Improving water use efficiency with rootstocks

Everard J. Edwards
Marisa J. Colins, Annette Boettcher, Peter R. Clingeleffer, Rob R. Walker

Plant Industry
www.csiro.au

CSIRO

Why improve water use efficiency?

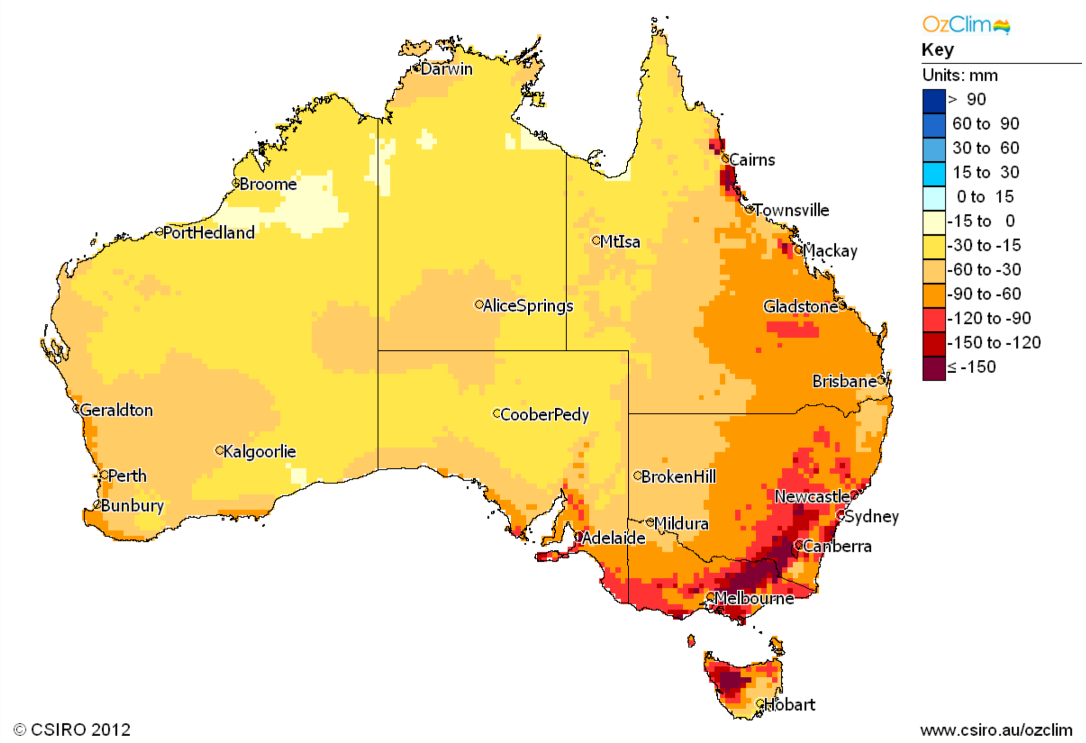
92% of vineyard area in Australia is irrigated,

- 73 GL of water (but <10% of MDB use),
- 4.5% from intercepted on farm rainfall,
- 78% from rivers/irrigation schemes.

Availability of irrigation water is, and will remain, under pressure:

- environmental demands,
- future droughts,
- climate change.

A changing climate – Australia in 2050



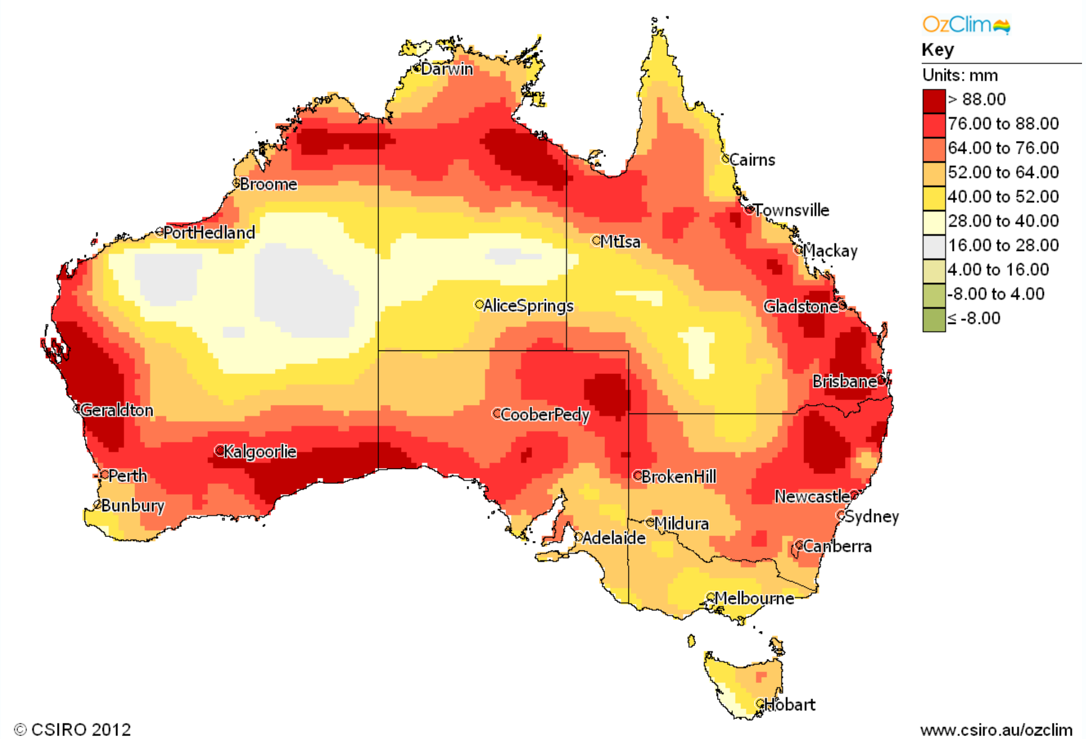
Reduced winter rainfall

OzClim: SRES A1B emission scenario, CSIRO Mk 3.5 model, moderate global warming rate.

A changing climate – Australia in 2050

Hotter summers

State	Air temperature increase
South Australia	+2.3
Victoria	+2.1
New South Wales	+2.5
Western Australia	+2.4
Tasmania	+1.6
ACT	+2.1



Higher evapotranspiration

OzClim: SRES A1B emission scenario, CSIRO Mk 3.5 model, moderate global warming rate.

Water use efficiency (WUE)

Water use efficiency may be defined in many ways:

$\frac{\text{photosynthesis}}{\text{transpiration}}$ (leaf level) = instantaneous WUE

fruit mass/irrigation applied = irrigation WUE

as fruit mass/water transpired = crop water use index

Physiologist

Grower

Breeder

To improve WUE we can optimise the crop management, the vine or both (intrinsically linked).

Optimising *the vine* requires improving the crop water use index (CWUI):

i.e. increase yield and/or reduce transpired water.

A role for rootstocks?

Limited acceptance of improved scion varieties by consumers.

Decisions on use of rootstocks by vineyard/winery not marketing.

A role for rootstocks?

Limited acceptance of improved scion varieties by consumers.

Decisions on use of rootstocks by vineyard/winery not marketing.

Rootstocks known for effect on vigour,
e.g. Ramsey vs 1103 Paulsen.

Vigour (canopy size) and water use linked. Opportunity to use rootstocks to alter WUE.

Shiraz on 1103 Paulsen

Shiraz on Ramsey

Crop water use (transpiration)

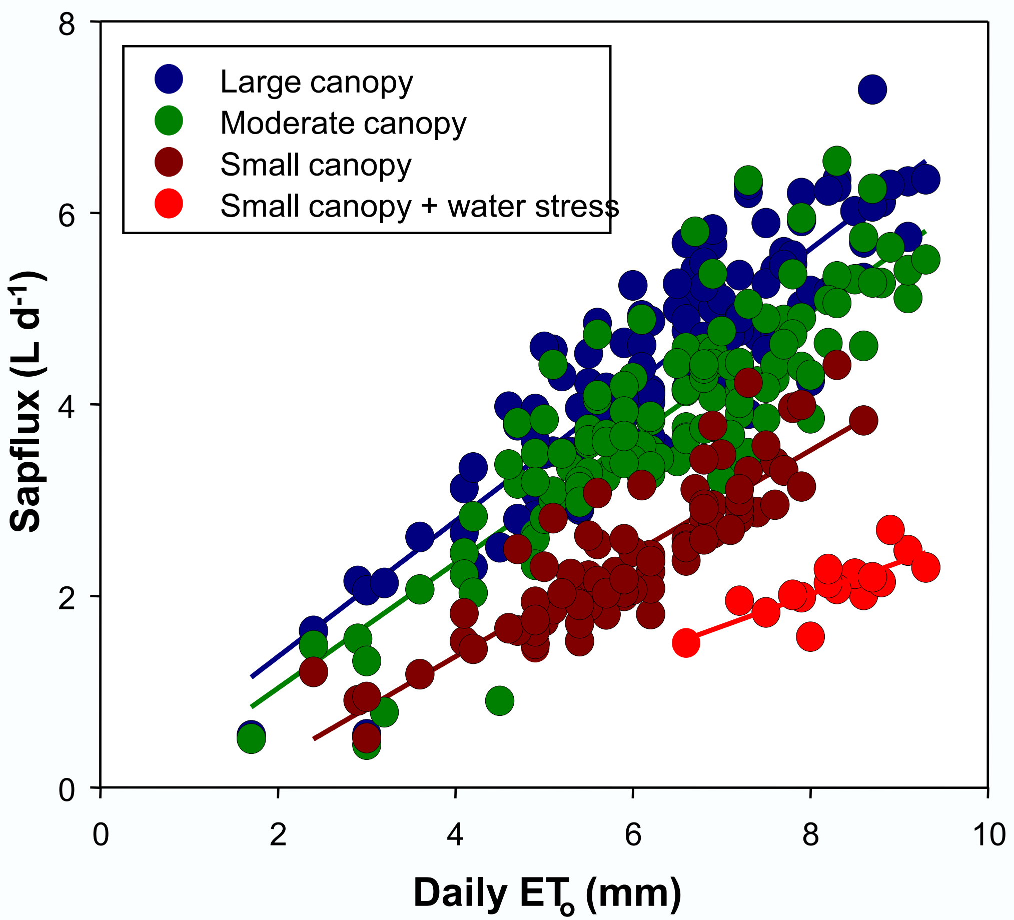
Vine water use is a function of:

•*vapour pressure deficit (air dryness),*

•*canopy size,*

•*stomatal conductance ('ease' of water loss).*

For example:



Cabernet Sauvignon, Murray Valley, Australia.

Improving crop water use index (CWUI) with rootstocks

Crop water use index = yield / water transpired

Water transpired = VPD*conductance*canopy size

Rootstock choice may alter:

- yield per vine,
- canopy size,
- conductance (via hormones or hydraulics).

Sunraysia rootstock trial

- 60+ rootstocks,
- Grafted with Shiraz.
- Over 20 years old.
- Project utilising:
  - Dog Ridge,
  - Ramsey,
  - 1103 Paulsen,
  - 140 Ruggeri,
  - Three CSIRO released stocks (M5489, M5512 & M6262).

Rootstock conferred vigour: canopy size

Flowering

Canopy closure

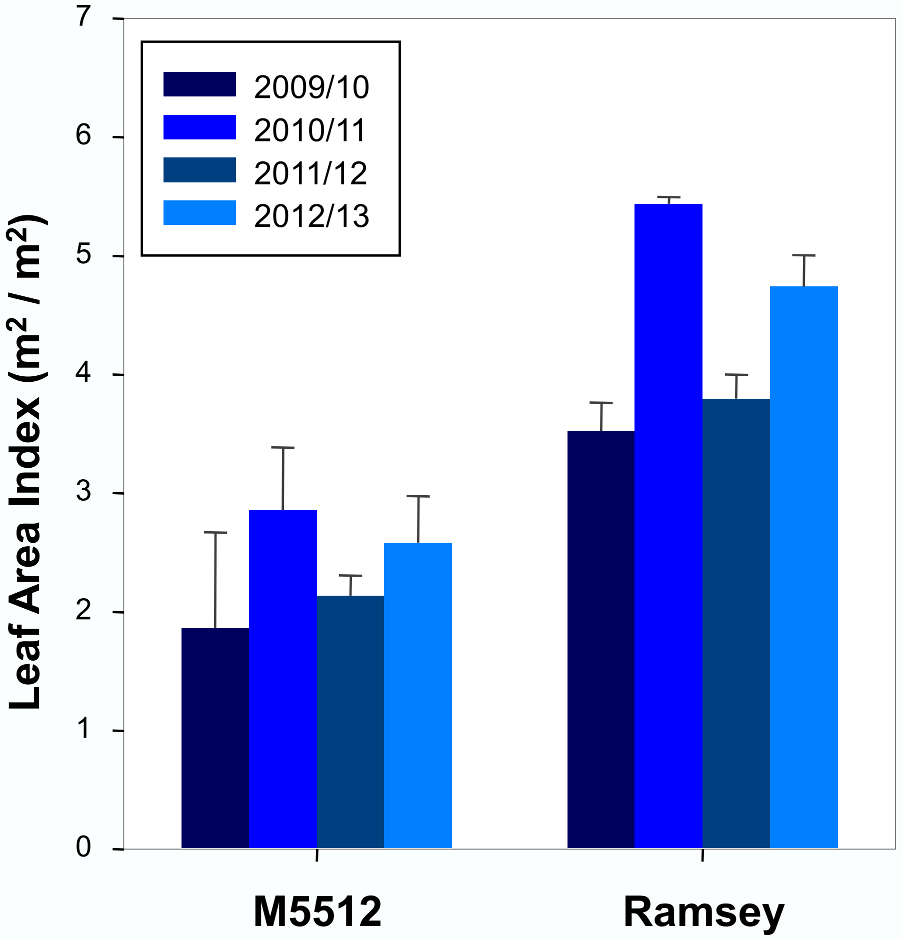
Ramsey 1103 Paulsen M5512

Canopy size: rootstock and season

Can directly measure canopy size to compare rootstocks.

Easiest as *leaf area index* (LAI), area of leaf / area of ground.

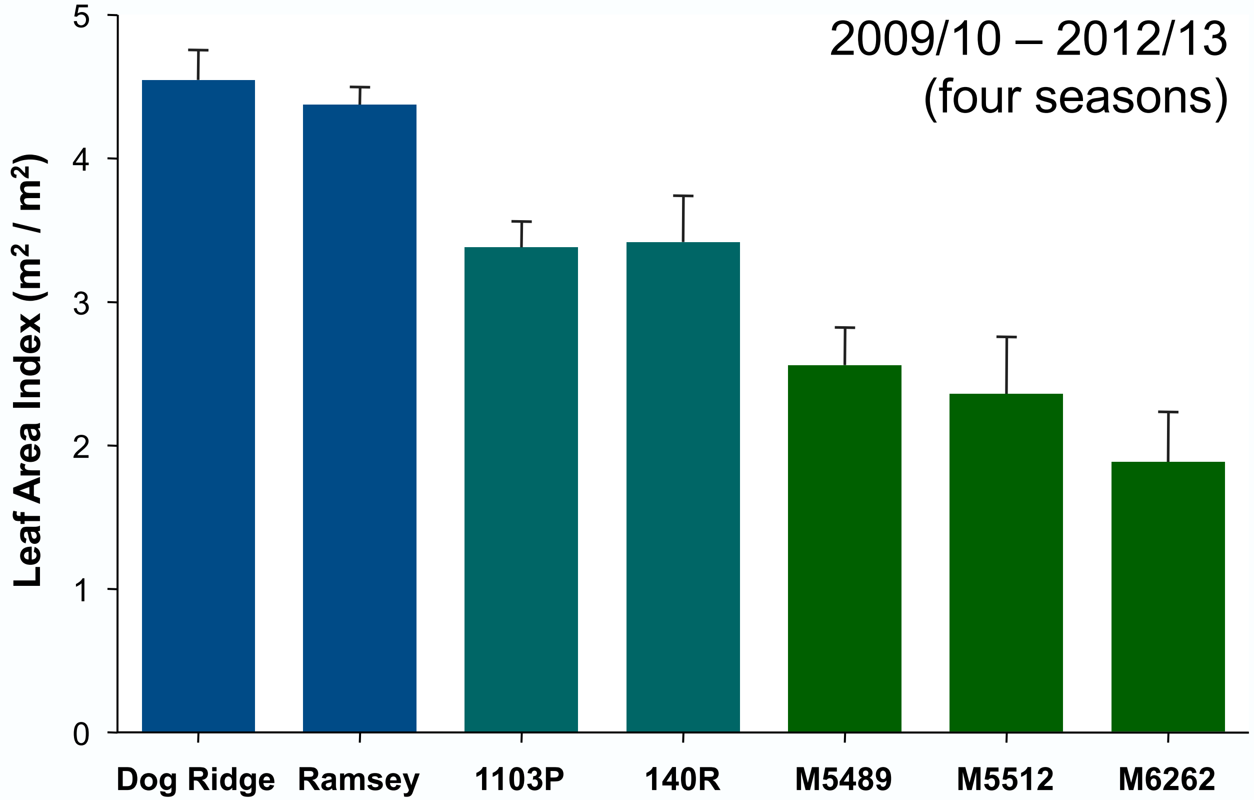
Large effects of both season and rootstock.



Rootstock conferred vigour: canopy size

Averaging across many seasons isolates effect of rootstock.

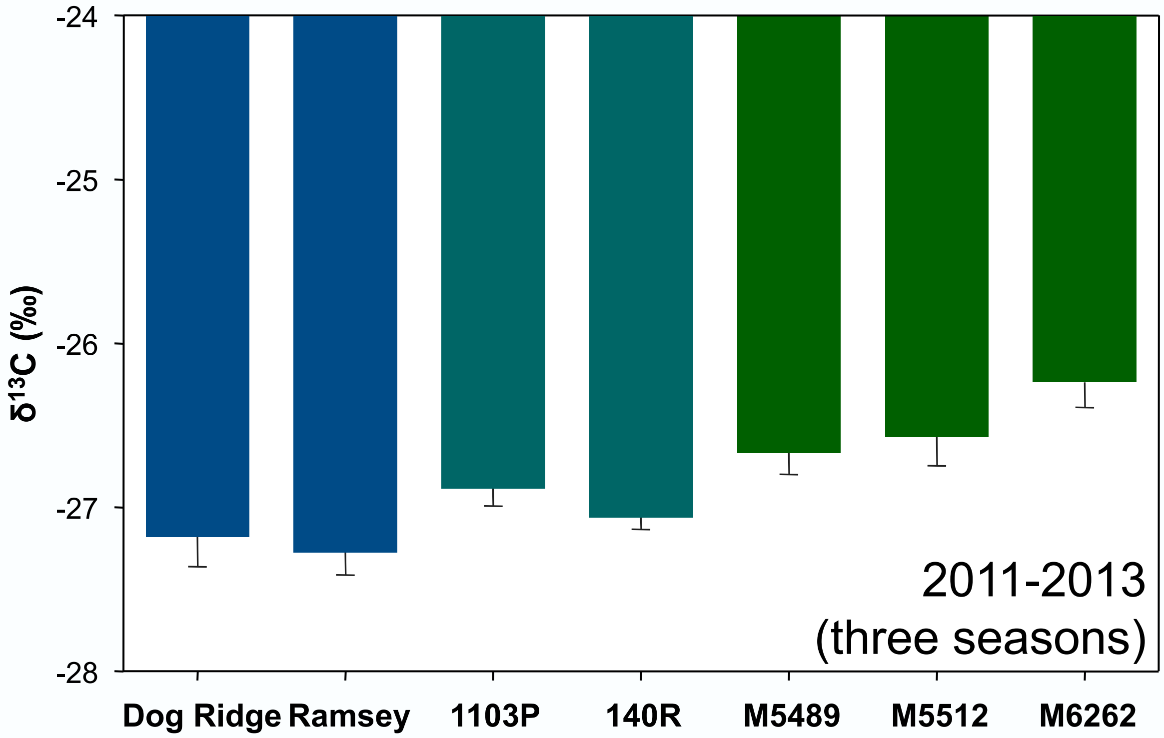
Rootstocks split into three groups, two-fold range.

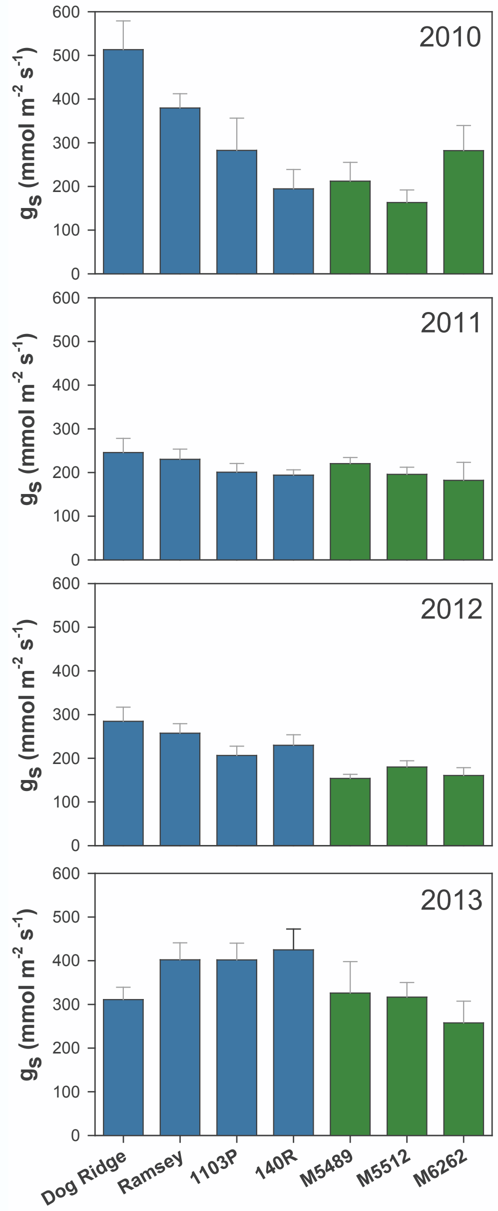


Drivers of water use: stomatal conductance

Effect of rootstock on a given day was variable, but typically related to vigour.

Over entire seasons (lower $\delta^{13}C$ = higher conductance), the lower vigour rootstocks conferred lower conductance.

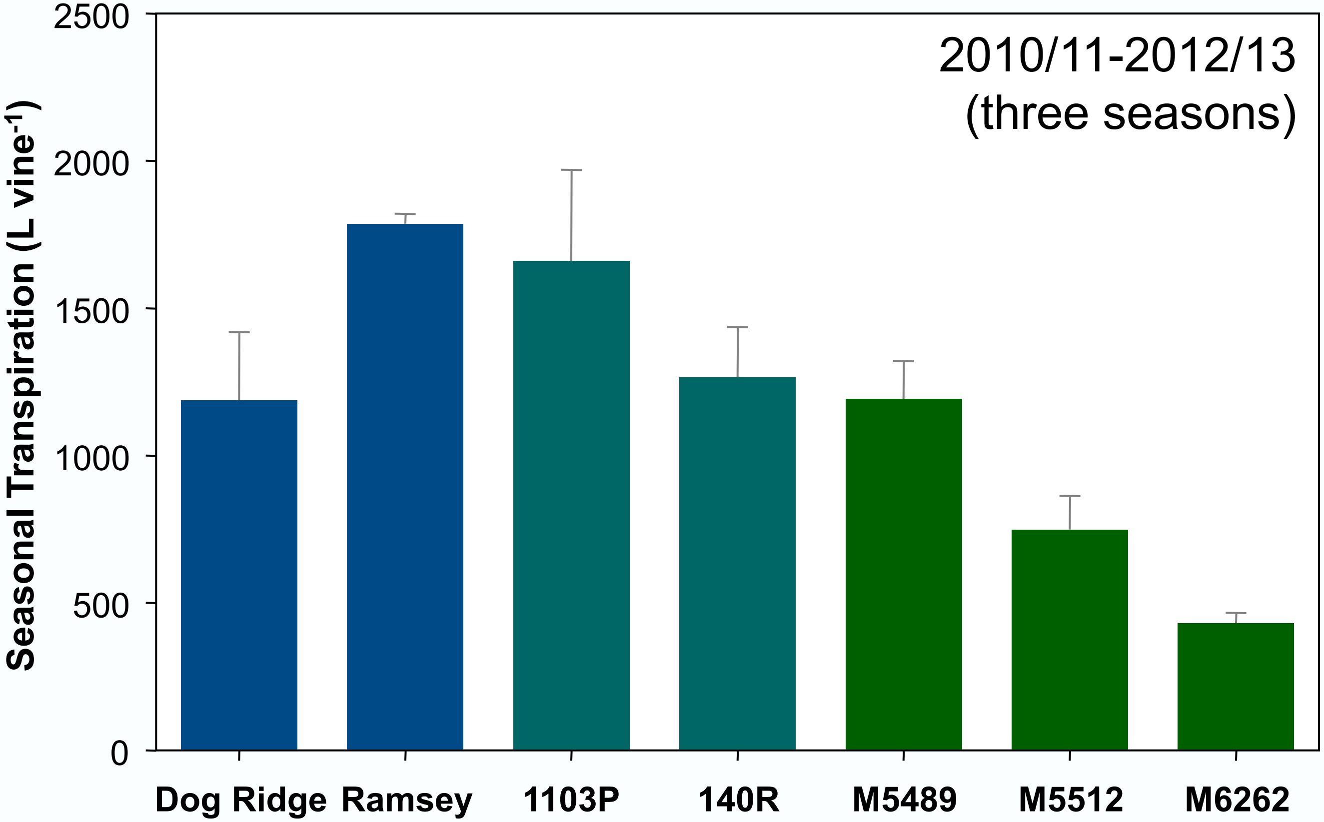




Vine water use – sap flow

Expect rootstock effect on vine water use due to effect on canopy size and conductance.

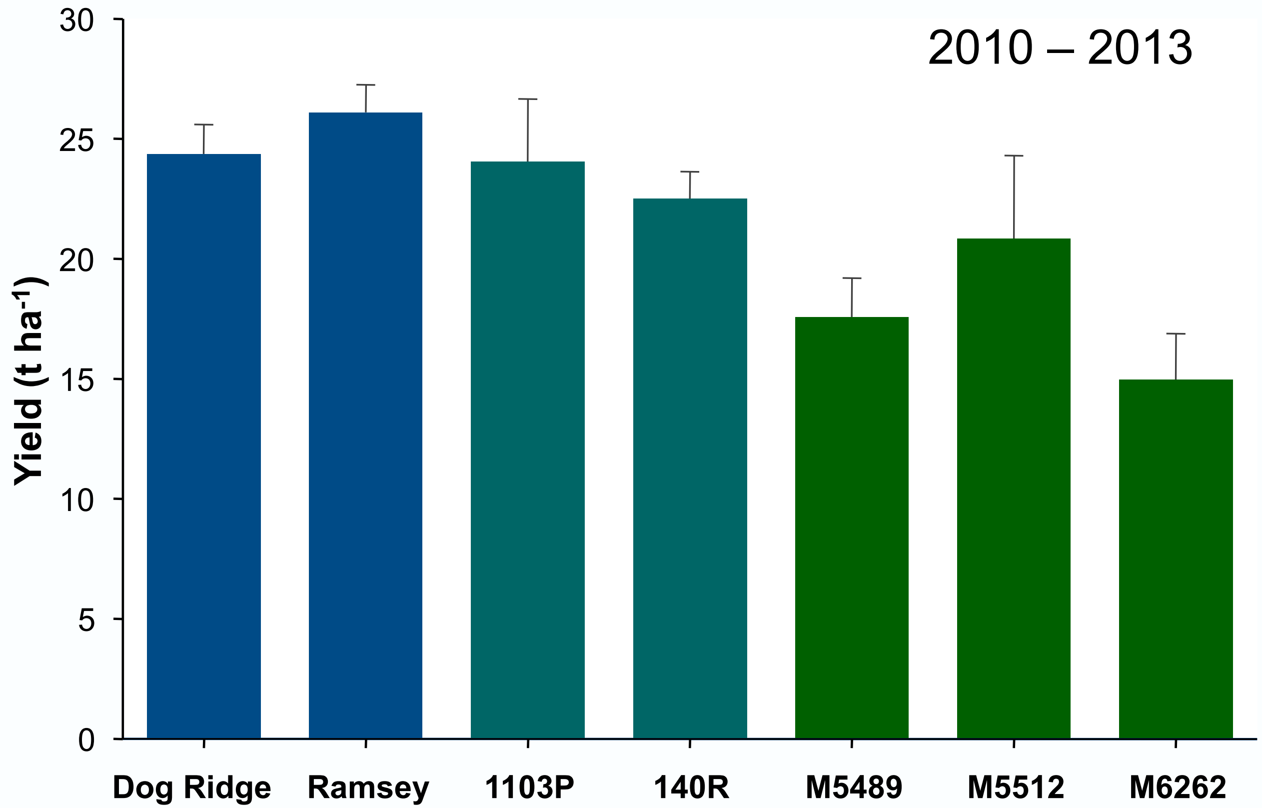
Can measure directly with sap flow sensors.



Rootstock impact on yield

Vigour groupings much less distinct for yield.

Some yield penalty for lower vigour.

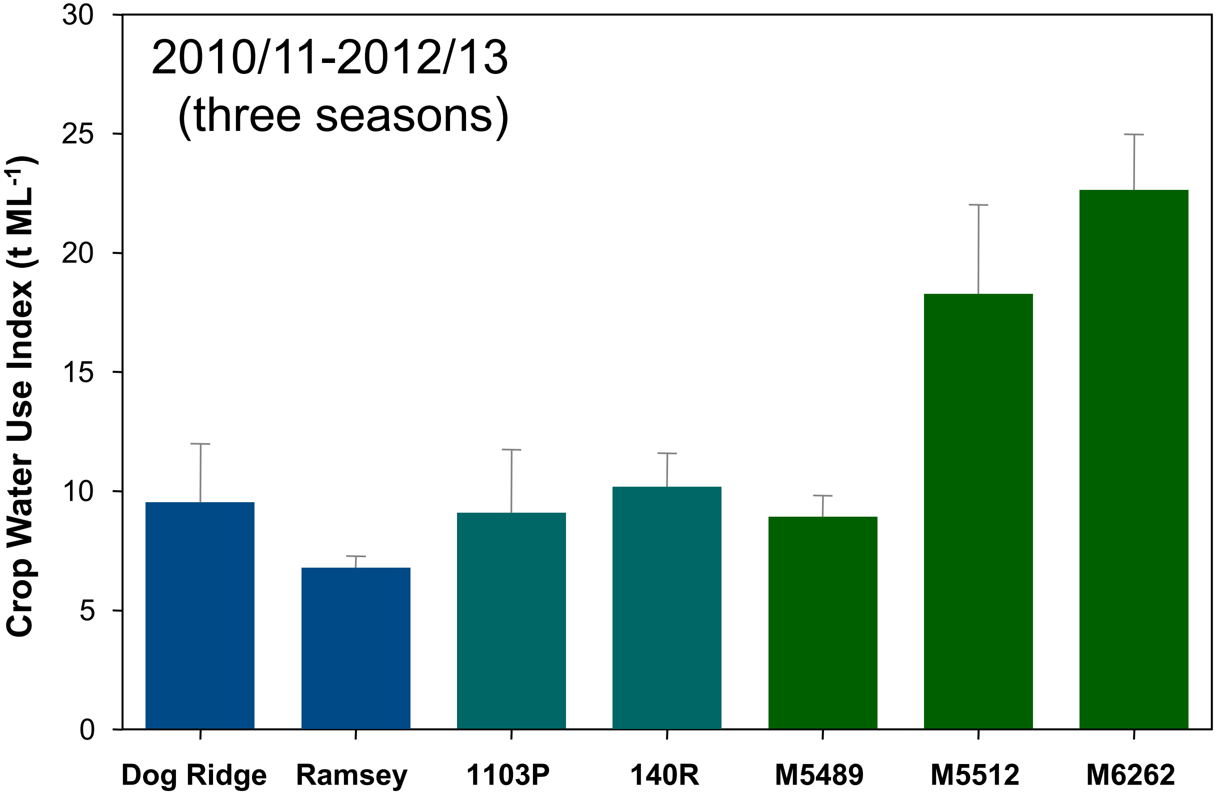


Mean yield over four seasons, n=6.

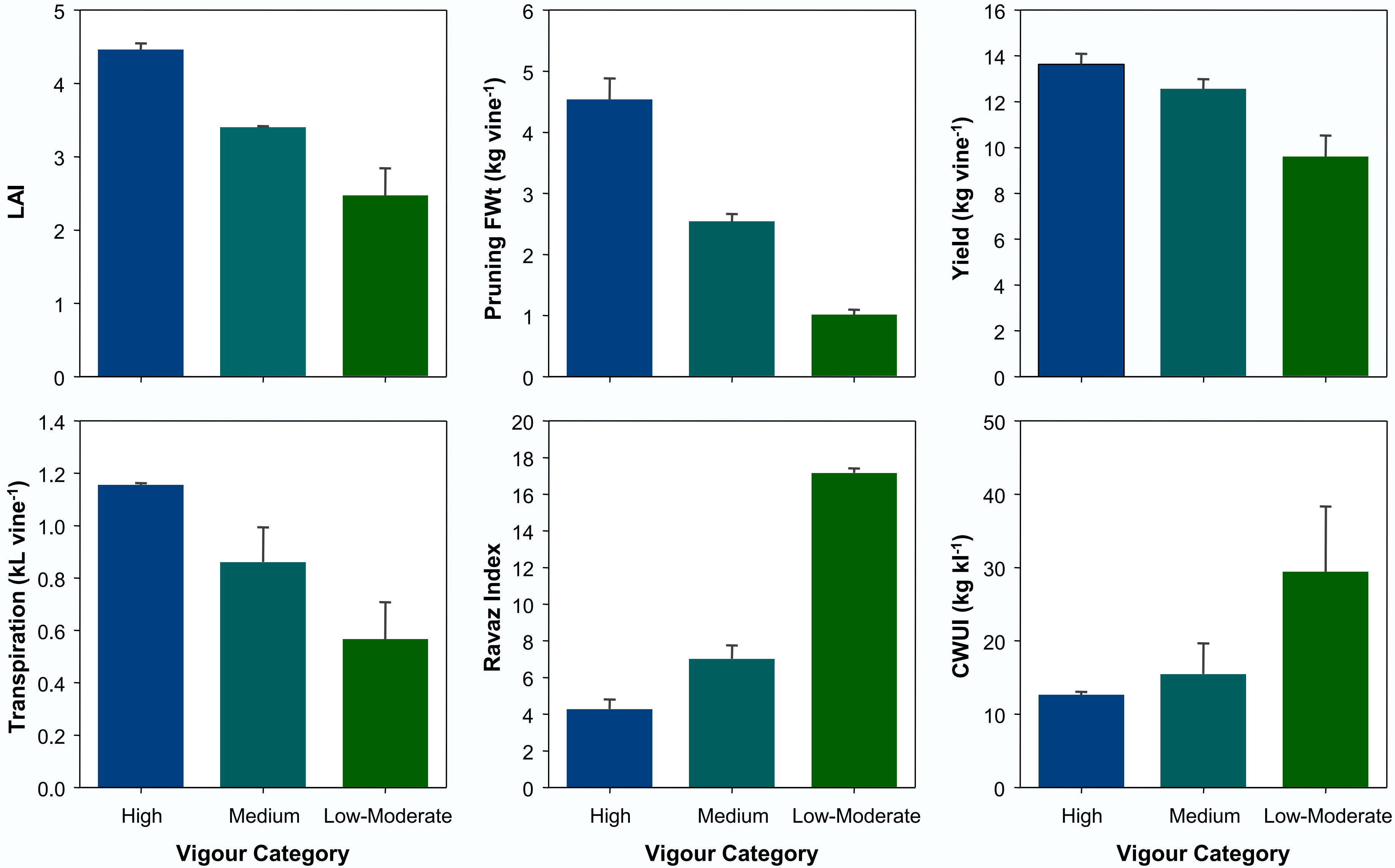
Water use efficiency ranking

Same irrigation applied to all vines, therefore *irrigation water use efficiency* = yield rank.

But ranking of vine water use efficiency (defined as CWUI) almost the reverse.



Summary: rootstock effects on water use efficiency



Summary: rootstock effects water use efficiency

- Rootstocks conferred differences in vigour, stomatal conductance and yield.
- Resulted in direct link between rootstock conferred vigour and water use efficiency.
  - Low vigour = high water use efficiency.
- But maximum productivity (yield per ha) only achieved with high vigour rootstock.
- Water savings will only be achieved through irrigating specifically to rootstock.
- Opportunities for higher density planting etc.

Acknowledgements

Arryn Clarke (farm manager).

GWRDC funding.

Plant Industry
Everard Edwards
Research Team Leader

t +61 8 83038649
e everard.edwards@csiro.au

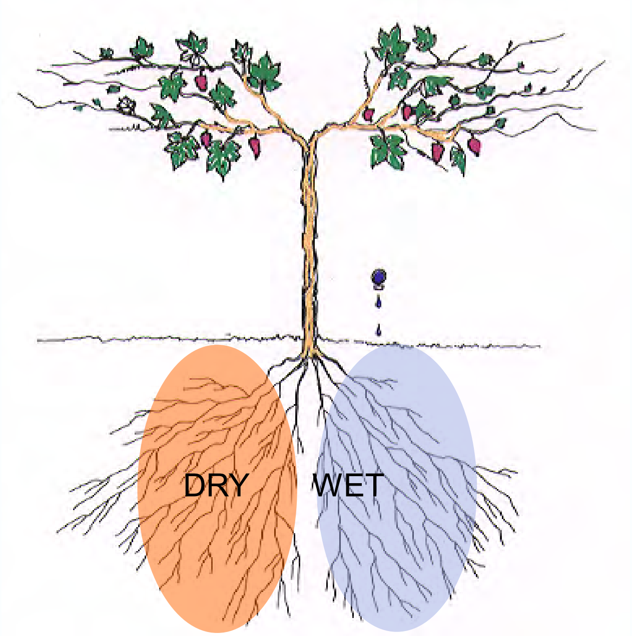
GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

Improving WUE with irrigation strategies?

Irrigation strategies can be used to alter vine water use, e.g. PRD, RDI.

- Do not always improve WUE.
- Can be complex to implement.

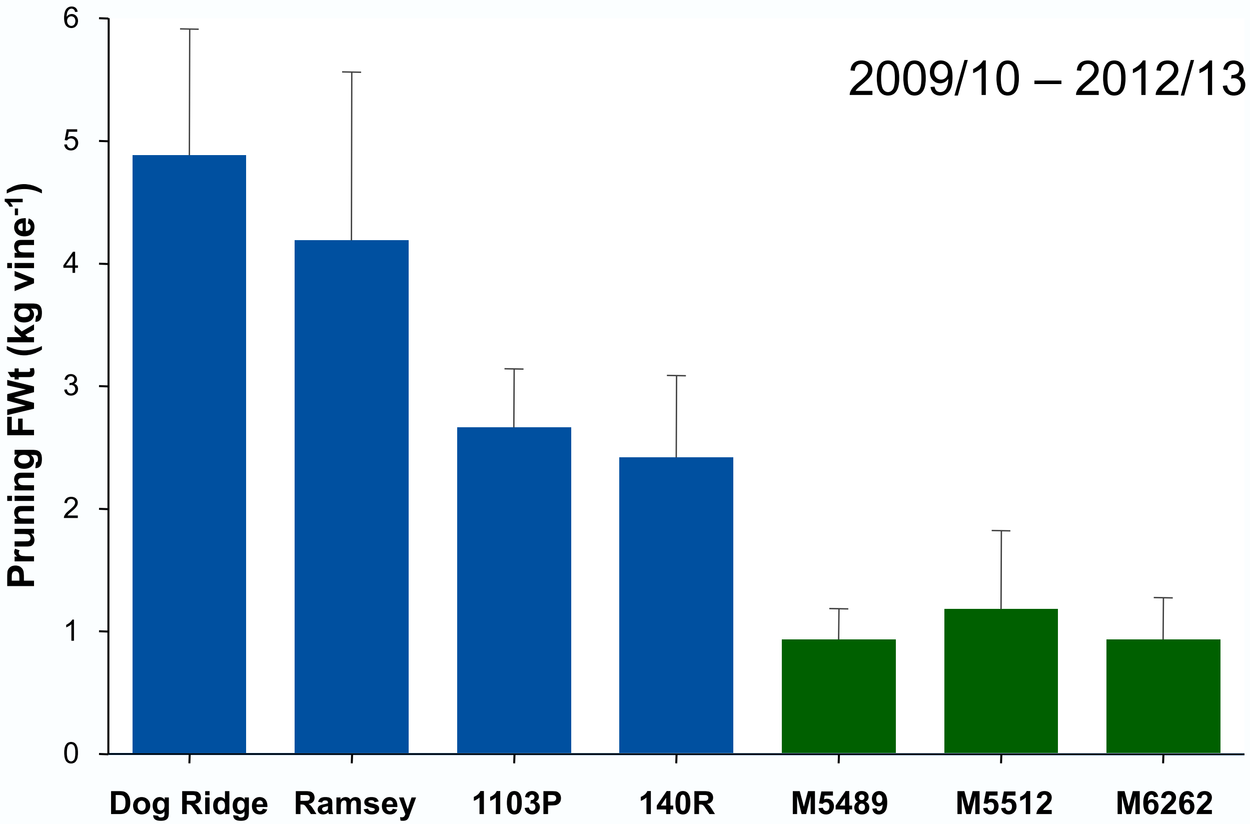
	Irrigation ($ML\ ha^{-1}$)	Yield/Irrigation ($t\ ML^{-1}$)	Yield/Sap flux ($t\ ML^{-1}$)
RDI	5.6	5.2	38
Control	11.2	2.9	39



Rootstock conferred vigour: pruning weight

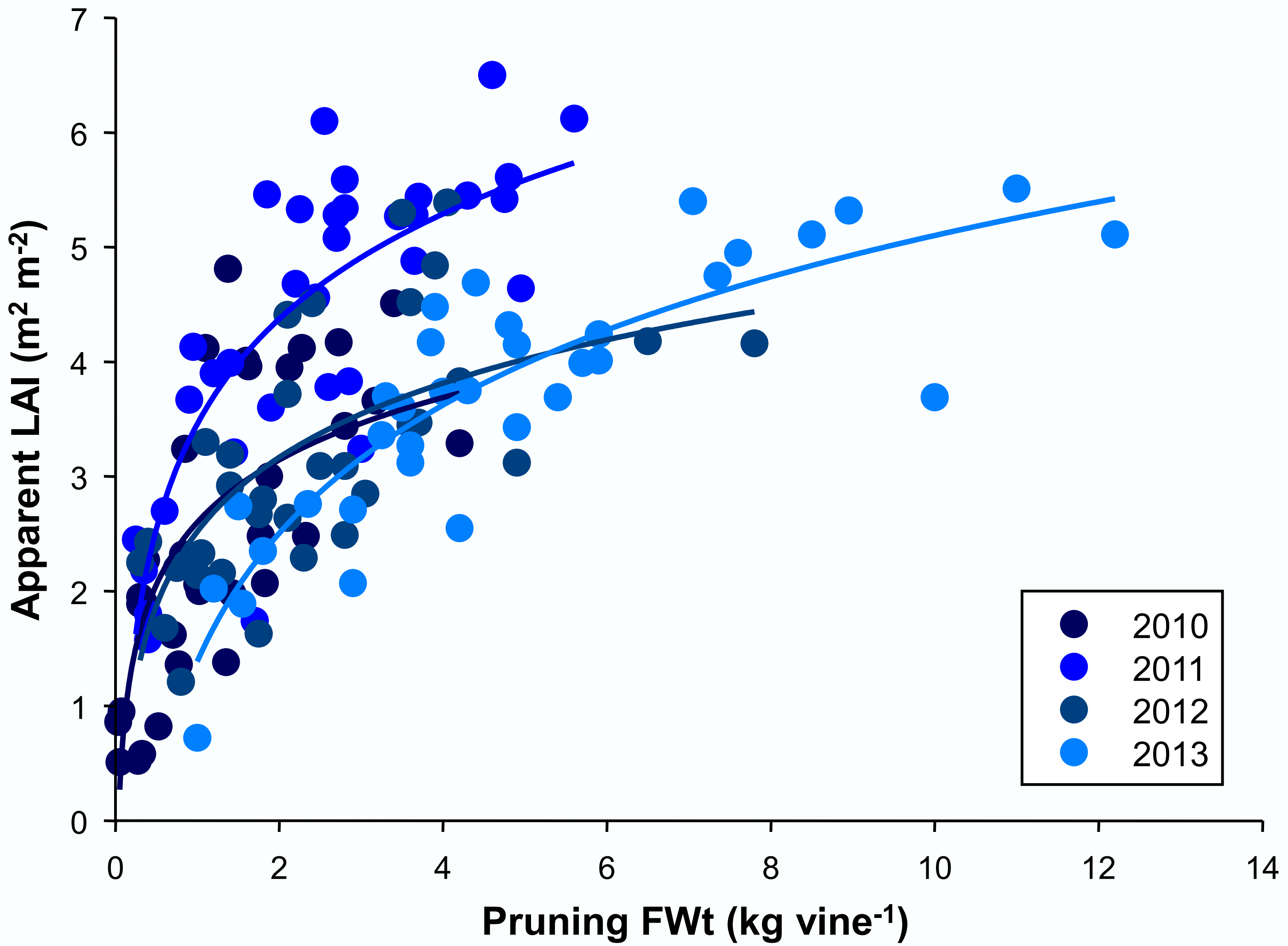
Three vigour groups still apparent.

Four fold difference in pruning weights.

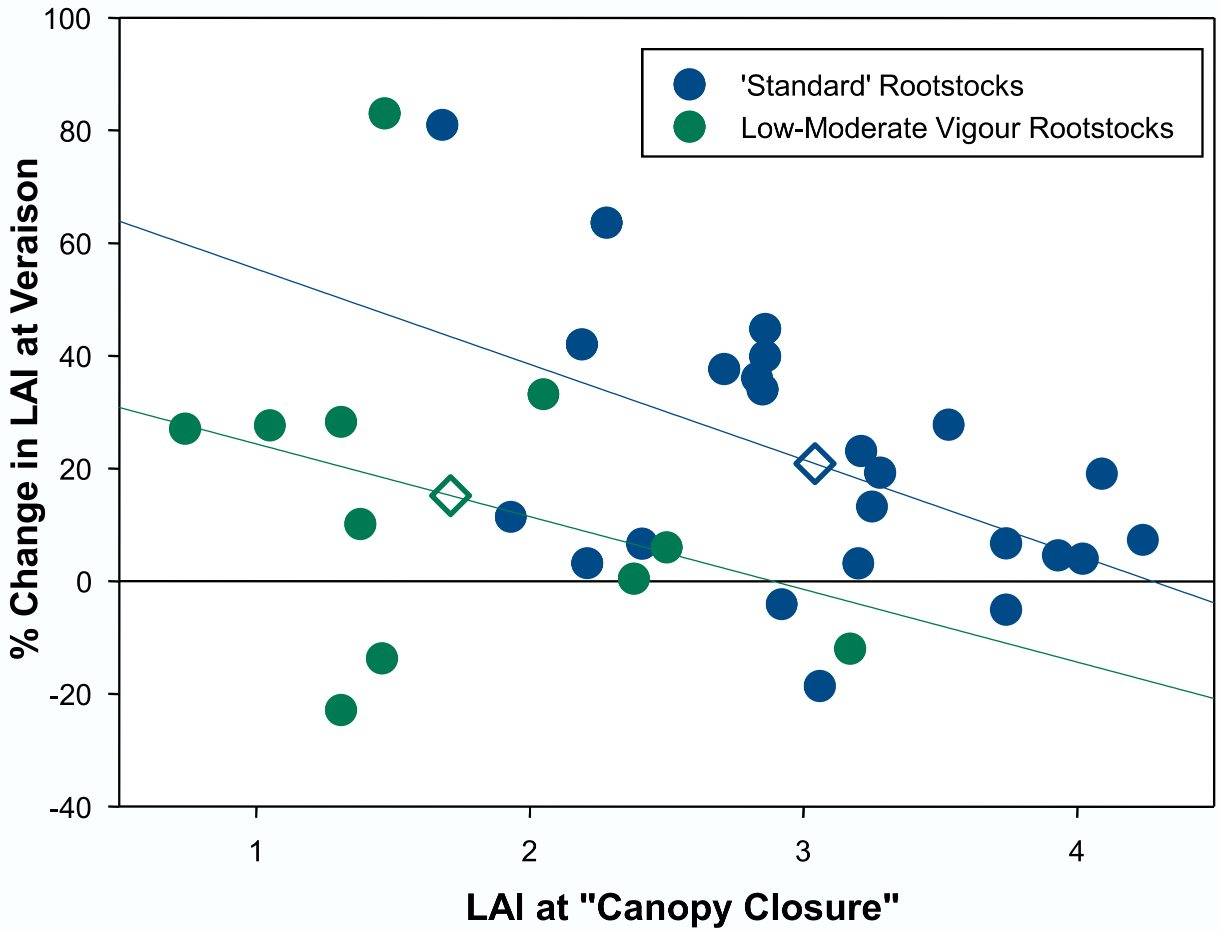


Mean pruning FWt over four seasons, n=6.

The relationship between leaf area and pruning weight



2010/11 season – extended growth period?

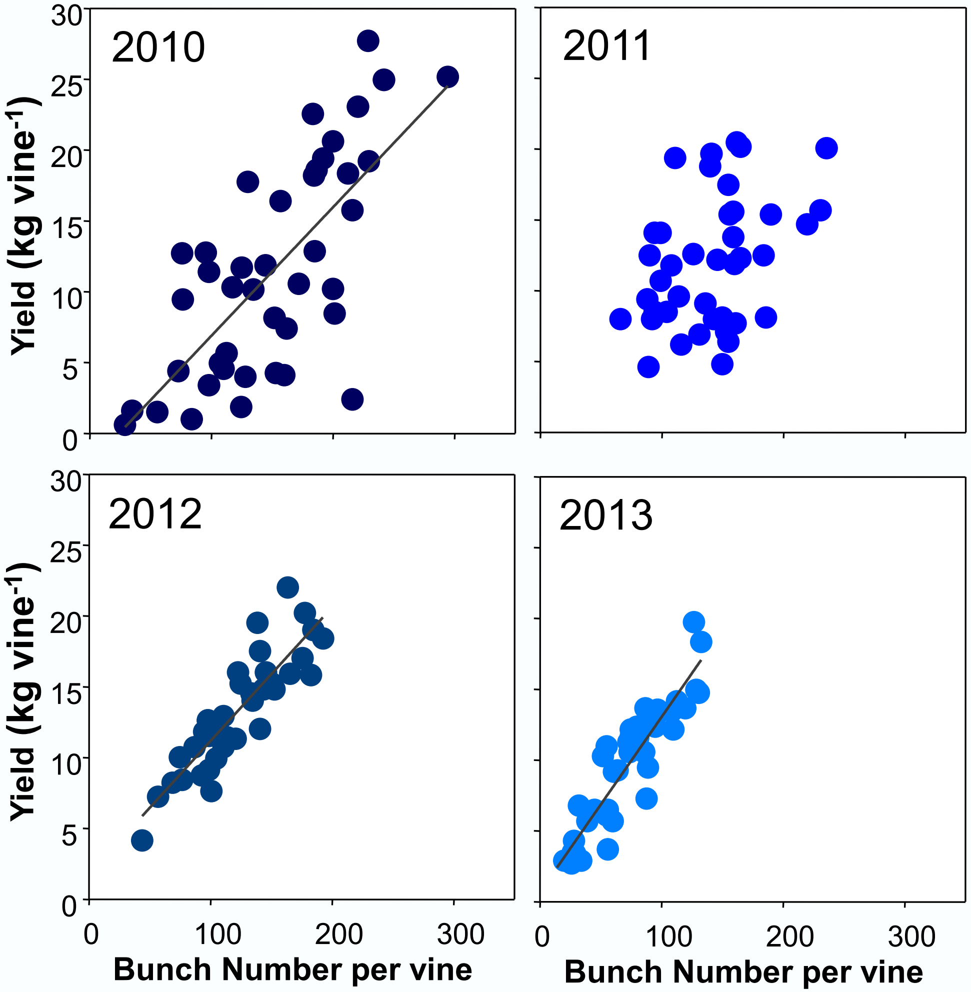


Relative growth similar , but growth reduced at much smaller canopy size in low-moderate stocks.

Rootstock impact on yield components

Rootstock effect on yield primarily via bunch number.

2010: shift to drip. 2011: high disease incidence.



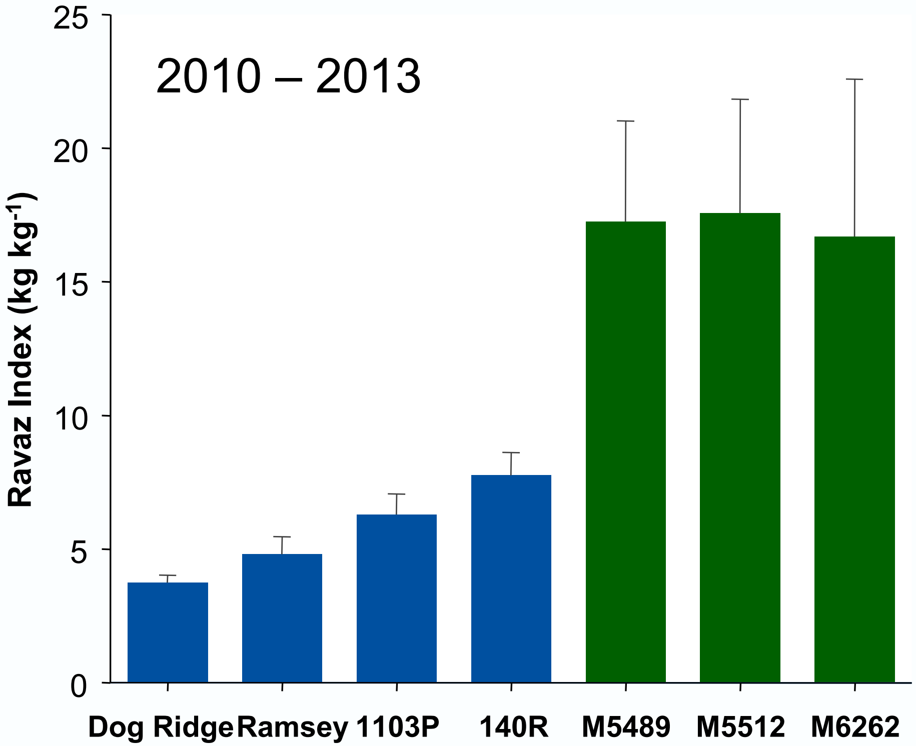
Relative effect on yield

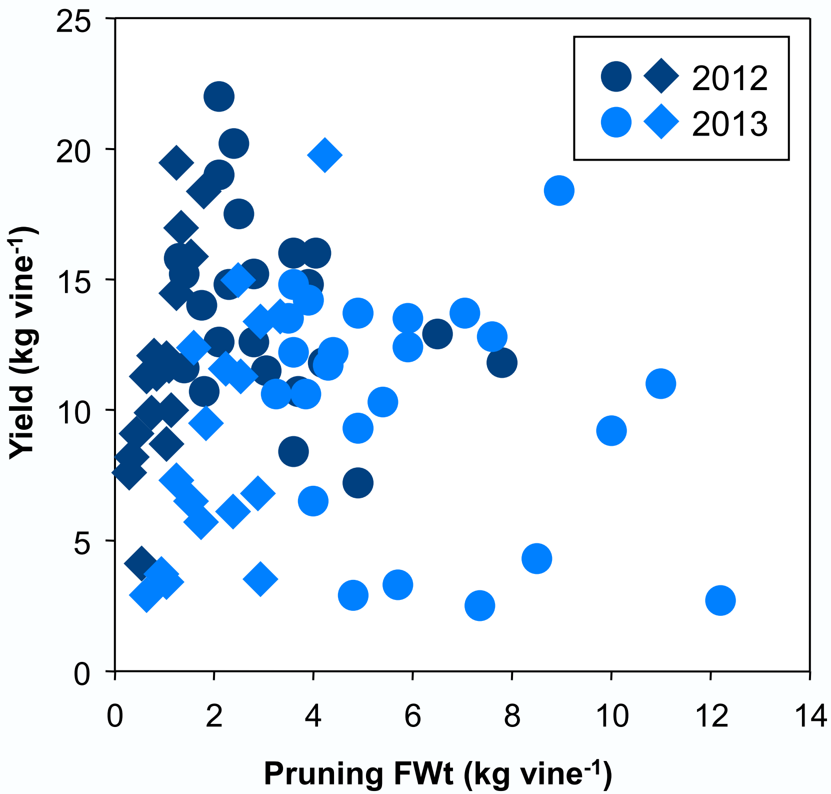
Year	Bunch No.	Bunch Weight	Rootstock
2010	0.07	0.13	0.80
2011	0.40	0.19	0.41
2012	0.83	0.17	0.00
2013	0.88	0.12	0.00

The Ravaz index

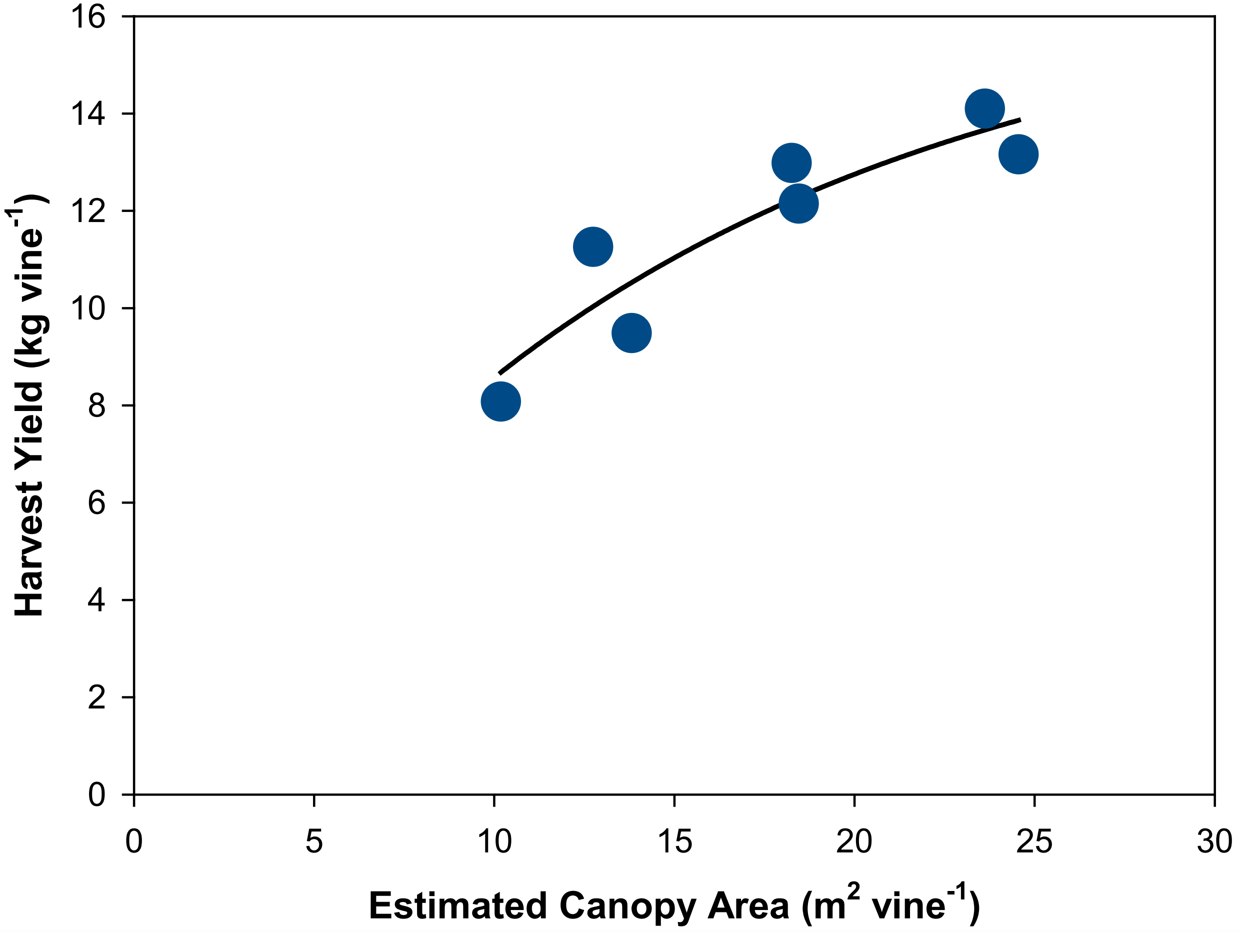
= yield / pruning weight

Sometimes referred to as harvest index.





Mean index over four seasons, n=6.



Harvest Yield (kg vine-1)
16
14
12
10
8
6
4
2
0
0
5
10
15
20
25
30
Estimated Canopy Area (m2 vine-1)

Root : shoot communication

Rootstock effects on the scion (and *vice versa*) are the result of root : shoot communication.

Root : shoot signalling may be:

- chemical signals (e.g. plant hormones, ions, assimilate supply)
- mechanical signals (e.g. hydraulics)

Effects can be long-term (e.g. vigour) or short-term (e.g. ABA production during drought).

We need to understand the mechanisms behind rootstock effects on the scion for:

- targeted breeding,
- efficient evaluation of current rootstocks,
- optimisation of resource management.

Rootstocks, drought and WUE

Does improved WUE = drought tolerance?

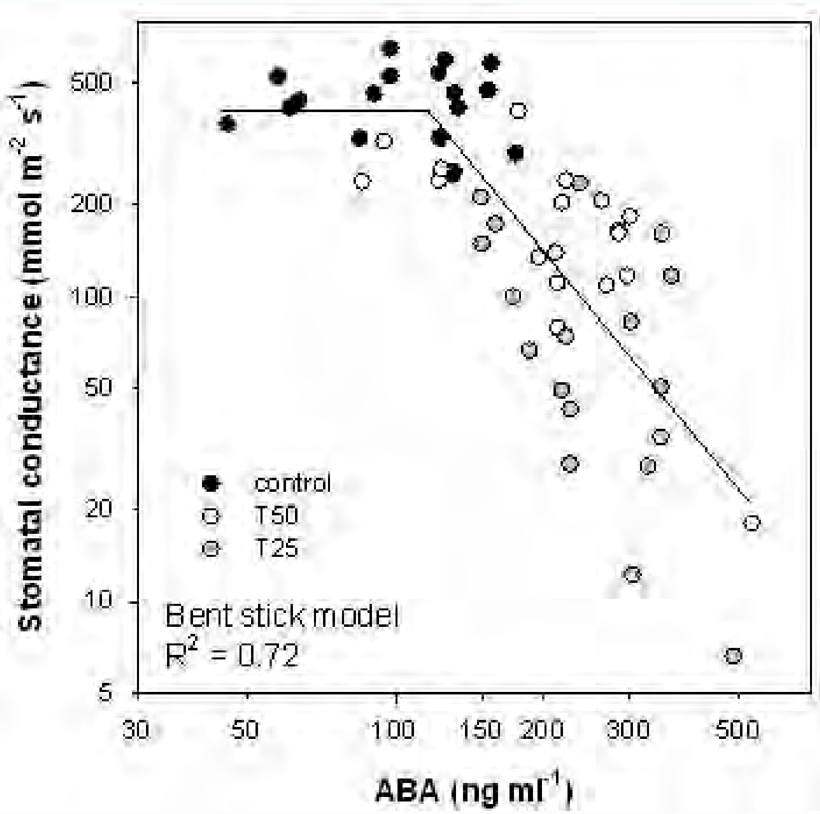
Existing evidence suggests high vigour = drought tolerance.

Current project also examining:

- Interactions with water deficit.
- Interactions with salinity.

Rootstocks could alter drought avoidance or tolerance.

Canopy response to deficit largely governed by ABA.



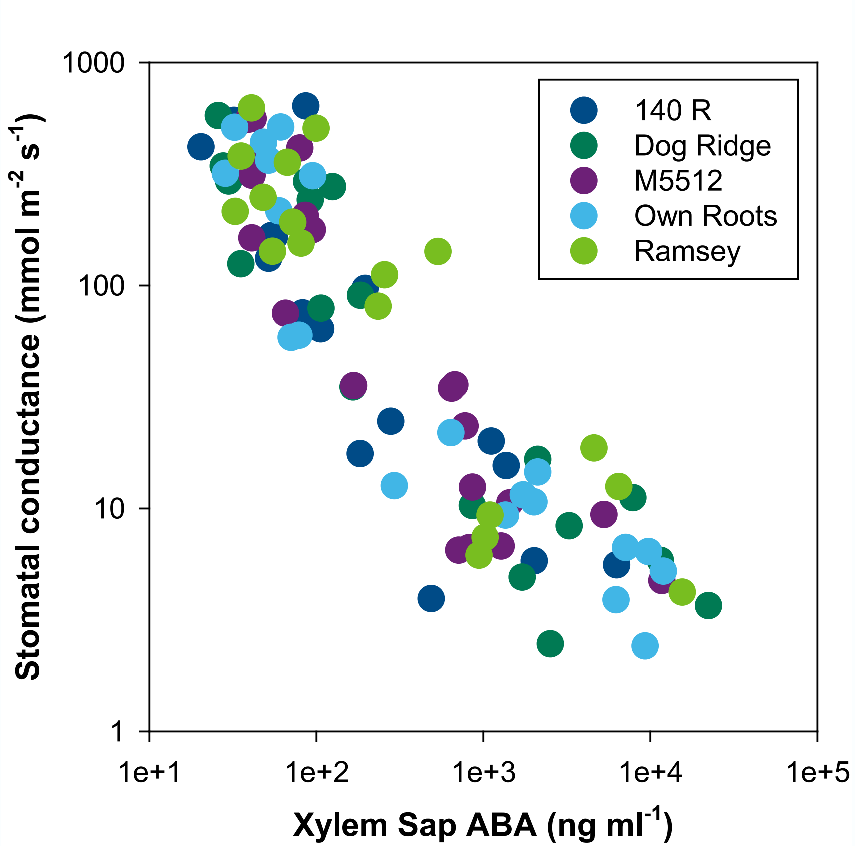
Collins & Loveys 2010

Root produced hormones?

Roots produce a number of chemical signals that can influence aboveground part of plant.

But do signals actually differ between rootstocks?

If so, does scion metabolism adjust to the differences?

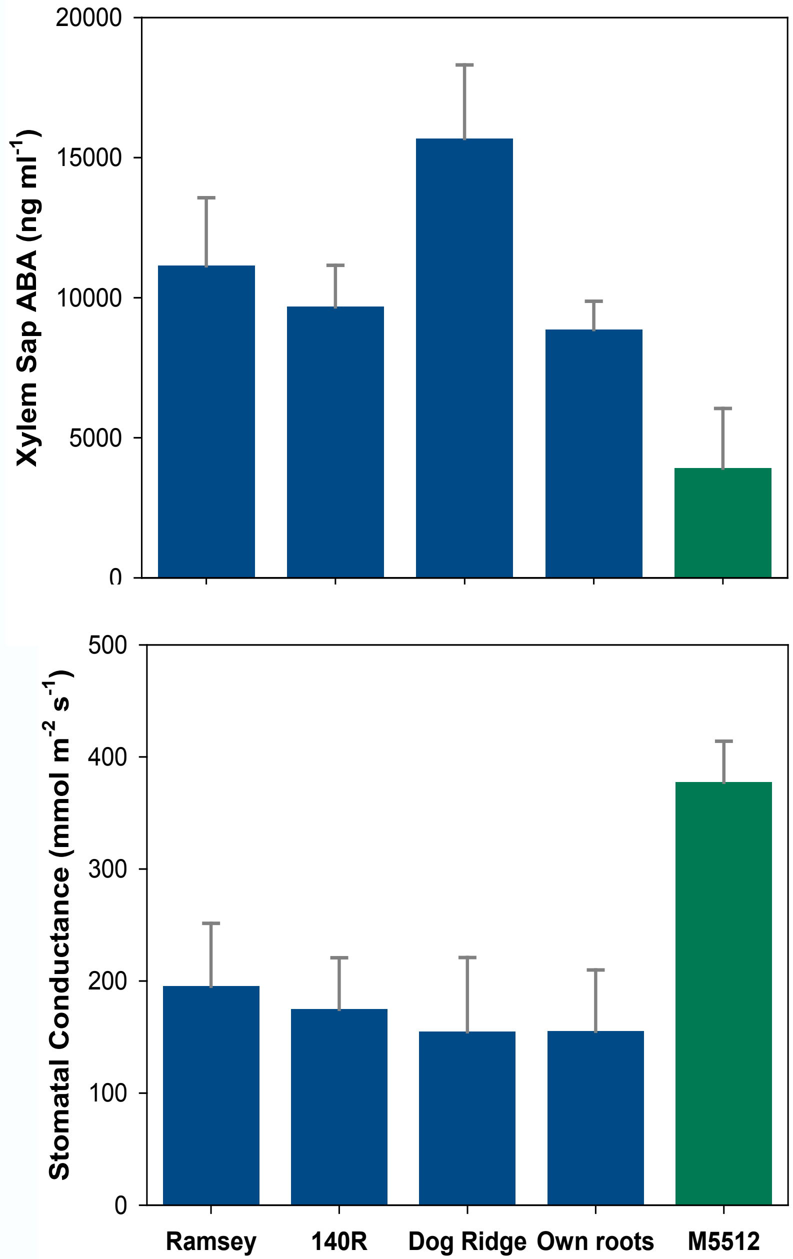


Water availability and ABA

ABA at end of experiment lower in Merbein 5512.

Stomatal conductance higher during drought stress.

Rootstock choice has the potential to alter vine response to abiotic stress.



Glasshouse experiment on 1 yr old vines, five weeks deficit irrigation.

Xylem ABA of well watered control: 50-100 ng ml^{-1}. Excluded for clarity.

Mean soil H2O in M5512: 6.7%

Mean soil H2O in standards: 8.2%

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Winery Cost Reduction Strategies

Neil Scrimgeour
Research Manager, Commercial Services

Understanding customer value

What does the market/consumer want?

Attribute	Levels	Importance
Brand, packaging, origin	32	36.1%
Price	8	16.0%
Medal	4	15.0%
Wine sensory description	2	12.4%
Rating points	2	8.4%
Managers recommendation	2	5.6%
Alcohol level	4	2.5%
Price discount	4	2.3%
In store tasting available	2	1.3%
Closure	2	0.4%

Core product and pricing: 57%

Awards and shelf communication: 43%

Discrete Choice Experiment

Maximise value/ minimise waste

"Customer Value-Adding"
The tip of the iceberg

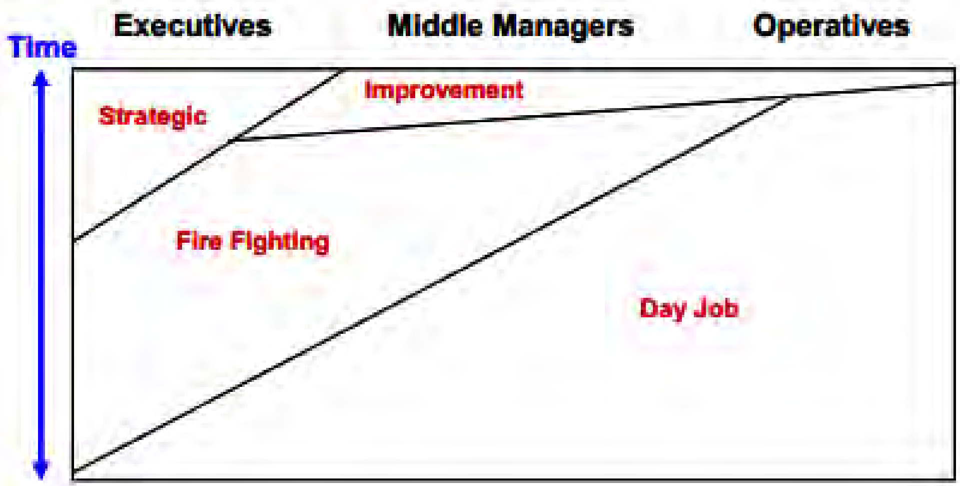
Customer Non Value-Added Steps
"The hidden opportunity for improvement"

Tradition vs Innovation

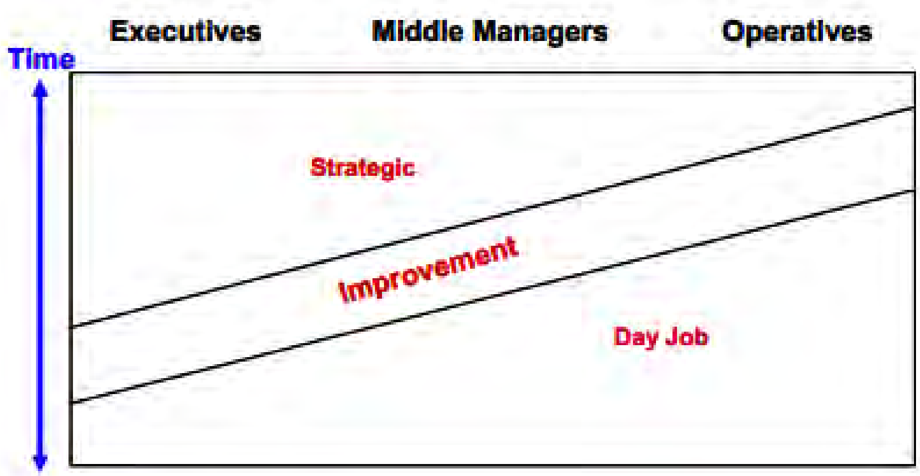
Familiar
Comfortable
Safe

Costly
Onerous
Limiting

The impact on organisational roles



Current state

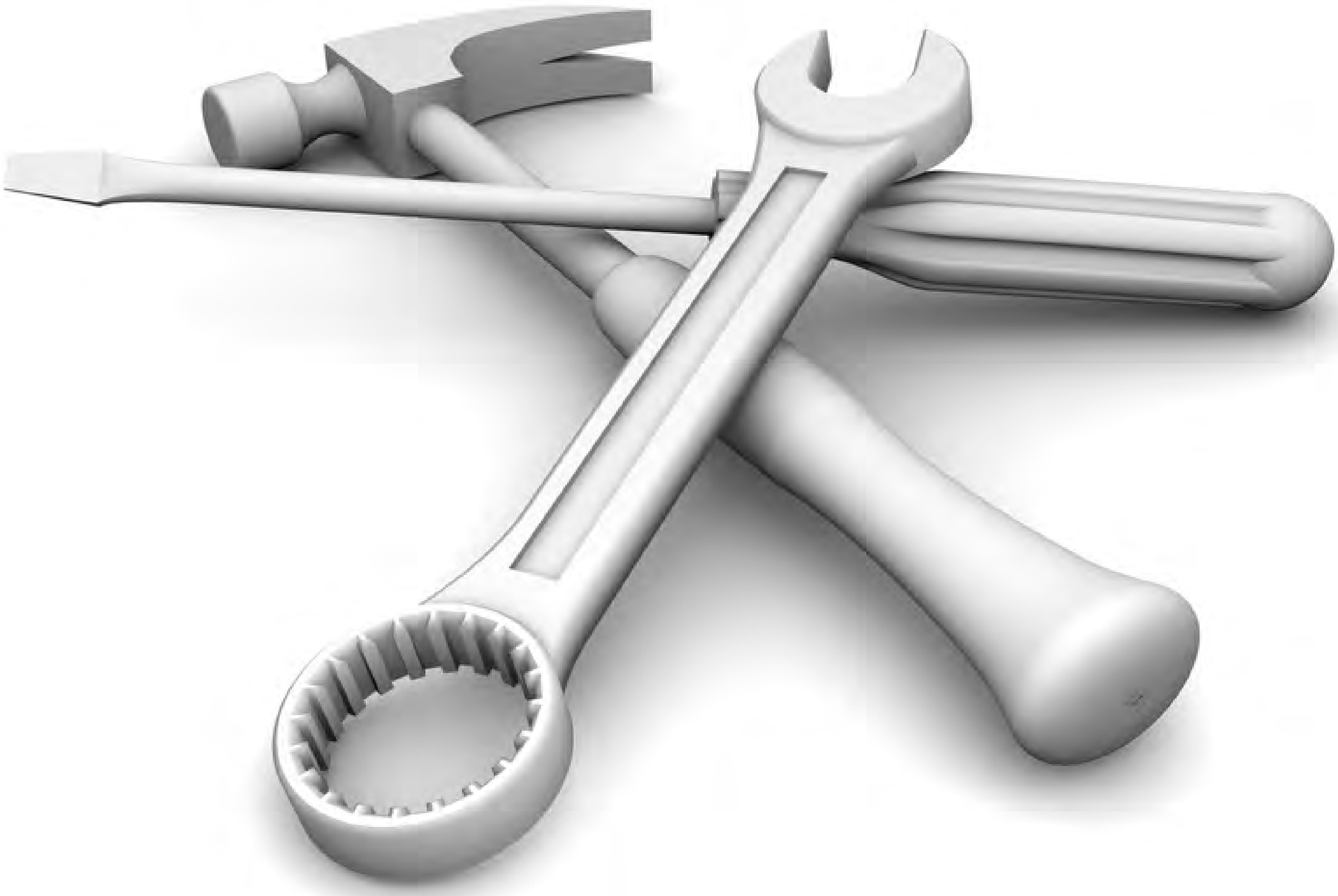


Ideal state

Data management

90%

Supporting Australian producers



Activities based costing

Determining the true cost of production

Direct costs

- ***Materials (Grapes)***
- ***Labour***

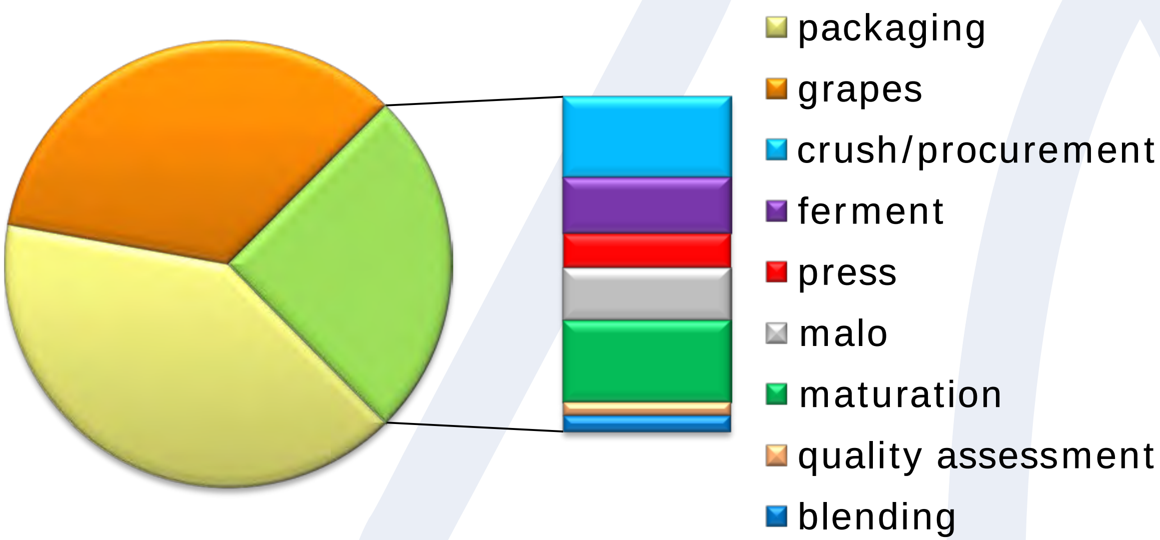
Activities

- ***Crushing***
- ***Ferment***
- ***Pressing***
- ***2nd Ferment***
- ***Maturation***
- ***Quality assessment***
- ***Blending/ullage mngt***
- ***Packaging***

Cost pools

- ***Production management***
- ***Utilities***
- ***Waste management***
- ***Process equipment***
- ***Laboratory***

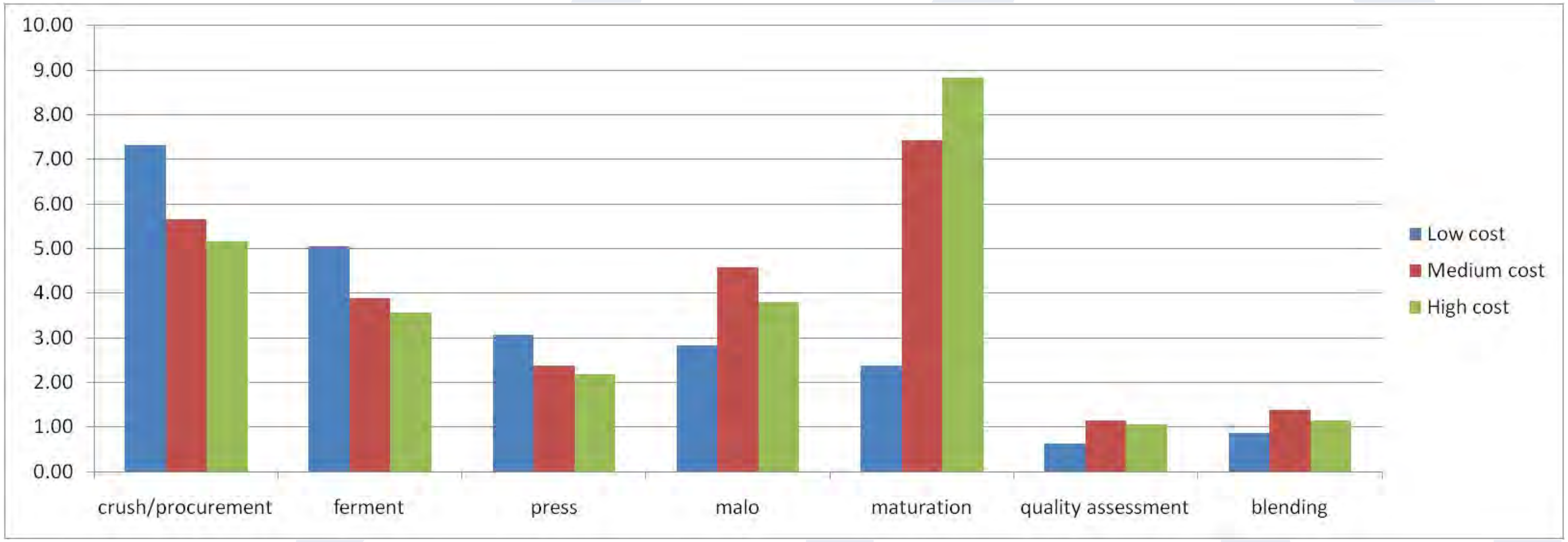
The cost of production



Opportunities exist at:
- Crush
- Ferment
- Maturation

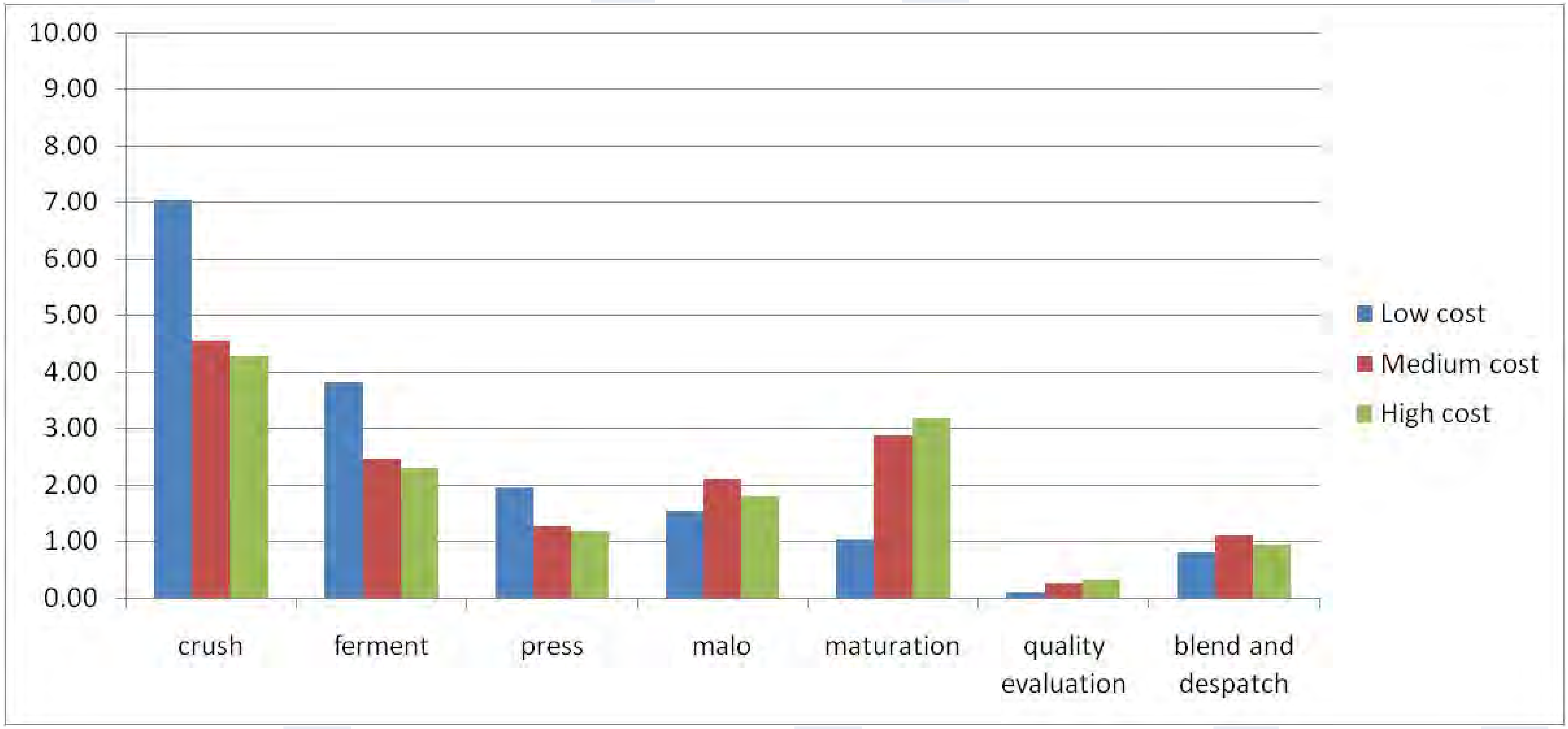
Highly complex grading system and large number of processing units

Distribution of costs for product ranges



- **Low price point product opportunities at crushing**
- **High price point product opportunities at maturation**

Labour cost contributions



- Procurement and crushing costs driven by labour
- Malo by analytical costs
- Maturation by barrels

Maximising value from grapes

1. Maximise use of low cost grapes

- Design wine styles around varieties that enable high tonnage cropping (Colombard, Fiesta etc)
- Incorporate high yield grapes as “fillers” into blends
- Processing options to enhance flavour and aroma

2. Maximise grape yield (>40tpha)

- Heavy irrigation throughout entire ripening period
- Targeted or no pruning regimes
- Appropriate trellis designs
- Spray irrigation in close proximity to harvest

3. Maximise production yield

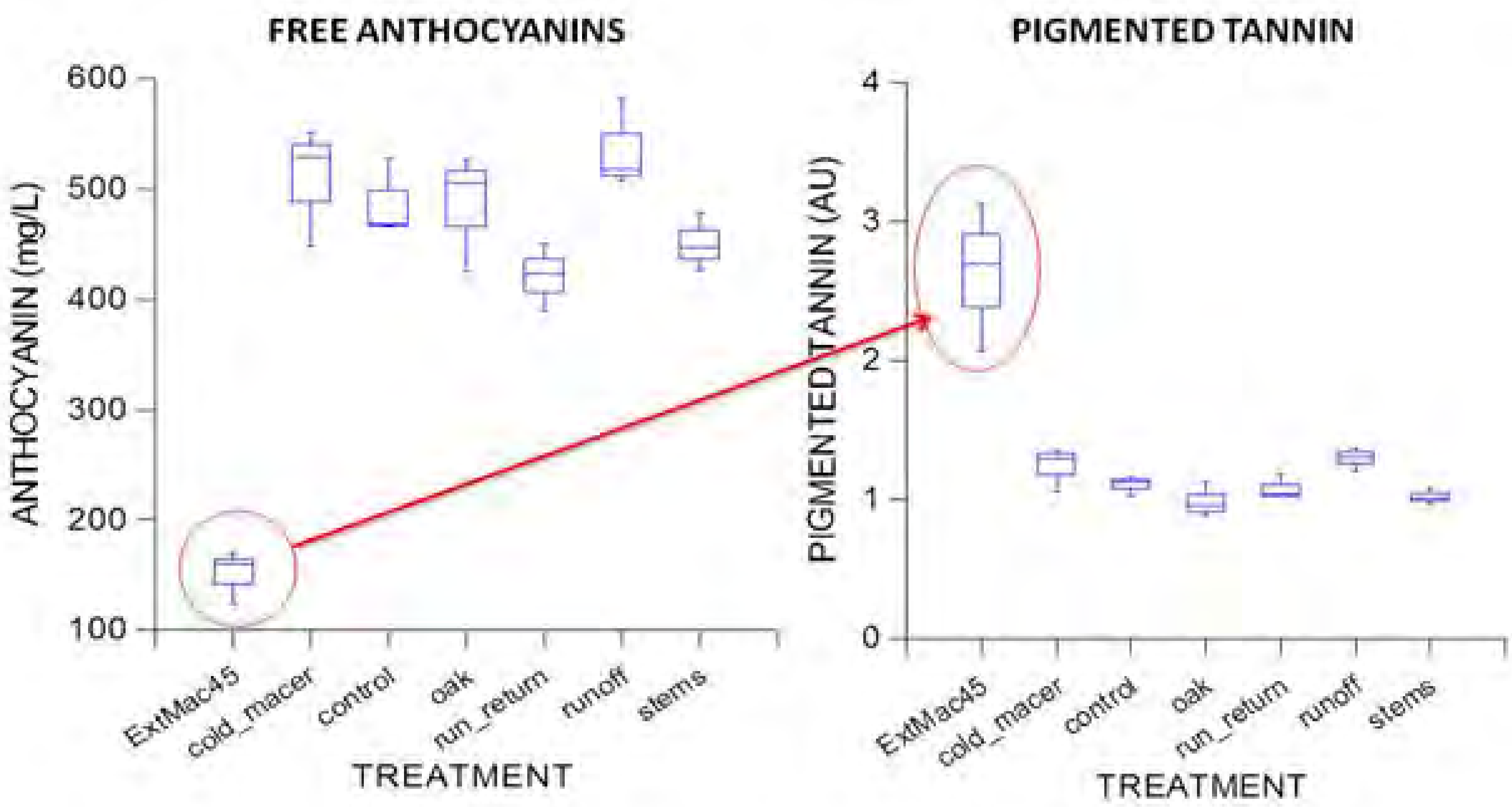
- Wine styles that allow minimal separation of press fractions
- Less conservative press fraction cuts

Benefit - Reduced cost of grape juice

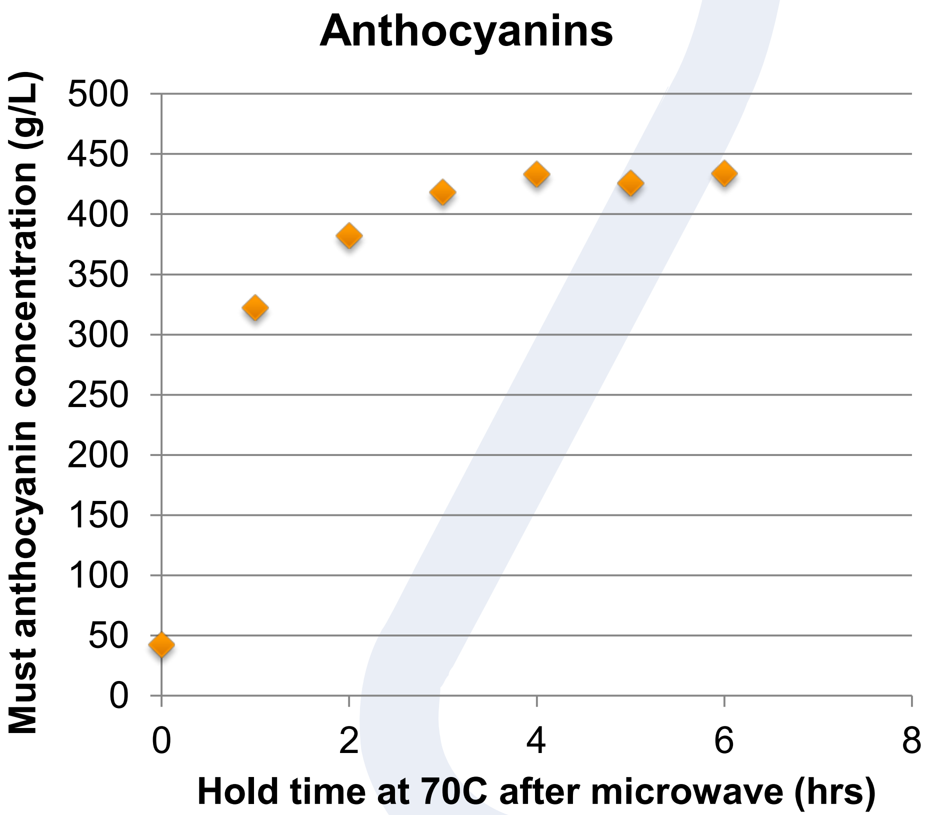
Research requirements

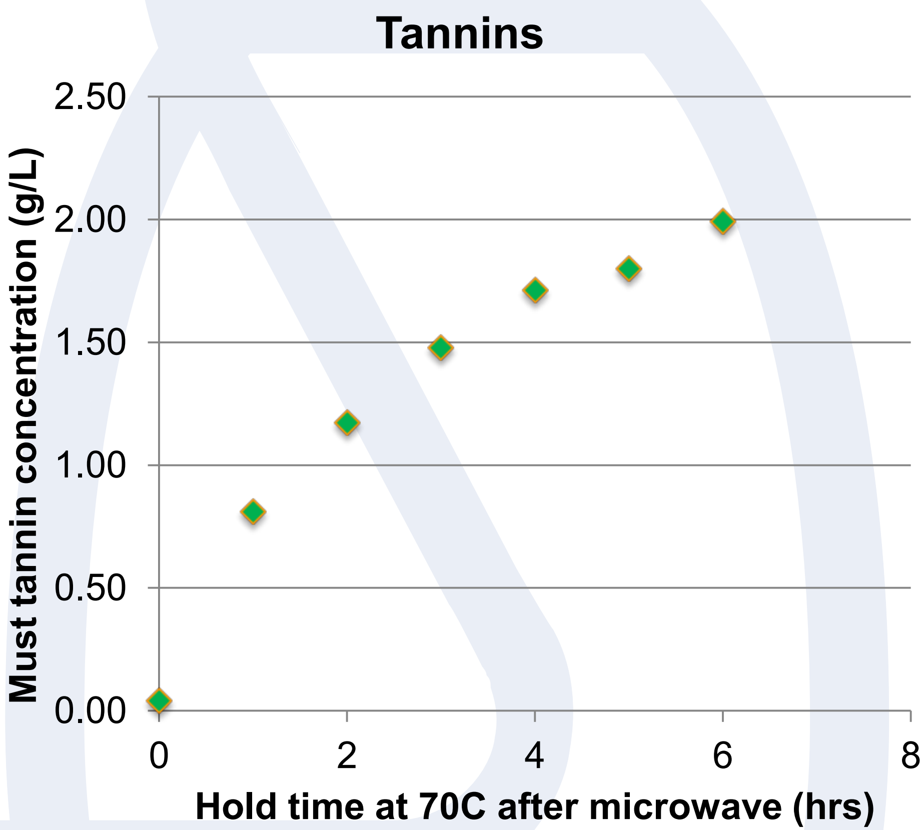
- Impact on consumers
- Demonstration studies - how to implement yield increase and minimise value loss
- True cost evaluations – reduced juice cost versus increased complexity in blending operations

Maximising value from grapes

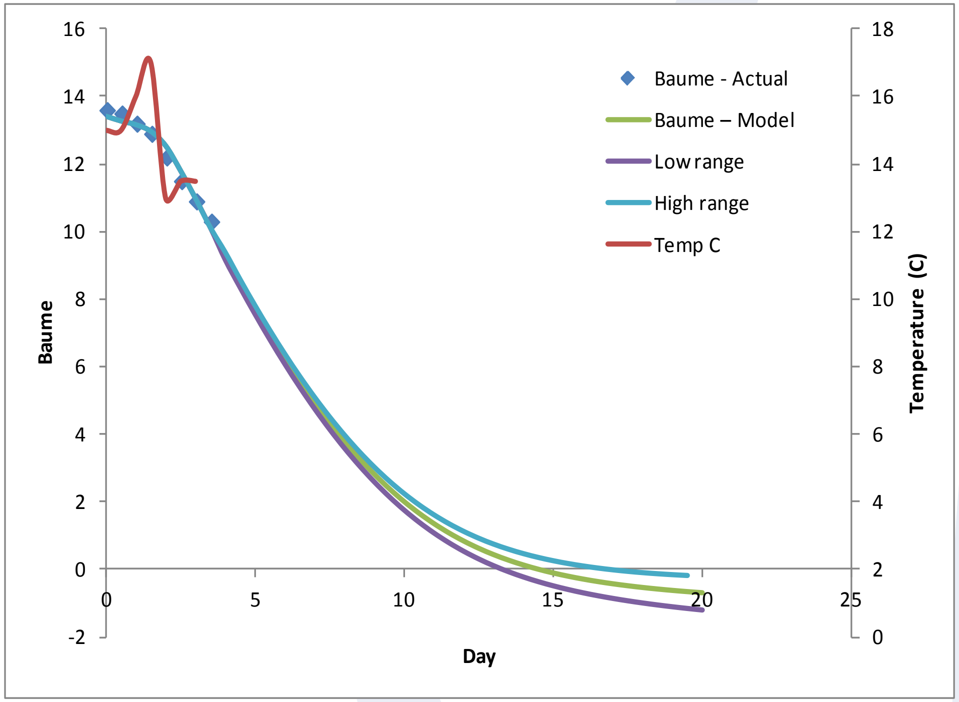


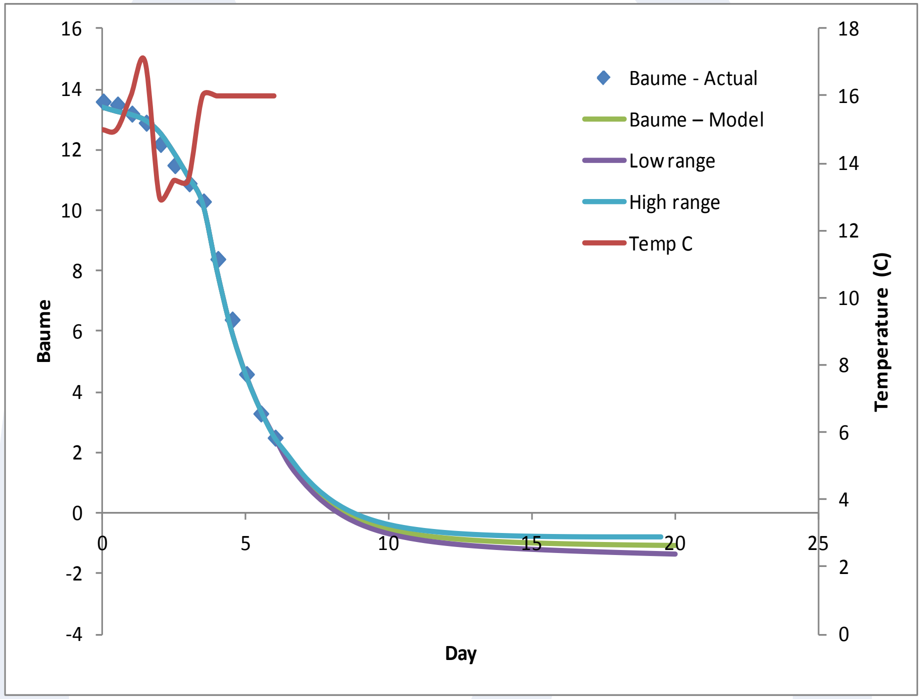
Maximising value from grapes





Predicting ferment behaviour





Alternative maturation

Reducing Wine Transfers

1. Reduce number of processing units

- Less quality categories
- Less product types
- Blend earlier in value chain

2. Minimise ullage management activities

- Finished wines often transferred 8 times to avoid tanks being left on ullage
  - o Staff devoted to packing down tanks and managing ullages
  - o Large inert gas costs
  - o Bottling to bin
- Eliminate need to pack down
  - o OTR – 4L per day
  - o Thermal expansion – 0.15 mg/L per refrigeration event
  - o Open lid – 28L per event
  - o CO_2 use ineffective

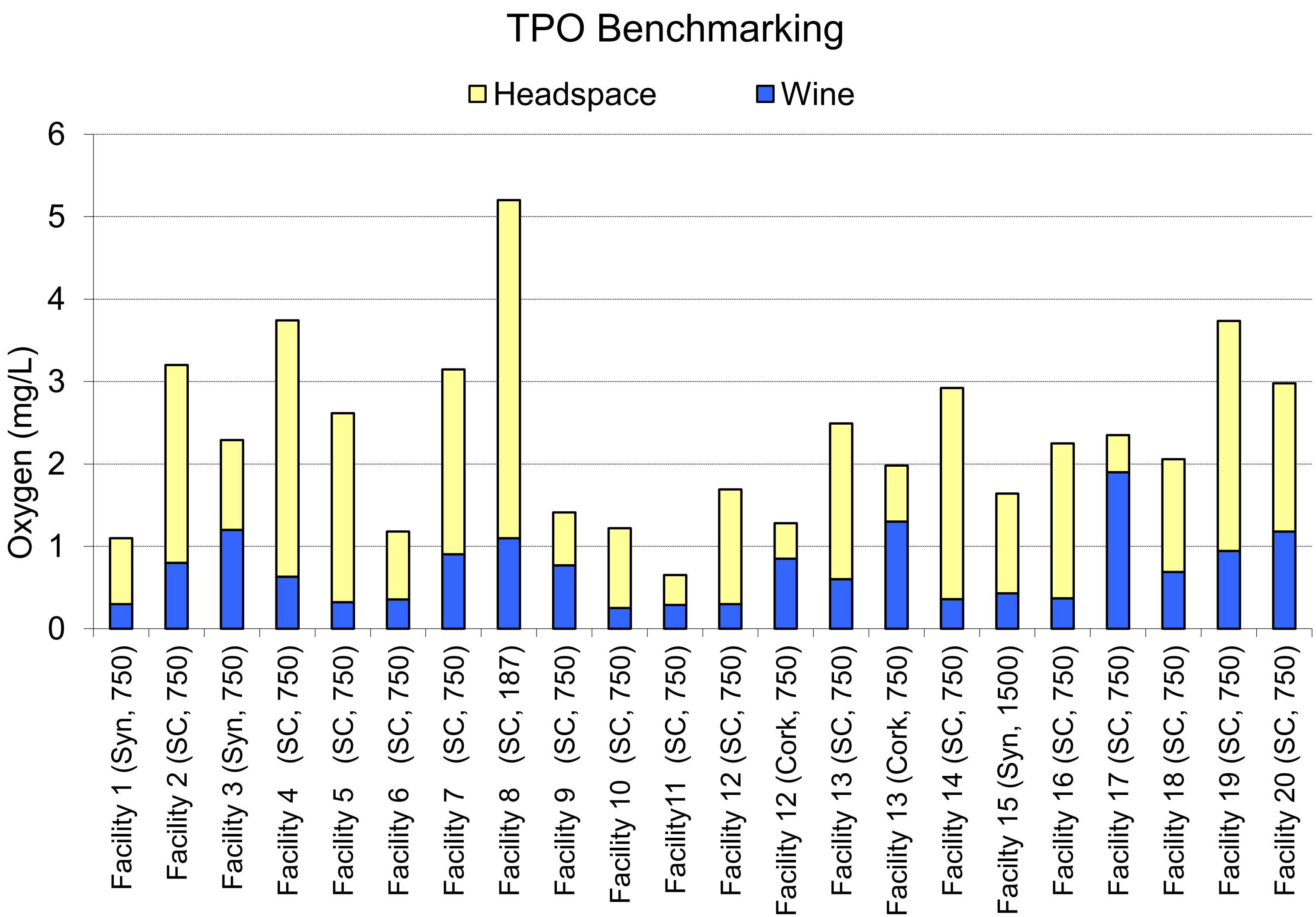
Benefit

- Improved efficiency of resource use
- Improvement to environmental performance

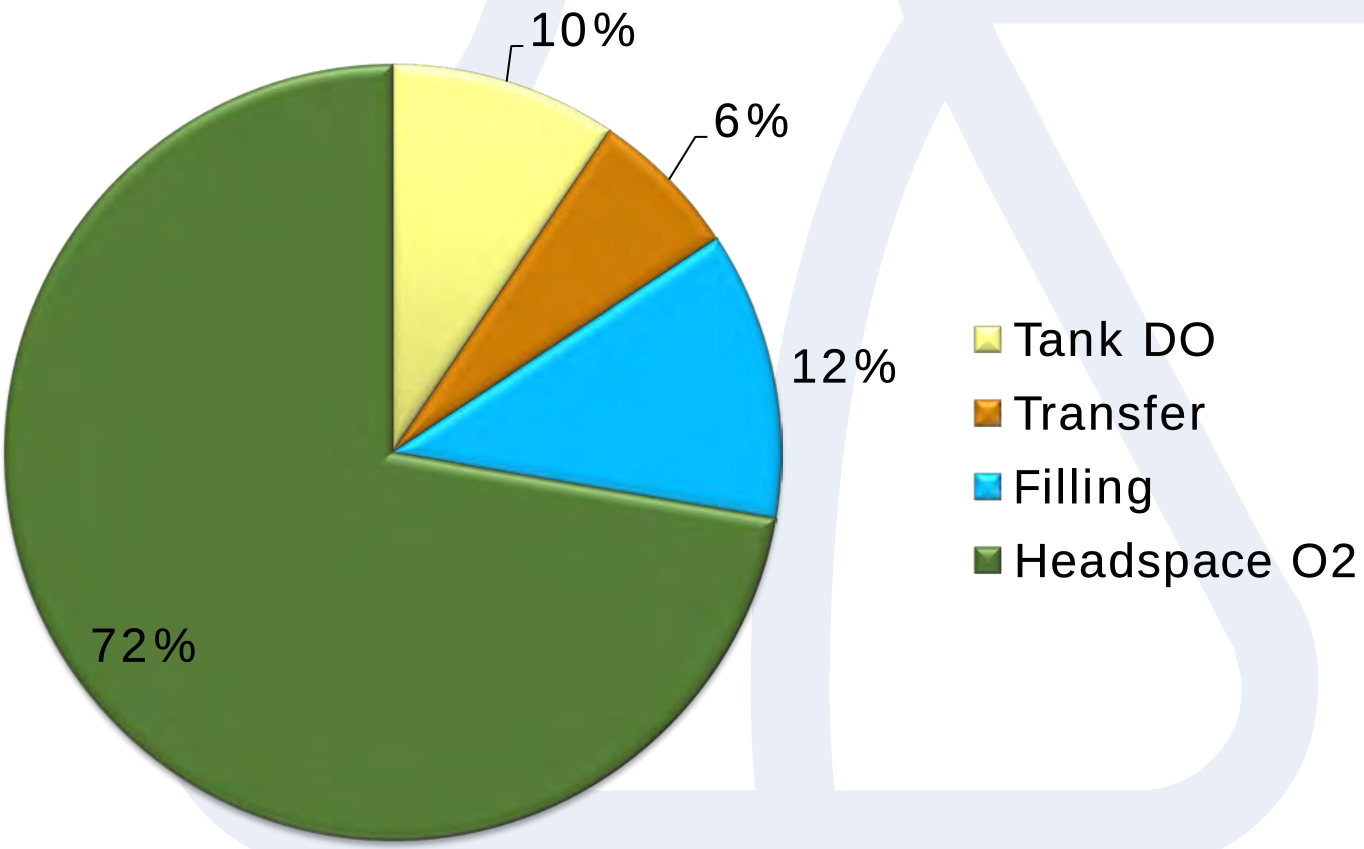
Research requirements

- Requires fundamental development work on sparging ; oxygen damage; volatile loss & ageing on wine value

Packaging challenges

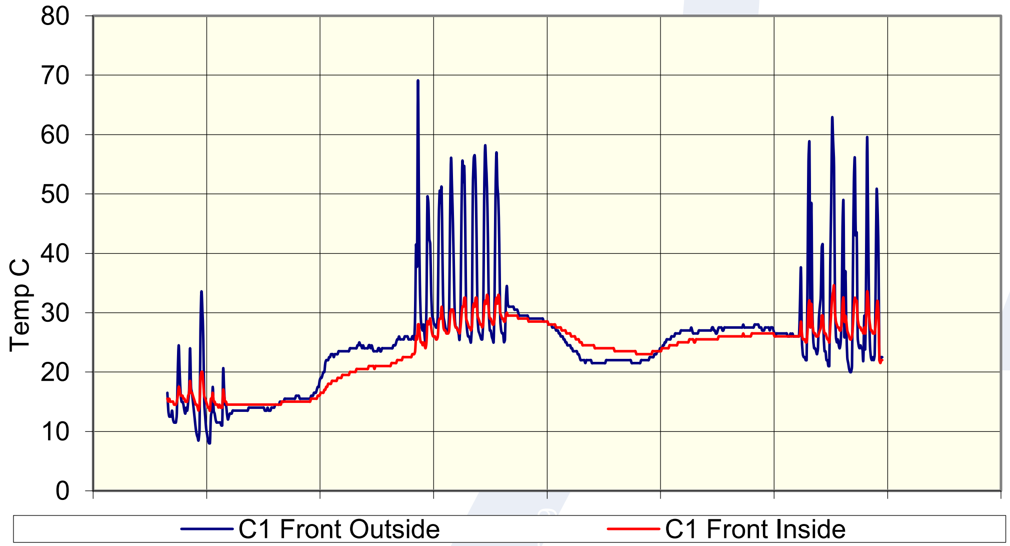


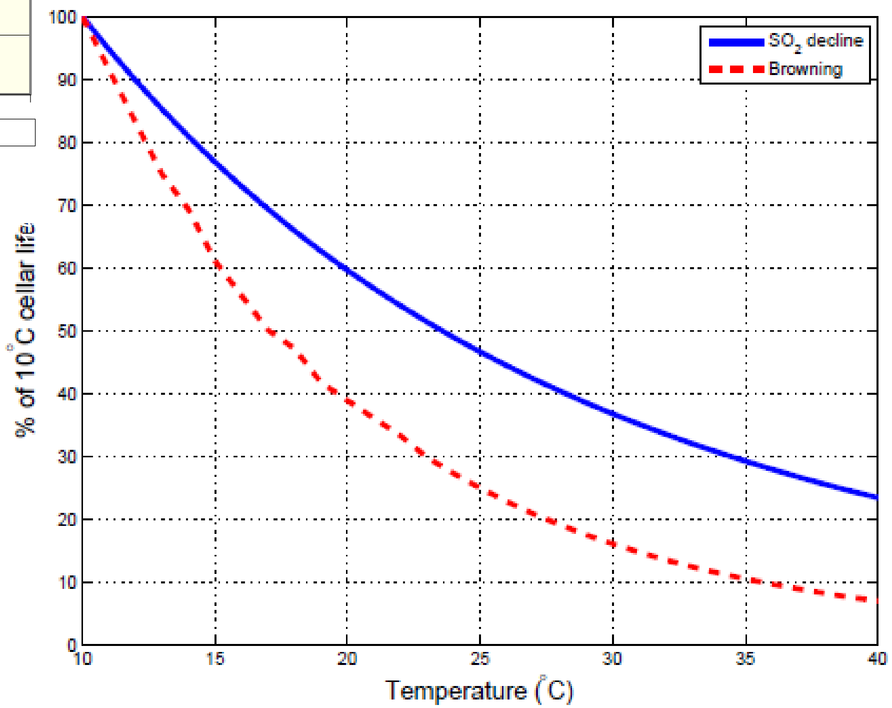
Packaging challenges



Shelf-life impact

Impact of shipping





Summary of Opportunities

- Maximise value from grapes
- Better control and added value from fermentations
- Alternative maturation
- Reduce process complexity
- Managing ullage effectively AND reducing wine transfers
- Controlling packaging and downstream impact

Thank you

AWRI

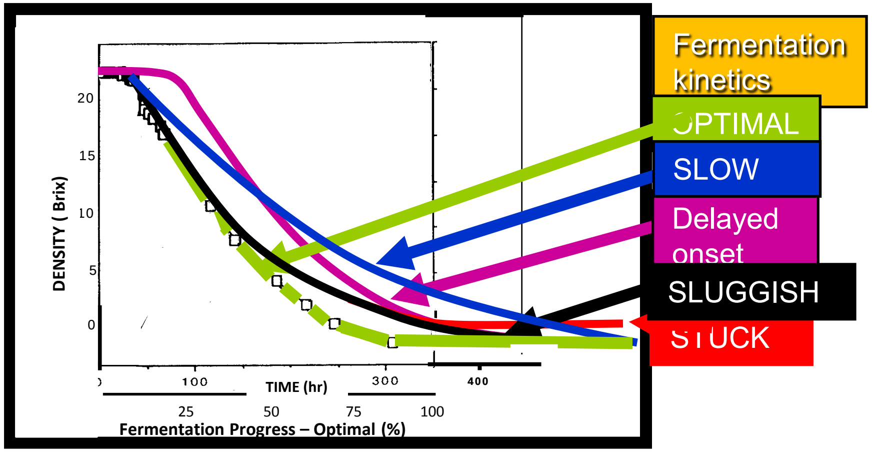
The Australian Wine Research Institute

Causes and Management of Slow and Stuck Fermentations

Paul Henschke, and

AWRI Industry Development & Support team

- Con Simos
- Adrian Coulter
- Geoff Cowey
- Matt Holdstock



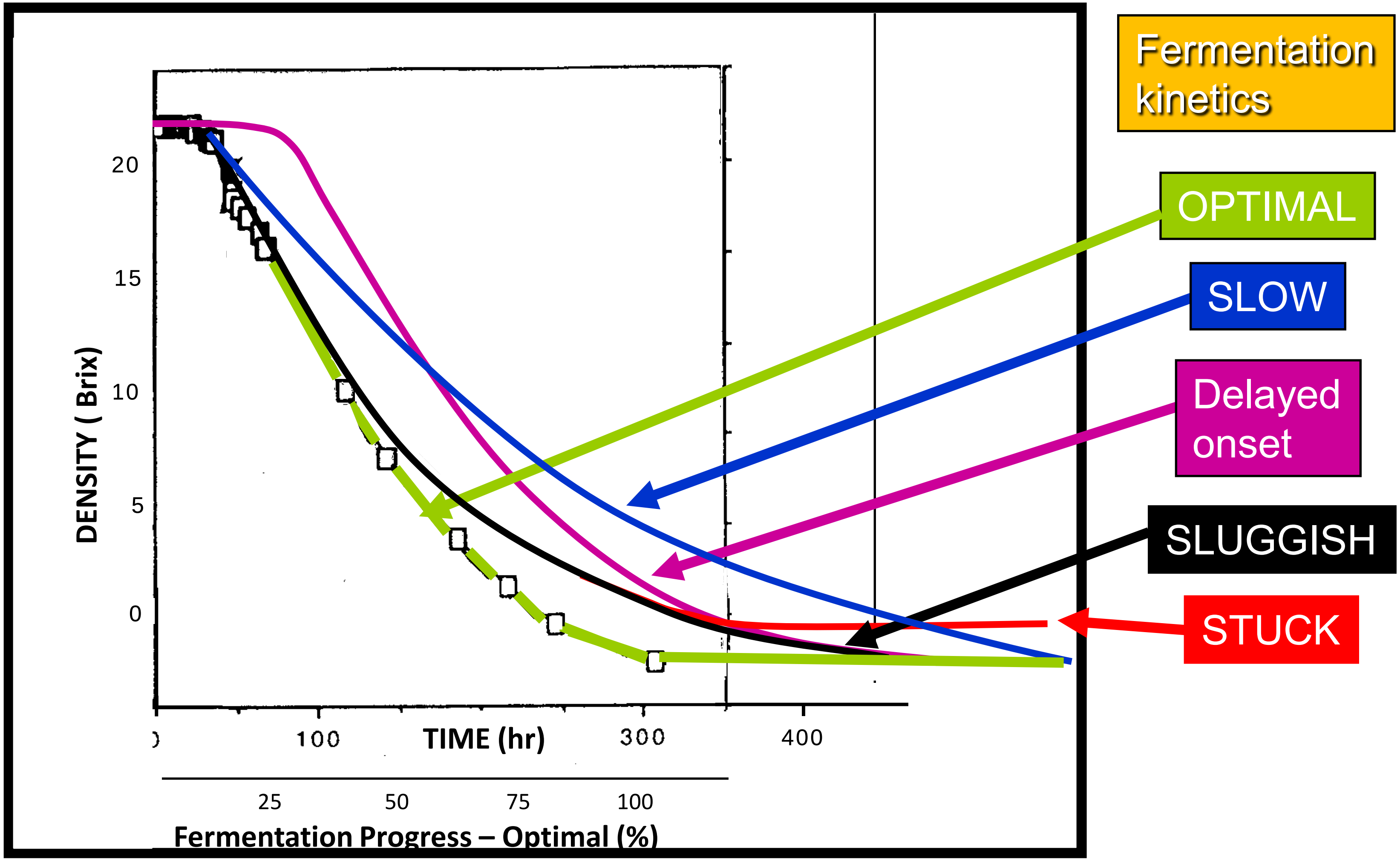
The problem of sub-optimal fermentation

- A common seasonal problem, but exacerbated by hot weather
- Affects most wineries at some stage, both in Australia and overseas
- White, red & sparkling wines, in tanks & barrels
- Multifactorial problem, including yeast, nutrients, toxic substances and fermentation conditions/management
- Most (all ?) yeast types are affected, including benchmark EC1118/PDM/Prise de Mousse
- Expensive in resources (time, energy, yeast, tank space) and potential loss of quality

>>> This talk contains practical information on how to reduce the risk and how to rescue a fermentation

Sub-optimal fermentation profile

The Australian Wine Research Institute



Environmental changes during fermentation - major stresses to which yeast must adapt

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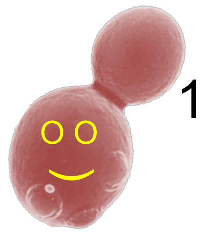
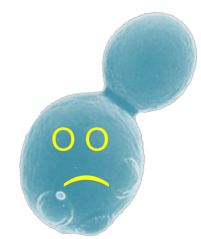


Factor	Grape juice	Wine
Sugar (g/L)	180 – 260	0 – 4
Alcohol (% v/v)	0	10 – 16
Nutrients:		
YAN (mg N/L)	50 – 300	<50
Oxygen (ppm)	0 – 9	0
Conditions	***Nutrient rich***	***Nutrient poor High conc. toxic products***



Failure to adapt results in sub-optimal fermentation

Causes of sub-optimal fermentation

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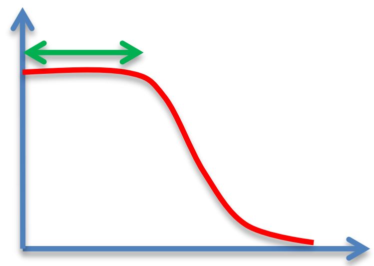
❖ Delayed onset of fermentation



Causes:

- Poor quality starter culture
  - Low viability or low cell count/inoculation rate
  - Poor physiological condition (low metabolic rate)
- High SO_2, resulting in growth inhibition until level of free SO_2 has decreased below a critical point

Diagnosis:

- Perform a microscopic cell count before & after treating the sample with vital stain, eg methylene blue (see Iland et al. 2007)
- Viability <75% indicates poor yeast culture or must toxicity, eg SO_2
- Measure must/juice SO_2; should be <10-15 mg/L free SO_2

Vital staining of yeast culture to assess culture health (viability)

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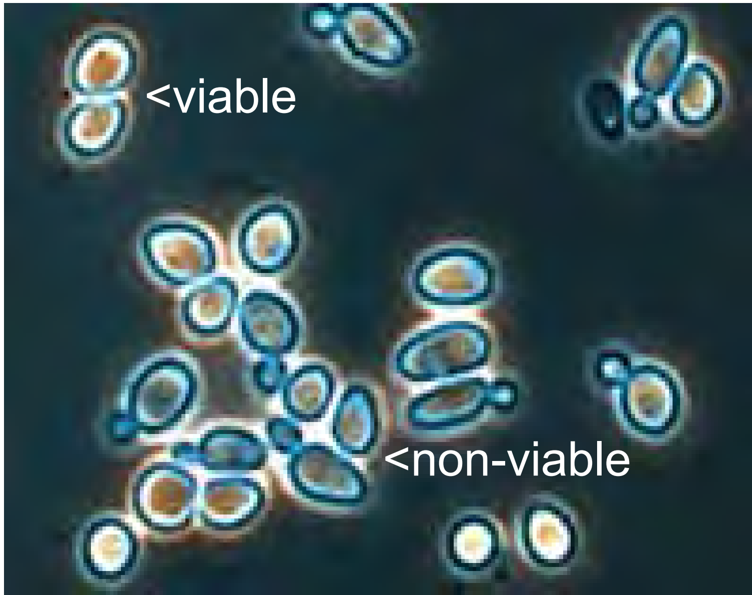
- Methylene blue is a dye that is used to differentiate live and dead yeast cells in a culture.
- Methylene blue is a redox sensitive dye, such that metabolically active cells reduce it to the colourless form; viable cells are highly reductive.
- Dead cells (non-metabolically active) stain blue, ie the oxidised form.
- Population viability is a strong indicator of culture health:
  - Healthy culture typically contains >95-98% viable cells
  - <75% viability indicates toxicity, which can lead to stalled fermentation



Consult Iland et al (2007): Microbiological analysis of grapes and wine: techniques and concepts

Causes of sub-optimal fermentation

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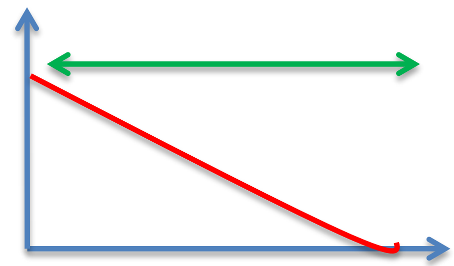
❖ Slow (continuously) fermentation



Causes:

- Low yeast biomass or cell number
- Low budding index
- Low level of key nutrient, typically YAN, O_2 or lipids

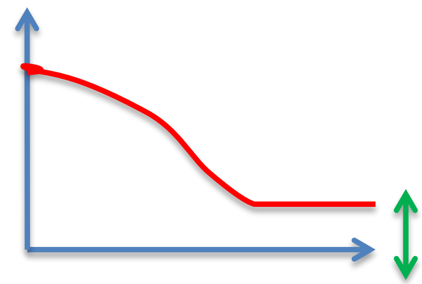
Diagnosis:

- Confirm by microscopic cell count:
  - 0% FP (Fermentation Progress) count should be >1-5x10^6 cells/mL;
  - 35% FP should exceed 50x10^6 cells/mL
- Measure juice/must YAN, should exceed 100-150 mg N/L
- Failure of aeration or grape solids addition to stimulate fermentation suggests deficiency of a key nutrient, eg YAN

Causes of sub-optimal fermentation

The Australian Wine Research Institute

❖ Sluggish & Stuck fermentation



Causes:

- Multifactorial problem

  Interaction between:

  1. yeast strain
  2. juice/must (nutrients, toxic substances) and
  3. fermentation conditions/management (under control of winemaker)

- Most yeast types are affected, including the industry benchmark strains EC1118 / PDM / Prise de Mousse

Diagnosis: complex & the subject of this talk

Sub-optimal fermentation kinetics
Risk Factors – common high risk factors

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Yeast-related factors

- incorrect choice (alcohol stress tolerance)
- poor quality starter culture
  - rehydration / reactivation
  - viability / vitality
- indigenous microflora (esp yeast & LAB)
- unsuccessful inoculation
- temperature stress
- vigour and sedimentation

Nutrient deficiency

- yeast assimilable nitrogen (YAN)
- phytolipids (grape solids – clarification)
- oxygen
- vitamins (thiamin)
- minerals (ie low K+ & pH)

Inhibitors

- high concentration of sugar (high Brix/Be)
- high ethanol
- fatty acids (acetic acid & mid chain length FAs)
- SO_2
- toxic (killer) proteins/other organisms
- residues (pesticides, cleaning agents)

Adapted from Henschke (1997)
ASVO Seminar Procs pp. 30-38,41

Active Dried Yeast
Rehydration/reactivation risk factors

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Research Institute

- Follow manufacturers instructions precisely
- Rehydration medium
  - Tap/Mineral water/Grape juice or diluted concentrate
  - Consider proprietary 'inactivated yeast' reactivation nutrients rich in sterols for high risk juices
    [ie high sugar (>13 Be), bright (low solids), low YAN (<150 mg/L), to be fermented cold (<15C)]
- Temperature of medium: 38-40 C unless specified
- Ensure yeast is correctly rehydrated
- Use within 30 min of rehydration
- Do not use expired stock

Hydration temperature is very important

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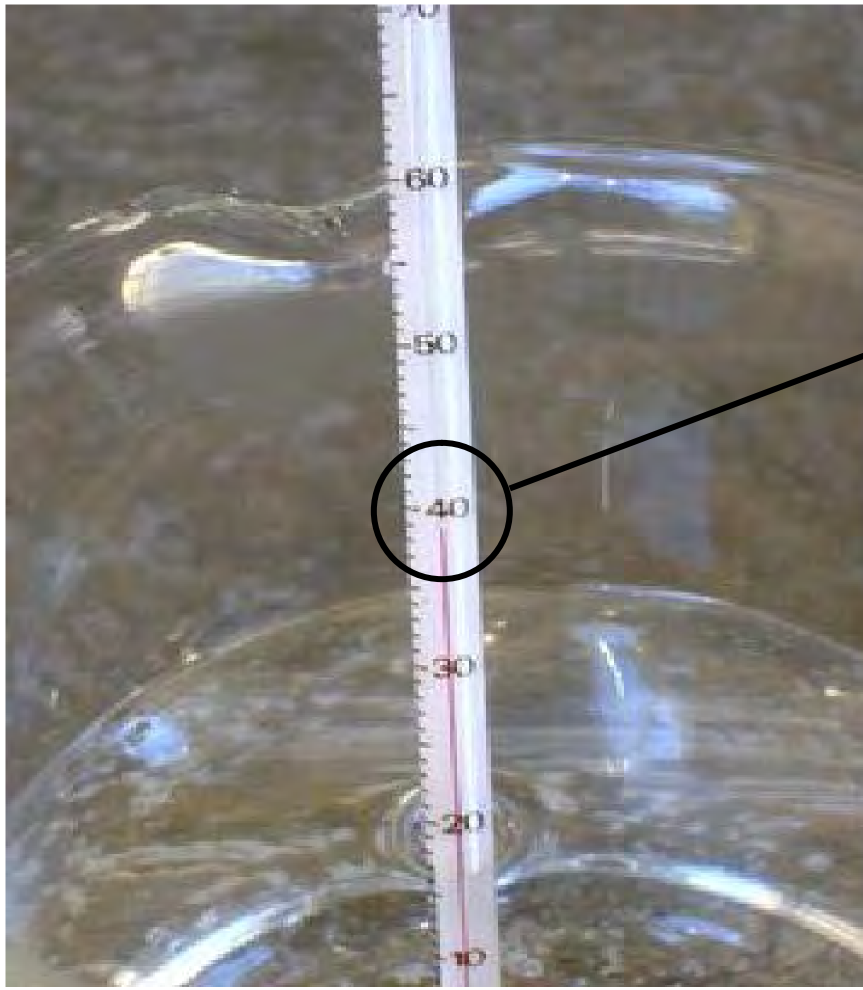

Critical
38 – 40 ° C

Hydration step – prevent 'dry lumps' of yeast

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Correct

Incorrect

Active Dried Yeast
Rehydration/reactivation risk factors

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- Add rehydrated yeast to pre-warmed juice (ie after cold settling or cold soak, preferably >15°C
- Step-wise cool reactivated yeast in 5-10°C steps at 5 min intervals by adding appropriate volumes of the juice to be inoculated for high risk juices (ie cold (<15°C), highly clarified, anaerobic, high sugar juice ferments)
- Ensure sufficient time has elapsed after SO_2 addition to must to avoid damaging yeast (<10 ppm SO_2 @ pH3.5) – consider adding a ‘sacrificial culture’ of about 15–20% of aerated active yeast (containing aldehyde) to the juice in order to bind SO_2 and other potentially inhibiting substances, about 30 min before inoculation

Fermentation Management

The Australian Wine Research Institute

- Add yeast hulls for high risk ferments (detoxification role)
- Allow ~10% of sugar to ferment before cooling
  - It is critical to build-up cell number (growing yeast - v. stress sensitive)
  - Do not cool in greater than 2-4° C increments
- Monitor fermentation progress & temperature daily
  - Spreadsheets provide an efficient record of fermentation data, comparison with similar ferments and early identification of problems
- Look for a steady fermentation rate; compare with previous data of similar ferments and/or previous years data to identify problems
- Cell numbers should reach 70 x 10^6 cells per ml for cellar bright juice ferments (determine with microscope and haemocytometer)
  - Monitor budding % as an indication of yeast growth or problems
  - Expect high % budding during first third stage of fermentation
  - Vital staining (eg methylene blue) is also a useful diagnostic for dead yeast cell estimation – check when fermentation rate becomes slow
  - **Also look for presence of (lactic acid) bacteria, which can adversely affect yeast activity and lead to fermentation arrest**

Optimising yeast inoculation

Factors affecting yeast implantation

- Pure culture inoculation strategy
  - Maximising the benefits of selected yeast strains

❖ Minimise indigenous yeast population of must (<10^5 cfu/ml)

- Minimise must exposure to moderate-hot temperature, during harvest, transport, juice preparation (enzyme treatment, clarification, etc) which otherwise promotes indigenous yeast & bacteria growth
- Add sufficient SO_2 (50-100 ppm, depending on fruit condition) during machine harvest to limit indigenous microbial growth
- Clarification procedures can lower indigenous microbial growth
- High indigenous yeast count can indicate nutrient depletion – add nutrs.

❖ Recommended Inoculation rates

Under inoculation will compromise ability of culture yeast to dominate

- whites: 5 x 10^6 cells/ml (typically 250 g ADWY per kL juice);
- reds: 5 x 10^6 cells/ml ; lower rates can compromise yeast implantation (typically 200 g ADWY per Tonne must)

Nutritional deficiency risk factors

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- Yeast Assimilable Nitrogen (YAN)
  - A variable proportion of Australian juices/musts have inadequate YAN
  - Measure YAN on a grape maturity sample or juice sample
  - Low YAN (whites <150 mg N/L; reds <100 mg N/L) high risk slow/stuck ferm
  - Adjust with DAP (200 mg N/1g DAP) or proprietary N supplement
- Lipid deficiency (phytosterols and unsaturated fatty acids (UFA))
  - Over clarification removes lipids essential for yeast growth
  - i.e. when <0.1-0.5 v/v juice solids (ie 'cellar bright') or <5 NTU
  - Addition of "fine" settled grape solids highly stimulatory to yeast growth
  - Avoid "hard" settled grape solids, which can impart phenolic coarseness, hotness, bitterness to wine
  - Rehydrate yeast with proprietary inactivated yeast product rich in sterols
- Dissolved Oxygen (dO_2)
  - dO_2 is highly variable in juice/must – ranging 0 – 8 ppm (air-saturated)
  - Aerating fermentations at least once, at the stage when they are most active (during fermentation of 35-50% sugar) is highly beneficial
  - Aerate to give max ~5 ppm oxygen (sparge, pump over, rack-return, etc)
  - Oxygen alleviates yeast REDOX imbalance & stimulates sterol formation

Nutritional deficiency risk factors

The Australian Wine Research Institute

Vitamins

- Vitamin status of Australian musts/juices is unknown
- **Thiamine** - essential for ethanol production by yeast

  - **major losses caused by high SO_2 use and wild yeast growth** (ie during transport or must processing)
- Vitamins (thiamine, niacin, biotin, pantothenate, pyridoxine, inositol) can be added to starter cultures under ANZFA Wine Regulations
- Some proprietary yeast foods provide a useful source of vitamins

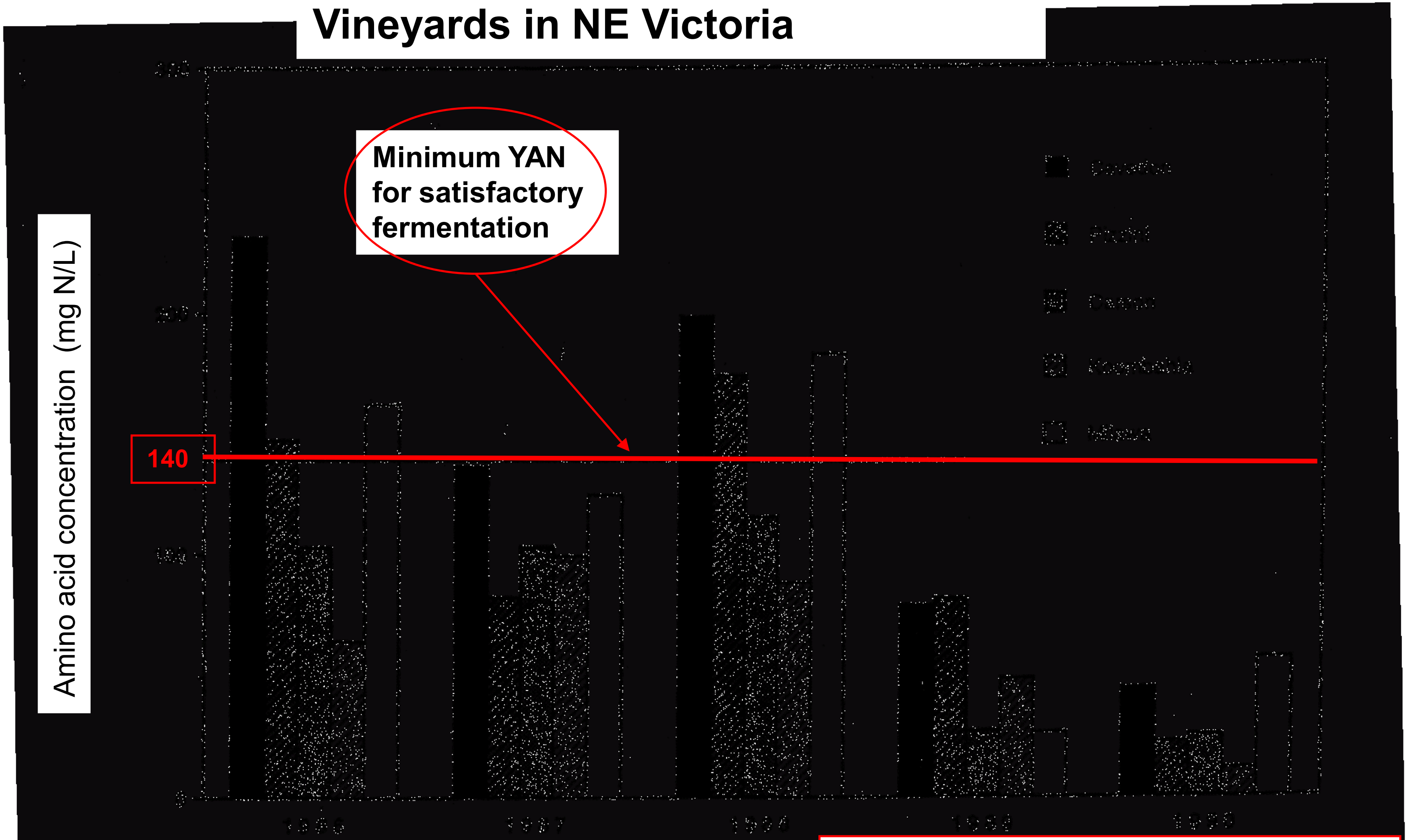
Minerals

- Mineral status of Australian musts/juices poorly known (see Schmidt et al 2010)
- **Phosphate – normally considered adequate; can be added with DAP**
- **Low K^+/Low pH** - stuck ferms with some yeast strains (sparkling/tirage or early harvest must)
- **Magnesium, zinc, manganese, which are enzyme co-factors are thought to be sub-optimal** (these cannot be added under ANZFA Wine Regulations)
- Some proprietary yeast foods provide a limited source of minerals and can be beneficial

Low YAN juices/musts

- Low YAN musts can also be suboptimal in other nutrients
- **Useful to add proprietary inactivated yeast nutrients to yeast starter cultures when deficiencies are suspected, especially to difficult to ferment juices/musts**

Vineyard & Year effect on juice YAN



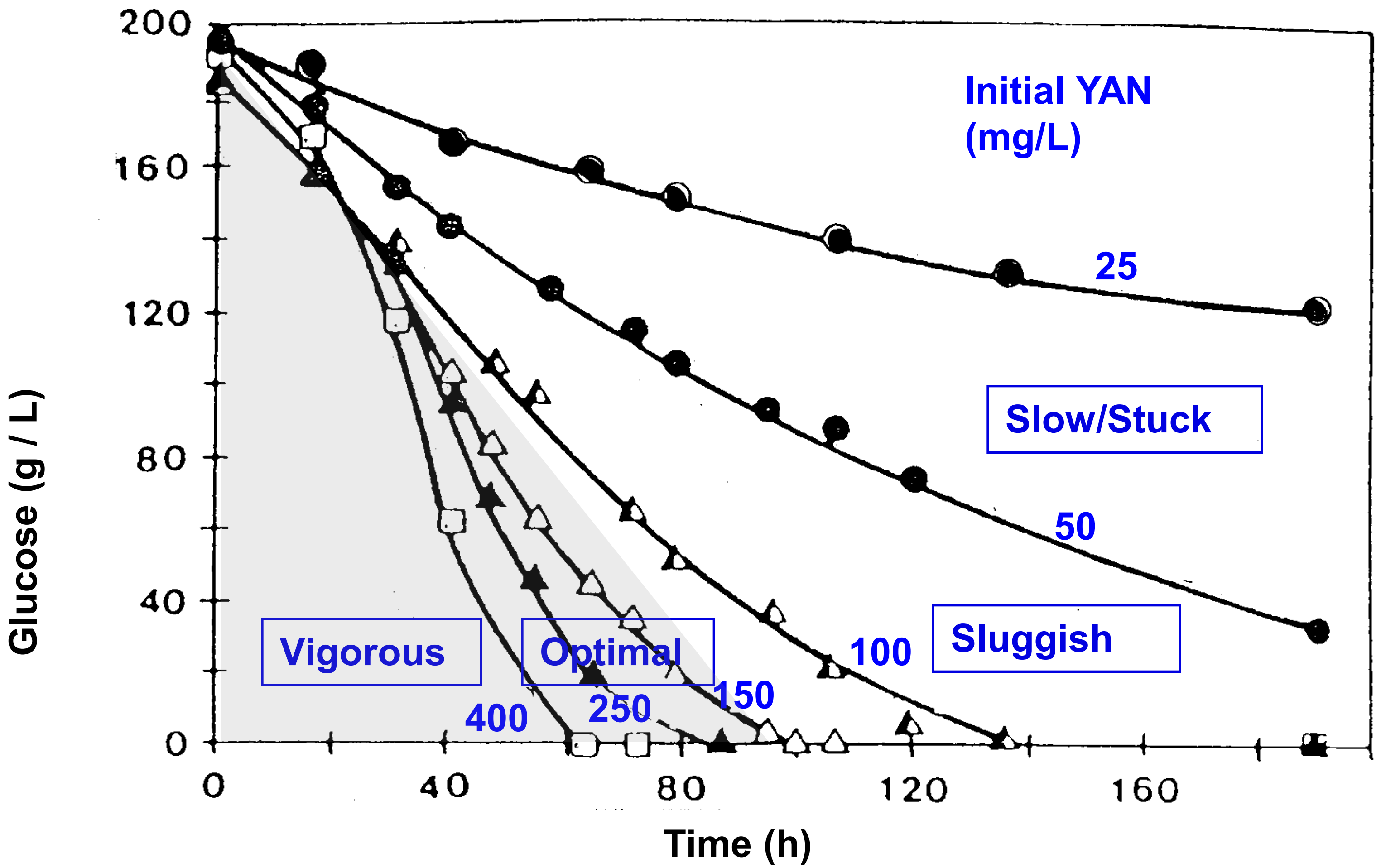
>>> Note large variation in YAN by vineyard as well as by year

>>> Recommended to monitor YAN of juices from problem vineyards over several vintages

Fermentation response to YAN

Synthetic juice ≡ 'cellar bright' juice

All other nutrients are adequate, representing Nitrogen-limited growth



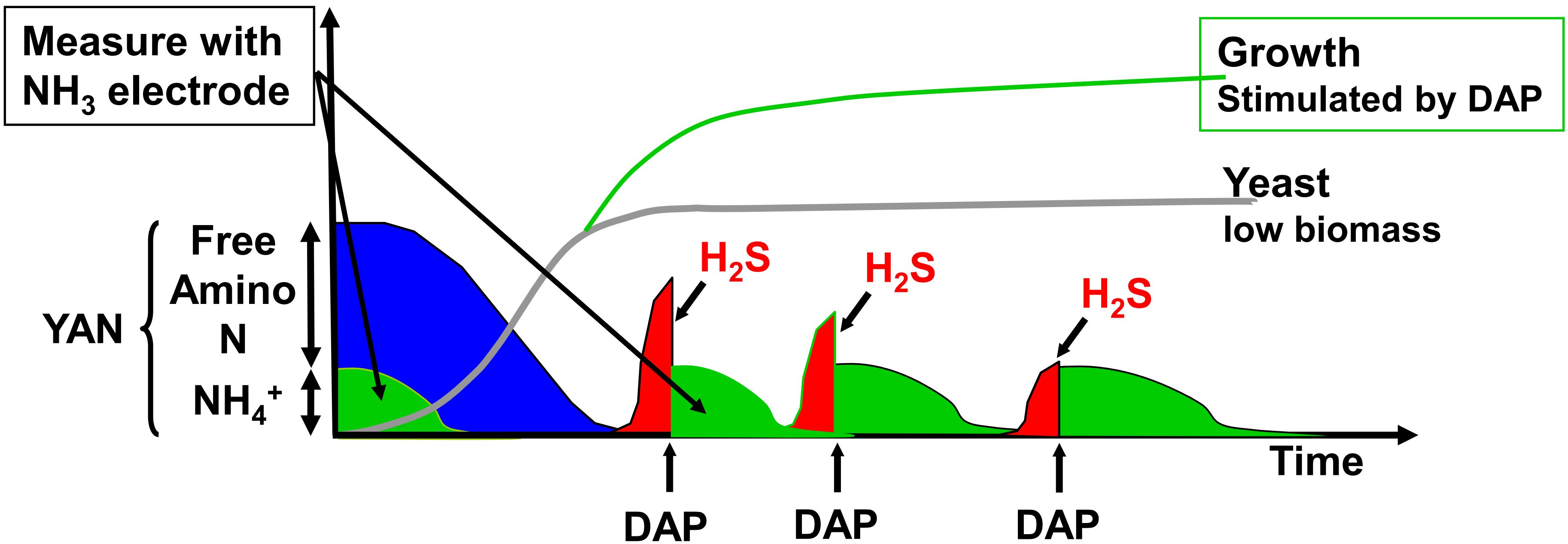
>>> Low YAN - slow/stuck fermentation
Excessive YAN – too vigorous

Sourced from Salmon (1989)
Appl. Envir. Microbiol. 55:953-958

Nitrogen utilisation – Low YAN fermentation
Risk of H_2S as well as slow fermentation

The Australian Wine Research Institute

Low Nitrogen (<200 mg N/L)
Low biomass increases risk of slow/stuck fermentation and H_2S production



- Inverse relationship between Initial YAN and H_2S production
- Initial YAN should exceed 250 mg N/L YAN to prevent H_2S but H_2S profile depends on yeast strain X juice/must interactn
- Not all Yeast H_2S responds to DAP; could be a vitamin deficiency?

YAN Requirements of Yeast

The Australian Wine Research Institute

(depends on yeast, solids content, fermentation conditions & wine style)

1. **Maximum N demand:**
   Mean = 400 mg N/L
   Range = 330 – 470 mg N/L
2. **Minimum YAN requirement**

   Whites (clarified) – approx. 150 mg/L

   Reds (high solids) – approx. 100 mg/L
3. **Minimum YAN to prevent H_2S**

   approx. 250 – 350 mg/L (yeast x must dependent)
4. **Optimum flavour formation (YAN & DAP affects ester prod^n)**

   Whites (strong style effects – complex thr' to fruity)

   – Chardonnay – fruity: 250–350 mg/L; <200: complex

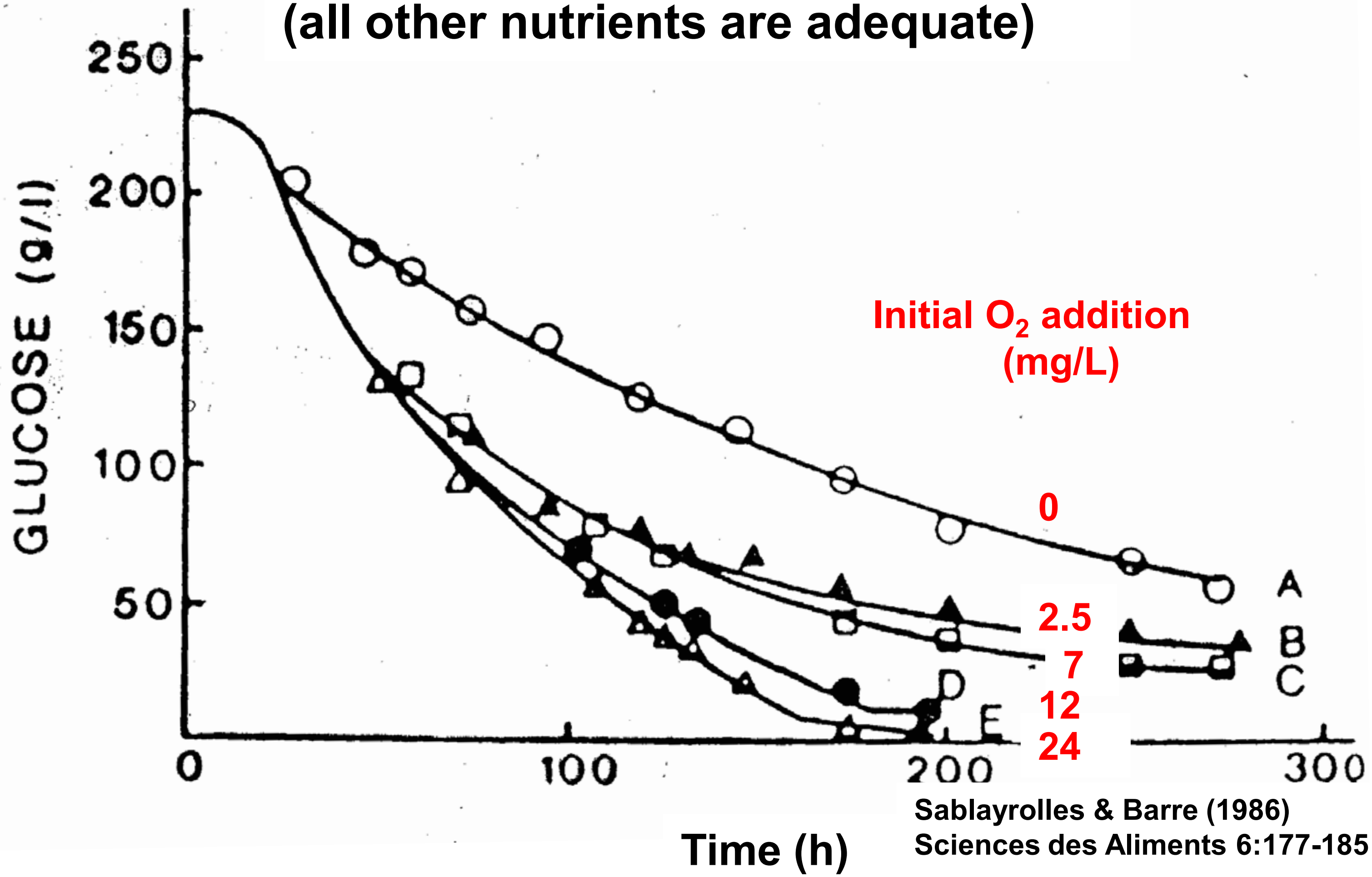
   – Sauvignon Blanc – ? mg/L

   – Reds – fruity: 250–350 mg/L ; <200: complex

Fermentation response to O_2

The Australian Wine Research Institute

Synthetic juice ≡ 'cellar bright' juice (all other nutrients are adequate)



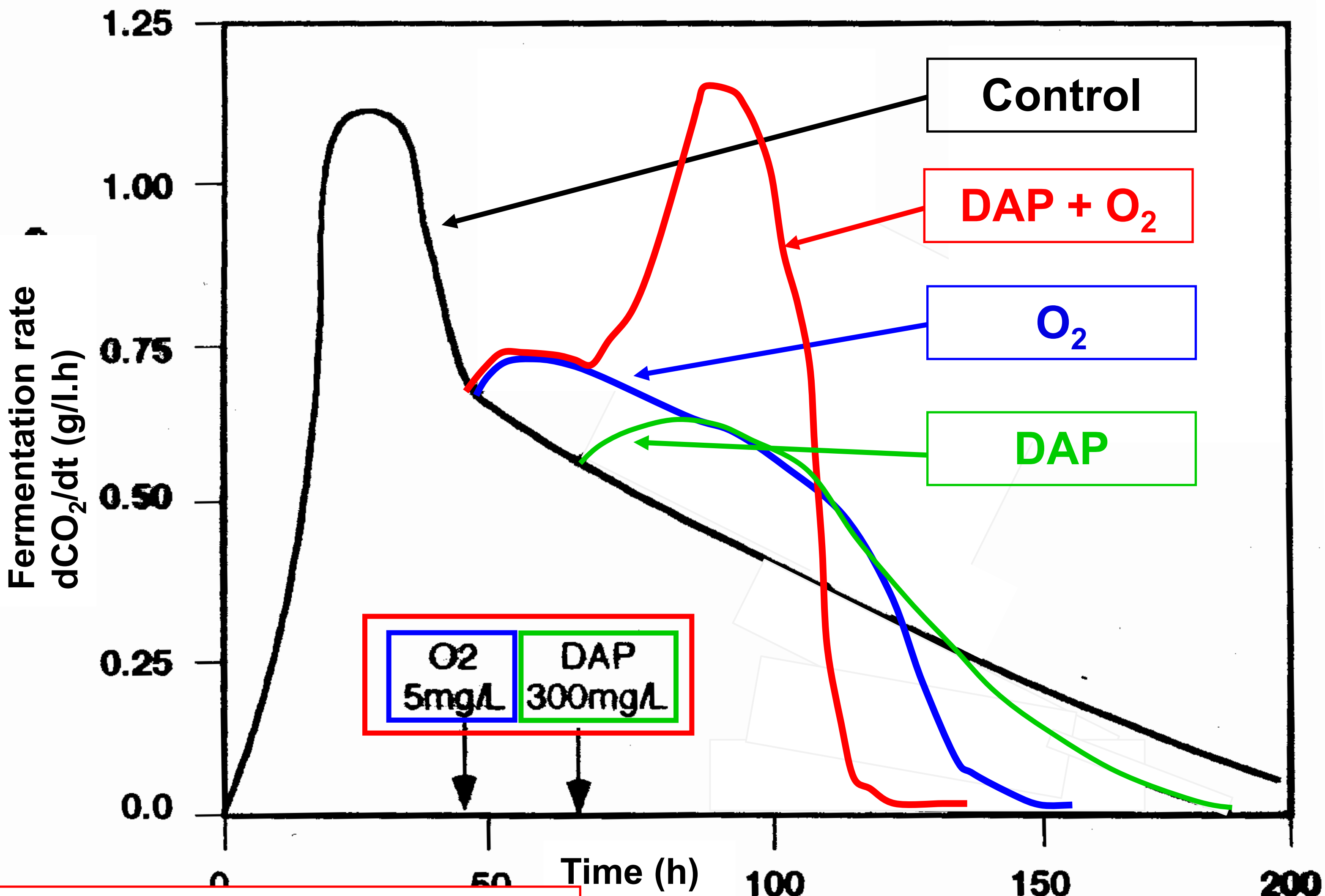
Sablayrolles & Barre (1986) Sciences des Aliments 6:177-185

>>> Oxygen stimulates fermentation rate and is shown to prevent most suboptimal ferments

Combined effect of DAP + O_2 on fermentation

Nutrient strategy for stimulating fermentation

The Australian Wine Research Institute



>>> Combined O2 and DAP greatly stimulates fermentation rate

Sablayrolles, Dubois, Manginot & Barre (1986)
J. Ferment. Bioeng. 82:377-381

Practical strategies for ensuring a complete fermentation with low vigour yeasts

eg S. bayanus AWRI 1375

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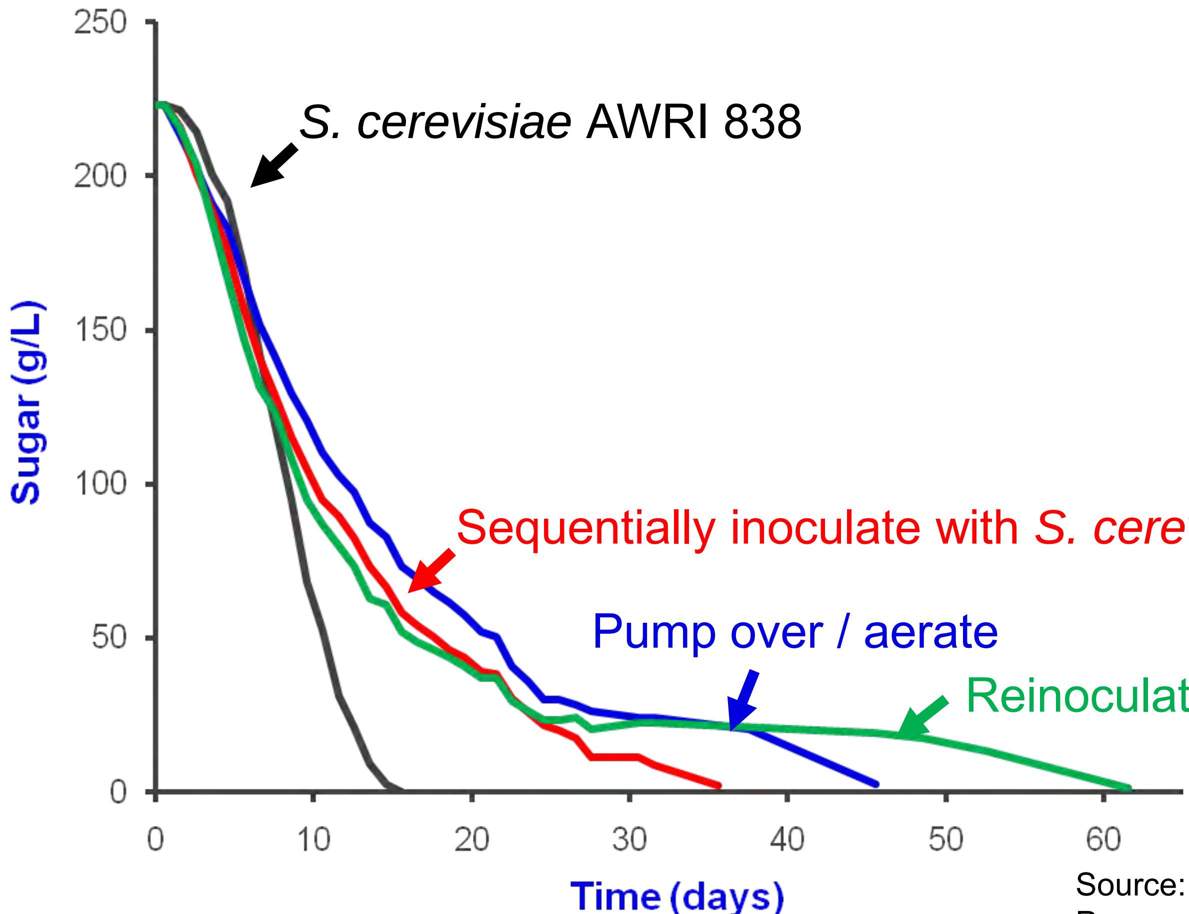


Source: Eglinton & Henschke 2001
Proceeding AWITC

All treatments tested promoted refermentation and had no signif. sensory affects

N.B. Rescue cultures were prepared by AWRI step-wise acclimatisation procedure

Juice Clarification affects Fermentation Rate and Wine Residual Sugar

The Australian Wine Research Institute

Ferment rate	Wine residual sugar	turbidity	Clarification treatment
Highest	Lowest		Cold settled
			Bentonite treated and settled
			Enzyme treated and settled
			Centrifugation, 10 min at 1500g
			Coarse filtration
			Centrifugation, 20 min at 10000g
Lowest	Highest		Fine filtration (eg Sietz EK)

High clarity enhances varietal character BUT increases fermentation risk
Therefore, turbidity is adjusted to balance yeast performance and flavour

Inhibitory substances – risk factors

The Australian Wine Research Institute

- **Ethanol – probably largest cause of stuck ferments**
  - inhibition is strain dependent: growth at 8-12%, fermentation at 12-16%
  - **determined by grape maturity at harvest**
- SO_2
  - strain dependent inhibition, typically >10 mg/L free SO_2 at pH 3.5
  - cell death at 45 mg SO_2/L at pH 3.5 (0.8 mg/L mol. SO_2)
- Fatty acids (FAs) (good hygiene / aerate ferments)
  - acetic acid: yeast growth inhibited at >1.5 g/L at 8% EtOH
    fermentation inhibited at 3-4 g/L
  - aliphatics (C6, C8, C10 FAs): ca. >3 mg/L at 10% EtOH
- Toxins (low risk except for lactic acid bacteria infection)
  - yeast toxins most active in low solids (bright) ferments
  - Do not coinoculate non-killer with killer wine yeast
  - **some Lactobacillus toxins can inhibit ferm. (high or low solids) check microscopically for lactic acid bacteria**
- Agrochemical residues (very uncommon)
  - copper oxychloride 10-15 mg/L
- Residues of winery sanitisers (uncommon)
- **Yeast hulls can be used as a broad spectrum detoxification additive**

From: Henschke (1997) ASVO Seminar Procs pp. 30-38,41

Fermentation management – Risk factors

The Australian Wine Research Institute

- **Temperature stress**

  Do not commence cooling until 10% sugar fermented
  Excessive temperature (32-35 ºC depend on [EtOH]) can inactivate yeast
  Over-cooling for particular yeast (non-cryophilic) / may need to use methods to maintain yeast in suspension if T<13-15 ºC
  Excess heating or cooling (transition exceeding 5 ºC)
  Cooling preferably should be <3 ºC per day to avoid yeast stress during growth

- **Vigour and sedimentation** (flocculation)

  Yeast sediments in low vigour ferments (CO_2 bubbles keep yeast in suspension and assists ferment circulation)
  Physical stirring can help prevent sedimentation
  Avoid flocculating strains in cool, cellar bright, anaerobic, high sugar ferments

- **Grape solids – avoid over-clarification**

  Beneficial to wine style but deprives yeast of key nutrients
  Lipids increase yeast tolerance to ethanol stress – consider adding cold-settlings to increase turbidity

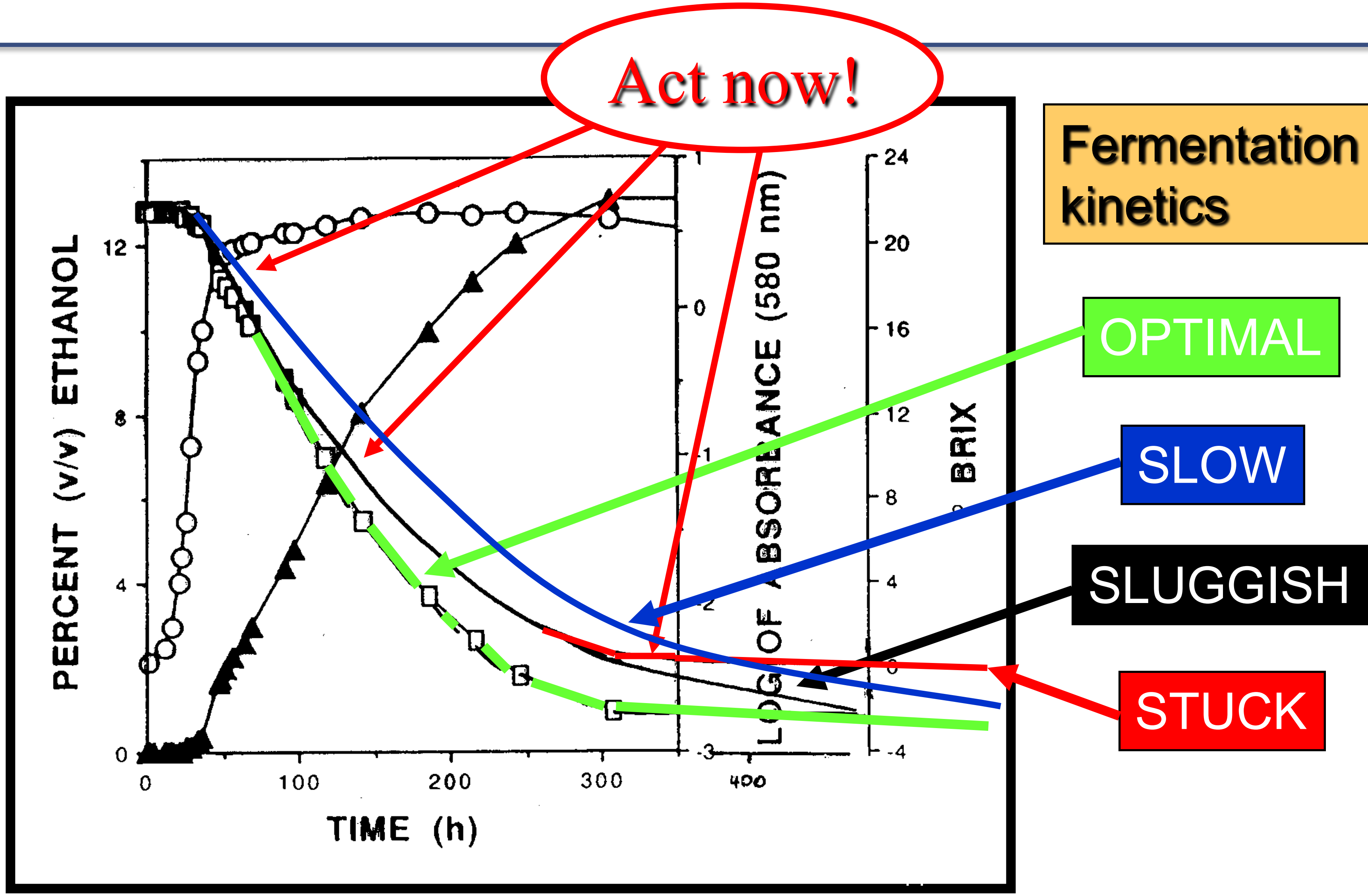
- **Nutrients**

  If known or suspected lack of nutrients (especially YAN and O2) recommend aeration (ca. 5 ppm O_2) and adding 300 mg/l DAP at 30-50% fermentation progress; yeast hulls and proprietary ferment nutrients can be beneficial

Henschke (1997) ASVO Seminar pp. 30-38,41

Problem fermentations

The Australian Wine
Research Institute



Take corrective action early

Choice of rescue procedure

If ferment stops with <10 g/L residual sugar and the alcohol content is <12 % v/v:

- **Then recommend** preparing a starter culture in grape juice with a recommended yeast. This procedure is relatively quick and will produce moderate tolerance to alcohol / fresh yeast sediments from active ferments can also prove successful

- **Otherwise** use a rescue culture prepared by stepwise acclimatisation of a recommended rescue yeast. This procedure builds tolerance to the toxic substances present in the problem ferment

AWRI Rescue procedure – key factors

The Australian Wine Research Institute

- Use high yeast rate 500 mg/L (EC1118, PDM, Uvaferm 43 are successful – consult yeast supplier)
- Rehydrate with sterol-rich reactivation nutrient
- Don't let culture run dry – go onto next stage when 50% of sugar has gone (monitor with hydrometry)
- Add DAP/Yeast hulls and aerate once culture is active
- Treatment of stuck wine before adding rescue culture:
  - Measure YAN and add DAP if necessary
  - Adding yeast hulls/ferment nutrients can be beneficial
  - If bacteria present treat stuck wine with SO_2
  - Rack or centrifuge stuck wine (remove dead yeast)
- Add wine to culture, rather than culture to wine
- Avoid temperature shock / Keep yeast in suspension
- Limited aeration beneficial only when yeast are active
- Keep good records

Yeast acclimatisation procedure for restarting difficult and stuck ferments
(See AWRI Website for details)

The Australian Wine Research Institute

Procedure for 1000 L of ferment

Stage	Function			Cumulative volume
1	Preparation of rescue culture			20 L
2	Acclimatisation			
		Step	Proportion of ferment	
		1	50%	40 L
		2	75%	80 L
		3	88%	160 L
		4	94%	320 L
3	Inoculate problem ferment			1020 L

Adapted from Henschke (1997)
ASVO Seminar Procs pp. 30-38,41

Important principles of rescue procedure

- Stepwise acclimatisation of yeast to toxic substances of the problem ferment – if possible, incrementally add the ferment to the culture rather than the culture to the ferment
- No sugar depletion stress
- No nitrogen depletion stress
- Aeration yeast during acclimatisation procedure
- Keep yeast in suspension - agitation prevents nutrient starvation stress

Agitation aids refermentation

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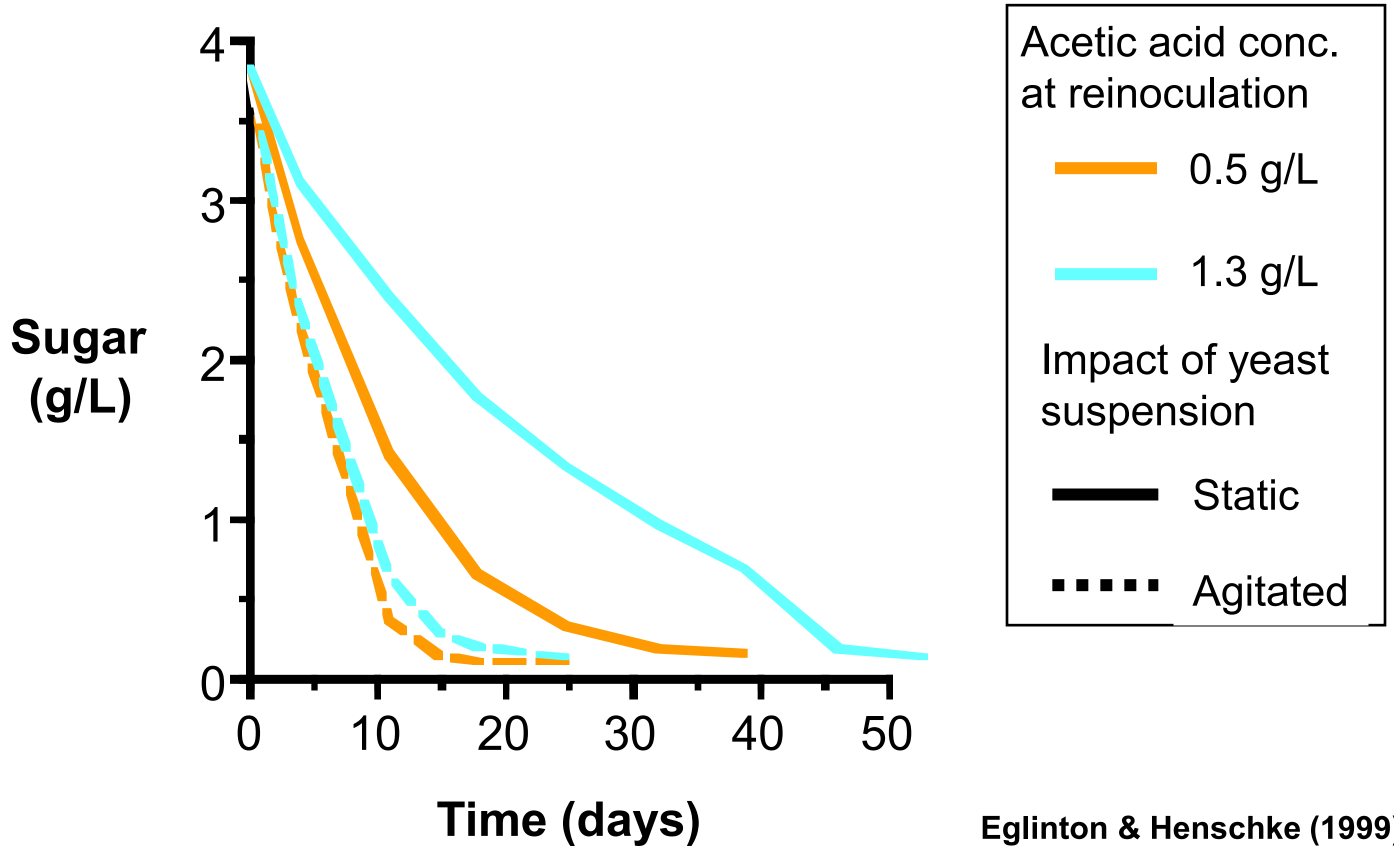


Eglinton & Henschke (1999)
***Aust. J. Grape Wine Res.* 5:71-78**

>>> When restarting fermentation, important to keep yeast in suspension by physical means until CO_2 production commences, which then maintains yeast in suspension

For more information

The Australian Wine Research Institute

- **AWRI website – wealth of practical information**
- **ASVO seminar proceeding (1997) papers by: Henschke, Monk & Four industry practitioners**
- **Industry Services Group ; AWRI Technical Note 05 (updated 2013)**
- **Contact AWRI Industry Development & Support team: Con Simos, Adrian Coulter, Geoff Cowey, Matthew Holdstock for technical advice**

Acknowledgments

Peter Leske (former AWRI team leader)/Peter Godden (IA Team)

Wine Microbiology team:

Simon Schmidt, Radka Kalouchova, Paul Chambers , Paul Henschke

(former members: Jeff Eglinton, Holger Gockowiak, Nancy Davis and Lisa Buckingham)

Research at The AWRI is supported by Australia's grapegrowers and winemakers through their investment agency the Grape and Wine Research and Development Corporation, with matching funds from the Australian Government.

GRAPE AND WINE RESEARCH AND DEVELOPMENT CORPORATION

The Australian Wine Research Institute

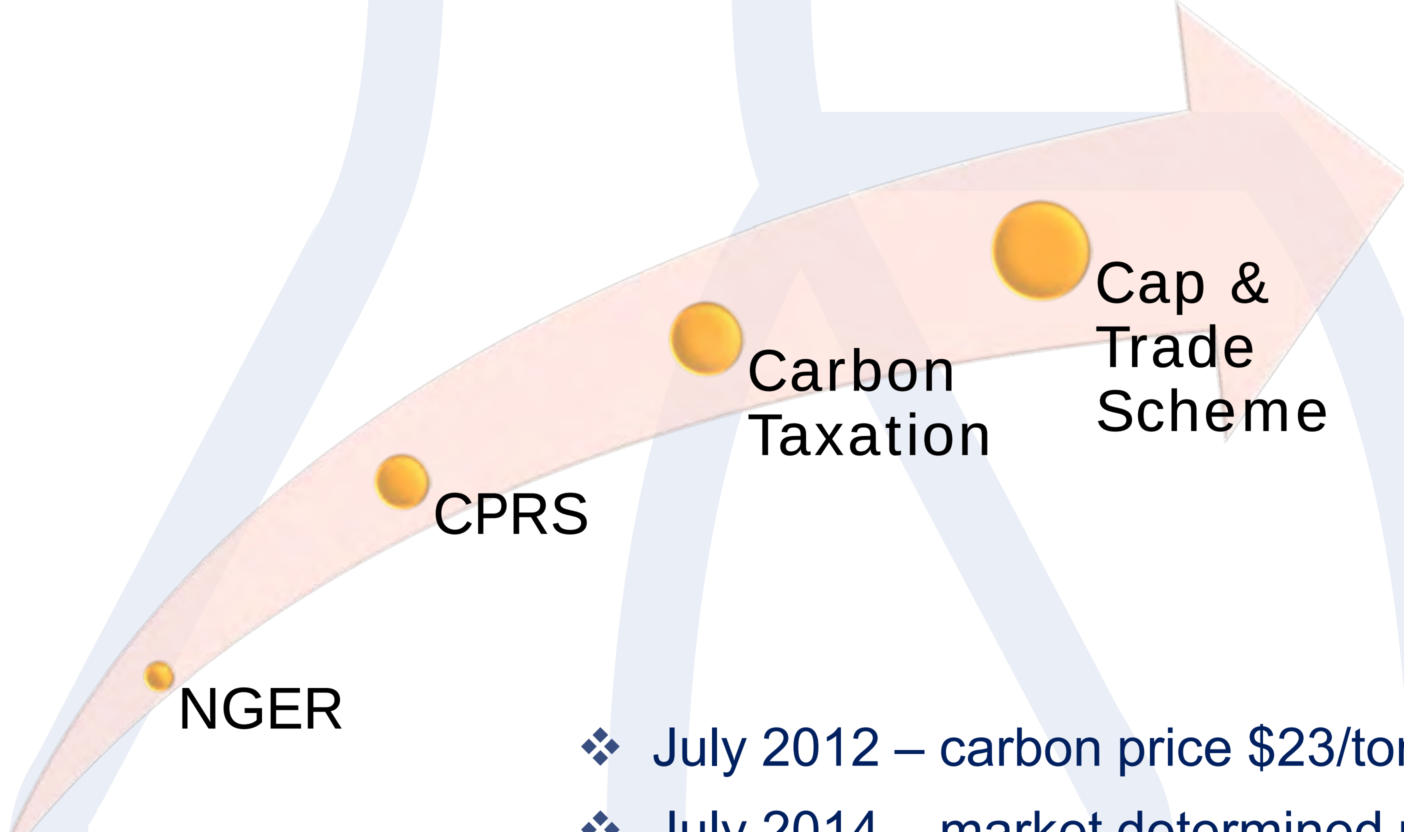
How to reduce your carbon footprint without spending any money

Neil Scrimgeour
Research Manager, Commercial Services

Australia's impact on the global carbon economy

- <2% of global GHG
- Export 2-3x annual emissions in coal
- 30% of global budget in Aust. coal

Carbon pricing



- July 2012 – carbon price $23/tonne
- July 2014 – market determined price
- Excludes transport fuels
- Mandatory >25,000 tonnes/year

Australian Government
Department of Climate Change

BUT....

LIBERAL
ABOUT
OUR TEAM
OUR PLAN
NEWS
DONATE
We have a Plan for Real Action
10. REDUCE CARBON EMISSIONS
We will take direct action to reduce carbon emissions inside Australia, not overseas – and also establish a 15,000-strong Green Army to clean up the environment.
10 OF 12
The Coalition is on track for a 32-seat majority after wresting a swathe of seats from Labor and independents in Tasmania, New South Wales and Victoria in Saturday's poll.
MAP: Canberra 2600

Clean Energy Future Act

- Carbon Pricing Mechanism
- Financi
  - Rene
- Clean T
- Carbon
- Land Se
  - Carbo

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Clean Technology Food and Foundries Investment Program

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- Eligibility
- Application Process
- Funding Agreement
- Resource Centre
- Customer Stories and News
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Clean Technology Food and Foundries Investment Program

Listen

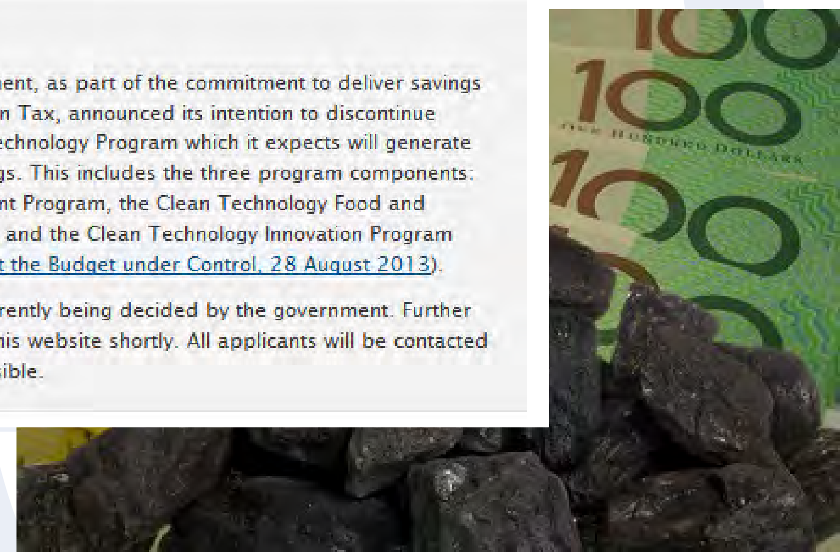
Program status

Open for Applications.

Note:

The Australian Government, as part of the commitment to deliver savings by abolishing the Carbon Tax, announced its intention to discontinue funding for the Clean Technology Program which it expects will generate $0.4 billion in budgetary savings. This includes the three program components: the Clean Technology Investment Program, the Clean Technology Food and Foundries Investment Program, and the Clean Technology Innovation Program (Media Release: Our Plan to get the Budget under Control, 28 August 2013).

Program arrangements are currently being decided by the government. Further information will be posted on this website shortly. All applicants will be contacted by AusIndustry as soon as possible.



Business interests

- Risk management
  - Cost of business inputs
  - Retail pressure
- Branding
  - Recognition
  - Image
  - Product differentiation
- Process improvement
  - Cost reductions
  - Grants

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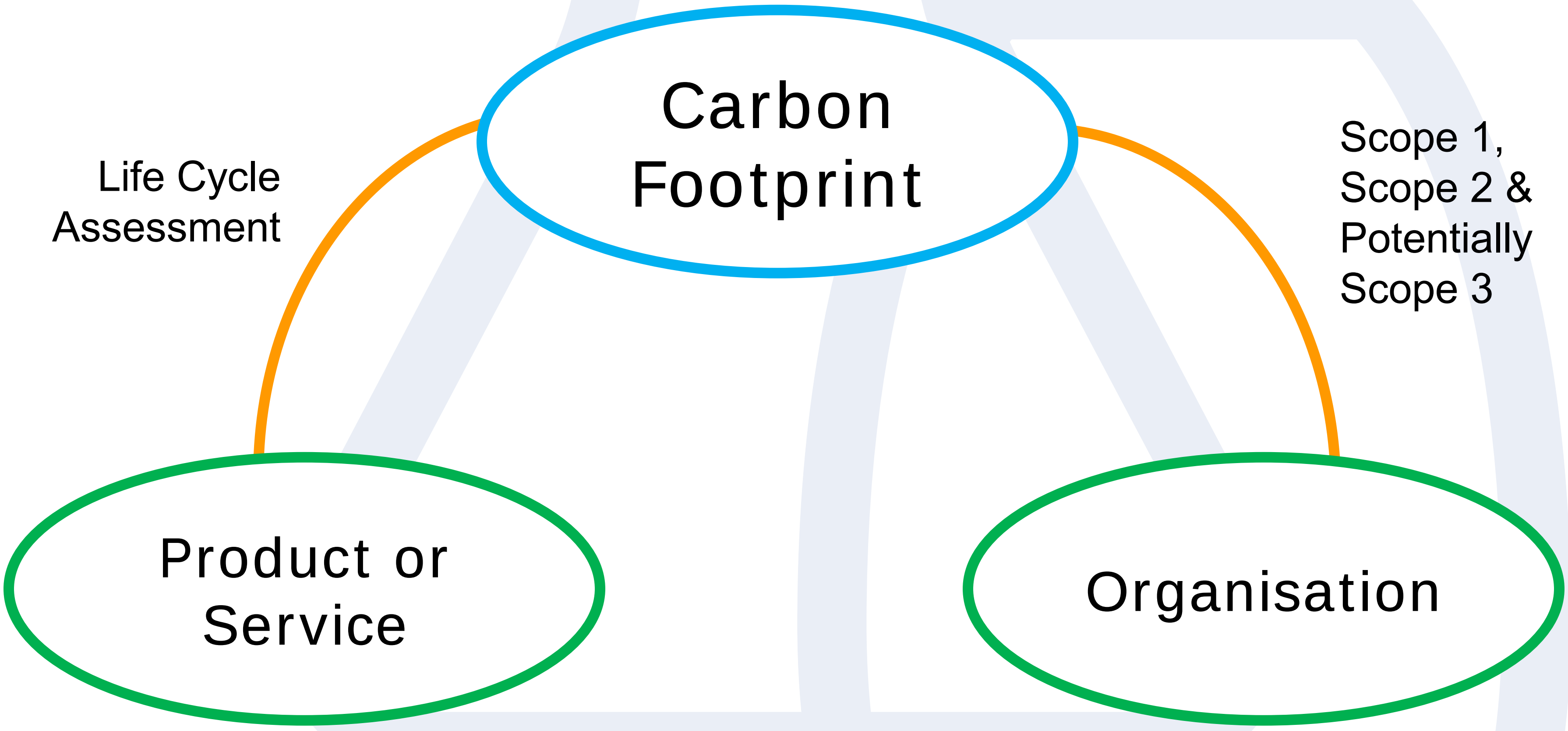
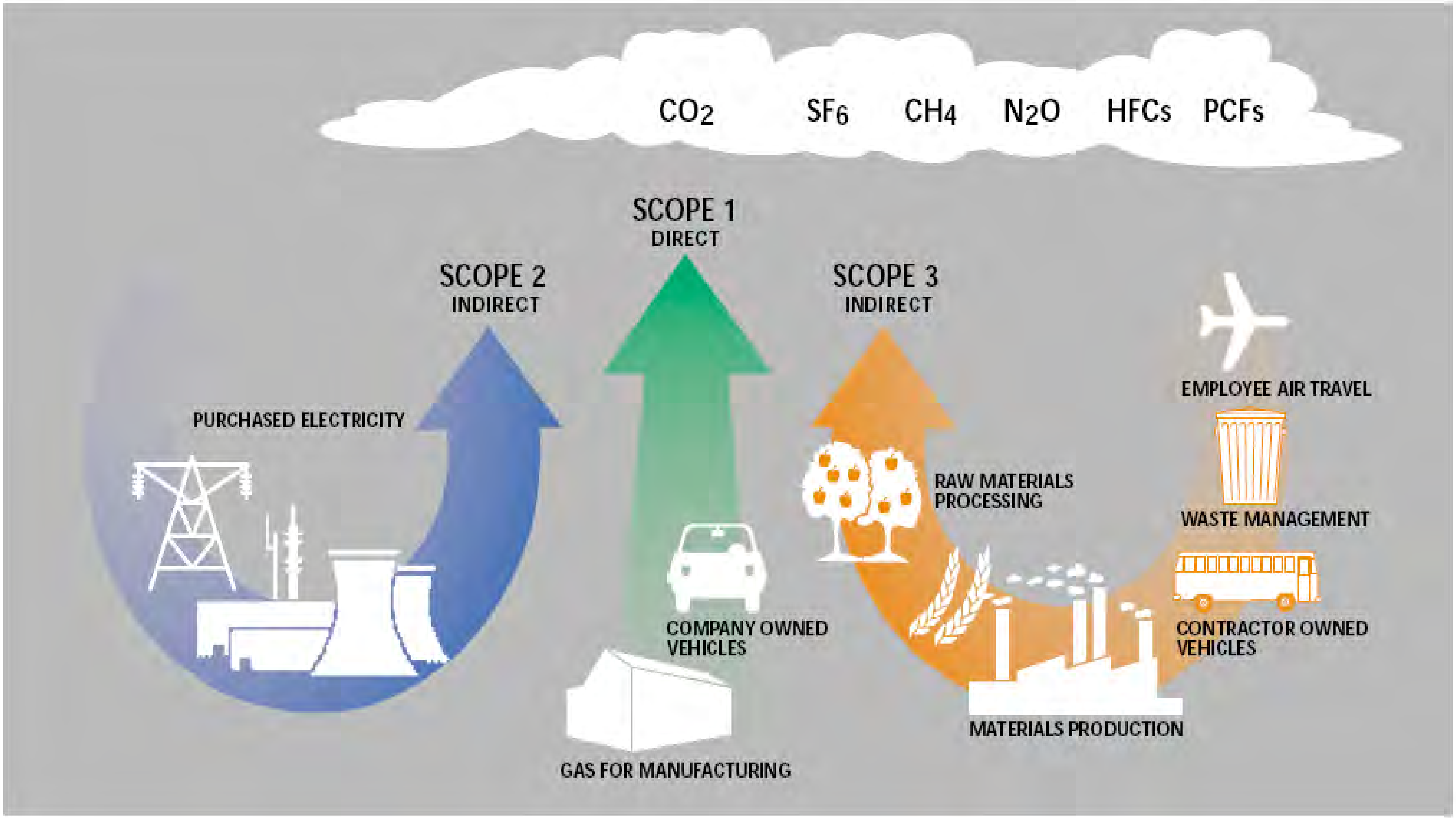
COP15 COPENHAGEN
UNITED NATIONS CLIMATE CHANGE CONFERENCE 2009

100% CARBON NEUTRAL
ISO 14044

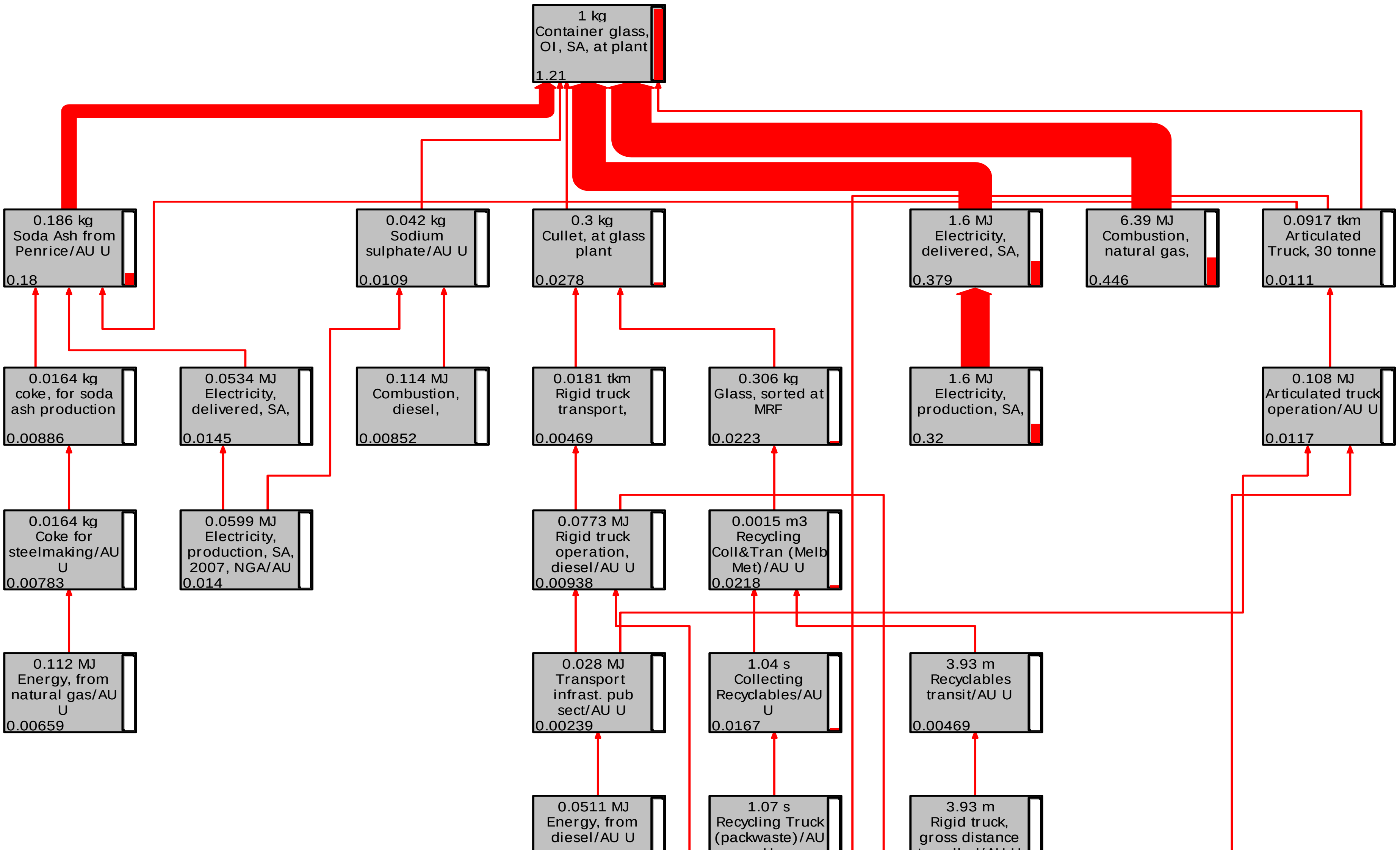
Carbon Accounting



Organisational foot-printing



Lifecycle analysis



Supply chain impacts

GRAPE GROWING & WINEMAKING

28%

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PRODUCTION & PACKAGING

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TRANSPORT & SALES

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CONSUMPTION & DISPOSAL

18%

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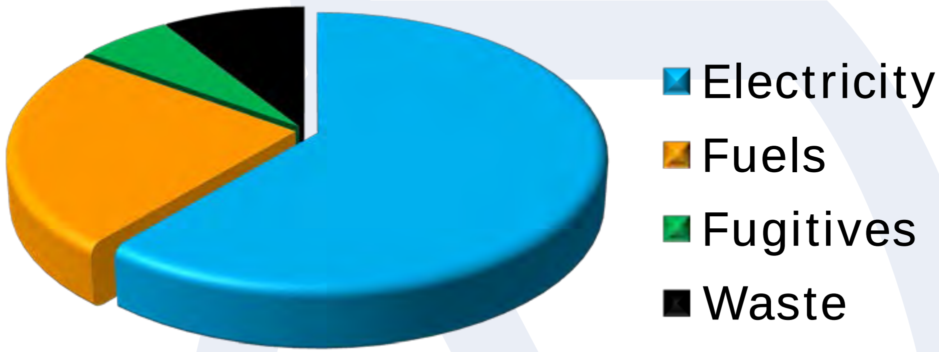
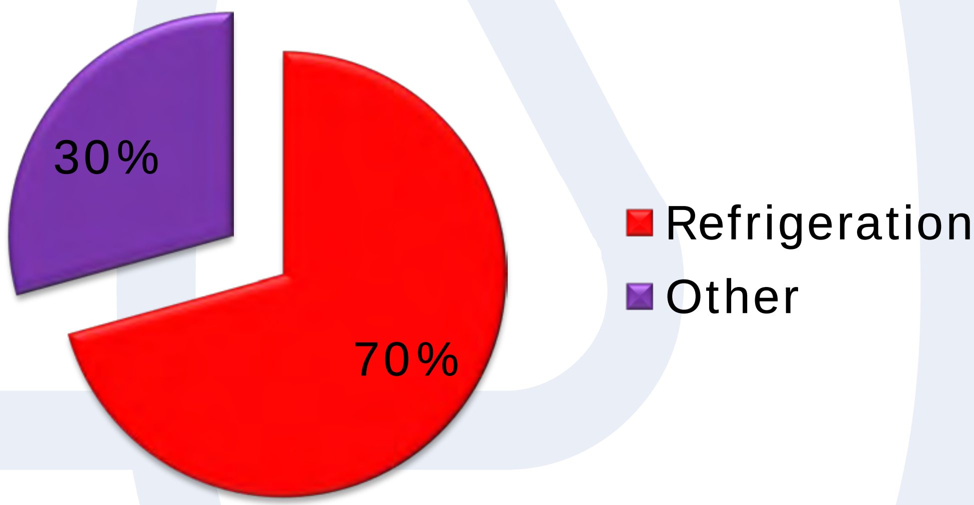
Power Consumption

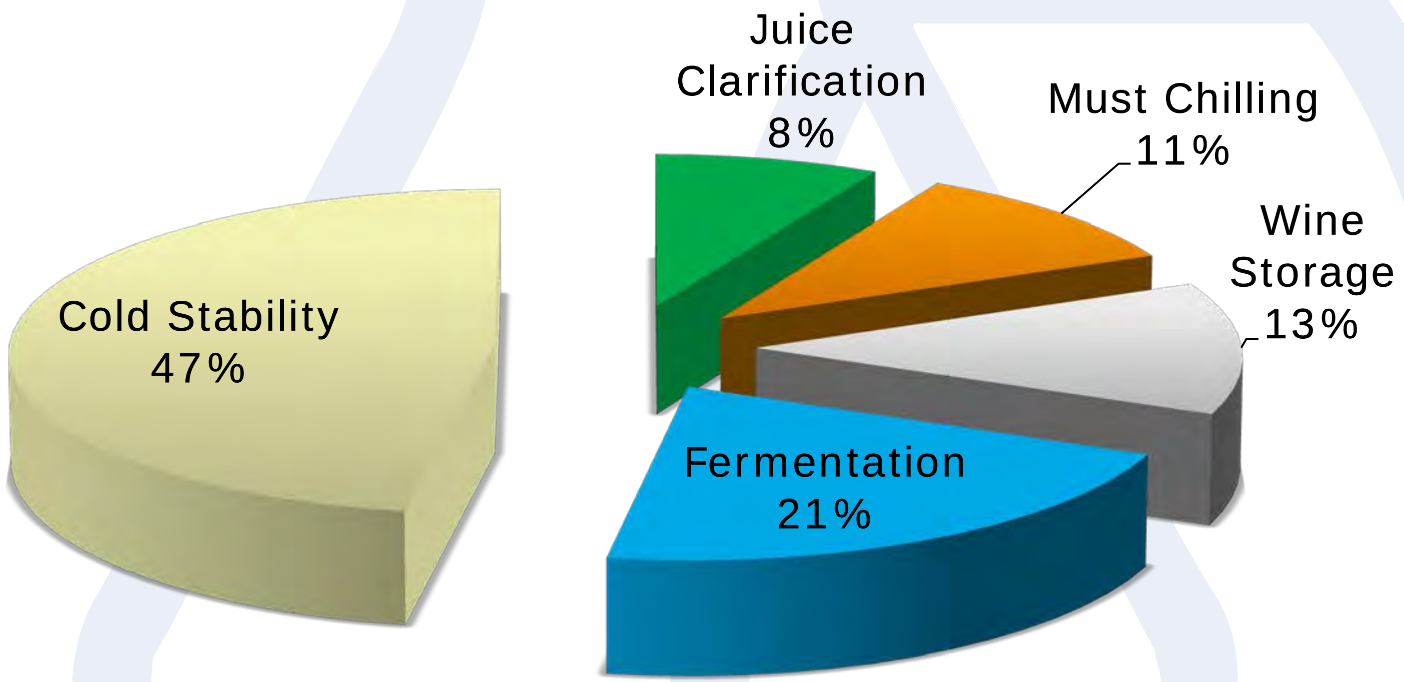
Carbon Footprint



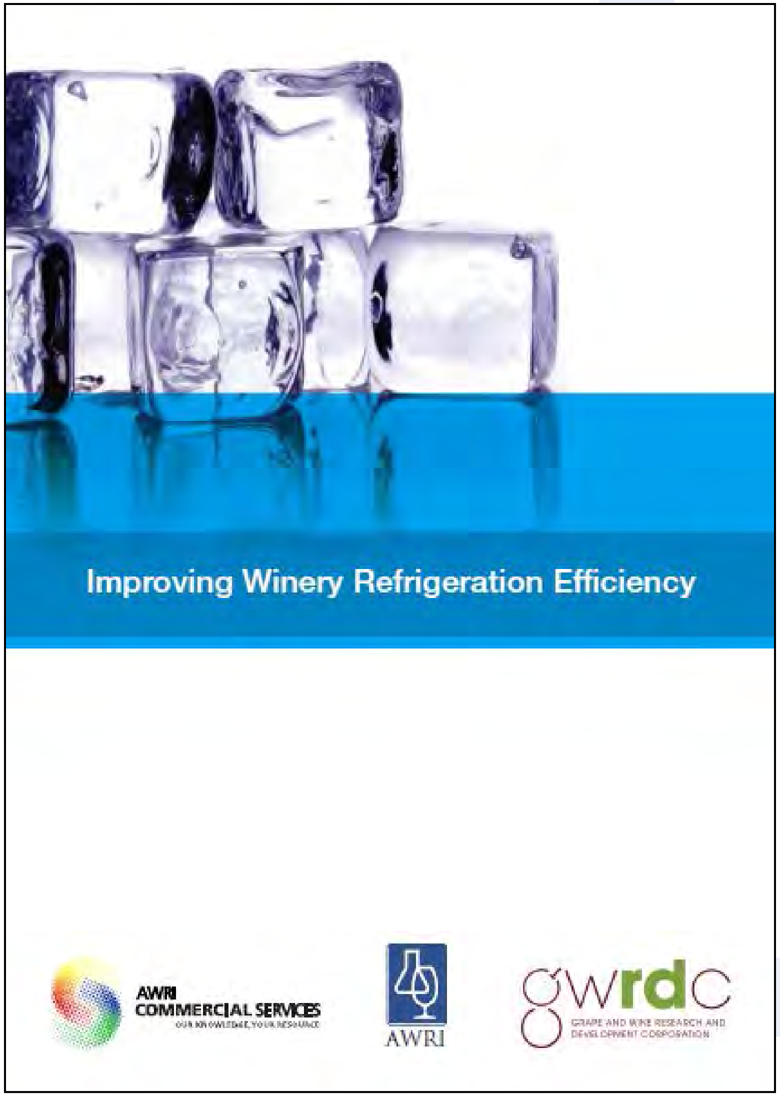
Power Consumption



Cooling Requirements



Refrigeration Handbook



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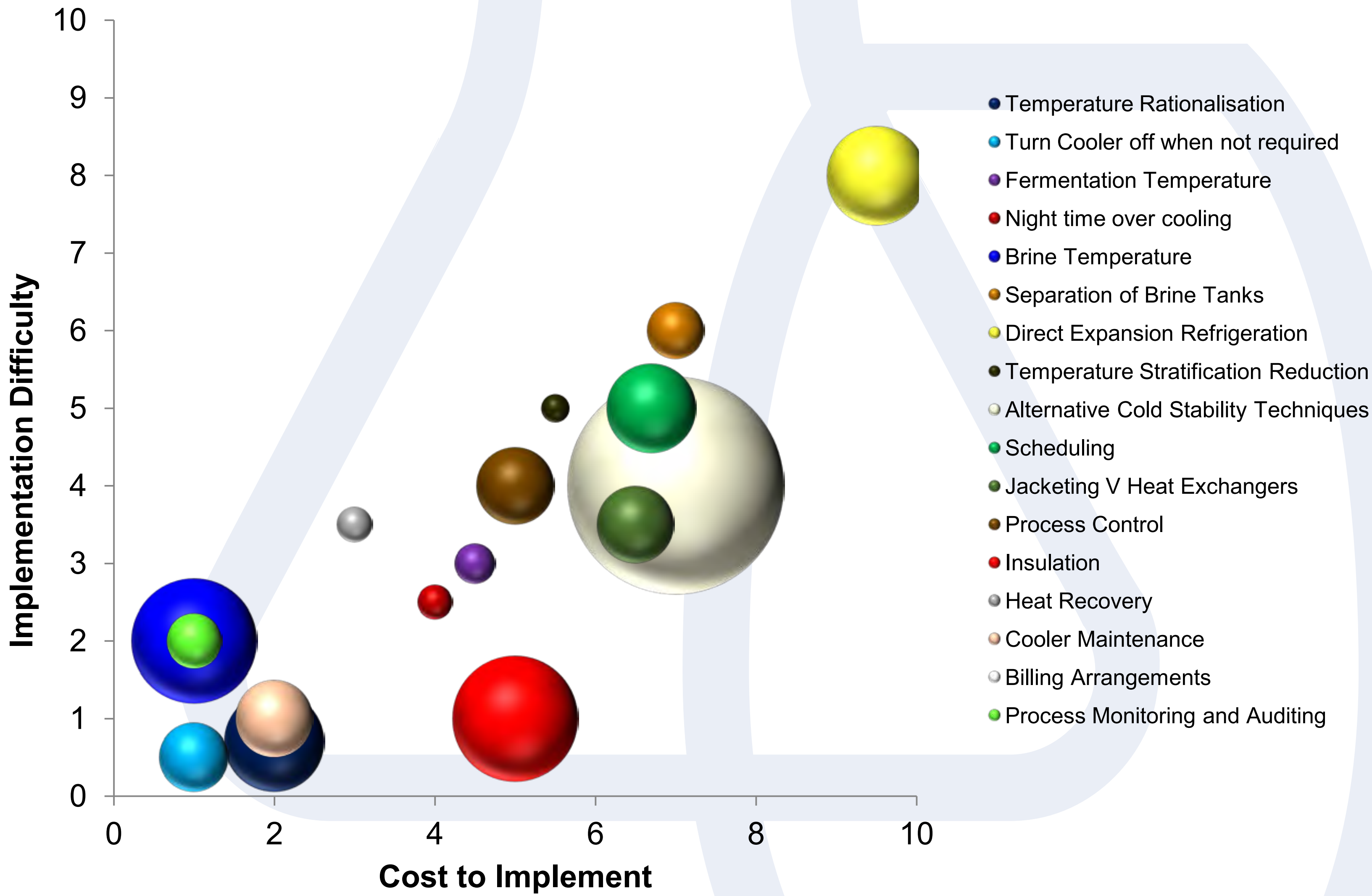
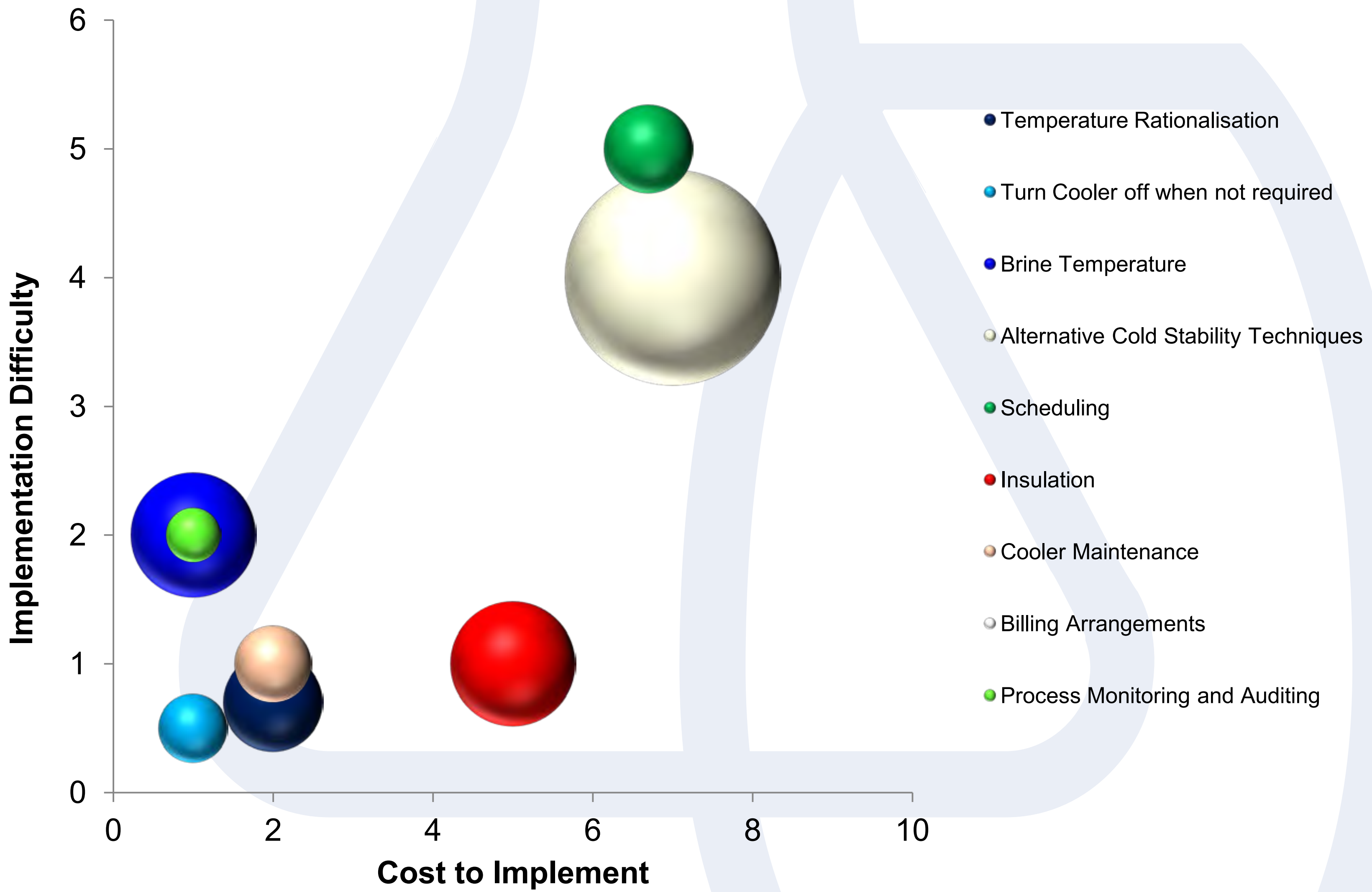
Refrigeration opportunities



Refrigeration opportunities



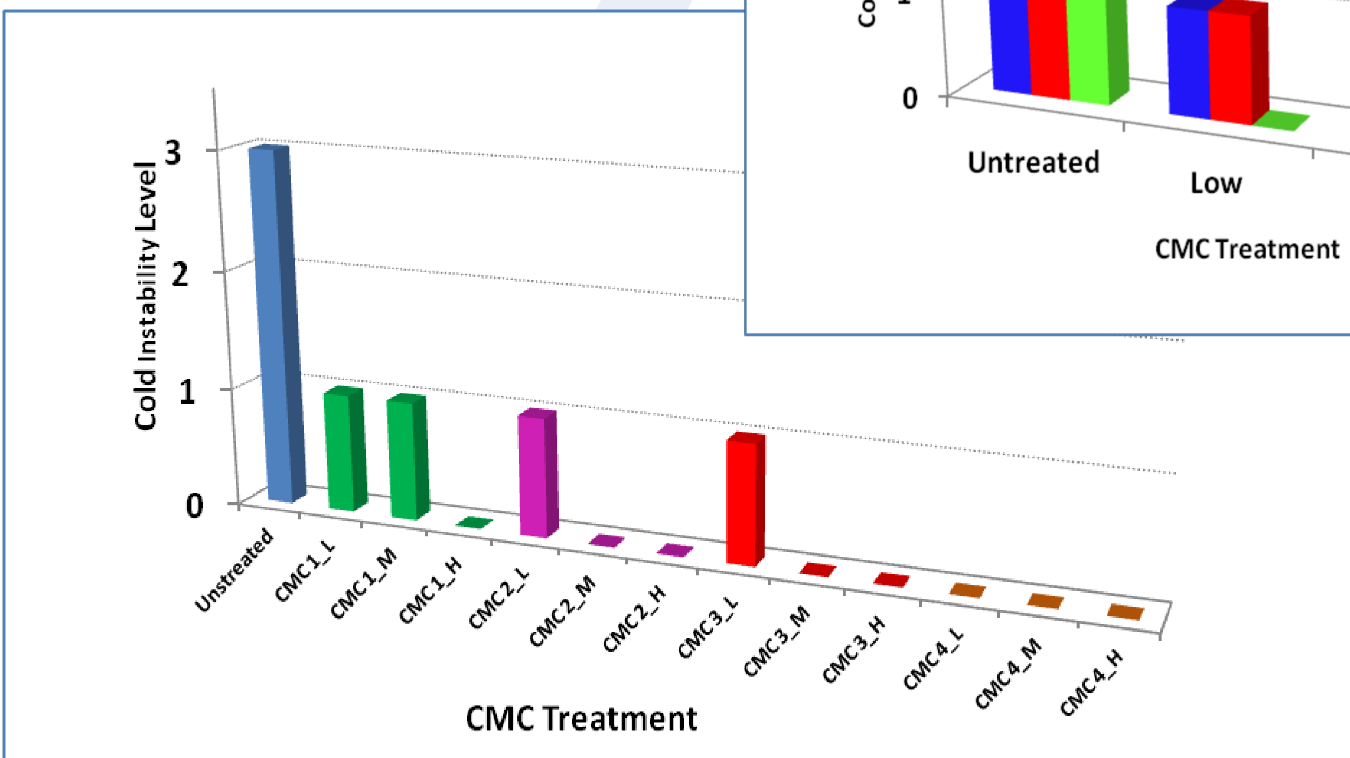
Alternative options for tartrate stabilisation

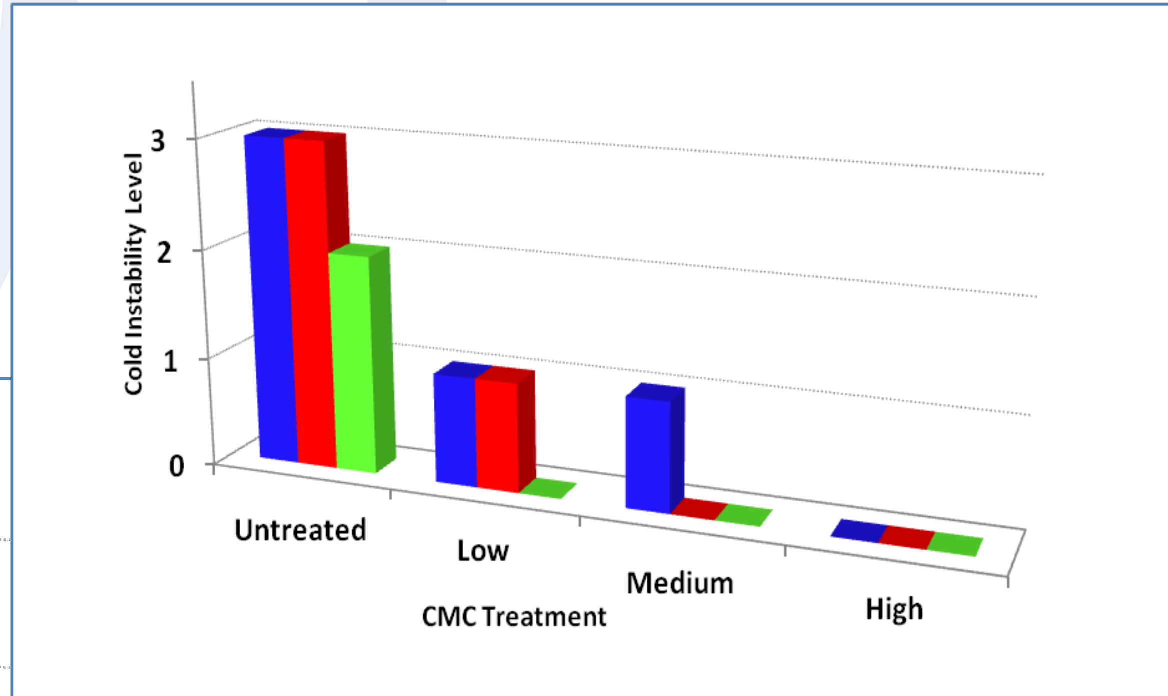
- Elimination/reduction of precursor compounds (e.g. potassium, bitartrate):
  - Traditional slow cold stabilisation
  - Rapid contact stabilisation
    - Batch
    - Continuous
  - Ion-exchange
  - Membrane processes
    - Nanofiltration
    - **Electrodialysis**
- Crystallisation inhibitors:
  - Metatartaric acid
  - Yeast mannoproteins
  - **Carboxymethylcellulose** (**CMC**)

Electrodialysis: comparing performance

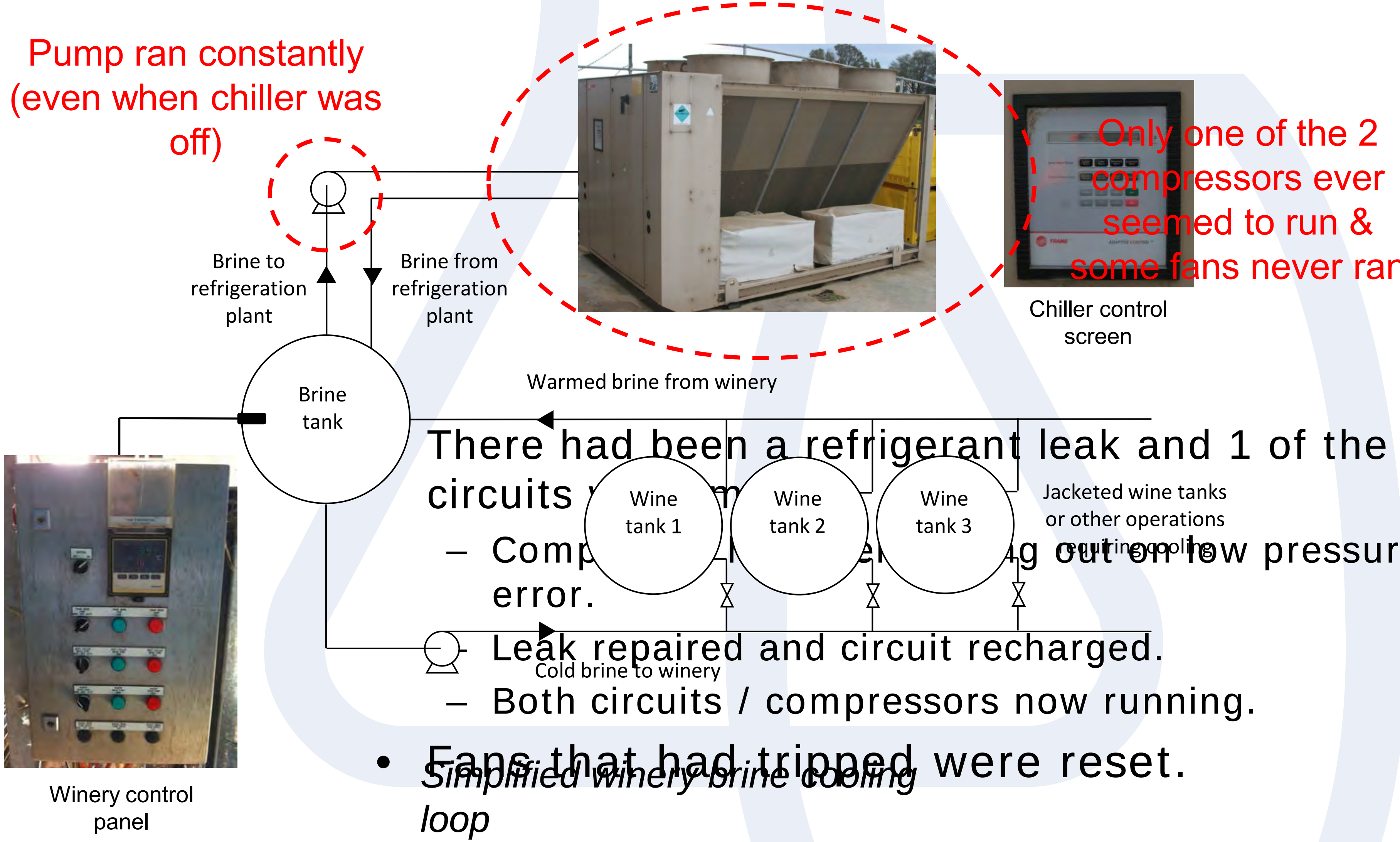
	Electrodialysis	Cold Technique
Wine Stability	Fail - Level 1	Fail - Level 1
Volume of Wine Processed	29,100	29,100
Performance Metrics		
Power Consumption (kWh)	**77**	**2,968**
Water Consumption (L)	**7,683**	**3,606**
Wastewater (L)	**7,683**	**1,581**
Waste Water Composition		
K mg/L (from water measurements)	1,170	-
K mg/L (from wine metal analysis)	1,251	4,381
K Load on treatment Centre (kg)	5.2	7
Na mg/L (from water measurements)	112	-
Na mg/L (from wine metal analysis)	42	42
Wine Potassium Content (mg/L)	395	335
Wine Losses (L)	**136**	**424**
Labour Requirements (hrs)	17	9
Time Taken to process wine (hrs)	**17**	**384**
Sensory Results	Not significantly different	

Carboxymethylcellulose (CMC)





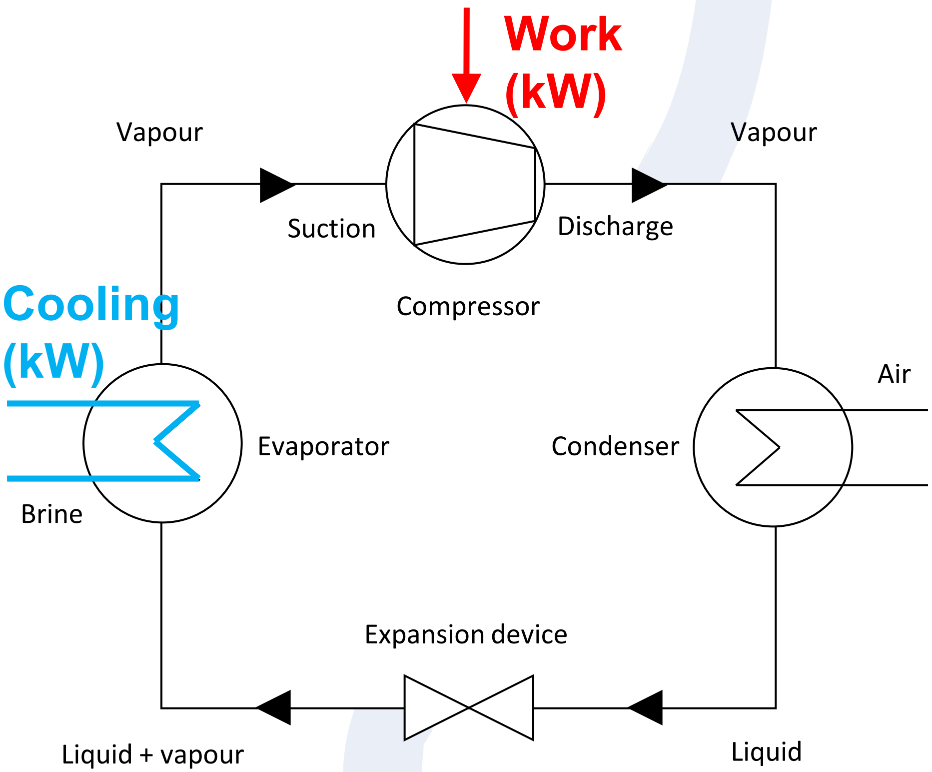
Process Auditing/Maintenance

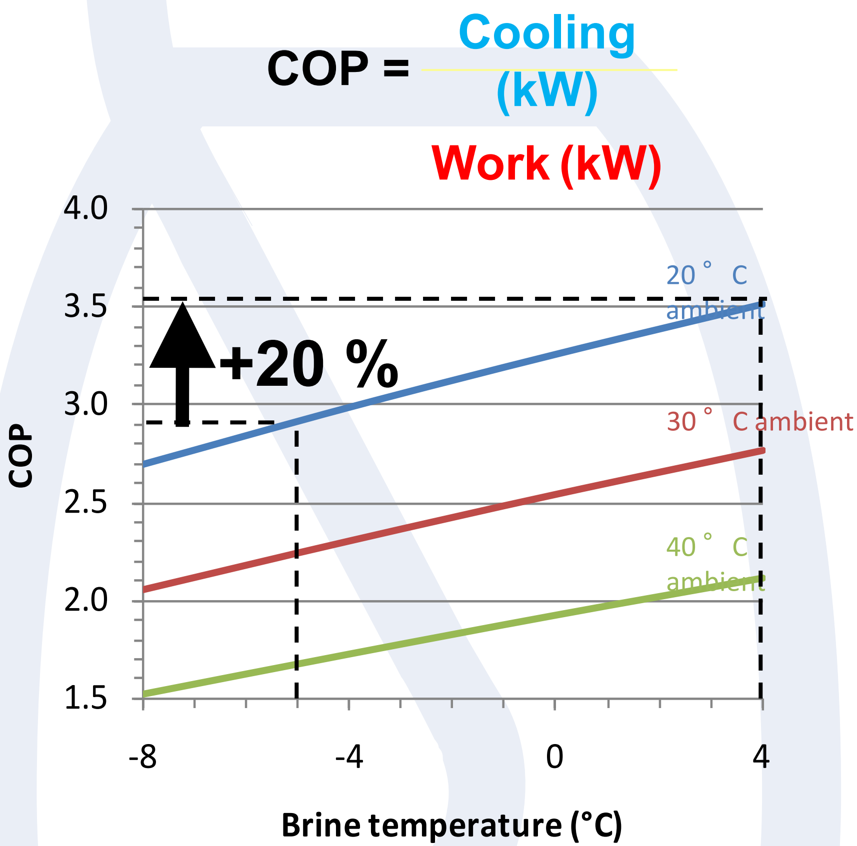


- There had been a refrigerant leak and 1 of the 2 circuits [illegible]
  - Comp[illegible] out on low pressure error.
  - Leak repaired and circuit recharged.
  - Both circuits / compressors now running.
- Fans that had tripped were reset.

Simplified winery brine cooling loop

Brine Temperature





Brine Temperature

Process / Activity	Brine Set-Point	Refrigeration COP
Must Chilling / Juice Chilling	-3 ˚C	2.1
Fermentation	+2 ˚C	2.4
Cold Stabilisation	-7˚C	1.8
Wine Storage (winter)	+2 ˚C	2.5
Bottling	-3˚C	2.1

Brine Temperature

- Problem operations for warmer brine temperatures (must/juice/wine temperature is getting close to the brine temperature):

		Alternatives
• Must chilling	→	Night-time harvesting / Dedicated refrigeration system
• Juice settling	→	Flotation
• Cold stabilisation	→	Electrodialysis, packaged rapid contact systems, crystallisation inhibitors (CMC, Mannoproteins, etc.)

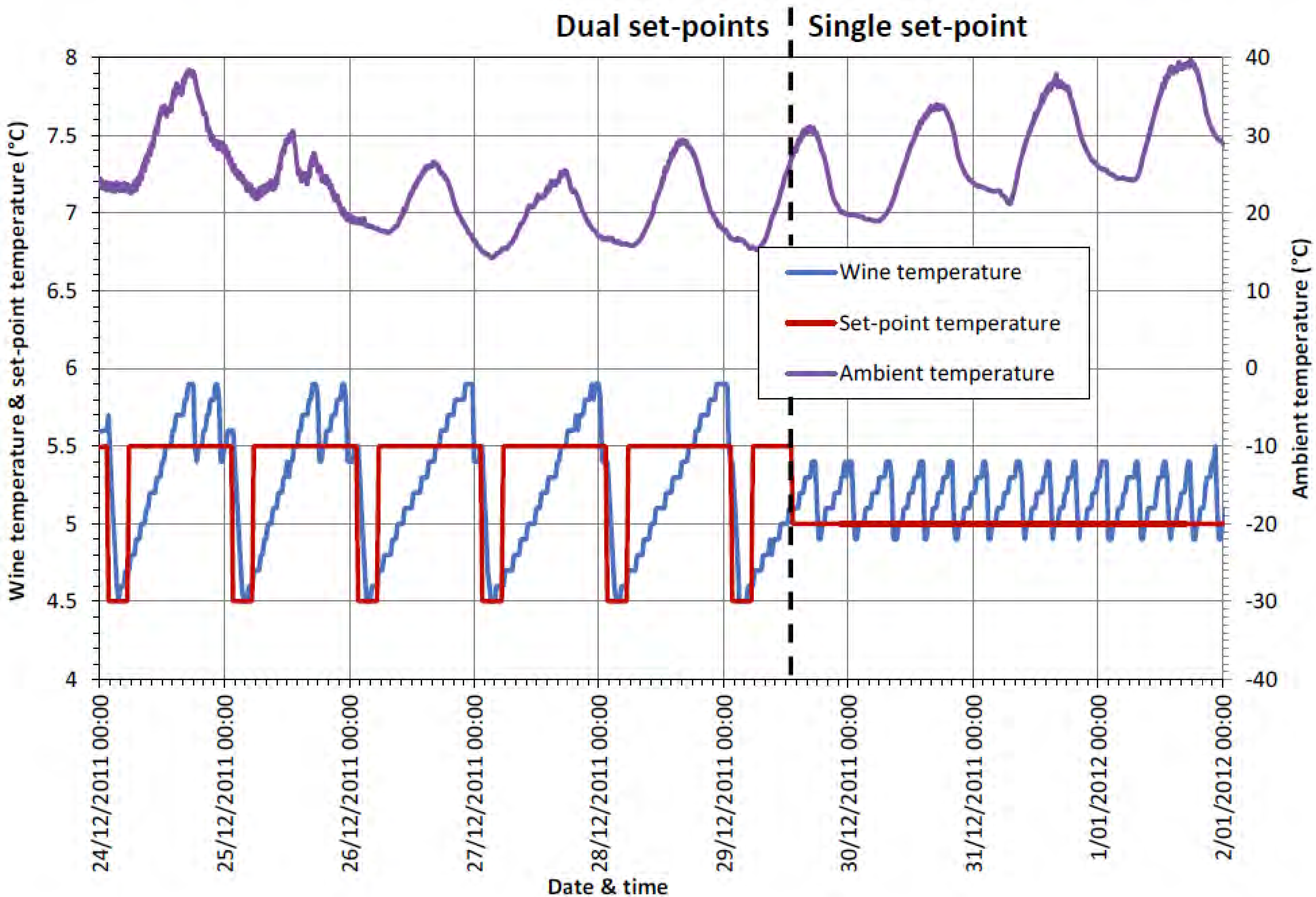
- Use as high a brine temperature as practicable for as long as practicable.
- Schedule operations that require low brine temperatures concurrently so can keep brine warmer the rest of the time.

Night-time/off-peak cooling

- Advantages:
  - Use cheaper off-peak electricity (often much cheaper).
  - Refrigeration plant may operate more efficiently at night when it is colder.
    - Depends on whether control systems are in place that allow the refrigeration plant discharge (head) pressure to reduce (i.e. float) when the ambient temperature is lower.
  - Low risk:
    - Wine is still being stored at essentially the same temperature.

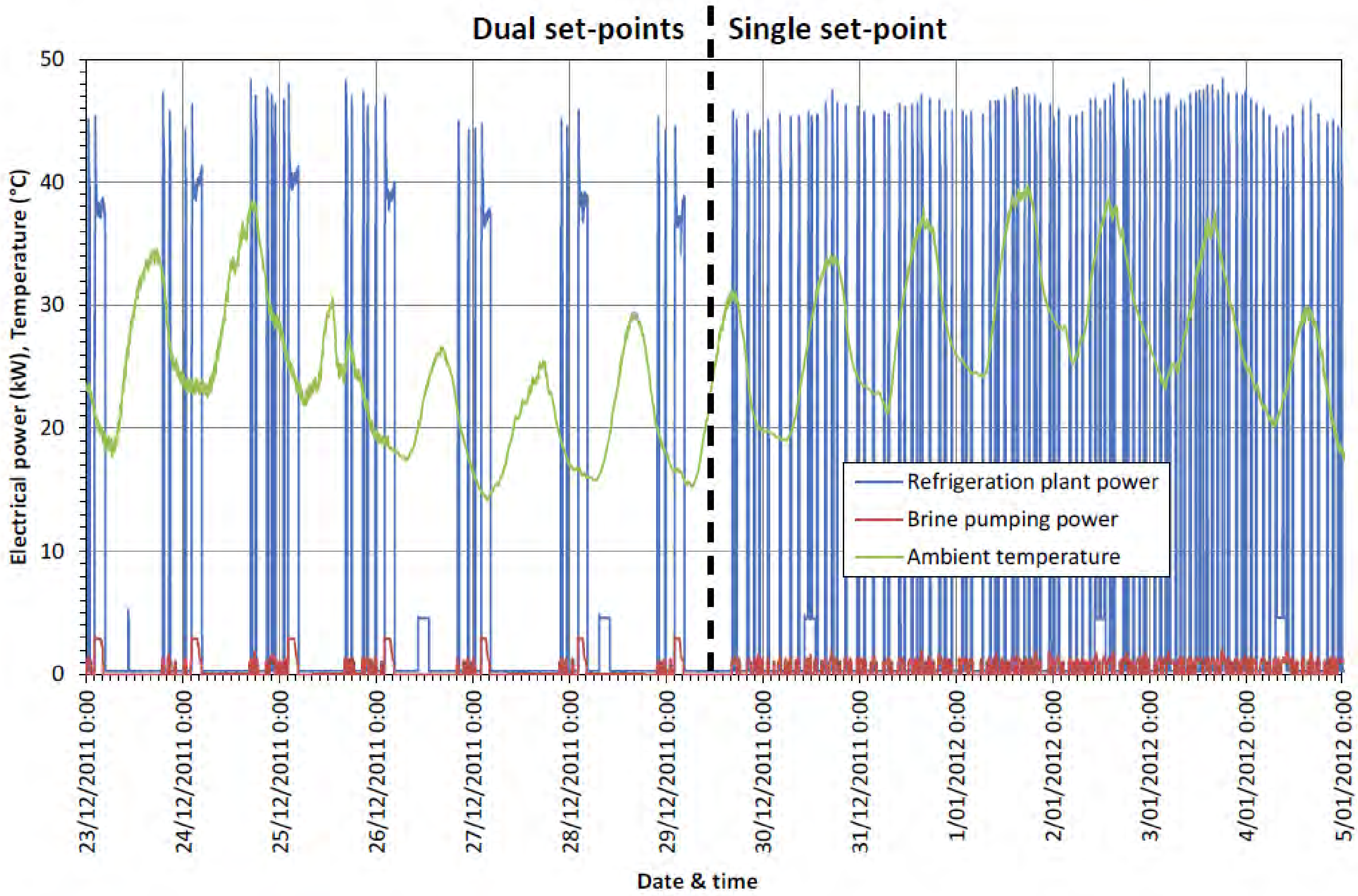
Trial with dual set-point strategy

- Influence of dual set-point strategy on actual wine tank temperature:



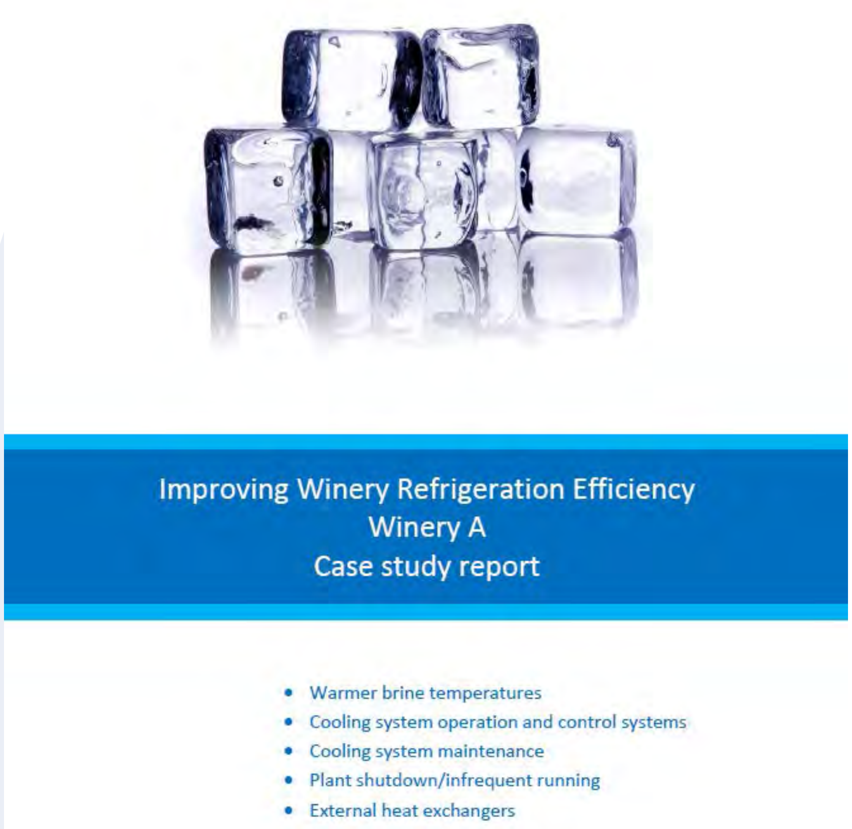
Trial with dual set-point strategy

- Electrical power monitoring showing shift of operation to predominantly at night with dual set-points:



Summary

- Carbon pricing mechanism for industry in state of flux
- Winery emissions dominated by energy use
- Reducing energy use makes good business sense
- Many strategies to reduce energy use <u>without</u> spending much money


Improving Winery Refrigeration Efficiency
Winery A
Case study report

- Warmer brine temperatures
- Cooling system operation and control systems
- Cooling system maintenance
- Plant shutdown/infrequent running
- External heat exchangers

http://www.awri.com.au/commercial_services/process-optimisation/refrigeration/

The Australian Wine Research Institute

Thank you

AWRI

Simon Nordestgaard
Karl Forsyth
Eric Wilkes
Vince O’Brien

gwrdc
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Information and online tools available on the AWRI website

www.awri.com.au

The Australian Wine Research Institute

Supporting Australian grape and wine producers

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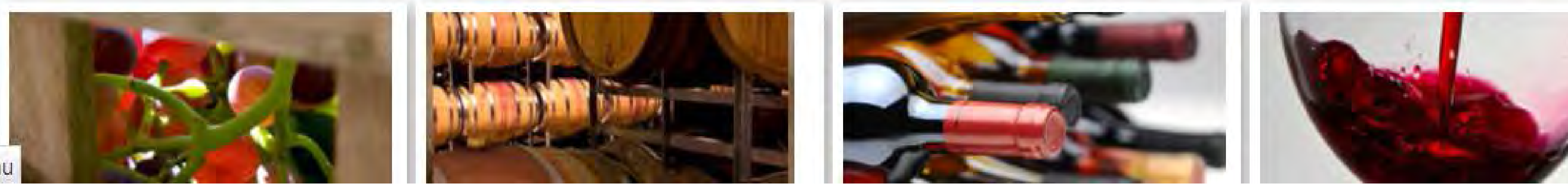

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New resources navigation

The Australian Wine Research Institute

Resources for vineyards

Information on agrochemicals and related analytical services, advice and support, fact sheets and more.

Resources for wineries

Includes permitted additives, winemaking calculators, laboratory setup and method, Frequently Asked Questions, and products and suppliers.

Resources for wine exporters

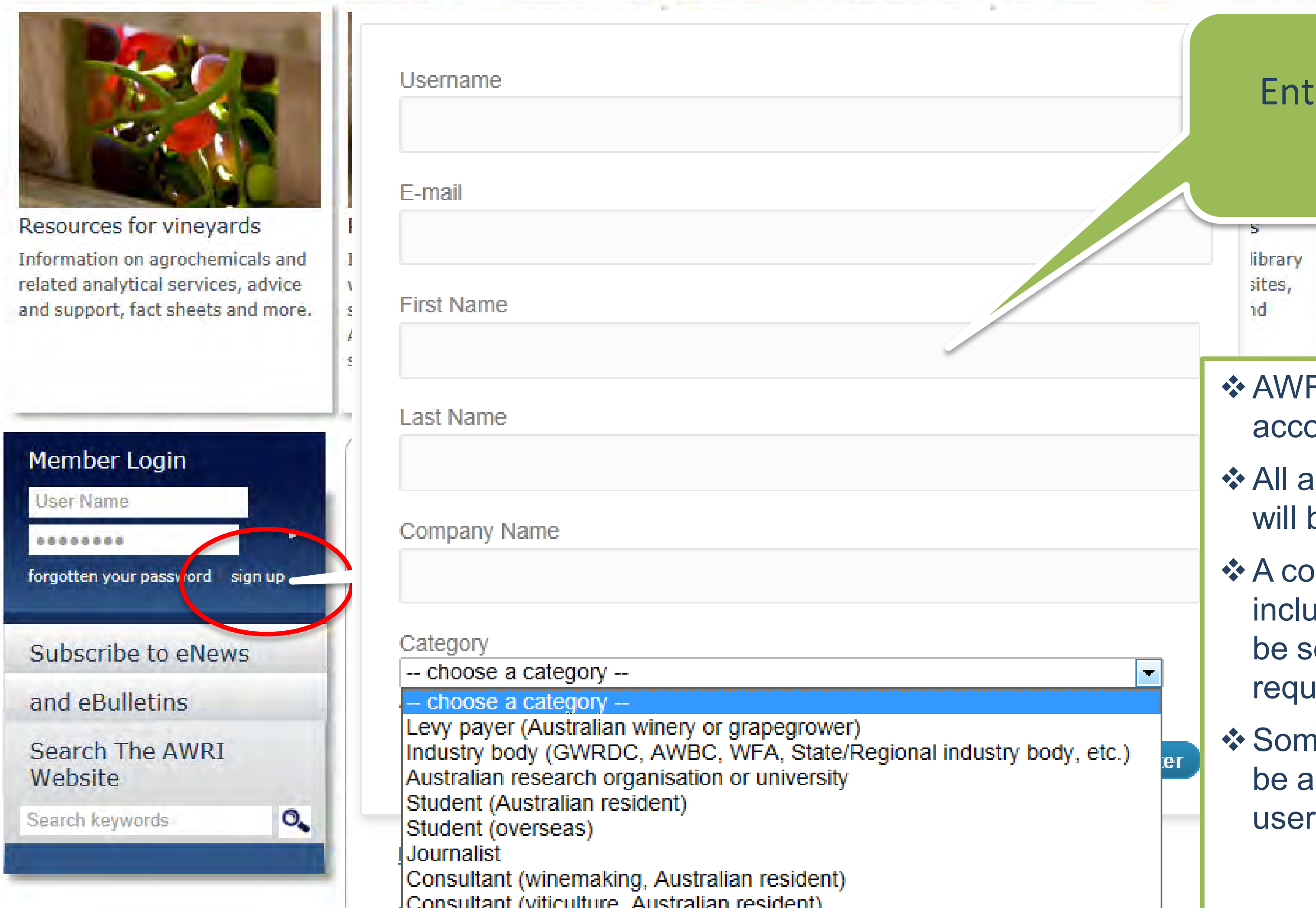
Information for exporters such as factsheets and publications, analytical services and more.

Resources for consumers

Factsheets and publications, library resources, links to other websites, research projects and wine and health

Sign up for new website account

The Australian Wine Research Institute



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- All approved requests will be activated.
- A confirmation email including password will be sent to the requester.
- Some sections can only be accessed via username / password.

Regulatory Assistance

The Australian Wine Research Institute

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- Environment
- Online videos
- Regulatory assistance
  - Analytical requirements for the export of Australian wine
  - Additives & processing aids
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Industry Support and Education > Regulatory assistance

Regulatory assistance

- Analytical requirements for the export of Australian wine
- Wine standards
- Additives & processing aids

The AWRI provides regulatory and technical advice to the Australian grape and wine
the Managing Director, the Health and Regulatory Information Manager and membe
Industry Development and Support team. The AWRI handles approximately 150 ind
information requests annually, on technical, scientific and regulatory issues from go
producers and the general public. The AWRI also prepares numerous position papers
submissions in relation to viticulture and oenological practices.

The AWRI is represented on the following committees of relevance to regulatory mat

- South Australian Wine Industry Council;
- The Winemaker's Federation of Australia Wine Industry Technical and Advisory Co
- The Winemaker's Federation of Australia Wine Industry National Environment Com
- Wine Committee of the Royal Agricultural and Horticultural Society of South Austra
- Organisation Internationale de la Vigne et du Vin (OIV)

The AWRI's Library (the John Fornachon Memorial Library) maintains the largest coll
related literature in the southern hemisphere. It also houses an extensive print colle
European Union wine and grape legislation (updated weekly) which is linked electron

View requirements by country

China

display

View requirements by certificate

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View requirements by analytical parameter

--please choose--

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Industry Support and Education > Regulatory assistance > Analytical requirements for the export of Australian wine

Analytical requirements for the export of Australian wine

China

Quick Guide to Export Requirements

Export Region	Wine Standards	Minimum Specification	Maximum Specification	Continuing Approval Application	Certificate of Origin	Other Requirements
China	Y	Y	Y	Y	Y	Certificate of Free Sale

Standards

ANALYTICAL PARAMETER	SPECIFICATION MINIMUM	SPECIFICATION MAXIMUM
Alcohol strength at 20°C		
wines[Δ]	7.0 % v/v	–
Total sugar (glucose)[*]		
Still	–	–
Dry wines[†]	–	4.0 g/L
Semi-dry[#]	4.1 g/L	12.0 g/L
Semi-sweet	12.1 g/L	45.0 g/L
Sweet	45.1 g/L	–
Sparkling	–	–
Brut[‡]	–	12.0 g/L
Extra-dry[‡]	12.1 g/L	17.0 g/L
Dry	17.1 g/L	32.0 g/L
Semi-dry	32.1 g/L	50.0 g/L
Sweet	50.1 g/L	–
Dry extract		
White	16 g/L	–
Rosé	17 g/L	–

Searchable databases on permitted additives and processing aids, and export analytical requirements

Winemaking calculators

The Australian Wine Research Institute

- Acid addition
- Ascorbic acid addition
- Bentonite addition
- Carbon addition
- Copper sulfate addition
- Crème of Tartar addition
- Deacidification
- Diammonium phosphate additions
- Ferro Cyanide trial
- Fining trial
- Fortification
- Gelatine addition
- General conversion calculators
- Grape juice concentrate (GJC) addition using Pearson Square
- Hydrogen peroxide addition
- Interconversion of acidity units
  - Acetic acid
  - Citric acid
  - Lactic acid
  - Malic acid
  - Sulfuric acid
  - Tartaric acid
  - Tartaric acid (meq/L)
- Isinglass addition
- Laboratory stock solution
- Methanol expressed as proportion of ethanol calculator
- Micro-ox addition
- Molecular sulfur dioxide addition
- Number of standard drinks
- Paired preference
- PMS addition
- PVPP addition
- Same/Different
- Sensory difference test
  - Duo-trio
  - Paired comparison
  - Triangle
- Sorbic acid addition
- Sulfur dioxide addition
- Tannin addition
- Winery stock solution

Industry Support and Education > Winemaking resources > Winemaking calculators > Number of standard drinks

Number of standard drinks

Suggestions / questions / comments? email the calculator services staff

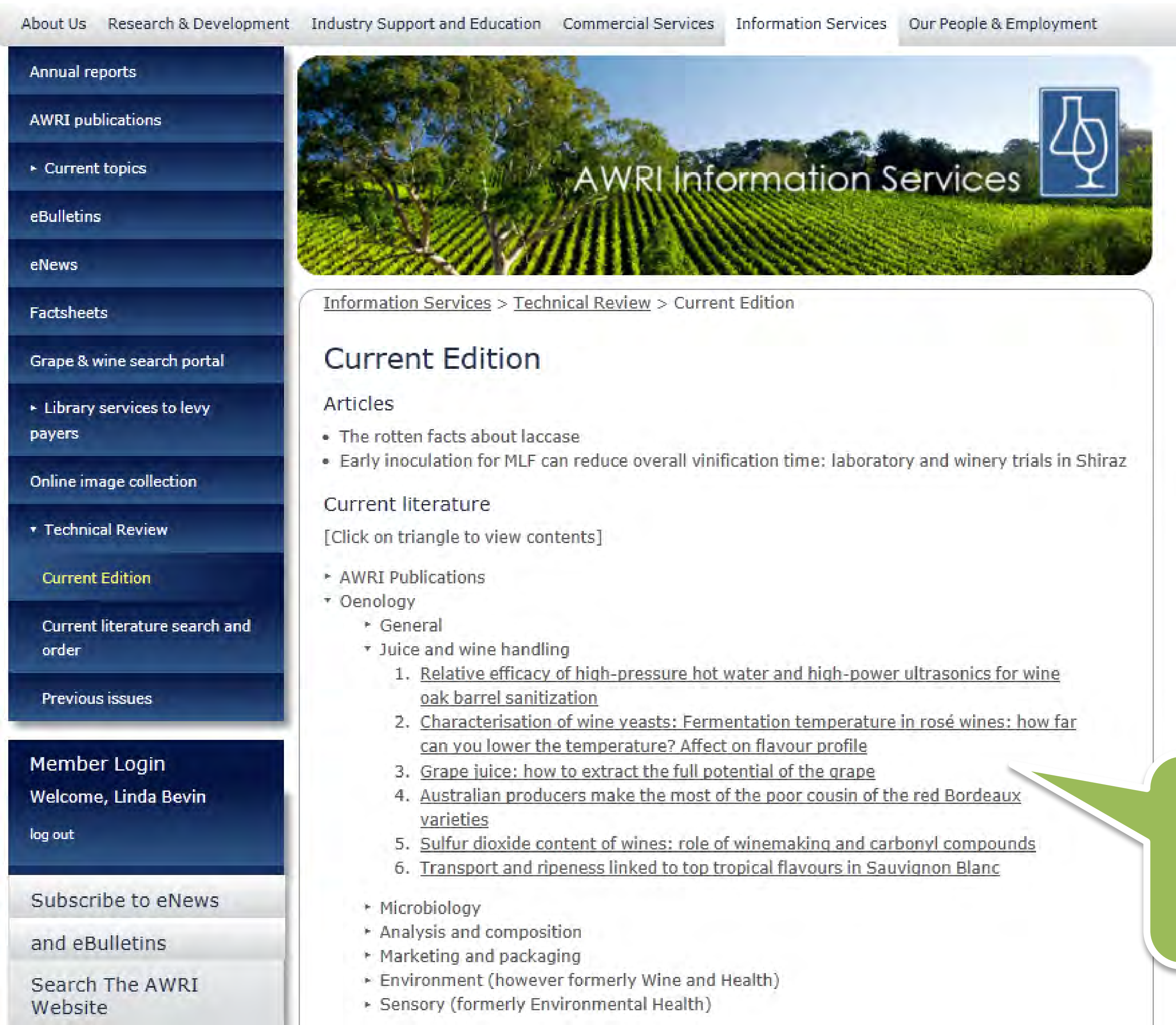
Approximate standard drinks

Container volume	750	mL
Alcohol content	14.5	% v/v
Calculate number of standard drinks	8.6	standard drinks

Clear

Information Services

The Australian Wine Research Institute

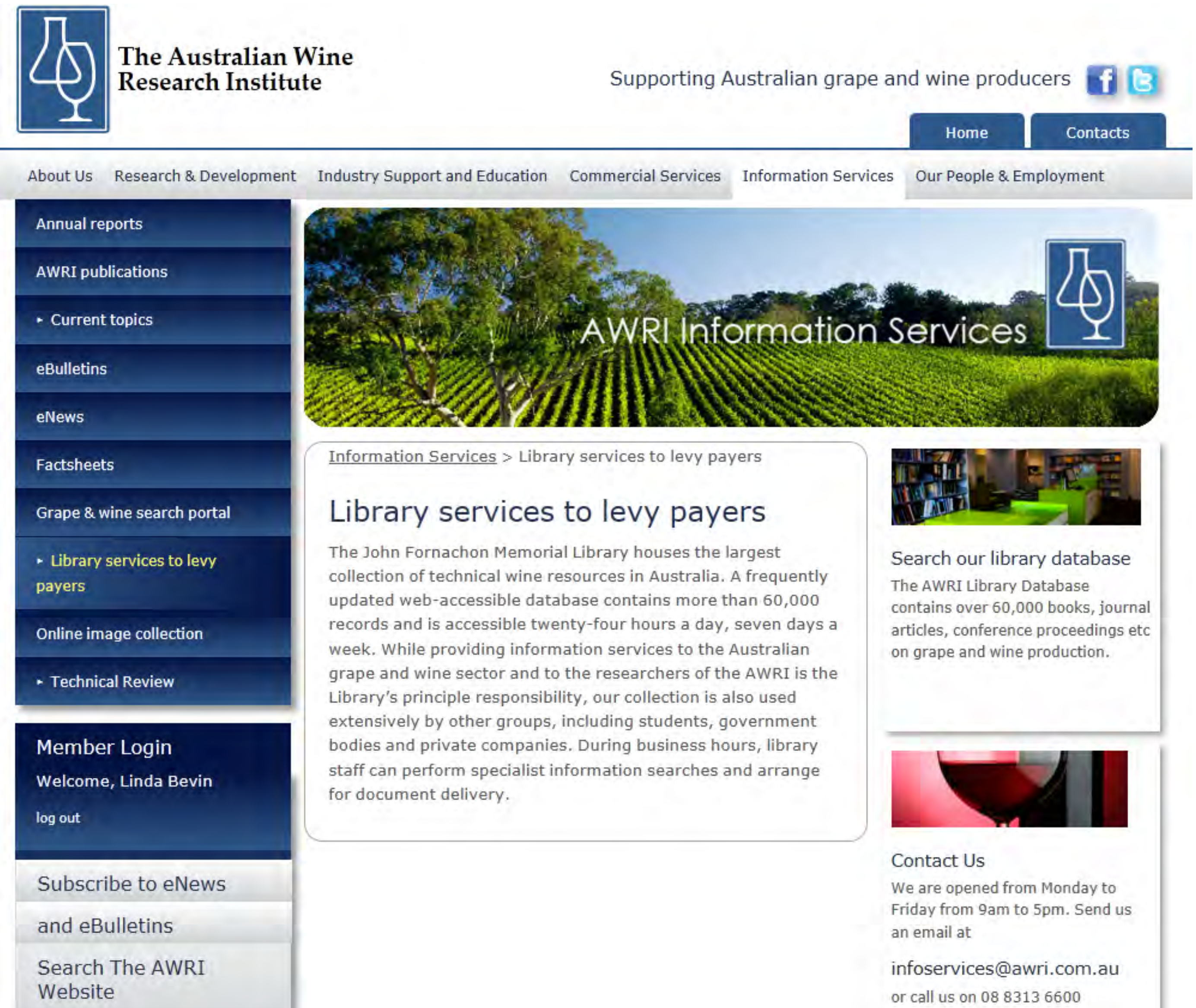


- eBulletins
- eNews
- Online image collection
- Grape and wine search portal
- Factsheets
- AWRI publications
- *Technical Review*

Click on article name to view more information and to order a copy of the article

Library Services

The Australian Wine Research Institute



- Free library service to Australian grape and wine producers
- Over 65,000 books, journal articles, conference proceedings etc
- Online library database
- *Fast response time (1 to 3 days)*

Mobile website

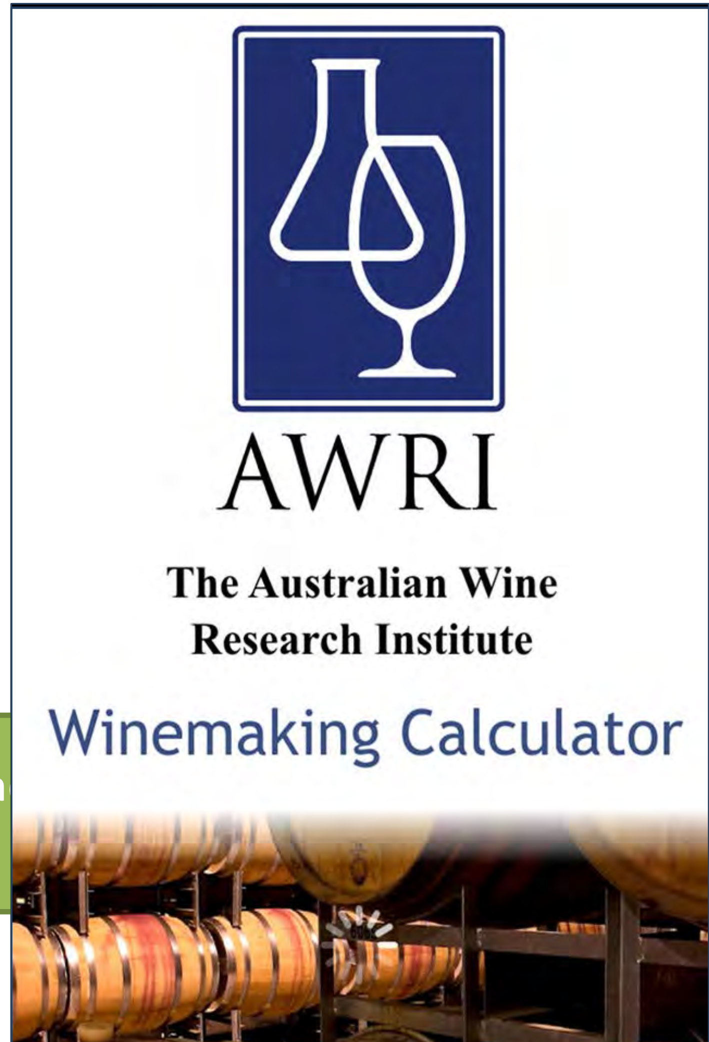
The Australian Wine Research Institute

Mobile-friendly website launched in October 2012.

Provides content to key projects and services offered by the AWRI.

Linked to full website for detailed information.

Winemaking calculator app



Calculators grouped for easy access

Enter the search an
select 'Calculate'

http://www.awri.com.au/industry_support/winemaking_resources/winemaking-calculators-app/

Webinars

The Australian Wine Research Institute

Annual webinar program since 2011

Participate in a live seminar from your desk using a computer with Internet access

Weekly session consisting of 20 min presentation and 20min Q&A

The 2013 Program features 23 webinars

http://www.awri.com.au/industry_support/courses-seminars-workshops/webinars/

2013 webinar program

Presentation	Description	Presenter	Date	Register
Optimising your laboratory for the best results	Laboratories are a critical, and often expensive, part of modern wine production. This webinar will highlight a number of areas that are important to not only ensure results are accurate, but to achieve them in an efficient and cost effective manner. Some of the topics that will be discussed include basic lab quality systems; LIMS; lab design; lean systems and troubleshooting common laboratory issues.	Eric Wilkes (The AWRI)	23/07/2013	Register
Strategies for reducing alcohol levels in wine	The AWRI has taken a holistic approach to the development of strategies for the reduction of alcohol concentration in wine. Several viticultural and fermentation practices show considerable promise for the production of good quality reduced-alcohol wines. This session will present our latest findings and point to the need to evaluate a combinatorial approach to reducing alcohol concentration in wine.	Cristian Varela (The AWRI)	30/07/2013	Register
The latest on CMCs	Carboxymethylcellulose is becoming an important part of the winemaker's tool box for white wine tartrate stabilisation. However, like all wine additives, there is more to the successful use of CMCs than sales brochures might suggest. This webinar will look at how CMC works; when it is appropriate to use; what precautions you need to take and the best ways to test the wine when using it.	Eric Wilkes (The AWRI)	6/08/2013	Register
Till death do us part: Cell death in the grape berry as a quality measure	TBA	Steve Tyerman (The University of Adelaide)	20/08/2013	Register
Climate influence and trends for the wine industry	TBA	Darren Ray (Bureau of Meteorology)	27/08/2013	Register
[illegible]	[illegible]	[illegible]	[illegible]	

http://www.grapeandwineevents.com.au/home

The Australian Wine Research Institute

australian grape & wine events calendar

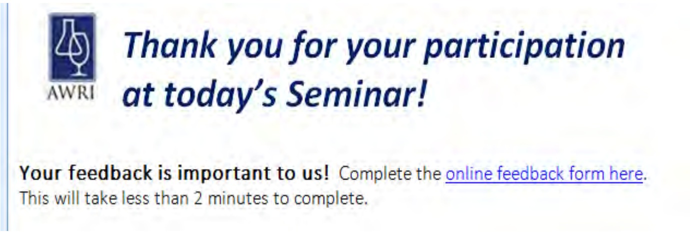
event search | events calendar | locations | events | members log-in | contact us

Date	Event
14 May 2013	AWRI Hunter Valley Seminar *Mercure Resort Hunter Valley, Pokolbin NSW*
14 May 2013	New Technologies in Grapegrowing and Winemaking *Treasury Wine Estates vineyards, Padthaway SA*
15 May 2013	AWRI Barossa Adapting to difficult vintages workshop *Vine Inn, Nuriootpa SA*
21 May 2013	AWRI Clare Adapting to difficult vintages workshop *The Artisan Table, Clare SA*
21 May 2013	AWRI Langhorne Creek and Adelaide Hills Seminar *Langhorne Creek Football Clubrooms, Langhorne Creek SA*
22 May 2013	Regional Smoke Taint Update *Gum San Chinese Heritage Centre, Ararat VIC*
23 May 2013	GWRDC #INseries workshop - China Insights: McLaren Vale
23 May 2013	Regional Smoke Taint Update *Yarra Glen Memorial Hall, Yarra Glen VIC*
24 May 2013	GWRDC #INseries workshop - China Insights: Barossa
24 May 2013	Regional Smoke Taint Update *Oxley Shire Hall, Oxley VIC*
27 May 2013	GWRDC #INseries workshop - China Insights: Hunter Valley
28 May 2013	GWRDC #INseries workshop - China Insights: Yarra Valley
30 May 2013	GWRDC #INseries workshop - China Insights: Margaret River
30 May 2013	Margaret River Wine in Sydney *The Barnet Long Room, Customs House, Circular Quay NSW*

Complete the survey & access presentations online

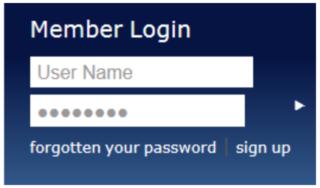
The Australian Wine Research Institute

Complete online feedback (link in email)



Redirected to AWRI Website

Log in



Save to USB

Instructions will be emailed after today's seminar

Thank you for your participation today!