Alternative Varieties for the Australian Wine Industry

Varieties to help Australian wine grape producers in a changing environment and market

A report for

By Martin Gransden

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Executive Summary

In 2018 there was an estimated 1.79 million tonnes of Australian wine grapes crushed worth $1.11 billion dollars (Wine Australia, 2018). Currently the Australian wine industry relies heavily on “traditional” varieties that have been cultivated since the industry began. Most of these varieties originate from France and have been widely planted throughout most of Australia’s 65 wine producing regions. Whilst these varieties are extremely important to the Australian wine industry and will continue to be, there is room to build on the work that has been done to identify and cultivate alternative wine grape varieties that are better suited to the continuous challenges of the Australian environment, a changing climate and a changing consumer palate.

The majority of wine grapes grown in Australia are grown in warm inland regions which require substantial irrigation and nutrition inputs to achieve commercial production levels. In a period of increasing climate variability and potential water insecurity, wine grape varieties that have a tolerance of heat and drought should be considered as an alternative to the varietals that are currently grown.

Challenges to the uptake and adoption of alternative varieties include a lack of viticultural and wine making knowledge, consumer awareness, understanding and pronunciation.

The author travelled to numerous wine regions across six countries to identify and evaluate wine grape varieties that may help Australian grape and wine producers meet these challenges.

Fifty two alternative varieties were identified in Armenia, Georgia, Greece, Portugal and Spain as showing great potential to be cultivated across Australia’s varied climates and wine producing regions.

The varieties identified have; to varying degrees, tolerance of warm to hot temperatures during their growing season, the ability for production in dry climates, the ability to tolerate some vine diseases and the potential to make quality table wine across a range of price points.

This report summarises the viticultural and vinicultural characteristics of the regions visited, and the varieties deemed most suitable for cultivation in Australia.

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Foreword

The primary audience for this report will be small to medium size Australian grape and wine businesses. These businesses have traditionally been very successful in growing, making and selling traditional French wine grape varieties but are evolving and adapting to a changing market and grape growing environment.

After enduring the recent downturn in the wine industry, many grape growing and wine making businesses have come out the other side with a renewed focus on sustainability, regionality of grapes and wine, and diversity of varieties grown.

Wine is an amazing drink that is unique in its ability to display flavours and aromas giving the drinker a glimpse of where, when and how it was grown. No other beverage can create an emotional connection with the consumer this way.

There has never been a more exciting time to be involved with the Australian wine industry and I feel lucky to be able to contribute to its development through this report.

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Acknowledgments

I would like to thank and acknowledge Nuffield and Wine Australia for the opportunity to study a topic I am passionate about. My hope is as a result of my report the Australian wine industry can continue to develop, diversify and increase its resilience.

I must also thank the numerous viticulturists and winemakers that generously shared their time, networks, knowledge, insights and passion for grape growing and winemaking. Special thanks need to go to Stephen and Rhonda Doyle for their guidance and advice, Stefanos Koundouras, Kostas Bakasietas, Simon Appleby, Frederico Falcao, Vasco Garcia, Javier Andreva and Javier Dominguez.

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Abbreviations

AAVWS	-	Australian Alternative Varieties Wine Show
AQIS	-	Australian Quarantine and Inspection Service
CSIRO	-	Commonwealth Scientific and Industrial Research Organisation
GSDD	-	Growing Season Degree Days
Ha	-	Hectare
ISP	-	Individual Selling Point
MJT	-	Mean January Temperature
ML	-	Megalitres
T	-	Tonnes
T/Ha	-	Tonnes per Hectare

Objectives

The objectives of this report are to increase the demand and premium paid for Australian wine by identifying alternative wine grape varieties that:

- will better suit Australia's climate that are either not yet in Australia or not widely grown;
- will better suit a changing and variable climate; and
- will better suit a changing consumer palate.

Chapter 1: Introduction

The Australian wine industry is the world's fifth largest producer of wine by volume with a total area of 135,000 Ha under vine and is the fifth largest exporter (Wine Australia, 2018). There are 65 recognised wine growing regions spread across the country with large variations in temperature, soils and rainfall.

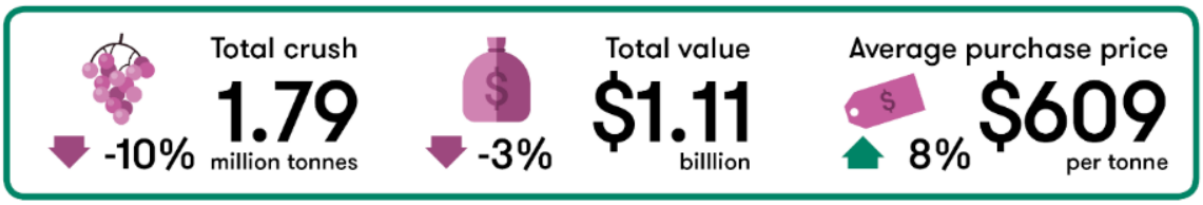

Figure 1: 2018 National Vintage Report. (Source: Wine Australia 2018)

The Australian wine industry has suffered in recent years from a number of issues. On the production side there is climate variability (heat waves/drought) impacting on production as well as the hangover from oversupply of the 2000's of traditional varieties impacting on profitability.

During the planting boom during the 1990's and early 2000's enormous areas of land were planted to traditional varieties to satisfy demand both domestically and internationally. Australia's area under vine rose from 60,000 Ha in 1986 to over 160,000 Ha in 2008 (Anderson, 2015). Towards the end of the 2000's, the industry saw many of these varieties drop out of fashion resulting in oversupply and a drop in farmgate value. At the time, the 2009 Wine Industry Restructuring Action Agenda estimated that 20% of Australia's vineyards were surplus to requirements (Australian Wine and Brandy Corporation, 2009). Due to this, there has been a contraction in vineyard area in Australia, as well as a change in the varietal mix, with producers grafting or replanting vineyards to varieties that are either in demand or that are better suited to their environment/region albeit on a very small scale.

Export sales have been impacted by a strong Australian dollar which is only now recovering and increased competition in traditional export markets from lower cost producers such as Chile, South Africa and Argentina. Whilst domestically there has been an increase in importation of more "fashionable" wines and styles (think Italian Pinot Grigio and Prosecco, Argentinian Malbec or New Zealand Sauvignon Blanc), increased competition from other beverage sectors such as craft beer and a slow global economy.

Today's consumer has also evolved. One simply has to look at the diversity of cuisine that is consumed and is available in Australia today compared to 20 years ago to see that consumers today are willing and wanting diversity and something new; and the Australian wine industry cannot ignore this. Australia's wine export markets have also changed over the last ten years.

China is now Australia's largest market by value and is continuing to grow annually (Wine Australia, 2018).

All these factors have impacted on fruit and wine sales both domestically and internationally over the past few years and only recently have things started to slowly improve.

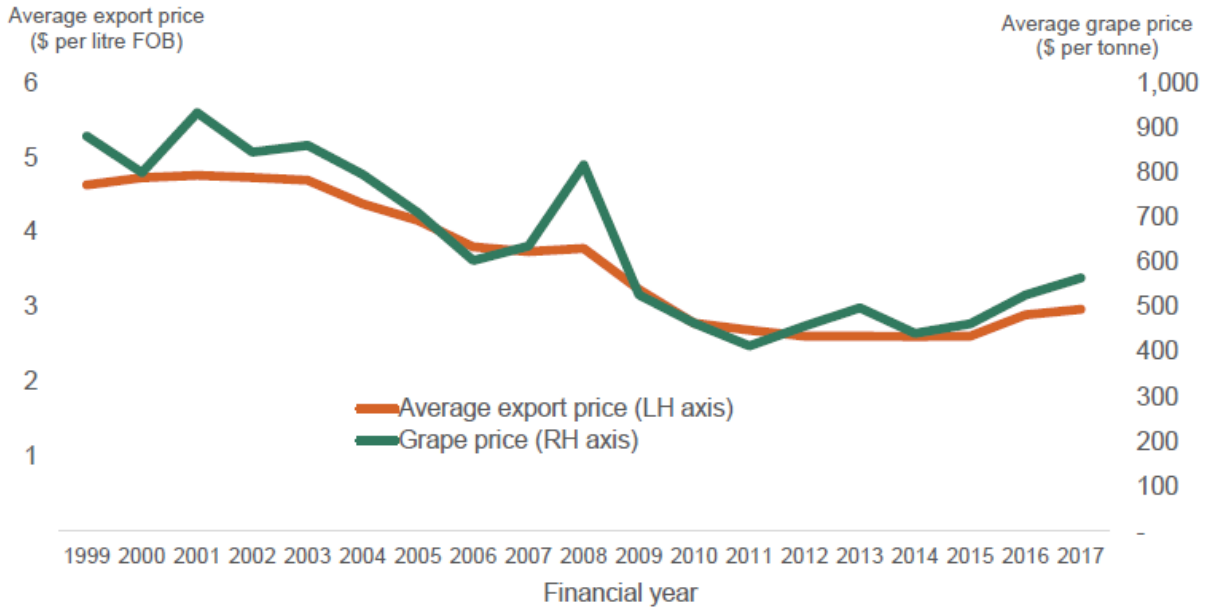

Figure 2: Average export price and average wine grape purchase price over time

These challenges provide an opportunity to diversify Australia's varietal mix to better meet the demands of the market and the diversity of our environment and climate and alternative wine grape varieties are part of the solution.

Definitions

The Australian Alternative Varieties Wine Show describe alternative varieties as "simply by what it is not: common and widely available" (AAVWS, 2019). It should be noted that varieties referred to in this publication as "alternative" are considered as indigenous in their country of origin.

Traditional varieties are known within the Australian wine industry as having originated in Europe and have been widely grown in most Australian wine regions for many years. Some examples are Shiraz, Cabernet Sauvignon, Merlot, Chardonnay, Riesling and Semillon. It should be noted that these varieties are known worldwide as international varieties and that the cultivars studied in this report are not considered alternative in their country or region of origin.

Chapter 2: Australia's Wine Industry

History

Vitis Vinifera cuttings were introduced to the continent of Australia with the arrival of the first fleet and small vineyards were established in and around what is now known as Sydney. There are no known Vitis species native to Australia. The early development of the wine industry was seen as method of gentrification, a reminder for the early settlers of their homeland and even a tool to discourage consumption of spirits (McIntyre, 2012). James Busby was an important figure in the early establishment of the industry through his role as Colonial Administrator. He collected and imported about 650 types of vine cuttings of which 362 arrived alive and healthy. Most of these varieties were sourced from the French national collection and botanic garden in Montpellier.

During the late 19th to early 20th centuries fortified wine dominated production. It was not until the end of the second world war which saw an increase in immigration from Europe that a food culture and table wine rose in popularity. Varietal wines (wines labelled by grape variety) also started to replace generic terms such as Hermitage and Claret. It was the 1990's and early 2000's that saw a boom in planting of vineyards and production of wine largely to the traditional French varieties of Chardonnay, Semillon, Riesling, Cabernet Sauvignon, Shiraz and Merlot. (Caillard et al. 2017).

In 2018, three varieties accounted for 61% of the total crush; those being Shiraz, Chardonnay and Cabernet Sauvignon.

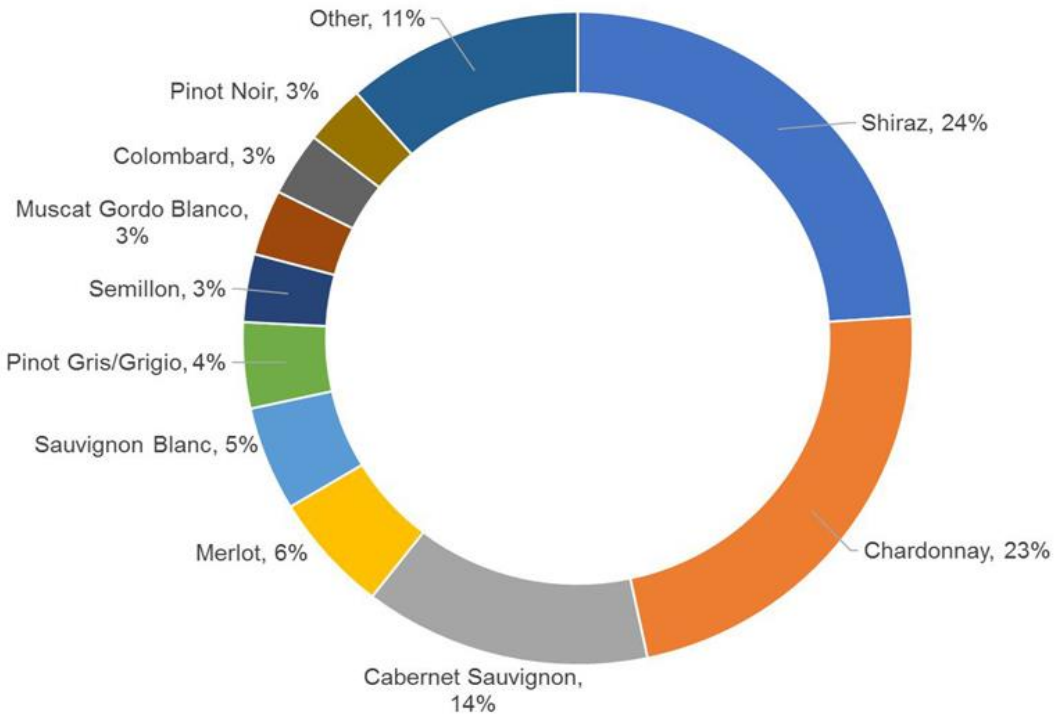

Figure 3: 2018 Australian wine grape crush by variety (Source: Wine Australia, 2018)

The reliance on three varieties in such proportions should be seen as risk to the whole of industry where the threats are changes in consumer tastes and preferences, and a changing climate which may alter fruit composition and wine style.

Wine grape production is also heavily reliant on three warm-to-hot inland regions. The Riverina, Riverland and Murray Valley wine regions accounted for 72% of the 2018 wine grape harvest (Wine Australia, 2018).

The typical Australian vineyard has three meter row spacing, 1.5 to 2 meter vine spacing, is trellised with one or two pairs of catch wires that are either lifted and fixed during the growing season to maintain upright foliage growth or permanently fixed to support a sprawling canopy of foliage. Most vineyards have a high level of mechanisation due to Australia's high cost of labour.

Climate

A changing climate is nothing new to agriculture but it's severity of change has become a prominent concern for farmers. Drought, frost, heat waves, unseasonal rain events and a deterioration of seasonal predictability are all challenges facing the grape growers of today. This variability coupled with a projected average temperature increases of between 0.3 to 1.7 degrees Celsius by 2030 and 0.4 to 2.6 degrees Celsius by 2050 is likely to have an impact on fruit composition and quality (Barlow et al. 2013). Varying slightly from region to region, the projected impact on grapevine harvest date is between six to 23 days earlier. The relevance on harvest date is significant as the temperature of the months that the fruit is growing, and ripening has the greatest impact flavour and aroma compounds in the resulting fruit and wine.

Barlow's modelling also found due to the predicted warming, a more compressed harvest period could be expected for all regions putting winery infrastructure (fermentation space and processing capacity) under pressure.

The climates of Australia's wine regions can be classified several ways. Mean January (July is used in the Northern hemisphere) Temperature (MJT) classifies the mean temperature of the hottest month of the growing season, however in some cases February can be hotter and this does not reflect the growing season in its entirety. Growing Season Degree Days (GSDD) measures heat summation during the length of the growing season and can also be used. Rainfall, sunshine hours, diurnal temperature difference and humidity should also be taken into account during classification. In general terms wine regions using the above methods can be classified as either being cool, warm or hot climate.

Australia's warm and hot inland wine regions which are responsible for a significant proportion of Australia's total yearly crush are relatively high-water users compared with cooler wine growing regions and are reliant on Australia's river systems for irrigation water supply. Two obvious factors at play here are warm to hot temperatures during the growing months and higher yields (due to lower farm gate prices). In the Riverina wine region during the 2012/13

growing season, average water use was 4.0ML/Ha and average yields were 14.9T/Ha (Retallack, 2013). In early 2019 Ashley Ratcliff, a leading grower in South Australia's Riverland region detailed some of his growing figures on water use of traditional varieties versus alternative varieties on his vineyard. Comparing Chardonnay to Nero d'Avola grown on Ruggeri rootstock (which he states uses 50-60% irrigation less water) he found that with a water price of $525/ML (price as at 11 February 2019) combined with other growing costs, a Riverland grower needed to grow Chardonnay at a yield of 27T/Ha to break even compared with 5T/Ha for Nero d'Avola that commanded a higher fruit price per tonne but also used much less water.

Varietal supply and demand is certainly at play in this example but it does highlight the benefit of variety/root stock combinations that require less water.

MJT range	Australia[3]	Other[4]
16.0 – 16.4		
16.5 – 16.9	Tasmania-Hobart	
17.0 – 17.4	Tasmania-St Helens	Marlborough (NZ)
17.5 – 17.9	Tasmania-Launceston , Henty (V)	
18.0 – 18.4	Mount Benson (S), King Valley-Whitfield (V)	
18.5 – 18.9	Macedon Ranges (V), Adelaide Hills-Stirling (S)	Hawkes Bay (NZ), Rheingau (Ger), Champagne (Fr), Willlamette Valley (US)
19.0 – 19.4	Gippsland (V), Gramplans (V), Adelaide Hills-Lenswood (S), Strathbogie Ranges (V), Yarra Valley (V), Eden Valley (S), Great Southern-Albany (W), Southern Highlands (N), Sthn Fleurieu (S)	Sancerre (Fr), Napa Valley-south (US), Chablis (Fr), Santa Clara Valley (US), Rias Baixas (Sp), Wachau (Aut), Lourinha (Por), Anjou-Saumur (Fr)
19.5 – 19.9	Coonawarra (S), Pemberton (W), Orange (N), Sunbury (V), Upper Goulburn (V)	Burgundy (Fr)
20.0 – 20.4	Tumbarumba (V), Great Southern-Mt Barker (W), Manjimup (W), Wrattonbully (S), Canberra District (A), Padthaway (S), Beechworth (V), Margaret River (W)	Alsace (Fr), Vinho Verde (Por), Rioja –west (Sp)
20.5 – 20.9	Langhorne Ck (S), Great Southern-Frankland River (W), Pyrenees (V), Shoalhaven Coast (N)	Tras-o-Montes (Por), Medoc (Fr), Beaujolais (Fr), Eger (Hun)
21.0 – 21.4	Heathcote (V), Goulburn Valley (V), Barossa Valley (S), Alpine Valleys (V), Blackwood Valley (W), McLaren Vale (S)	Balaton (Hu), Cahors (Fr), Rioja –central (Sp), Tokaj (Hu), Ribera del Duero (Sp)
21.5 – 21.9	Granite Belt (Q), Clare Valley (S), Bendigo (V), King Valley-Milawa (V)	Hermitage (Fr), Yakima Valley (US), Dao (Por), Napa Valley-north (US), Sonoma-north (US)
22.0 – 22.4	Adelaide Plains (S)	Valtellina (It), Alto-Adige (It)
22.5 – 22.9	Hilltops (N), New England (N), Geographe (W)	Setubal (Por), Friuli-Venezi a Giulia (It), Chateauneuf-d-P. (Fr), Languedoc (Fr), Istria (Cro), Sardinia-north (It)
23.0 – 23.4	Sthn Flinders (S), Riverland (S), Rutherglen (V), Mudgee (N), Hastings River (N), Swan Hill (V)	Alentejo (Por), Bandol (Fr), Pleven (Bul), Umbria (It) , Douro-west (Por), Sardinia-west (It), Corsica (Fr), Verona (It)
23.5 – 23.9	Sth Burnett (Q), Cowra (N), Murray Darling (V,N), Gundagai (N), Hunter (N), Peel (W), Riverina (N)	Barolo (It), Chianti (It), Roussillon (Fr), Catalonia (Sp)
24.0 – 24.4		Salento (It), Roero (It), Mendoza (Arg), Sardinia-south (It)
24.5 – 24.9	Swan District (W)	Catalonia(Sp),Naxos (Gr), Valencia (Sp), Split (Cro), Dubrownik (Cro), Sardinia-south (It), Montalcino (It)
25.0 – 25.4		San Joaquin Valley- north (US), Epirus (Gr), Salento (It), Thessaloniki (Gr), Douro-mid (Por)
25.5 – 25.9		Jerez (Sp), Levkas (Gr), Sicily (It)
26.0 – 26.4		Campania (It), Sicily (It), Rodos (Gr), Patra (Gr)
26.5 – 26.9		Thessaloniki (Gr), Calabria-south (It)
27.0 – 27.4		
27.5 – 27.9		San Joaquin Valley -south (US)

Figure 4: Comparison of Australian grape growing regions and selected international sites based on their MJT. Source: Research to Practice (2017)

Cooler climate wine regions such as the Orange wine region in New South Wales require much less water for more moderate yields with a long-term average water use of 0.6ML/Ha for an average yield of 8.5T/Ha (Author's personal data).

If climate variability continues and/or worsens, water security and availability is likely to become more of an issue particularly in the warm inland regions which have low annual rainfall and are reliant on Australia's river systems and government water allocations for irrigation of vines.

Consumers

Consumer preferences for alternative varieties and styles can also be seen as a threat to the current status of the Australian wine industry and its varietal mix. Sales of traditional varieties have been easy for retailers as their availability is widespread and are familiar to the majority of current wine consumers. The Australian wine industry has been very successful over a number of years in educating consumers about traditional varieties as they have needed to (Henry, 2017). However, this is changing. Tomorrows wine consumers are today's millennials and are looking for something different. When we consider the range of beverages wine now must compete with such as craft beer, gin and cider, it is clear that wine must also evolve.

Wine Business Solutions' 2018 report "Wine on Premise" shows a decline in traditional varietal bottle listings (or sales) on premise across both red and white varieties. Listings of Sauvignon Blanc and Chardonnay fell by 11% and 9% respectively, while Shiraz and Merlot fell by 20% and 19% respectively. This is telling as wine consumers will try a wine "on-premise" at venues such as hotels, clubs and restaurants which will influence what they buy at "off-premise" venues such as bottle shops.

Wine Australia's 2018 "State of the Sector" report highlights growth of alternative varieties and blends such as Malbec, Roussanne/Viognier, Tempranillo and Montepulciano in our largest market by volume (UK). The report also mentions Wine Intelligence research finding that the proportion of consumers saying they had drunk Viognier in the last 6 months had increased from 9% in 2013 to 11% in 2016.

Figure 5 below shows a clear trend of increased listings of alternative varieties and a decrease in listings of traditional varieties.

Style	2018	2017	CHG
Sauv Blanc	18.8%	21.2%	-11%
Chardonnay	17.9%	19.7%	-9%
Pinot Gris/Grigio	15.6%	15.7%	0%
Riesling	15.2%	15.3%	-1%
SSB/SBS	6.7%	6.2%	8%
Semillon	2.8%	2.3%	21%
Chenin Blanc	2.5%	2.5%	0%
White Blend	2.1%	2.1%	-2%
Vermentino	1.7%	1.2%	49%
Gruner Veltliner	1.5%	1.2%	22%
Gewurztraminer	1.4%	1.5%	-3%
Verdelho	1.4%	1.4%	2%
Fiano	1.3%	1.0%	38%
Viognier	1.1%	1.4%	-23%
Soave	1.1%	0.6%	89%
Albarino	1.1%	0.7%	46%
Pinot Blanc/Bianco	1.0%	0.8%	34%
Arneis	0.7%	0.5%	45%
Pecorino	0.4%		
Cortese	0.4%	0.3%	33%
Marsanne	0.4%	0.4%	8%
Trebbiano	0.3%	0.2%	40%
Others	4.6%	4.1%	13%

Style	2018	2017	CHG
Shiraz	18.7%	23.2%	-20%
Pinot Noir	17.4%	17.8%	-2%
Cab Sauv	12.0%	11.6%	3%
Merlot	6.3%	7.8%	-19%
Cab Merlot	6.0%	4.1%	48%
Red Blend	6.0%	2.9%	105%
Grenache & Blends	5.4%	3.5%	52%
Sangiovese & Blends	5.0%	2.5%	102%
Tempranillo	4.7%	4.1%	16%
Malbec	3.0%	2.7%	12%
Nebbiolo	1.7%	1.5%	13%
Rhone Blends	1.6%	1.1%	41%
Nero d'Avola	1.3%	0.9%	52%
Montepulciano	1.2%	1.1%	10%
Gamay	1.2%	1.3%	-10%
Barbera	1.2%	1.0%	19%
Bordeaux Blends	0.9%	0.9%	2%
Cab Franc	0.5%	0.8%	-33%
Dolcetto	0.5%	0.5%	2%
Primitivo	0.5%	0.3%	72%
Valpolicella	0.4%	0.3%	45%
Zinfandel	0.4%	0.5%	-11%
Others	4.1%	9.7%	-58%

Figure 5: Change of Share of Total Wine Listings by Varietal (Source: Wine Business Solutions, 2018)

Alternatives

Varieties that have been cultivated in warm to hot, and arid regions for centuries have adapted to and been selected for production of quality wine, tolerance of heat and a lower requirement for supplementary irrigation and nutrition (Martinez-Zapater, 2018). Varieties from less well-known wine producing regions should also be explored for their suitability to produce quality table wine and their adaptability to the Australian environment.

Australia has the advantage of the lack of legislation that defines which cultivars must be planted within a designated wine region. Growers can grow what they want, where they want. Many European wine regions have such legislation which limits their ability to change varieties in response to climate changes and consumer preferences.

To meet some of the challenges listed above, alternative wine grape cultivars that have originated and developed countries or regions with similar climates should be considered by Australian wine grape growers.

Varieties listed in the coming chapters with an Asterix (*) indicates that the variety exists in Australia.

Chapter 3: Greece

Around 50,000 Ha of vines are cultivated for wine in Greece with over 200 indigenous varieties. There are grapes grown in all parts of Greece (including islands) at latitudes between 33 and 41 degrees North and are considered some of the hottest in the world. Much of Greece is mountainous and vines can be found from flat low-lying areas near the coast to steep slopes at elevation (Robinson, 2015).

Figure 6: Wine Regions of Greece (Source: New Wines of Greece, 2018)

Viticulture and winemaking

Growing and trellising methods vary considerably throughout Greece with newer more modern vineyards being trellised with a higher vine density (>3000 vines per Hectare), irrigated, maintaining mid-row vegetation and mechanised. Older vineyards tend to cultivate under vine and inter-row, have a very low trellis or bush vines, were unirrigated and had a lower vine density (<2000 vines per hectare). Most harvesting is carried out by hand. Higher yields up to 12T/Ha were harvested off the modern and irrigated vineyards where older dryland vineyard yields were regularly around 4-6T/Ha. Irrigation volumes were low by Australian standards at 0.4 ML/Ha to 0.8ML/Ha. Annual average rainfall is 523mm per year in Heraklion on the island of Crete, 520mm in Drama and 675mm in Naoussa with the highest falls all occurring during the winter months. Nutritional inputs are similar to standard Australian programs with annual additions of Nitrogen, Phosphorus, Potassium and trace elements. It should be noted that soils generally had a higher Calcium level and higher pH (7.5 to 8.5).

Whilst each growing region in Greece had their regionally specific varieties, there is widespread planting of particular indigenous varieties to meet the demands of the market including Assyrtiko, Malagouzia and Agiorgitiko as well as plantings of international varieties such as Cabernet Sauvignon, Shiraz, Chardonnay and Sauvignon Blanc. Assyrtiko and Agiorgitiko were called “plastic” varieties as they are adaptable, can be grown in most regions and their wines reflect where they have been grown (Bakasietas, 2018).

The northern region of Thrace has a mean July temperature of 29 degrees Celsius and an average annual rainfall of 520mm. The city of Drama is the largest in the region and sits at 115m above sea level. The vineyards that surround drama are grown in red clay loams with scattered limestone throughout at elevations from 280m to 450m above sea level. The red variety Agiorgitiko (pronounced “I – Your – Gitiko”) is grown throughout Greece but was found to thrive in this region.

The famous region of Naoussa is located in Macedonia. This is the home of Xinomavro (pronounced “Sin – O – Mavro”). It is a curious variety and is often compared with Pinot Noir and Nebbiolo due to its very firm tannins but also its ability to age as a wine in bottle. The mean July temperature is 23.8 degrees Celsius with an annual rainfall of 491mm.

The Nemea region in the north eastern corner of the Peloponnese has a large variation in elevation. Vines are grown in deep red alluvial soils down to 250m above sea level and in stonier soils at elevations as high as 800m above sea level.

Vines are mainly grown on the northern side of the island of Crete, mainly to protect them from the hot winds generated from the African continent. As the island is quite mountainous, there are a variety of microclimates in which vines are grown. Heraklion’s mean July temperature is 26 degrees Celsius with annual rainfall of 523mm predominantly falling in the months of Winter. The annual rainfall in surrounding mountains is much higher, up around 900mm (Somarakis, 2018).

Of the wineries visited, all were quite advanced in the technology used in winemaking with most wineries employing a qualified oenologist. Processing technology tended to be more basic in smaller wineries and quite technologically advanced in larger wineries. However; all tended to be experimenting with new fermentation technologies and vessels. In particular Acacia barrels, large oak and concrete fermentation formats and extended skin contact whites.

White Cultivars

*Assyrtiko** is possibly Greece’s most famous white variety now widely planted in many regions. This is a very late ripening variety with good tolerance of drought and warm to hot growing conditions. Thick skins help provide some tolerance to disease and natural acidity is usually high at harvest. Newer clones show differing bunch structures, berry shapes and organoleptic characters. Assyrtiko can be used as a blending component but due to its current popularity is

usually bottled as a varietal. Assyrtiko can be made in more simple aromatic styles for early consumption or aged in oak for more complex and age worthy wines (Koundouras, 2018).

Athiri is a mid-budding and ripening, vigorous white variety grown mostly on the southern islands. Good tolerance of dry growing conditions and some diseases but susceptible to Powdery Mildew. It is grown on a number of sites but the best tend to be higher elevations with well drained soils. Wines tend to be fresh, aromatic and light bodied.

Dafni is quite a rare, late ripening variety with strong yields. Thick skins and good tolerance to diseases except Downy Mildew, Dafni has a unique set of aromatics reminiscent of laurel and rosemary. Bunches are loose and berries are large and slightly oval in shape.

Malagousia is quite susceptible to Botrytis due to its thin skins and tight bunches but has good drought tolerance and productivity. Wines are aromatic and tend to be full bodied. Acid adjustment was common as the juice has relatively high pH and low acidity.

Moschofilero is a pink skinned late ripening variety. Wines tended to be extremely aromatic due to high levels of thiols and terpenes. Strong yielding and drought tolerant this variety maintains high natural acidity levels at harvest with some cooler climate wines needing de-acidification (Troupis, 2018). It is susceptible to diseases, in particular Botrytis.

Plyto is a very old and rare variety mostly grown on the island of Crete traditionally interplanted with other varieties to add acidity. A number of producers are now making varietal wines. Plyto is a vigorous and productive variety with excellent drought and heat tolerance producing delicate but textured white wines.

Roditis is a pink skinned variety which is widespread in Greece. Prone to Powdery Mildew and overcropping, it can make interesting wines when yields are controlled and grown in a cool climate. It is late ripening and maintains moderate natural acidity levels at harvest and excellent tolerance of drought and heat.

Thrapsathiri is grown mainly on the southern Greek islands and as with Plyto was traditionally used as a field blend. A heavy yielding variety with good tolerance of heat and drought, Thrapsathiri can produce high quality wines when yields are kept below 10T/Ha and it is cultivated on cooler sites (Somarakis, 2018).

Vilana is a vigorous and productive, mid budding and ripening variety traditional grown on the island of Crete. It is susceptible to fungal diseases but has good tolerance of drought and warm to hot growing conditions. Wines are medium to light bodied and have aromas of citrus, apple and florals.

Figure 7: Vineyards in the mountains of Crete, Greece. (Source: Author)

Red Cultivars

Agiorgitiko is mostly grown widely in the region of Nemea. A high yielding variety, it is capable of making a range of styles from rose to soft reds for early consumption to concentrated, oak matured wines that benefit from bottle age (Kyriakidis, 2018). It is late budding and ripening and has moderate tolerance to drought, warm growing conditions, some fungal diseases but is susceptible to Powdery Mildew.

Kotsifali is widely planted on the island of Crete. It is early to mid-ripening, has thin skins but good general tolerance to disease, heat and drought. Wines can be pale in colour but are generally very aromatic with soft tannins. Kotsifali has traditionally been blended to improve its lack of colour.

Limnio has traditionally been grown in Halkidiki in the north of Greece and is susceptible to some fungal diseases and has moderate tolerance of dry conditions. Late ripening, it is a productive variety that performs at its best on cool sites. The fruit generally has fresh natural acidity and low tannins at harvest.

Limniona has large thick-skinned berries which ripen very late. The best quality wines are produced in climates with warm to hot days and cool nights. Good tolerance of dry conditions

and heat, this is a quality variety of which plantings are increasing. Wines tend to be medium bodied, soft and aromatic.

Mandilaria is a vigorous and productive variety. There are two common clones; one with very large berries and one with small berries which is preferred by winemakers. A very tannic variety that is susceptible to diseases but tolerant of drought. Can produce high quality wine but requires a good exposed site, considerable work in the vineyard to keep yields down and to reach full maturity (Somarakis, 2018).

Xinomavro is late budding and very late ripening. It is highly productive fruit thinning is common and requires careful canopy management to achieve full fruit and tannin ripeness. Tannins can be very abrasive, and wines generally require time in the bottle for the tannins to soften. Xinomavro is also used for sparkling and rose wine production and as a red wine is often compared to Pinot Noir and Nebbiolo for its ability to age, its high quality and being demanding in the vineyard (Dalamara, 2018).

There are many clones of each variety spread across Greece with no national database or register in place making clonal selection difficult. Viral loads are a large problem with most varieties inspected showing visual signs of viral infection.

However, a significant amount of work has been carried out over the last few years particularly by VNB Nursery in Nemea in conjunction with ENTAV INRA in France to propagate and register virus free clones of many indigenous varieties.

Figure 8: Virus free Agiorgitiko vines at VNB Nursery, Nemea, Greece. (Source: Author)

Chapter 4: The Caucasus

The countries of Georgia and Armenia both lay claims to be the oldest winemaking regions on earth. Carbon dating of fossilised Vitis vinifera seeds, bunch stems and clay vessels found suggests that cultivation and domestication of grapevines and winemaking was taking place around 6,000 to 8,000 years ago (Rusishvili, 2010). Regardless of which country's claim is correct, it is highly likely that the domestication of the grapevine and winemaking first took place in the Caucasus. In 2016, there were 48,500Ha of wine grapes grown in Georgia and 16,600Ha grown in Armenia however much of this area in Armenia is used for Brandy production (OIV, 2019). The average annual rainfall of Yerevan (Armenia) is low at 319mm per year falling mostly in the winter months and 510mm in Tbilisi (Georgia) with the wetter months being May and June. Much of the wine made in both countries is consumed domestically and the largest export market for both Georgia and Armenia is Russia, however Georgian wines have recently seen exports grow slightly to the United States of America, United Kingdom and Europe.

Viticulture and Winemaking

Both Georgia and Armenia were both once part of the Soviet Union. During this period and for some time since, agriculture in general and viticultural technology does not seem to have progressed at the same rate as the rest of Europe. During the Gorbachev era around 2/3 of vineyards were destroyed by Central Government decree to combat alcoholism (Appleby, 2018). Smaller grape growers and winemakers are still very traditional in their approach to viticulture and winemaking, but larger vineyards and wineries are much more modern due to foreign investment.

During the Soviet period, Armenia was primarily a brandy producing state for the Union and a number of indigenous varieties were lost due to higher yielding varieties being favoured (Saghatelyan, 2018). Brandy production is still a large part of the wine industry, but table wine production is increasing. Most of the fruit produced from the Ararat plain below the capital Yerevan is destined for Brandy production. Soils in this region are deep and fertile, but once off this plain most soils become very light and free draining with a high percentage of rock. It is on these slopes, off the Ararat plain where most of the wine grapes are grown.

In Armenia vines are grown at elevations from 800m to 1,800m above sea level on basic single wire trellis systems with minimal mechanisation. Drip irrigation has only been adopted on new larger scale vineyards with flood and furrow irrigation widely practiced without much regulation or accuracy. Difficulty was experienced in trying to obtain irrigation volumes and fertiliser applications per hectare. The very cold winters require most grape growers to bury their vines to avoid winter chill injury which is arduous due to the extremely rocky soils of most growing regions. Most vineyards both old and new have a vine density of between 1,500-2,000 vines/Ha.

Traditional fermentation and maturation in buried clay vessels called either Karas (in Armenia) or Qvevri (in Georgia) only represents around 5% of wine produced in both countries (Honnef, 2018) with most of the wine being fermented in stainless steel and matured in oak barrels.

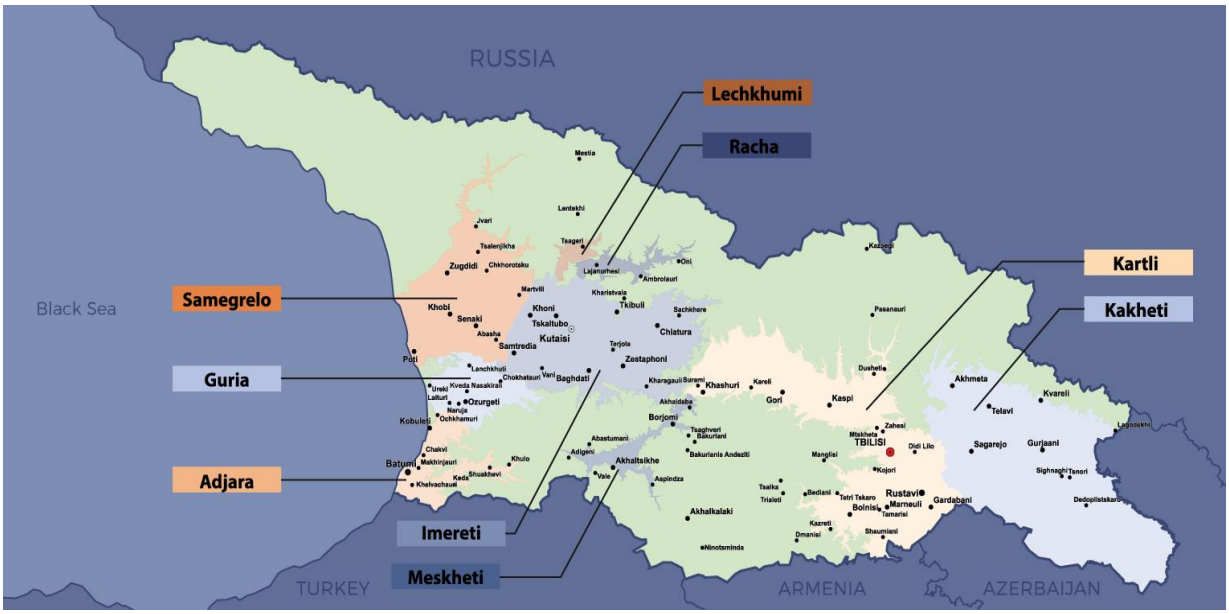

Figure 9: Wine Regions of Georgia. Source: Wines of Georgia (2018)

White Cultivars

Chinuri is late budding and ripening with high vegetative vigour and good tolerance to Downy Mildew but susceptible to Powdery Mildew. Grown mostly in eastern and central Georgia, Chinuri is known as an aromatic, high acid variety and is commonly used for both still and sparkling wines.

Goruli Mtsvane is predominantly grown in the Kartli region of central Georgia and has large bunches with thick skins that have good tolerance to Downy Mildew and Botrytis but is susceptible to Powdery Mildew. Late budding and ripening, it is a productive variety that can produce wines with honey and floral aromatics. It is also commonly used for sparkling wine production.

Khikhvi is late budding and mid ripening and maintains good levels of natural acidity at harvest. It is mostly grown in the Kakheti region in south-eastern Georgia and has good general disease tolerance but is susceptible to Powdery Mildew. Wines are generally soft and full bodied and are often made in traditional qvevri.

*Mtsvane** is widely planted in Georgia and. It is a late budding and productive variety with excellent ability to retain natural acidity at harvest. It has some good disease tolerance but is susceptible to Powdery Mildew. Wines are vinified in traditional qvevri as well as stainless steel tanks and display floral and fruity aromatics.

*Rkatsiteli** is a versatile white used for sparkling, still and sweet wines. It is the most widely planted variety in Georgia (Robinson, 2012) and is also found in Armenia. It is late budding and

ripening and productive with good cold hardiness. The large bunches and small berries give it reasonable tolerance to Botrytis, but it is susceptible to Powdery Mildew. A high acid variety that can make quality wines.

Voskeat is a productive multi-purpose Armenian variety with thin skins. Voskeat has a long vegetative cycle and is quite susceptible to disease but can make high quality sparkling, still, fortified and sweet wines.

Red Cultivars

Aleksandrouli from North West Georgia has a long vegetative cycle and bunches of large berries with thick skins. Late ripening and tolerant of dry conditions, it requires a warm climate and site to produce ripe fruit that is low in tannin but high in natural acidity. Wines are usually soft and deeply coloured.

Areni is a high-quality Armenian variety that can be used for sparkling, rose and dry table wine. It is predominantly grown in the cool climate, high elevation Vayots Dzor region (up to 1800m) and has recently been planted throughout Armenia. Areni is late budding and ripening with thick skins and reasonable disease tolerance. Wine styles vary from soft and spicy full bodied wines to light to medium bodied aromatic wines reminiscent of Pinot Noir.

Khindogni is found throughout Armenia. It has good tolerance of dry growing conditions and fungal diseases. It is productive, late ripening and can produce deeply coloured quality wines thanks to its partially coloured red flesh.

Ojaleshi from Western Georgia is early budding and very late ripening often harvested in late-November. Preferring well drained soils, it is vigorous with medium sized berries and bunches with good tolerance to fungal diseases and humid growing conditions. Wines are known to have characters of pepper and spice.

Shavkapito from Georgia's Kartli region is mid budding and ripening with moderate productivity, thick skins and moderate disease tolerance. A versatile variety which reflects the region where it is grown producing rosés, medium to full bodied wines from warmer sites and elegant, aromatic wines from cooler sites.

Tavkveri has only functionally female flowers so can be low yielding. Vigorous, late ripening with large berries and bunches, Tavkveri has good disease tolerance to Powdery Mildew but is susceptible to Downy Mildew and Botrytis. Grown mostly in the Kartli region of Georgia it suits a wide variety of soils and has good drought tolerance. It can produce high quality light/medium bodied savoury wines.

Figure 10: Maturation Cellar, Telavi Wine Cellar, Telavi, Georgia. (Source: Author)

Chapter 5: Portugal

Viticulture and Winemaking

Portuguese viticulture and winemaking practices are as diverse as its climate. Older vineyards in warm and hot regions tend to have low trellis, vine density and crop levels (<6T/Ha) while newer vineyards have been set up for mechanisation with higher density plantings, crop levels (>15T/Ha) and drip irrigation (Garcia, 2018). Mid row and under-vine cultivation is common and mechanical harvesting is becoming commonplace apart from region such as the Douro Valley where geography is the inhibiting factor. Nutritional inputs are similar to standard Australian programs with annual additions of Nitrogen, Phosphorus, Potassium and trace elements. Irrigation volumes were between 1 to 2 ML/Ha in the drier Southern regions such as Azeitao to support larger crops of 12-15T/Ha. Modern winemaking technology and practices are common.

As one would expect with such an old wine growing nation, Portugal's indigenous varieties are grown in regions which have the climate that is best suited to commercially produce and ripen those varieties. Rainfall in Setubal is 641mm and 1178mm in Porto falling predominantly during the winter months in both regions.

White Cultivars

*Antao Vaz** is a vigorous and productive variety with excellent tolerance of hot and dry growing conditions. Grown mostly in the south of Portugal, it is mid budding and ripening with loose bunches of thick-skinned berries which give it good tolerance to diseases. Antao Vaz grows best in free draining soils and does not like water logging. It is used to produce medium bodied aromatic white wines in Alentejo and is often blended with Arinto and Roupeiro.

Grown throughout Portugal, *Arinto** is late budding and ripening and has moderate tolerance of heat and drought. A vigorous variety that prefers deep well drained soils with small, tight bunches it can make aromatic, citrussy table wine on its own and is also used to freshen blends.

Encruzado, grown mostly in the Dao region is mid budding and ripening and quite tolerant of dry conditions. It is vigorous and its berries have thick skins, but it does have some susceptibility to fungal diseases. Preferring deep well drained soils, Encuzado maintains good natural acidity levels to harvest. It can produce high quality wine which suits oak maturation and can age very well (Garcia, 2018).

*Fernao Pires** is early budding and ripening and very productive. It is sensitive to moisture stress but tolerant of warm to hot growing conditions and prefers deep well drained soils. Widely grown in Portugal, its wines can be very aromatic but also quite lean and will usually form part of a blend.

*Gouveio** (known as Godello in Spain) is grown mostly in the north of Portugal. Best suited to dry sites, it is early budding and ripening with productive yields that require little irrigation. Berries have medium-thick skins and are susceptible to Powdery Mildew and Botrytis, but this variety can maintain high natural acidity levels to harvest. Gouveio can produce aromatic wines that suit barrel maturation which can age well in bottle due to the variety's high natural acidity.

*Loureiro** is a major component of Vino Verde. It is productive, mid budding and ripening. It is susceptible to fungal diseases and drought but very tolerant of humid growing conditions and best suited to deep soils with moderate fertility. Retaining high natural acidity to harvest, it is often blended contributing aromatics and acidity to blended wines.

*Viosinho** is another northern Portuguese variety grown mostly in the Douro Valley that is early ripening but low yielding with only moderate vigour. It is susceptible to fungal diseases but quite tolerant of drought and warm to hot growing conditions. It has been described as Portugal's Sauvignon Blanc (Robinson, 2012) thanks to is intense aromatic potential. It grows best in dry but fertile, well drained soils.

Figure 11: Loureiro grapes in the Alentejo close to harvest (Source: Author)

Red Cultivars

Castelao is one of Portugal's most widely planted variety planted mostly in the south (Robinson, 2012). Adaptable to a range of sites, early budding and ripening, this is a robust variety that has low susceptibility to fungal diseases and good tolerance of dry and hot growing conditions. Castelao can produce a range of styles from light and soft, easy drinking red wines to concentrated and darkly coloured reds suited to oak maturation and aging (Garcia, 2018).

Tinta Francisca is grown mostly in the north of Portugal in the Douro Valley. Traditionally used in port production, it has low to moderate yields and vigour and some disease susceptibility thanks to its thin skins. However, it does have good tolerance of dry and warm to hot growing conditions and is best suited to hot dry climates and sites. It can produce soft easy drinking wines that are low in acid and tannin.

*Touriga Franca** is vigorous, mid to late ripening and moderately productive. Grown mostly in the Douro Valley, it has good tolerance to heat and dry growing conditions and only moderate disease susceptibility. Varietal wines are said to be less concentrated than Touriga Nacional but have more finesse and are more aromatic (Robinson, 2012).

Figure 12: Vineyards in the Douro Valley, Portugal. (Source: Author)

*Touriga Nacional** is traditionally grown in the Douro Valley but has spread throughout Portugal due to its popularity. It is moderately productive, mid to late ripening and has low general disease susceptibility and moderate tolerance to drought and heat. Foliage tends to droop which can lead to shading and disease problems if not managed. A high-quality variety for both port and table wine production.

*Trincadeira** is mostly grown in the warm to hot region of Alentejo and in the Douro where it is known as Tinta Amarela. It is productive with medium vigour. It is a robust variety that performs best in dry, well drained soils and warm to hot climates. It is susceptible to fungal disease, notable Botrytis but can make rich red table wines that suit oak maturation and bottle aging.

Vinhao,* grown in the far north west of Portugal in the Vinho Verde region and in the Douro where it is known as Souzao is a productive variety with moderate vigour and thick-skinned berries giving low general disease susceptibility. It is not tolerant of drought, but it's strong shoots stand up to wind damage. Wines are very densely coloured thanks to the varieties red flesh and have good natural acidity.

Chapter 6: Spain

Viticulture and winemaking

Spain has the largest planted area of grape vines for wine production in the world but is only the third largest wine producer thanks largely to its arid climate (OIV, 2018). Many growing regions in central and southern Spain can be described as warm to hot climate with high growing season temperatures and low annual rainfall; and cooler climate regions in the north and north west (Robinson, 2015).

As with Portugal, viticultural practices and the varieties that are grown are matched to the climate of the region. Warm inland regions with low annual rainfall (445mm/year in Valencia) tend to have low vine density with vines grown on a low trellis or as bush vines, and cool regions (1174mm/year in Bilbao) have higher planting densities with significant canopy management. Drip irrigation, whilst relatively new in Spain has become very popular with application ranging from 0.5 to 1.2ML/Ha (Martinez-Zapater, 2018). Modern winemaking technology and practices are common.

White Cultivars

Garnacha Blanc,* known as Grenache Blanc in Australia is the white variant of Garnacha Tinta. It is mid budding and ripening and like Garnacha Tinta has some susceptibility to fungal diseases but has good drought tolerance. Sugar levels can be quite high and acidity levels quite low at harvest leading to unbalanced, full bodied and alcoholic wines so blending may be appropriate.

*Macabeo** is widely grown throughout Spain and is commonly underestimated due to its tendency to overcrop. It is productive and late to ripen particularly with heavy crops. It is sensitive to Botrytis and Powdery Mildew but less so to Downy Mildew. Macabeo prefers warm growing conditions and well drained soils. If crops are regulated, wines can be fresh and aromatic but do tend to be low in natural acidity.

Maturana Blanco is a rare variety found in the Rioja region of Spain. It is early budding and ripening and very productive. Susceptible to Botrytis but less so to other fungal diseases it can produce aromatic and alcoholic wines with high levels of natural acidity with flavours and aromas of citrus, tropical fruit and herbs.

Monstruosa is grown in Galicia in north west Spain. A rare variety that is late ripening and productive. Large bunches of berries with thick skins have low disease susceptibility but are susceptible to Powdery Mildew. A high acid variety that can produce wines with aromas of florals/flowers with moderate alcohol levels.

Tempranillo Blanco was discovered in 1988 from a natural mutation in a vineyard in Rioja (Martinez-Zapater, 2018). It was then propagated and evaluated at a local research facility and has since been planted commercially. Vine phenology is very similar to Tempranillo with

medium sized bunches and berries with thick skins. If vines are not overcropped, Tempranillo Blanco can produce interesting, aromatic and flavoursome wines with moderate alcohol and good levels of natural acidity.

*Verdejo** is grown in Spain's central Rueda region. It is early to mid-budding and ripening with low to moderate vigour and yields. It is susceptible to Powdery Mildew and Botrytis thanks to tight bunches and thin skins but has reasonable tolerance of heat and drought. Preferring light, well drained soils the wines can be highly aromatic with some savoury nutty characters. It is also used for production of sparkling wines.

*Xarello** is a vigorous and productive variety predominantly grown in Catalunya. Mid budding and ripening it has large bunches with thick skins and is moderately susceptible to fungal diseases and poor weather during flowering. It grows well in a warm to hot climate and can adapt to a wide range of soils and is used to produce both still and sparkling wines with high levels of natural acidity at harvest.

Red Cultivars

Bobal* is commonly grown around Valencia in Eastern Spain. Late budding and ripening, it is very productive and vigorous with large bunches and berries with thick skinned berries. It is extremely drought tolerant and can produce quality wines if yields are kept in check. It can adapt to a range of climates and soils with interesting aromatic examples being produced in Spain from higher elevations and cool climates.

Graciano* is late budding and ripening with strong vigour and good drought tolerance. Yields can be low to moderate; Botrytis can be a problem but Powdery and Downy Mildew less so. Best suited to clay and limestone based soils, the wines are very dark and perfumed and have good levels of natural acidity.

Garnacha Peluda is another mutation of Garnach Tinta. It has similar growth habits to Garnacha Tinta but has developed white down underneath its leaves which decreases its rate of transpiration making it even more suitable for hot and dry climates. It has thicker skins and slightly higher levels of natural acidity at maturity than Garnacha Tinta.

*Mazuelo** is commonly known elsewhere as Carignan. It is late budding and ripening and is grown widely throughout Spain. Mazuelo is susceptible to most fungal diseases, but it is very productive and tolerant of dry and warm to hot growing conditions maintaining high levels of natural acidity to harvest. It is used widely as a blending component thanks to its acidity and needs a warm growing region to fully ripen.

*Mencia** is grown mostly in the north west of Spain. Early budding and mid ripening Mencia can produce aromatic, very soft and approachable red wines thanks to its low levels of acidity at harvest. Fertile and productive, it has medium-thick skins and is susceptible to most fungal diseases but grows well in a dry climate.

Moristel produces very aromatic but light to medium bodied wine. Low yielding with compact bunches and thin skins, it is best planted on fertile clay-based soils and is often blended with Tempranillo in the Navarra region of Spain to add an aromatic lift. It has good tolerance to drought, pests and diseases.

Chapter 7: Barriers to Adoption

Although many of these alternative varieties may seem like a natural fit for Australia's wine industry there are some potential problems in being able to successfully grow them, make quality wine and eventually sell a bottled product.

Lack of capital available to grape growers to graft or replant may be a limiting factor. The current fiscal climate within the wine industry has recently improved however farmgate fruit prices have not risen in every region, bulk wine prices are still only moderate and competition on the retail shelves is still strong.

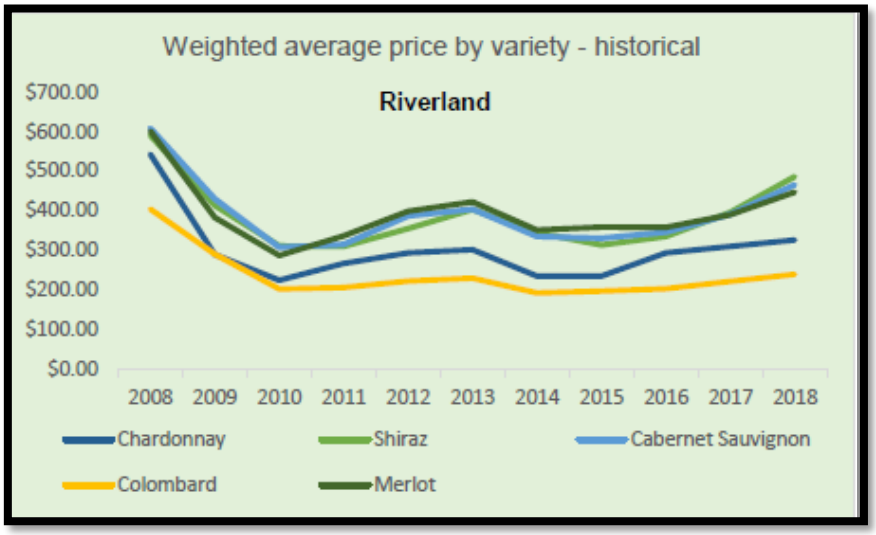

Figure 13: Regional Snapshot 2018 – Riverland. Source: Wine Australia (2019)

Accessing clean propagation material is another. Most of the vineyards and varieties observed in Greece were carrying a significant viral load with Grapevine Virus A, Fanleaf Virus and Grapevine Leafroll-Associated Virus 1 being the most prevalent (Koundouras, 2018). These viruses can lead to lower yield, light red wine colour, inferior wine quality, graft incompatibility and vine decline (Habili, 2015). The pathogen status of the varieties listed in previous chapters is unknown even within their countries of origin. Whilst yield and quality may not be immediately impacted, vineyard longevity and potential for viruses to spread needs to be taken into consideration. Whilst there is the facility to eliminate viruses, this can be a lengthy and expensive process.

Australia also has some of the strictest quarantine laws in the world and importation of new vine material is expensive. Importers will require a phyto-sanitary certificate from the source of the material as well as an import permit. There are three AQIS quarantine facilities to handle imported material. They are located at Eastern Creek (New South Wales), Knoxfield (Victoria) and South Perth (Western Australia). Once in Australia, imported material must undergo quarantine and screening for various pests and diseases. More information can be found at http://www.agriculture.gov.au/biosecurity.

Costs of importation including permits, freight, quarantine and testing can easily reach $5000 (Dry, 2017) and timelines can reach five years from import to source block establishment.

Imported dormant cuttings must be subjected to the following:

- Mandatory on-arrival inspection, fumigation, hot-water treatment and surface sterilisation.
- Mandatory growth in a closed government PEQ facility for a minimum period of 16 months for pathogen screening.
- Active pathogen testing through herbaceous host indexing and molecular tests including PCR or ELISA.

Basic knowledge of how to best grow a variety and how the grapes and wine should be handled in the winery also needs to be taken into consideration. Most varieties are likely to behave differently in Australia to that of their homeland and different to varieties that are commonly grown here. Australian grape growers and winemakers should not expect to be able to precisely replicate the wines and styles of overseas regions, rather use them to express Australia's terroir.

Consumer's lack of familiarity with alternative varieties is likely to make wine sales difficult initially. If a consumer finds it difficult or is unable to pronounce the name of a variety, they are less likely to make a purchase (DeGaris, 2017).

In the United Kingdom, Australian produced alternative varieties have been very well received but so far been generally sold at higher price points (>£15/bottle retail) which has limited sales to a certain extent to on-premise trade. (Jewel, 2018).

However, these are all barriers that can be overcome.

Australian winemakers have for years travelled widely around the globe to learn new growing techniques and winemaking methods and bring that knowledge home, and Australian viticulturists and vineyard managers are some of the most innovative and forward-thinking growers and farmers in the world. None of them are as bound by tradition as their counterparts in the old world which puts them in a great place to be able to grow varieties that are new to Australia.

The emergence of registered and certified virus free propagation material can give prospective growers and winemakers confidence that they are planting clean, healthy true to type varieties.

The fact that Australia has such a multicultural population is also a positive. The range of international cuisine available in Australia today suggests that consumers are wanting diversity, and demand for diversity in the wine available to them is following this trend.

This; when combined with events such as Wine Australia's Alternative Variety tastings in international markets, the increasing popularity and promotion of the Australian Alternative Varieties Wine Show and the ability of small and medium size produces to connect and educate consumers through traditional cellar door experiences as well as online content can be used to bring alternative varieties from obscurity to the fringe, and eventually to the mainstream.

There is enormous opportunity for collaboration at a regional and business level. Some areas where this might work are importation, knowledge sharing and regional marketing.

Conclusion

The Australian wine industry has a great history of innovation, collaboration and adaption. To increase the demand and the premium paid for Australian wine globally and domestically, diversity and quality will be two key drivers in the future. With the backdrop of a changing climate, increased climate variability and a changing consumer; alternative varieties can help deliver both diversity and quality.

This report has identified alternative varieties from five countries that are likely to perform well across a range of Australia's regions, climates and markets; of which small to medium size grape growing and winemaking businesses are best placed to explore, grow, promote and sell.

The varieties identified have; to varying degrees tolerance of warm to hot temperatures during their growing season, the ability for production in dry climates, the ability to tolerate some vine diseases and the potential to make quality table wine across a range of price points.

These varieties are largely grown on rootstocks in their country of origin due to the presence of Phylloxera or for drought tolerance. The ability for Australian grape and wine producers to now access rootstocks developed by the CSIRO specifically suited to Australia's growing conditions further enhances the potential for these varieties in Australia.

Some varieties identified during the research are already being grown in Australia; some have been for many years and others are more recent arrivals, but none are widely grown or known.

Due to the potential lack of consumer awareness of "new" varieties, the alternative varieties recommended may initially be a better fit for wines that can be hand sold by sommeliers, sold at speciality wine stores or by small and medium size wineries at their cellar door where they can be promoted, and customers can be educated about the variety and style.

The barriers to growing and selling alternative varieties in Australia can seem significant. However, if as an industry varietal diversity is not encouraged the risk of losing market share only increases with the change in our consumers. The lead time from importation to being able to sell a bottled product is years but we must start sometime.

The author's top five varieties that would suit Australia's climate and changing market are *Plyto* from Greece, *Areni* from Armenia, *Shavkapito* from Georgia, *Gouveio* from Portugal and *Bobal* from Spain.

Recommendations

The following recommendations are made to vine nursery, grape growing and winemaking businesses:

- The alternative varieties identified that are currently in Australia be assessed for suitability to local climates and soils through small plot growing trials across several regions funded by Wine Australia and administered by relevant state industry organisations (material accessed through the Australian National Nuclear Grapevine Collection if available).
- The alternative varieties identified that are currently not in Australia be imported (over a number of years) and added to the Australian National Nuclear Grapevine Collection once screened for and/or cleared of pathogens, funded by Wine Australia and CSIRO.
- A refreshed index of varieties and clones held in the Australian National Nuclear Grapevine Collection as well as those privately held and recently imported.
- Further research of the varieties (in the small plot growing trials mentioned above) including clonal attributes and growing habits and rootstock compatibility and wine sensory attributes.
- Cultural growing techniques should be considered including trellis style, canopy management, pruning methods and yield management.
- Cultural winemaking techniques should be considered including processing methods, fermentation and maturation techniques.
- Collaboration between businesses and within regions to share grape growing and winemaking knowledge, and promotional activities facilitated by the Australian Vine Improvement Association and the Australia Alternative Varieties Wine Show.

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Plain English Compendium Summary

Project Title:	Alternative Varieties for the Australian Wine Industry
Nuffield Australia Project No.:	1822
Scholar:	Martin Gransden
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Objectives	The objectives of this report are to increase the demand and premium paid for Australian wine by identifying alternative wine grape varieties that: • Will better suit Australia's climate that are either not yet in Australia or not widely grown • Will better suit a changing and variable climate • Will better suit a changing consumer palate
Background	The majority of wine grapes grown in Australia are traditional French varieties grown in warm inland regions which require substantial irrigation and nutrition inputs to achieve commercial production levels. In a period of increasing climate variability and potential water insecurity wine grape varieties that have a tolerance of heat and drought should be considered as an alternative to the varietals that are currently grown. Consumer preferences are also shifting away from traditional varieties with towards food friendly alternative varieties.
Research	Research and evaluation of indigenous vine varieties, viticultural methods and winemaking practices was carried out in Armenia, Georgia, Greece, Portugal and Spain via interviews of viticulturists and winemakers as well as vineyard visits.
Outcomes	Australian grape growers and wine producers should evaluate the alternative varieties suggested for suitability to their climate, soils and potential markets. The varieties suggested to varying degrees provide tolerance to some fungal diseases, heat and dry conditions during the growing season and have the potential to produce quality table wine across a range of price points.
Implications	Propagation, cultivation and production of alternative varieties will increase the resilience Australia's wine industry in a changing and variable climate. It will also help increase the demand of a changing wine market by offering the consumer diversity and sustainably produced product.
Publications	Nuffield Australia National Conference, Brisbane, September 2019.

Appendices

Appendix 1: Recommended Greek Varieties

Variety	Colour	Location/Region	Comments
Agiorgitiko	R	All over	Capable of high yields but also high quality and a range of styles. Thick skins but some susceptibility to diseases.
Assyrtiko	W	Santorini	Vigorous and productive. Disease and drought tolerant. Long vegetative cycle. Capable of very high quality wines.
Athiri	W	Santorini	Vigorous, drought resistant, mid budding and ripening. Makes fresh lemony fruity easy drinking styles. Best wines come from high regions and light soils. Moderate yields.
Dafni	W	Crete	A rare variety. Productive, late ripening, loose bunches, thick skins and disease resistant. Laurel and citrus scented aromatic variety.
Kotsifali	R	Crete	Vigorous, productive, good disease Tolerance but some susceptibility to Botrytis. Early to mid ripening. Wines may be pale but can be very aromatic.
Limnio	R	Limnos	Productive with a long vegetative cycle. Small to medium compact bunches. Susceptible to disease but resistant to water stress.
Limniona	R	Thessalia	Long vegetative cycle. Big thick skinned berries. Enjoys hot days and cool nights. Soft styled wines.
Malagousia	W	Thessalia	Vigorous and productive, drought tolerant but has some disease susceptibility due to thin skins. Full bodied and very aromatic wines.
Mandilaria	R	All over	Vigorous and productive. Drought tolerant but susceptible to disease. Deeply coloured and very aromatic wines.
Moschofilero	P	Pelponnese	Late ripening at higher elevations, vigorous and productive. Excellent natural acidity. Very aromatic.
Plyto	W	Crete	A rare variety. Vigorous, productive and mid ripening. Large bunches and thick skins. Good retention of acidity, tolerant of drought and disease.
Roditis	P	Peloponnese, Patras	Vigorous and productive. Maintains natural acidity in warm conditions. Late ripening. Susceptible to Powdery Mildew but tolerant of drought.
Thrapsathiri	W	Crete	Vigorous, productive and mid ripening. Medium bunches and thick skins. Good retention of acidity, tolerant of drought and disease. Suits cool sites.
Vilana	W	Crete	Vigorous and productive. Susceptible to diseases but tolerant of drought. Long vegetative cycle and prone to over cropping but can make excellent wines.
Xinomavro	R	All over	Late budding and ripening. Best suited to poor soils and close planting. Lots of work in the vineyard. Tannins can be abrasive, but high quality.

Appendix 2: Recommended Armenian and Georgian Varieties

Variety	Colour	Location/Region	Comments
Aleksandrouli	R	Georgia	Mid budding but late ripening. Retains its acidity up to harvest. Deep coloured wines that have cherry, mulberry and floral aromatics.
Areni	R	Vidzor/Armenia	Mid budding and late ripening. Thick skins that has good disease tolerance. Can make a range of styles and can grow in a range of climates. Very high quality potential.
Chinuri	W	Georgia	Vigorous and productive. Late budding and ripening. Good tolerance to Powdery and Downy Mildew. Aromatic variety used for both still and sparkling wines.
Goruli Mtsvane	W	Georgia	Vigorous and productive. Late budding and ripening. Tolerant of Downy Mildew but susceptible to Powdery Mildew. Aromatic variety used for both still and sparkling wines.
Khikhvi	W	Georgia	Moderate yielding. Late budding and ripening. Has some disease tolerance but susceptible to Powdery Mildew. Maintains natural acidity to harvest. Can make full flavoured aromatic wines.
Khindogni	R	Armenia	Productive and late ripening. Quite tolerant of diseases and drought. Can make a range of red style usually high quality.
Mtsvane	W	Georgia	Vigorous and productive. Late budding and ripening. Has some disease tolerance. Maintains its natural acidity to harvest. Can make full flavoured aromatic wines.
Ojaleshi	R	Georgia	Very late ripening and has good tolerance to disease. Can make soft red wines similar to Merlot.
Rkatsiteli	W	Georgia	Productive with large bunches of small berries. Late budding and ripening with some disease tolerance. Can make high quality wine with good acidity at harvest.
Shavkapito	R	Georgia	Mid budding and ripening. Moderate productivity. Large bunches with thick skins and moderate disease tolerance. Can make interesting, aromatic and high quality wines.
Tavkveri	R	Georgia	Late budding and ripening. Vines only have female flowers so cross pollination is required. Produces light and savoury red wines that can be of high quality.
Voskehat	W	Armenia	A productive and late ripening variety. Has susceptibility to most diseases but can make excellent table and sparkling wines.

Appendix 3: Recommended Portuguese Varieties

Variety	Colour	Location/Region	Comments
Antao Vaz	W	Alentejo	Vigorous and productive. Tough skins with good tolerance of diseases, heat and drought. Wines are tropical with fine acidity.
Arinto De Bucelas	W	All over	Late budding and ripening. Adaptable to different climates. Copes well with heat and drought but needs soils with moisture retention. High quality.
Castelao	R	All over	Very adaptable. Early budding and ripening. Hardy with good all round disease tolerance.
Encruzado	W	Dao	Vigorous. Quite tolerant of drought but some susceptibility to disease. Mid bud and ripening with thickish skins. Makes very complex wines that can age very well.
Fernao Pires	W	All over	Early bud and ripening. Productive but sensitive to water stress and can drop acidity at harvest. An aromatic variety that might be best suited to cooler climates.
Gouveio	W	NW Iberia	Well suited to dry sites. Small bunches with thick skins. Fertile and productive. Early budding and ripening. Retains acidity well making complex and quite full bodied wines.
Loureiro	W	NW Iberia	Productive. Mid to late budding and ripening. Some susceptibility to diseases but tolerant of humidity.
Tinta Francisca	R	Dao, Douro	Late ripening. Low and irregular productivity. Thin skins with some disease susceptibility. Best suited to dry and sunny sites.
Touriga Franca	R	Douro	Mid to late ripening. Productive and vigorous. Good general tolerance of disease and drought.
Touriga Nacional	R	Douro	Productive and vigorous but foliage tends to droop. Thick skinned berries that are susceptible to Powdery Mildew but less so to Downy Mildew and Botrytis.
Trincadeira	R	Dao, Douro	Medium vigour with high productivity. Robust variety with some sensitivity to Botrytis but tolerant of heat and drought.
Vinhao	R	NW Iberia	Medium vigour and productivity. Thick skinned berries. Good tolerance of diseases but sensitive to drought. Produces very dark coloured wines.
Viosinho	W	Douro	Early ripening with low productivity. Some susceptibility to diseases but drought and heat tolerant. Maintains its natural acidity and can make very aromatic wines.

Appendix 4: Recommended Spanish Varieties

Variety	Colour	Location/Region	Comments
Bobal	R	Valencia	Productive and vigorous. Large, compact bunches. Mid to late budding and ripening. Some susceptibility to disease but extremely drought tolerant. Quality wine if yields are kept in check.
Graciano	R	Rioja	Productive and late ripening. Moderate yields. Some disease susceptibility but drought tolerant. Maintains natural acidity at harvest. Deep coloured and aromatic wines.
Garnacha Blanca	W	All over	Similar to Garnacha Tinta (Grenache). Productive. Tolerant to heat and drought. Can make aromatic full bodied wines.
Grenache Peluda	R	All over	Very adaptable to hot climate, lots of down under leaves. Strong shoots resistant to wind damage. Small berries with thicker skins.
Macabeo	W	Catalunya	Very vigorous, productive and late ripening. Sensitive to Powdery Mildew and Botrytis but tolerant of heat and dry conditions. Can make interesting wines if yields are kept in check.
Maturana Blanco	W	Rioja	Productive, early budding and ripening. Some disease tolerance but sensitive to botrytis. A rare variety that maintains its natural acidity and makes aromatic wines.
Mazuelo	R	All over	Vigorous, productive and very late ripening. Low susceptibility to diseases but some susceptibility to Powdery Mildew. Drought and heat tolerant. A high acid and high colour variety.
Mencia	R	Castilla Y Leon	Early budding and mid ripening. Susceptible to diseases but moderate tolerance of heat and drought. Can have low acidity at harvest but can make high quality soft fruity wines.
Monstruosa	W	Galacia	Vigorous with thick skinned berries. Mid budding and late ripening. Susceptible to Powdery Mildew. Wines are usually high in acidity with moderate alcohols and are very aromatic.
Moristel	R	Navarra	Low yielding with compact bunches and thin skins. Mid to late budding and ripening. Good drought and disease tolerance. Adaptable. Wines can be light and fresh - early drinking styles.
Tempranillo Blanco	W	Rioja	Discovered in the 1980's. Identical to Tempranillo with slightly smaller leaves and berries. Wines tend to be high in alcohol and acidity. Aromatic and well structured.
Verdejo	W	Rueda	Medium to low vigour and productivity. Compact bunches with thin skins. Susceptible to diseases but tolerant of drought. Can make high quality, very aromatic wines.
Xarello	W	Catalunya	Vigorous, mid budding and ripening. Compact bunches with thick skins. Adaptable. Susceptible to Powdery and Downy Mildew but good resistance to Botrytis. High quality for still and sparkling wines.