Exploring winegrape varieties from the eastern Mediterranean for South Australia

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Executive Summary

The threat of climate change to the Australian wine industry is well documented. As such, many wine regions are expected to face significant impacts in the next 50 years encompassing increasing temperatures, reduced rainfall, earlier harvests and heat induced berry composition changes. The majority of vineyards and wineries base their businesses on western European grape varieties that traditionally do not have problems with water resources. This has led Australian producers to investigate options to adapt to these challenges, with a particular focus on the drought and heat tolerant indigenous grape varieties of hot Mediterranean climates. To date producers have been seeking potential drought tolerant varieties from Greece, Portugal, Spain, Italy and Georgia.

The mere act of importing “alternative”, lesser known, climate matched winegrape varieties, however, does not automatically guarantee their success in the marketplace. Wines made from these varieties must be acceptable to the consumer and meet their current demands.

In November 2020 large import tariffs were placed on Australian wines entering China, with these only being removed in March 2024. Consequently, these tariffs identified a large weakness within the Australian wine industry. That is, it’s an over reliance on the mass cultivation of red winegrapes and manufacturing of bulk red wines predominantly for the Chinese market. Since then, the industry has seen a great upheaval with many large growers, that concentrate on two or three varieties unable to sell their crops and having to leave the industry.

This report identified 70 winegrape varieties from the eastern Mediterranean that grow in similar conditions to South Australia and also have the potential to appeal to the current market. The author travelled to five different countries to meet with growers, producers and researchers to discuss different varieties, their cultivation, new breeding techniques, winemaking processes and the appeal to consumers in their home countries. From the list of 70 varieties, 10 from the 5 countries were earmarked as being suitable for imminent importation to Australia.

Previously it was thought that the unusual names of winegrapes was an impediment to the adoption of these varieties. Recent studies have refuted that claim and simply supplying a phonetic spelling of a variety name can increase the sales of a wine made from a new variety.

The project also included attendance at the United Nations (UN) Food and Agriculture Organisation (FAO) in Rome, Italy for the World Food Forum (WWF) and Committee on World Food Security (CFS) conferences. These conferences provided a broad perspective on global agriculture and what the future of the wine industry might look like under the gaze of the UN and FAO.

Keywords: lesser known winegrape varieties, drought tolerant, heat tolerant, Cyprus, Greece, Malta, Turkey, eastern Mediterranean, wine.

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Foreword

Since becoming involved in the wine industry more than 20 years ago, I have been interested in the numerous winegrape varieties cultivated in different wine regions around the world. With the effects of climate change becoming more evident year by year, it has become imperative to explore the potential use of these varieties in Australia to introduce better climate matched winegrapes to local growing conditions. Following a PhD project at the University of Adelaide exploring two indigenous varieties of Cyprus, a desire to explore the region further for more varieties has evolved.

The eastern Mediterranean is not only the birthplace of grape growing and winemaking it also has a very similar climate and growing conditions to many parts of Southern Australia. Hence vineyards and wineries in this region were explored to offer the Australian wine industry options and opportunities for the future.

Table 1: Travel itinerary

Travel date	Location	Visits/contacts
Week 1 & 2: 3-13 October, 2023	Cyprus: Pafos and Pitsilia Wine Regions and the capital city Nicosia.	**Vasilikon Winery**, Kathikas. Aphroditi Constanti and Giannis Kyriakides. **Vouni Panagia Winery**, Vouni. Yiannis Kyriakidis. **Makarounas Winery**, Letymbou. Theo Makarounos **Nelion Winery**, Pretori. Marinos Ioannou. **Tsiakkas Winery and Kapnisis Vineyard**, Pitsilia. Panikos Kapnisis and Costas Tsiakkas. **Constanti**, Cypriot social and political analysis and project management. Met with CEO Costa Constanti.
Week 3: 14-16 October 2023	Malta: Paola and Dingli.	**Markus Divinus Winery**, Dingli. Mark Borg. **Marsovin Winery**, Paola. Glenn Farrugia.
Week 3 & 4: 17-29 October 2023	Italy: FAO Rome	**FAO** World Food Forum. **FAO** Committee on World Food Security. Wayne Dredge
Week 5: 29-31 October 2023	Greece: Athens and Thessaloniki	**Oinotika**, Cretan Wine Fair, Athens. Aikaterini Mylona. **Aristotle University of Thessaloniki**. Professor Stefanos Koundouras.

		Messimvria Winery Natalia Kataifsi.
Week 6: 1-7 October 2023	Greece: Island of Crete, Heraklion wine region.	**Fragospito Winery**. Nikos Gavalas **Lyrarakis Winery**. Nikos Somarakis.
Week 7: 6-13 June 2024	Turkey: Istanbul	**Root Origin Soil**, Conference on Anatolian Heritage Grapes. Met with many people, including conference convenor Dr Sabiha Apaydin.

Acknowledgments

I would like to acknowledge and thank Nuffield Australia and Nuffield South Australia for providing me with the scholarship and travel bursary. To date I have been able to experience things, I would have never imagined being able to do when I started working in the wine industry. A highlight for me was time spent at the FAO in Rome. That was truly a unique experience and very eye opening to see how decisions in global agriculture are made and discussed.

I would also like to thank the many wine industry people in Cyprus, Malta, Greece, Crete and Turkey that assisted my travels and answered all my questions. Including Aphroditi Constanti, Giannis Kyriakides, the Kyrikidis family, Theo Takarounas, Marinos Ioannou, the Tsiakkas family, Costa Constanti, Professor Stefanous Koundouras, Mark Borg, Aikaterini Mylona, Natalia Kataiftsi, Nikos Gavalas, Dr Sabiha Apaydin and Gözdem Gürbüzatik.

Lastly, I would like to thank my father Willibrordus Copper and my late mother Jannetje Copper and Dr Thuy Nguyen. They have all encouraged me to keep learning, keep researching and to keep asking questions. My dad has also been vital for assisting me with managing my new Cypriot vines that have been propagated. He has diligently taken care of them while I have been travelling around the world.

Abbreviations

AGW	Australian Grape and Wine
AWRI	Australian Wine Research Institute
ASVO	Australian Society of Viticulture and Oenolgy
COVID-19	Corona Virus Disease 2019
CFS	Committee on World Food Security
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DFAT	Department of Foreign Affairs and Trade
FAO	Food and Agriculture Organisation
FSANZ	Food Standards Australia New Zealand
GMO	Genetically Modified Organisms
NBT	New Breeding Techniques
NGC	National Grapevine Collection
OIV	International Organisation of Vine and Wine
SDG	Sustainable Development Goals
UN	United Nations
WFF	World Food Forum

Objectives

The objectives of this report are to identify winegrape varieties that require less cultivation inputs while increasing the demand and premium paid for Australian wine by:

- recommending and importing varieties that better suit South Australia and are either not yet in the country or not widely cultivated;
- better suit a changing and variable climate;
- better suit changing consumer demands and export markets;
- and increase the current genetic diversity.

Introduction

The Australian wine industry has been undergoing a period of upheaval over the last 10 years or so with the situation becoming worse in November 2020. Large tariffs placed on Australian wine being imported into China, along with climate challenges, the global COVID-19 pandemic and changing consumer preferences have all resulted in a dramatic drop in sales.

In 2023 winegrape production dropped by 24% to 1.32 million tonnes and was the lowest volume since 2000. Australia has slipped to 6th in the global production ranking and 5th in terms of exports. This has led to an oversupply of wine with an estimated 2 billion litre stockpile of wine. The majority of this stockpile is red wine, made up of Shiraz and Cabernet Sauvignon (Wine Australia 2023a).

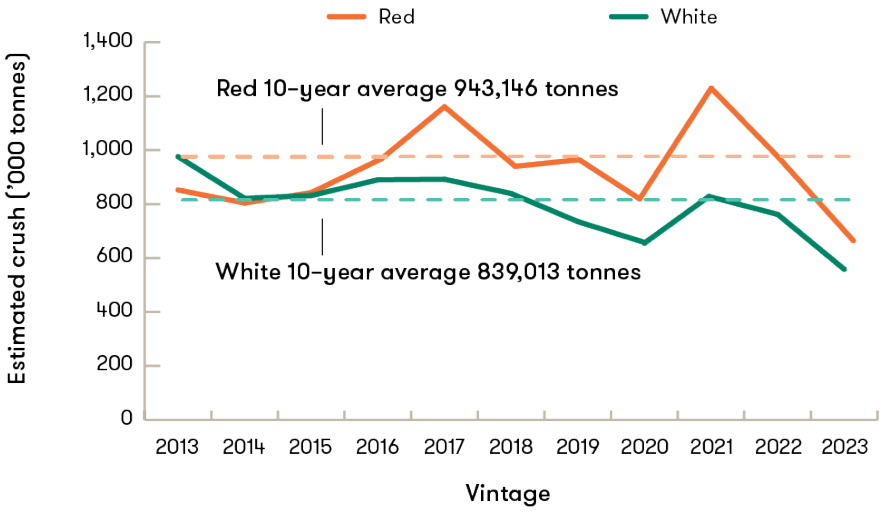

Figure 1: Total volume of red and white grapes crushed 2013-2023 (Source: Wine Australia 2023 vintage report)

Consequently, many growers are now seeking to leave the industry, especially in the inland Riverland region. In April 2024, the regional industry body Riverland Wine proposed a government funded exit package for growers that included a payment of $4,000 per hectare to remove up to 3,000 hectares of vines across the region. The package included support for vineyard owners to remove vines and plant other crops, assistance to develop export opportunities and a domestic marketing campaign. Australian Grape and Wine (AGW) also requested an $86 million recovery package from the federal government in the 2024-2025 budget, but no sector-specific funding was forthcoming. Instead, the federal government provided $3.5 million to help the wine industry address the wine and grape oversupply (AGW 2024).

In March 2024, the Chinese government removed the tariffs that were imposed on Australian exports in 2020, however the large stockpile of wine means it will be several years before an improvement in the export market will be seen. This has meant that Wine Australia has had to adjust its goals somewhat to meet these industry challenges. These include seeking new markets for Australian wine, investigating varieties that require less resource inputs, greater sustainability priorities, different styles of low/no alcohol wine and a larger focus on white wine (Wine Australia 2024a).

Figure 2: Wine sector sustainability strategic priorities (source: Wine Australia 2024a).

One solution to these problems has been the ongoing exploration of “alternative” winegrape varieties. However, the term “alternative” has become contentious, with many in the industry now eschewing the term as these varieties are not alternative in their homelands. The term “emerging” varieties also has similar connotations. Therefore, the terms “non-traditional” and “lesser known” varieties has become commonplace in research fields (Copper et al. 2019, Mezei et al. 2021). Lesser known varieties is the term that will be used to describe the varieties explored in this report.

Chapter 1: Australian Wine Industry

History

Australia's grape and wine history is over 200 years old and begins with the arrival of the British First Fleet in 1788. During the voyage, grapevine cuttings and seeds were collected at Rio de Janeiro and the Cape of Good Hope. These cuttings and seeds provided the source of Australia's first vineyards at Farm Cove (NSW), the site of the first settlement. Philip Schaeffer, the colony's first free settler, was producing wine at his farm called 'The Vineyard' by 1795. John Macarthur also planted vineyards in that period at his properties 'Elizabeth Farm' at Parramatta and at Camden Park to the southwest of Sydney (Bastian and Iland 2020).

In 1816, John Macarthur travelled with his sons to France and collected vine cuttings for shipment back to Australia. In 1831, James Busby travelled to Europe to study grape growing and collected and shipped about 650 types of vine cuttings to his vineyards. Official records indicate that 362 arrived alive and healthy. Plantings were made of these cuttings at the Sydney Botanic Gardens, Kirkton in the Hunter Valley, and the Macarthur family's property at Camden Park. These collections brought French and Spanish grape varieties to Australian vineyards (Bastian and Iland 2020).

Material from Busby's collection established many vineyards planted in the1800s. Current popular varieties including Riesling, Semillon, Grenache, Mataro, Shiraz, Cabernet Sauvignon, and Pinot Noir can be traced back to the Busby collection or perhaps to William Macarthur's own imports in 1838. Some of these old vineyards still survive today in the Barossa Valley region of South Australia. These vines are some of the oldest continuously producing vines in the world. They have been able to survive because of the absence of the grapevine pest phylloxera, which to date has never been found in South Australia (Bastian and Iland 2020).

Since there are no indigenous grape varieties to Australia, this tradition of importing vines has continued. Today over 160 different winegrape varieties are cultivated commercially in Australia (Wine Australia 2023b). With over 10,000 winegrape varieties in the world (OIV 2017), the potential to find varieties that are well matched to the Australian climate and consumer is almost endless and an exciting prospect for the industry's future.

Climate

Australia is experiencing the effects of climate change with 2019 reported as the hottest and driest year since records began in 1910. The area-averaged mean temperature for 2019 1.52°C above the 1961–1990 average, while mean maximum temperatures were 2.09°C above average and mean minimum temperatures were 0.95°C above average. It was also the driest year on record, with a nationally averaged rainfall of 277.6mm, which is 40mm below the 1961–1990 average. A triple La Niña weather event in 2020/21, 2021/22 and 2022/23 increased average rainfalls and decreased average temperatures nationwide. However, Winter 2023 was Australia's warmest on record, with the national mean temperature 1.53 °C above the 1961–1990 average. These data far exceed the previously reported increase in average

temperatures, which has been approximately 1°C since the middle of the 20th Century (Webb, 2007).

The changes in climate have made viticulture more challenging in many regions, causing an advancement in phenological development, particularly in hot years, which results in earlier harvest dates at higher temperatures and higher grape sugar concentration. This is partly due to warming climates, but it is also due to drought conditions and reduced water availability (Webb et al. 2013). Winegrape maturity is occurring earlier due to the warming climate. This creates the effect known as 'vintage/harvest compression', whereby different varieties ripen at the same time, placing great pressure on winery resources and logistics (Jarvis et al. 2019).

Ongoing climate change and a further reduction in average rainfall is expected over the coming decades (Johnson et al. 2018). For example, it is predicted that by 2030 most coastal regions in Australia will experience an increase in average temperatures of 0.7-0.9°C and 1-1.2°C inland. Annual rainfall is also predicted to decrease by 2.5 to 5% in most regions of Australia. In marginal wine growing regions such as South Australia, the suitability for growing grapes will decline more rapidly (Remenyi et al. 2019). In 2024 the Clare Valley wine region experienced an extremely dry period, receiving less than 100mm of rain from January 1st to the 30th of June 2024. (Australian Bureau of Meteorology, 2024).

It is therefore imperative for wine producers in warm to hot growing regions to develop strategies to mitigate and adapt to these changes in climate. Some of these strategies include sourcing lesser known varieties from regions in the world with similar climatic conditions. The majority of South Australian wine regions are located at a latitude of approximately 35 degrees South. Therefore, investigating wine regions at a latitude of approximately 35 degrees North is one possible pathway. As well as seeking to improve grapevine genetics and embracing new breeding techniques.

Consumers

Consistent with global trends, the number of people and the frequency of wine drinking in Australia are both decreasing. The main drivers of this reduced consumption are health and wellness, economic pressures, reduced discretionary spending and competition from other alcohol categories, particularly ready to drink (RTD) products. Some regular wine drinkers are choosing a narrower range of wine styles and varieties, possibly because of drinking on fewer occasions. Younger consumers also have different taste preferences compared with older consumers regarding attributes of both red and white wines. Sustainability is becoming more important to consumers but does not yet significantly drive wine purchases. While consumption of no/low alcohol wine is also expected to grow over the next five years, mainly driven by younger consumers (Wine Australia 2024b).

Recent consumer studies have also demonstrated that younger inexperienced wine drinkers are more likely to try lesser known wine varieties than older experienced consumers (Copper et al. 2019, Mezei et al. 2021, Long et al. 2023). Sales of the top six "traditional" white varieties and top four red varieties have decreased in the past 12 months, continuing a trend that emerged in 2022. Only some lesser known varieties such as Durif, Zinfandel/Primitivo, Gamay, Albariño and Grüner Veltliner have shown an increase in consumption since 2019 (Wine Australia 2024c). Other lesser known

varieties that have increased in popularity from the period 2007-2022 include Aglianico, Alicante Henri Bourschet, Arneis, Barbera, Canada Muscat, Cinsaut, Côt (Malbec), Dolcetto, Fiano, Graciano, Lagrain, Montepulciano, Nebbiolo, Nero d'Avelo, Prosecco, Rousanne, Saperavi, Tempranillo, Touriga National and Vermentino (Anderson and Puga 2023).

Previously it was thought that the strange and unusual names of lesser known winegrape varieties and their wines may be a hindrance to their popularity and be intimidating for consumers. Fortunately, this is changing and a recent study by Marbach et al. (2024) found that consumers, and in particular younger inexperienced wine drinkers, who were provided with phonetic spellings were more inclined to choose wines with intimidating names. The inclusion of phonetic spelling not only reduced the perceived risk in buying wines with unfamiliar names, but it also served as an educational tool for the consumers.

Different age groups are also looking for different attributes in an ideal wine. The most popular attribute for white wine is "easy to drink". Conversely, the younger age group are statistically more likely to choose "sweet", "delicate", "soft" and "simple" attributes in wine. When it comes to red wine, "smooth" is the most popular attribute, followed by "full-bodied". Full-bodied is a lot less popular with younger inexperienced consumers, and a lot more popular among older wine drinkers. (Wine Australia 2024c).

Similar results have been seen with recent Australian consumer studies for lesser known red wines (Mezei et al. 2021, Long et al. 2023) and white wines from Cyprus (Copper 2019). In both cases younger consumers preferred the fruitier, simpler styles. Excessively acidic and astringent white wines not well liked at all. Gargat (2024) has also highlighted this issue stating that; "One problem can be perceptions of acidity. There are perhaps too many winemakers for whom acidity rules, and for whom it seems that the higher the acidity, the better. It means that too often the acidity dominates and can lead to some wines being out of balance". This was also highlighted by Bazala et al. (2015), who found that younger consumers did not like overly acidic Riesling wines.

Therefore, this is an issue for the Australian wine industry when making white wines with high acidity. Older, experienced consumers may appreciate these stlyes, but younger consumers do not like them. This is a potential reason for young wine drinkers moving towards lesser known varieties, low/no alcohol wines and RTD's. This requires further research and investigation if the industry ambition is to attract more young consumers to Australian wine products, particularly white wine.

Chapter 2: Cyprus

Cyprus is a small island of 9251km² that sits at a latitude of approximately 35.1 degrees North in the Mediterranean Sea and is bordered by Turkey, Syria, Israel, Lebanon, Greece and Egypt. It is reported to have the oldest wine tradition in the Mediterranean with more than 5,500 years of wine production with a vineyard area of approximately 7,000 hectares (Chrysargyris et al. 2018b). It has been described by Evans (2009) and Lelieveld et al. (2016) as the cradle of viticulture and that this area is gradually and steadily becoming hotter and drier due to climate change. Many indigenous grape varieties originating from the region have been hand selected for millennia for their resistance to heat and drought (Fraga et al. 2016; Patakas et al. 2005). During the summer period, grapevines cultivated in the Mediterranean are often subjected to a combination of environmental stresses including strong winds, high air temperatures, heat waves and soil/atmospheric water deficits (Beis and Patakas, 2012 and Chrysargyris et al. 2018a). Average rainfall varies from 450-700mm depending on the region.

There are more than 10 indigenous Cypriot grape varieties on the island, with many of them very well adapted to drought. They require less water and fertilisers when compared to introduced varieties and offer promising prospects for adaptation to climate change (Litskas et al. 2017). This climate scenario of Cyprus is very similar to that of South Australia and as such their indigenous varieties may also be a suitable strategy to mitigate climate change effects in Australian conditions.

Six wineries and vineyards were visited during the study tour of Cyprus, with discussions held with winemakers and viticulturists. A meeting with Costa Constanti the CEO of a consulting company was also held in Nicosia, to discuss the state of play of culture, food and agriculture in Cyprus.

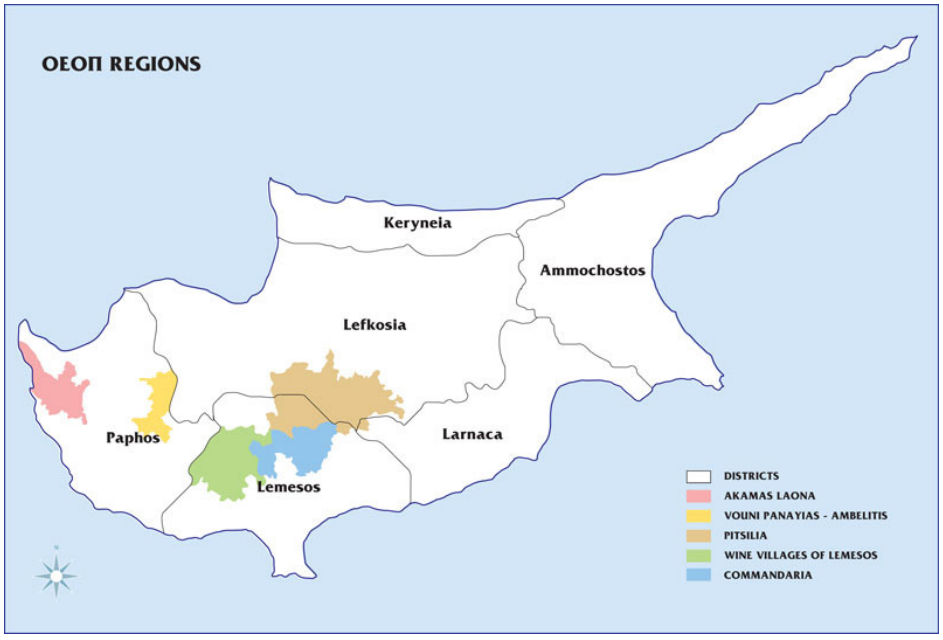

Figure 3: Wine regions of Cyprus (source: cypruswine.com)

Viticulture and winemaking

For this project, the Pafos and Pitsillia wine regions were chosen to be explored as they had the highest number of indigenous vine plantings. The majority of vineyards are still cultivated in the traditional bush vine method, with frequent tillage of the vineyard and no irrigation. Cyprus reportedly has never had an infestation of phylloxera; therefore all vines are grown on their own roots, without the need for resistant rootstock. This is a unique situation with the majority of European countries using grapevines planted on rootstock.

With the changing climate, many wineries are now converting their vineyards to trellising systems with some installing irrigation as well. The vineyard soils have a high predominance of calcium due to limestone, loam, sand and clay soil types. Some vineyards are also embracing organic and biodynamic cultivation methods, with cover crops, animal manure-based fertilisers and compost being used in lieu of synthetic fertilisers. All vineyards are hand harvested. Yields therefore can vary greatly depending on cultivation methods, with bush vines averaging 3-5 tonnes per hectare, while irrigated/trellised vineyards can achieve 8-15 tonnes per hectare depending on the variety.

The following varieties have been identified as candidates for future cultivation in Australia and were arrived at by discussions with the various vineyard and winery owners interviewed. (Tsiakkas, Kapnisis, Koundouras, Kyrikadis, Makarounas, Ioannou, Constanti and Kyrikades 2023).

White cultivars

Kanella: Is a rare variety thought to be related to Morokanella, but this has not been proven genetically. It has similar growth characteristics to Morokanella as well. Meaning “cinnamon” the variety has more of a spicy, cinnamon characteristic than Morokanella.

Morokanella: A mid-season ripening variety with good drought tolerance due to a “fury” underside of the leaves. Average skin thickness with good disease resistance. It has medium acidity with characteristics of floral, spice, peach, pear, quince and citrus.

Promara: Meaning “early” is the first indigenous variety to ripen in Cyprus. It is a rare variety that is resistant to drought, has thick skin and good disease resistance. It has medium acidity and characteristics of apricot kernel, watermelon and citrus.

Spourtiko: According to DNA analyses, it is closely related to the red variety Opthalmo. It ripens mid-season, is relatively resistant to various diseases and has moderate to high acidity with characteristics of grapefruit and lemon sherbert. It has a thin skin, which is where its name is derived, meaning “to burst”.

Vasilisa: For a long time Morokanella was confused with this variety, they are however not genetically related. The flavour profile is very similar but with slightly more apricot kernel characteristics. The leaf characteristics and berry shape also distinguish it from Morokanella. It is mid-season ripening, with moderate acidity.

Xynisteri: Is the most widely grown variety in Cyprus and is utilised for table wine, the sweet wine Commandaria and traditional sweets. It is late ripening with low to medium acidity and has characteristics of white peach, tropical, pineapple and citrus. It is grown in all regions predominantly without irrigation and is extremely drought tolerant. It has

thick skin and good disease resistance. It was imported into South Australia in 2018 and is currently undergoing field trials in three different wine regions.

Red cultivars

Giannoudi: Means “Little John” and the variety is literally the little brother to Maratheftiko. The wines are very similar in characteristic, but less intense and a somewhat lighter version of Maratheftiko. The leaves do not have the same “furry” characteristic of Maratheftiko, however its drought tolerance appears to be similar and ripening is slightly earlier than Maratheftiko.

Lefkada: Is technically not a Cypriot variety, it was imported to the island over 1600 years ago from Greece where it is known as Vetzami. Its plantings in Cyprus exceed those in Greece and Lefkada has been adopted as a native Cypriot red grape. It is a drought tolerant, mid-season ripening variety which produces small bunches of thick-skinned grapes. It has characteristics of red berries, cherries, savoury, herbs and strong tannins if not vinified with care.

Maratheftiko: Is the red variety with the most promise. It is very drought tolerant, partly due to its “fury” underside of the leaves. It is a late ripening variety with thick skins, good disease resistance and moderate acidity. It has characteristics of violets, floral, spice, chocolate, red fruits and a good tannin structure.

It does however have fruit set problems when grown as a bush vine. The low self-pollination rate is due to the “stumpy” male structures of the flowers. Although the flowers have well-developed pistils, the stamens are reflexed, which can decrease pollination. This has been overcome by planting trellised vines with alternating rows of Xynisteri and Maratheftiko at a 2:1 ratio. This ratio may even be too high, with over cropping an issue, further research for the ideal ratio of Xynisteri to Maratheftiko rows is required.

Maratheftiko was imported to Australia in 2018 and trials with alternating rows have shown no issues with pollination and fruit-set. Research is ongoing, but the fruit and wines produced so far show very good promise under South Australian conditions.

Mavro: Meaning “black” is a large berry variety that has traditionally been used to blend with Xynisteri to make the sweet wine Commandaria. It is mainly grown a s a bush vine and produces a large number of bunches per vine. It is late ripening, has low acidity, and moderate red fruit characteristics. It is very drought tolerant and is grown throughout the island without irrigation.

In recent times there has been a resurgence by producers utilising this grape for making rose or a light bodied, low alcohol chillable red wine. These charatcteristics make it an interesting candidate for use in Australia, if not only for its genetic profile.

Opthalmo: Meaning eye in Greek. This variety is a bit of an enigma with only one commercial producer of the variety. Some people believing it is the Turkish variety Öküzgözü and others the Greek variety Voudomato. It has good drought tolerance, mid to late ripening and moderate acidity with soft tannins. It has characteristics of herbs, sun dried tomatoes and black olives.

Chapter 3: Malta

Malta and its capital Valletta cover 316km² and is located at a latitude of 35.9 degrees North. It is located in the Mediterranean Sea approximately 90km south of Sicily, with the coast of Africa approximately 300km away. It consists of the three inhabited islands of Malta (246 km²), Gozo (67 km²) and Comino (3 km²) as well as the uninhabited islands of Cominotto, Filfla and St. Paul's Islands.

Wine growing was established by the Phoenicians, who settled the island around 800 BC. This was then continued by the Romans from 200 BC, when they occupied the island. The Knights of the Order of St John (the later Knights of Malta) produced mainly religious wine during their rule from the 16th to the 18th century.

The Mediterranean climate of Malta is characterised by hot, dry summers and cool, rainy winters. There are no rivers in Malta, making it one of the countries with the least water in the world. Irrigation is necessary for the international varieties as annual rainfall is approximately 600mm. The indigenous varieties are predominantly grown without irrigation (Robinson et al. 2013).

Meetings took place with two wineries. One based in the township of Paola, Marsovin winery and the other in the hills south of the capital of Valetta at Dingli with Mark Borg from Markus Divinus Wines.

Figure 4: Maltese vineyard areas, brown shading. (source: https://glossary.wein.plus/malta)

Viticulture and winemaking

The vineyard area covers approximately 1000 hectares on loam, sand, clay and limestone soils. International varieties were planted from the end of the 1970s. Before the grapevine pest phylloxera destroyed European vineyards, there were reportedly

120 indigenous varieties in Malta. Today only 2 are used in commercial winemaking with small plantings of other indigenous varieties believed to exist. Genetic testing of these remnant varieties is currently being undertaken by Maltese researchers (Borg 2023). Phylloxera resistant rootstocks are therefore necessary for all the varieties grown, including those indigenous to the islands.

Similarly to Cyprus, the majority of vineyards are grown as traditional bush vines with a few vineyards using trellising. Harvesting is all done by handpicking. Yields are also similar to Cyprus with bush vines averaging 3-5 tonnes per hectare, while irrigated/trellised vineyards can achieve 8-15 tonnes per hectare depending on the variety. The indigenous varieties have adapted to the local conditions in that they do not become over ripe with hot weather and are able to maintain lower alcohol levels and moderate acidity where the international varieties cannot (Borg 2023).

White cultivars

Gennarua: Not known to be used in any commercial wines. It is often used by small growers to make their own wine for home use. It is Similar to Girgentina, but with an even lighter flavour profile.

Girgentina: Produces numerous large bunches and must be managed well to avoid fungal problems. Wines are generally low in alcohol and have moderate acidity. The flavour is reminiscent of Sauvignon Blanc and it is often blended with that and Chardonnay to add complexity to the wines.

Red cultivar

Gellewza: Is a lighter style red that is similar to Pinot Noir but with a more intense colour. Wines are generally low in alcohol and have moderate acidity. It is often blended with international varieties to decrease their alcohol concentration.

Chapter 4: Greece

Greece has a rich 4000-year history of grape growing and wine making (Lazarakis 2005). It is comprised of four distinct wine regions, all with unique characteristics Currently approximately 50,000 hectares of vines are cultivated for wine in Greece with over 300 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, 2013).

This study builds on the work of fellow Nuffield Australia scholar Martin Gransden, who travelled through Greece in 2018. It does not seek to copy the work of Gransden 2018, but to add to it. The main area of interest for this project was Crete with a latitude of approximately 35.2 degrees North, however much of Greece has a hot, winter rainfall dominant climate similar to that of South Australia.

Meetings took place at the Cretan wine fair “Oinotika” in Athens. This was guided by winemaker and translator Aikaterini Mylona**,** to help ascertain wineries of interest before travelling to the island. The Ointotika meeting consisted of 30 wineries from Crete with some 300 different wines available to taste.

Extended meetings and discussions took place with the renowned viticulturist Professor Stefanos Koundouras in Thessaloniki. As well as visiting a winery near Thessaloniki and meeting with their chief winemaker Natalia Kataiftsi. On Crete two wineries and vineyards were visited, Lyrirakis and Fragospito, both of which only grow Cretan and Greek varieties, with Fragospito also being an organic vineyard.

Figure 5: Greek wine regions (source: Winefolly.com)

Viticulture and winemaking

Most of the soils of Greece, in both the mountains and the islands, are composed of limestone and sandstone. In most cases the soils are shallow and poor, often revealing the underlying rock. The notable exceptions are the three main plains, which are deep, more fertile, and have a higher proportion of clay. The areas closer to the sea also have richer, mainly alluvial soils, while some of the islands, like Santorini, can be volcanic with soils that are extremely deficient in nutrients. As a result, loam, schist, chalk, sand, and many other types of soils can be found (Lazarakis 2005). There are very few rivers, most are small and tend to dry up during the summer months. Rainfall is similar to that of Cyprus ranging from 500-700mm per year depending on the region (Koundouras 2023).

Crete and the southern Aegean islands are located at a latitude of approximately 35.1 degrees North, similar to that of Cyprus. Therefore, these regions and their varieties were the focus of this project. Many of these Greek varieties are heavy cropping and if care is not taken during cultivation, this can make them prone to fungal diseases such as mildews and Botrytis. Therefore, vines must be kept in balance to be able to ripen the fruit, provide a good yield and allow for sufficient airflow so as not to allow fungal disease to proliferate. Grape vine viruses are also an issue in many Greek vineyards, with research currently being done to improve resistance. Both fungal and viral diseases are potentially able to be irradicated utilising new breeding techniques and gene editing, this will be discussed further in chapter 6. Currently the majority of mainland Greek vineyards use phylloxera resistant rootstock, however some of the island vineyards use own-rooted indigenous vines.

The following list of cultivars was established following interviews with the Greek wine makers, researchers and viticulturists (Koundouras, Mylona, Kataiftsi, Gavalas 2023) as well as other literature resources (Lazarakis 2005, Robinson 2013).

White cultivars

Aidani: Is a robust variety with good drought resistance and mid-season ripening. It has large bunches of densely packed berries. It has characteristics of yellow peach, citrus, and flowers. It has moderate alcohol and moderate acidity.

Athiri: Is a vigorous growing variety with very good drought resistance and mid-season ripening. It has characteristics of white and yellow peach, citrus, apple and pear, with moderate alcohol levels, medium acidity and a medium body.

Dafni: Meaning Laurel or Bay tree in Greek is a late ripening variety with high yields. It has thick skin, large oval shaped berries and good tolerance to diseases. It has characteristics of bay leaf, rosemary, herbal, spice, tropical fruits, citrus and moderate acidity.

Malagousia: Has good drought tolerance and high yields of thin skinned buches. It has characteristics of peach, green capsicum, herbs, flowers and is quite aromatic with moderate acidity.

Melissaki: Is a rare variety meaning “little bee” in Greek. It is a very hardy and drought tolerant variety that is late ripening. It has characteristics of honey, white peach, lemon verbena, savoury herbs and moderate acidity.

Moschofilero Is a pink skinned late ripening variety, very drought tolerant and high yielding. It has characteristics of citrus, green apple, pear, peach and rose petals with a moderate to high acidity.

Monemvasia: Is a very drought tolerant variety grown on rocky soils. It has characteristics of citrus and white peach, spice, with moderate acidity and alcohol levels. It is often used in dessert wines.

Plyto: Is a vigorous high yielding variety with excellent drought and heat tolerance. It has characteristics of green apple, lemon, citrus, herbal and grassy with moderate acidity.

Roditis: Is one of the most widely planted variety in Greece. It is classed as a white variety, making white wines, but is pink skinned. It is very drought and heat tolerant, late ripening and capable of high yields. It has characteristics of citrus, green apple, pineapple, melon, pear, banana and white flowers. It has moderate acidity and alcohol levels and is often used as the base to make the famous Retsina wine with the addition of pine resin.

Savvatiano: Along with Roditis, this another of the most widely planted varieties in Greece. It is also used in the famous Retsina wines. Traditionally it was grown as a bush vine with mixed results. Nowadays it is grown on trellis and can tolerate heat and drought very well. It has characteristics of citrus, tropical and stone fruits with a moderate acidity.

Sideritis: Is another pink-skinned variety, with tough, thick skin. It is late ripening, drought tolerant, vigorous and high yielding. It produces large bunches with large berries. It has characteristics of citrus, white flowers, green apple, stone fruit and white pepper. It has moderate alcohol and moderate acidity.

Tachtas: Is another old and rare variety with only a few growers in Crete cultivating it. It is very drought tolerant and has characteristics of pear, apricot, peach, flowers and herbs. It has moderate acidity and alcohol levels.

Thrapsathiri: Is a high yielding variety with extremely good heat and drought tolerance. It is mid-season ripening and has characteristics of peach and melon with moderate acidity and alcohol.

Vidiano: Is a very drought and heat tolerant variety that is late ripening. It is somewhat rare with growers only recently increasing their plantings. It has characteristics of stone fruit, flowers and herbs. It has a medium to high alcohol and medium to high acidity.

Vilana: Is a vigorous, high yielding, mid-season ripening variety with good heat and drought tolerance. It has characteristics of lemon, orange, pear, jasmine and herbs. It also has medium acidity and alcohol levels.

Vostilidi: is another rare variety that grows on the rocky island soils. It has very good heat and drought tolerance with mid-season ripening. It has characteristics of orange, tropical fruits, honey and moderate tannins. It has moderate acidity and alcohol levels.

Red cultivars

Agiorgitiko: Is a high yielding, late ripening variety with moderate tolerance to drought and heat. It currently exists in Australia, but to date is not being commercially cultivated by any wineries. It has characteristics of red fruits, sweet spices, nutmeg, cinnamon

and chocolate. It has moderate acidity, moderate to high alcohol and moderate tannin levels.

Kotsifali: Is an early to mid-ripening, thin skinned variety with good tolerance to disease, heat and drought. It has been described as “the Pinot Noir of Crete”. It has characteristics of sweet flowers, dried black fruit, and spices. It has moderate acidity and tannins and moderate to high alcohol, however the wine is often low in colour.

Liatiko: Is an early to mid-ripening variety with good tolerance to disease, heat and drought. It has characteristics of red fruits, herbs, spice and leather. It is pale in colour with moderate acidity, low to moderate tannins and moderate to high alcohol.

Limnio: Is a mid-season ripening variety with good heat and drought tolerance. It has characteristics of herbs, red berries and is light in colour. It has medium acidity, medium tannins and moderately high alcohol.

Limniona: Is a very late ripening variety with very good heat and drought tolerance. It has large thick-skinned berries that make it disease resistant. It has characteristics of red fruit, herbs, grass and spices. It has moderate acidity, moderate tannins and moderate alcohol levels.

Mandilari: Is a vigorous and high yielding variety with high tolerance of heat and drought. It has been referred to as “the Cabernet Sauvignon of Crete” and has characteristics of red fruits, herbs, spice and leather. It has moderate acidity, moderate to high alcohol and high tannins.

Mavrodaphne: Is a mid-season ripening variety with good heat and drought tolerance. It has characteristic of dried prunes, currants, black berries, herbs, grass and leather. It is an almost black colour with high alcohol, medium acidity and moderate to high tannins.

Mavrotragano: Meaning black and crunchy, it is a vigorous, mid to late-ripening variety and has low fertility, leading to inconsistent yields. It is very drought and heat tolerant and has characteristics of red and black fruits, flowers, smoke, coffee, spice and leather. It has been described as “the Syrah/Shiraz of Santorini” and has a dark colour with moderate acidity, high tannins and moderate to high alcohol.

Mouchtaro: Is a very rare, late ripening, vigorous variety with very good heat and drought tolerance. It has characteristics of red and black fruits, spices, herbs, medium acidity, medium to high alcohol and medium to high tannins.

Negoska: Is a mid-season ripening, variety with good heat and drought tolerance. It has characteristics of red and black fruits, chocolate, medium acidity and tannins, with moderate to high alcohol.

Romeiko: Is a high yielding, late ripening variety that has excellent heat and drought tolerance. Although it is a red grape, it is sometimes made as a white wine as well. The red wines have characteristics of herbs, baked fruit, persimmons and apples. It is light in colour, medium acidity, moderate alcohol and moderate to high tannins.

Vetzami: See Lefkada in Cyprus Chapter 2. It is a drought tolerant, mid-season ripening variety which produces small bunches of thick-skinned grapes. It has characteristics of red berries, cherries, savoury, herbs and strong tannins if not vinified with care.

Vradiano: Meaning “lazy or moves slowly or arrives late”, is a vigorous, high yielding, very late ripening variety with good heat and drought tolerance. It has medium sized

grapes in medium sized bunches. It has characteristics of red fruit, spice and chocolate with medium acidity, medium tannins and medium to high alcohol levels.

Chapter 5: Turkey

Turkey has one of the longest winegrape growing and wine making histories of the region, stretching back 9500 years. Along with Georgia, Armenia, Syria, Israel and Cyprus, they claim to have the oldest and original wine making in the region. This title is much debated in the literature, however there is no doubt that some of the earliest grape cultivation began in Mesopotamia and western Asia some 10,000 years ago (Hirsch 2015).

Turkey has eight wine regions that sit at latitudes between 36-39 degrees North. It has approximately 448,000 Hectares of vineyards with 146 wineries producing 60 million litres of wine per year (LeMieux 2021).

Figure 6: Wine regions of Turkey
(source: https://thisdayinwinehistory.com/the-anatolian-wine-industry)

Viticulture and winemaking

Due to the large area of Turkey the vineyard soils and climate can vary greatly. Soil types are typically limestone, calcareous, clay, loam, volcanic, basalt and sandstone. The climate is typically arid to Mediterranean with hot summers and cold winters with rainfall predominantly in winter. Rainfall in the more southerly wine regions varies between 500-700mm.

Turkey has more than 1244 indigenous grape varieties, with only 60 of those regularly cultivated and used for winemaking today. Wineries continue to rediscover old varieties, some of these include Fesleğen, Narınç. Gelveri, Kızıl, Lake Koku, It,Taş, Selvi Karasi and Urla Karasi.

Unfortunately, their production is very small and limited data is available on their traits, growth and wine. However, researchers are continually rediscovering some of these old varieties and preserving their DNA for future reference. Currently Turkish vineyards are using a mixture of own-rooted vines and vines on rootstock. Many of the indigenous vines are cultivated on their own roots, particularly in the hot, dry southeast Anatolian region (LeMieux 2021, Karatas 2024, Apaydin 2024).

The Turkish wine industry is in a rather unique position, with approximately 65% of the industry workers being female. The percentage of female winemakers is closer to 80% and probably the highest for any country. This gives Turkish wine a unique perspective and potentially creates wines that are more suited to female tastes (Gürbüzatik 2024).

The following list of varieties was compiled following discussions with researchers, industry workers and authors at the Root, Origin and Soil conference in Istanbul (LeMieux 2021, Karatas 2024, Apaydin 2024, Gürbüzatik 2024).

White cultivars

Beyazkere: Is a recent discovery and is a spontaneous mutation of the popular red variety Bogazkere. It is a mid-season ripening variety that has good heat and drought tolerance. It has characteristics of citrus, quince, herbs and flowers with medium acidity and low tannin.

Bornova Misketi: As the name suggests is related to other Muscat varieties but is genetically unique. It has good heat and drought tolerance and is harvested at various times to produce a range of wines from dry to sweet dessert wines. It has pinkish green berries that grow in large bunches. It has characteristics of orange blossom, bergamot, melo, rose and flowers. It has medium acidity and low tannin.

Emir: Is very heat and drought tolerant and prefers sandy, otherwise infertile sites. It is mid-season ripening, producing medium sized bunches. It has characteristics of apple, pineapple, kiwi, citrus and rose. It has medium acidity and generally moderate alcohol levels.

Gök: Has good heat and drought tolerance and is a mid-season ripening variety. It grows in the mountainous mediterranean region and produces medium sized bunches. It has characteristics of apple, pear, quince, pineapple, lychee and flowers. It has medium acidity and moderate alcohol levels.

Hasandede: Is actually grown as a table grape predominantly and has thin skinned berries with medium sized bunches. Only a few producers vinify it, however it produces aromatic wines with characteristics of kiwi, citrus, orange blossom and flowers. It has medium acidity, medium tannins and medium to high alcohol levels.

Kerküs: Is mainly grown in the hot dry south-eastern Anatolian region and is very drought tolerant. It is late ripening and produces thick skinned berries on large bunches. It has characteristics of peach, citrus peel, herbs and pepper with medium acidity, medium tannins and moderate to high alcohol levels.

Kolorko: Is a very rare variety that has very good heat and drought tolerance. It is late ripening and produces thick skinned berries on medium sized bunches. It has characteristics of apple, pear, fennel and honey with medium acidity, high tannins and medium to high alcohol.

Marzona: Is grown in conjunction with Kerküs and they are often blended together. It is however a mid-season ripening variety and produces thin skinned berries on medium bunches. It has medium to high acidity and is therefore used to help balance Kerküs wines if they are lacking in acidity.

Narince: Is the most popular white variety of Turkey and is widely grown across all the wine regions. It has good heat and drought tolerance and has good adaptability to differing conditions. It is a mid-late ripening variety producing large berried, large bunches. It has characteristics of orange, grapefruit, apple, pineapple, herbs and flowers. It has a medium to high acidity, low tannins and can be made with medium to high alcohol levels.

Osmanca: Is another very rare variety with good heat and drought tolerance. It produces thin skinned, medium to large berries on medium to large bunches. It has characteristics of apple, citrus and white peach with medium to high acidity and moderate alcohol levels.

Sidalan: Is yet another very rare grape that has limited details on its growing preferences. It is a mid-season ripening variety with good heat and drought tolerance. It produces medium sized berries with large bunches. It has characteristics of lemon, citrus, pear, pineapple and tropical fruits with medium to high acidity and medium alcohol.

Sungurlu: Is often confused with Hasandede and there is much debate about whether they are related or actually the same variety. It does however produce wines different to Hasandede, that is, with characteristics of apple, pear, melon, cucumber, flowers and herbs. It has medium to high acidity and moderate alcohol levels.

Vasilaki: Is a heat and drought tolerant variety that produces small thick skinned berries on large bunches. It is known for its low acidity and is often harvested earlier in the season to try and maintain some of its natural acidity. It has characteristics of citrus, apple, pear, flowers and cloves. It has low tannins and moderate alcohol levels.

Red cultivars

Acikara: Is a rare variety with good heat and drought tolerance. The word “kara” in Turkish means black, hence many of the red varieties have “kara” in their name. Acikara has thick skinned, medium sized berries on medium sized bunches. It has characteristics of Plum jam, pepper, chocolate, pepper and cinnamon. It has medium acidity, medium to high tannins and moderate to high alcohol levels.

Ada Karasi: Is a thick skinned variety with good heat and drought tolerance. It is currently only cultivated by one producer and produces wines with characteristics of raspberry, red fruits, citrus, pepper and cloves. It has medium to high acidity, low to medium tannins and moderate alcohol. The wine is sometimes referred to as a” summer red” and is served slightly chilled.

Barburi: Is yet another rare variety being cultivated by a single producer. It has very good heat and drought tolerance and produces thick skinned berries on medium sized bunches. It has characteristics of blackberry, mulberry, cherry, pepper and violets. It has medium to high acidity, medium tannins and medium alcohol levels.

Bogazkere: Is the most popular red variety of Turkey. It originates from the hot, dry southeast Anatolian region, but is cultivated widely due to its popularity. The variety has also been exported to Australia and is currently being cultivated by Tallis winery in central Victoria. It is a thick skinned, mid to late season ripening variety with large bunches. It has characteristics of blackberry, mulberry, cherry, liquorice, pepper, clove, chocolate, eucalyptus and pine forest. It has medium acidity, high tannins and high alcohol levels.

Cakal: Is a very rare variety that has very thin skins and is early ripening. The berry skins are also very pale, so it is predominantly used to make rosé wines. It has characteristics of strawberry, mango, tropical fruits, medium acidity, low tannin and moderate alcohol.

Foca Karasi: Is another rare variety with thick skins. It is a mid-season ripening variety that produces medium sized bunches. It has characteristics of cherry, strawberry, prune, herbs, clove and pepper. It has high acidity, low to medium tannins with moderate alcohol. It is also grown in Greece, where it is known as Fokiano.

Kalecik Karasi: Is the third most popular variety that was “rediscovered” in the 1970’s and is now widely cultivated throughout Turkey. It produces thick skinned, medium size bunches and is harvested mid to late season. It has characteristics of strawberry, raspberry, cherry, capsicum, pepper, cloves and fairy floss. It has medium to high acidity, low tannin and moderate alcohol levels.

Karalahna: Is a variety that produces large berries that ripen mid to late season. The fruit does not achieve very high sugar levels and therefore its resultant wine is quite low in alcohol. It has characteristics of blackberry, cherry, pepper and spices with high acidity and high tannins.

Karaoglan: Comes from the hot and dry southeast Anatolian region and is therefore very suited to these conditions. It produces large bunches that ripen mid to late in the season. It has characteristics of cherry, fig, blackberry, plum, pepper, nutmeg and mint. It has moderate to high acidity, medium tannins and moderate alcohol levels.

Karasakiz: Is a very heat and drought tolerant variety that produces mid to late season ripening, large bunches. It has characteristics of cherry, strawberry, confectionary, pepper, thyme and spice. It has medium acidity, low tannin and moderate alcohol.

Kösetevek: Is a very heat and drought tolerant variety that comes from the hot and dry southeast Anatolian region. It is somewhat rare and only produced by two wineries. It has characteristics of cherries, plums, prunes and toffee with low acidity, medium/smooth tannins and moderate alcohol levels.

Merzifon Karasi: Another very rare variety that is mid to late ripening with very large buches. It has characteristics of raspberry, pomegranate, redberries, pepper and herbs. It has medium acidity, low tannin and moderate alcohol levels.

Öküzgözü: is the second most popular red variety after Bogazkere and originates from the hot and dry southeast Anatolian region. It is very heat and drought tolerant and therefore is now widely cultivated throughout Turkey. It produces large black berries in large bunches. It has characteristics of raspberry, cherry jam, pomegranate, chocolate, cloves and herbs. It has moderate to high acidity, medium tannins and moderate alcohol levels.

These vines are rumoured to have been imported into Australia, but as yet no commercial production of the variety or its wines can be found.

Papazkarasi: Or spelt Papaskarasi, this variety is over 1500 years old. It has good heat and drought tolerance and produces large bunches. It has characteristics of cherry, plum, olive, pepper, flowers and spice with high acidity, medium tannins and moderate alcohol.

Chapter 6: Food and Agriculture Organisation of the United Nations, Rome, Italy, October 2023

World Food Forum

The second edition of the Science and Innovation Forum, a key constituent of the annual flagship World Food Forum (WFF) was held in October 2023 in Rome at the Food and Agriculture Organisation (FAO) of the United Nations (UN). It involved three days of discussions and proposals on how technology can help agrifood systems deal with the climate crisis. Approximately 150 speakers from the world of academia, business, government and non-governmental organisations, as well as Indigenous People, shared their expertise and perspectives during a series of roundtables and panel discussions.

Take home messages relevant to this project were:

1. Agrifood systems are facing unprecedented challenges due to the adverse effects of climate change.
2. Science, technology and innovation are seen as the drivers of agrifood system transformation.
3. Cross-sector collaborations and strong partnerships play a key role in the transformation of agrifood systems.
4. Embrace inclusivity and equitable partnerships and engage youth, women and Indigenous Peoples in shaping the future of agrifood systems.
5. Climate resilience, adaption and mitigation cannot be achieved without science and innovation. It must include maintaining plant diversity in agriculture and furthering new breeding techniques such as gene editing.
6. Advancements in climate science regarding the assessment of loss and damage, as well as the potential of the global bioeconomy.
7. Bolster local knowledge networks and research institutions.

Committee on Food Security

The Committee on World Food Security (CFS) conference aims to eliminate hunger and malnutrition through improved policy convergence at global level, which leads to strengthened actions at national and regional levels. The conference also consisted of 36 side events over the five days of the main plenary. Each of these highlighted the work of stakeholders relevant to the CFS vision and mandate, especially where CFS policy guidance and frameworks are being effectively used to foster partnerships to advance the 2030 Agenda. In particular, the Sustainable Development Goal 2 (SDG2) of creating a world free of hunger by 2030.The global issue of hunger and food insecurity has shown an alarming increase since 2015, a trend exacerbated by a combination of factors including the pandemic, conflict, climate change, and deepening inequalities.

The side events of interest and relevance to this project related mainly to the issues of sustainability, biodiversity and climate change:

1. Harnessing evidence-based agrifood transformation for navigating multiple crises.
2. Food systems for the 21st century.
3. Promoting energy access to safeguard food security and nutrition gains within the agrifood systems and beyond.
4. Nature based solutions and decent rural employment in agrifood systems.
5. Implementing CFS guidelines on engaging youth in agriculture and food systems.
6. Global dialogue on water tenure for water & food security, social inclusion, and climate resilience.

Implications for the Australian wine industry

While wine is not a basic food requirement, it is however a discretionary food related product that holds significant cultural importance to many people. The growing of grapes and fermenting into wine has been occurring for thousands of years and has evolved alongside many other agricultural practices.

The Australian wine industry has increasingly been cognisant of its sustainability requirements within the agriculture sector and the issues highlighted by the UN CFS conference. The industry body Wine Australia has recently implemented a program entitled Sustainable Winegrowing Australia (SWA). SWA is Australia's national program for grape growers and winemakers to demonstrate and continuously improve their sustainability credentials in the vineyard and winery through the environmental, social and economic aspects of their businesses. The program takes a holistic approach to managing, supporting and promoting sustainability. It's modelled on global best practices and aligns with the United Nations Sustainable Development Goals (SDG2), with progress towards these being monitored annually (Wine Australia 2024a).

The SWA is an important initial step along with others such as the Eco-vineyards program. The national Eco-vineyards program aims to accelerate adoption and practice change outcomes to increase the land area dedicated to enhancing functional biodiversity by 10 per cent, and to increase the use of vineyard cover crops and soil remediation practices by 10 per cent (Ecovineyards 2024).

However, a major issue that was highlighted in the WFF as being one of the key factors in climate resilience, adaption and mitigation was that of maintaining the diversity of cultivated plants through new breeding techniques (NBT) such as gene editing or gene technology. Wine Australia and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) are currently conducting research into NBT's and gene editing (due to conclude in 2027) to produce clones of established grape varieties to improve their drought tolerance, disease resistance and their flavour profile characteristics. This is extremely valuable research, but unfortunately it is currently a purely academic pursuit. Gene editing and NBT's are presently considered Genetically Modified Organisms (GMO) and as such cannot be used for human consumption in Australia.

In a recent report published by the former Australian Grape and Wine CEO, Anthony Battaglene (2023) stated that; "It is the Australian wine industry's position that no genetically modified organisms, as defined under the Australia New Zealand Food

Standards Code (FSANZ) can be used in the production of wine. Our GMO policy encompasses gene splicing (gene editing), and these techniques cannot be used in wine grapes or wine additives in Australia at present.

FSANZ have been consulting on the definitions of ‘food produced using gene technology’ and ‘gene technology’, as the code currently lacks clarity on where certain new breeding techniques fall. Some of these techniques involve splicing and deleting susceptibility genes without the introduction of any foreign genetic material. International alignment is also important to avoid trade barriers and we are aware that there are currently a number of countries also having these discussions”.

This issue was discussed at the WFF science and innovation forum and the CFS side events and the general consensus from panel discussions was that NBT and gene editing is not GMO and as such should not be an obstacle to allowing crops from these new techniques be available for human consumption.

As part of the Australian delegation at these meetings, several members of the Department of Foreign Affairs and Trade (DFAT), from the Australian Embassy in Rome were present. Questions regarding these gene editing issues were put to the government representatives, but they were unable to provide any clarity on this situation at that time.

Whilst the current Wine Australia and the CSIRO gene research is admirable, growers and producers are left with uncertainty. It is therefore imperative, that while these issues are being resolved, the importation of rare and novel winegrape varieties continue. The importation of this material allows for new sustainable products to continue to be developed. It also provides genetic material for traditional breeding techniques and a gene bank for future use once the regulatory restrictions have been resolved. New varieties also continue to be of value to help diversify the range of products available to consumers. The recent Chinese import tariff concerns highlighted the danger of producing a narrow range of wine varieties, no matter how disease free and sustainable their production is. Concurrently, the wine industry and federal government must commence campaigns to educate consumers about NBT and gene editing to ensure they understand that these techniques are not GMO and that they are completely safe.

Conclusions

The Australian wine industry has a long history of innovation, collaboration and adaption. To increase the demand and the premium paid for Australian wine both domestically and internationally, increased product diversity and quality will be key factors. Considering the challenges of a changing climate, increased climate variability and changing consumer preferences, lesser known varieties can help fulfill these ambitions.

This report has identified 70 lesser known varieties from five countries that have the potential to perform well in South Australia. They all have tolerance to warm/hot temperatures, dry climates, some vine diseases and the ability to make quality table wines. It is not expected that these lesser known varieties will completely replace current popular varieties, however they will provide small to medium businesses with options for producing new and novel products.

These varieties are grown on a combination of own roots and rootstocks in their country of origin due to the presence of phylloxera or for improved drought tolerance. There is however a growing trend for these varieties to be grown on their own roots or “Franc de Pied”, as it is believed the inherent qualities of the vines own roots assist in the production of quality wines. With the potential adoption of NBT such as gene editing, these varieties could be bred with improved disease resistance and improved sensory characteristics of their fruit and wine.

The CSIRO has previously embarked on a conventional breeding program to create some new Australian varieties. These varieties were however based on western European varieties and were given obscure, inauthentic French and Italian sounding names. Their uptake by the industry was extremely limited and overall, not successful. If collaboration with research institutions in the eastern Mediterranean was fostered, access to their genetic material could assist in a new breeding program for future “Australian varieties”. Naming the new varieties with names that incorporate the parent vines would also give the new varieties greater credibility. For example, if parentage included Xynisteri, Osmanca and Thrapsathiri a portmanteau of Xynosmathiri could potentially be used.

One of the barriers to greater use of lesser known varieties is the lack of unity and cohesion within the industry. There are currently numerous grape and wine industry bodies including Wine Australia, Australian Grape and Wine, Australian Society of Viticulture and Oenology, the Australian Wine Research Institute, CSIRO, the University of Adelaide as well as various state based bodies. Within these groups there are eight different vine repositories in the form of vineyards, nuclear collections and germplasm collections. Wine Australia is currently attempting resolve these issues by uniting and streamlining the industry bodies through the “One Grape and Wine Sector Plan” and the creation of a National Grapevine Collection (NGC). Their goal is to:

> *“create grapevine foundation assets to help secure the long-term competitiveness and sustainability of the Australian wine sector through the health, quality and integrity of its vineyards. Investment in these assets will enable the sector access to grapevine varieties and clones, provide certainty on the identity and health status of planting material and address the long-term security of germplasm collections. In turn, this will provide greater assurance of variety claims (and label integrity) on Australian wine*

products and help maintain our international reputation for innovation and best practice in supply chain management" (Wine Australia 2024).

The top 10 varieties identified in this project that would suit Australia's climate and changing market are listed below.

Table 2: The top 10 varieties identified that would suit South Australia's conditions.

Variety Name	Phonetic Spelling	Country of Origin	Cultivar Colour
Morokanella	Moro-can-ella	Cyprus	White
Giannoudhi	Yah-noo-dee	Cyprus	Red
Girgentina	Gir-gen-tina	Malta	White
Gellewza	Jell-we-zah	Malta	Red
Savvatiano	Sav-va-tee-ah-no	Greece	White
Vradiano	Vrad-thee-ah-no	Greece	Red
Vidiano	Vid-thee-ah-no	Crete (Greece)	White
Mandilari	Man-dee-laree	Crete (Greece)	Red
Narince	Nar-een-jeh	Turkey	White
Kösetevek	Kuh-se-te-vek	Turkey	Red

Recommendations

The following recommendations are made to the Australian wine industry:

- Any of the lesser known varieties identified in this project that are currently in the NGC or in private collections should be assessed for their suitability to local climates and soils through small scale growing trials across different regions of South Australia. Funded by Wine Australia, the Future Drought Fund and the University of Adelaide.

- An accessible database of these varieties already in Australia should be made available to industry members so the vines can be purchased and propagated if suitable for their site. Funded by Wine Australia.

- The varieties identified in this project that are not currently in Australia should be imported and added to the NGC once screened for and cleared of pathogens. Funded by Wine Australia and the Future Drought Fund.

- Conduct research on the newly imported varieties through small scale growing trials across different regions of South Australia to assess their suitability to local climates and soils, water usage, growth habits and wine sensory attributes. The research should include consumer trials of the wines to gauge market acceptability. Funded by Wine Australia, the Future Drought Fund and the University of Adelaide.

- Lobby the Federal Government regarding the FSANZ code that defines NBT and gene editing as GMO, thus prohibiting their use in grape and wine products. Funded by Wine Australia.
  Promotion and community education about NBT and gene editing to inform the wine consuming public that these breeding methods are safe and not GMO.
  Funded by the Federal Government and Wine Australia.

- Utilise imported grapevine genetic material for NBT and gene editing to create new clones and new Australian varieties (hybrids) that are tailored to specific regions, their climate and soils as well as being desirable to specific consumer groups. For example, hot climate grown white wines that have moderate acidity, moderate alcohol levels and have good fruit characteristics. Funded by Wine Australia, AGW, CSIRO, AWRI, ASVO and the University of Adelaide.

- Create credible portmanteau names for these new Australian varieties that are market researched and acceptable to young consumers. Funded by Wine Australia, AGW, CSIRO, AWRI, ASVO and the University of Adelaide.

References

Anderson, K. and Puga, G. (2023). Australia's viticultural trends: Insights from a new database. IVES Technical reviews. https://doi.org/10.20870/IVES-TR.2024.8028

Apaydin, S. (2024). Researcher and Convener of Root, Origin and Soil conference, Istanbul, Turkey. (A. Copper, Interviewer June 2024).

Australian Bureau of Meterology (2024), Recent rainfall tables. Accessed June 2024, http://www.bom.gov.au/watl/rainfall/observations/index.shtml

Australian Grape and Wine (2024). Federal government pre-budget submission for funding. Accesssed June 2024. https://www.agw.org.au/wp-content/uploads/2024/01/2024-25-Pre-Budget-Submission-Australian-Grape-Wine.pdf

Bastian, S. E. P., & Iland, P. G. (2020). Australian wine's taste evolution. In H. L. Meiselman (Ed.), Handbook of Eating and Drinking: Interdisciplinary Perspectives (pp. 543-573). Springer International Publishing. https://doi.org/10.1007/978-3-030-14504-0_169

Battaglene, A. (2023). Consumer and regulatory response to climate change-new plant breeding techniques. BIO Web Conference 56. https://doi.org/10.1051/bioconf/20235603001

Bazala, B., Knoll, M., & Derndorfer, E. (2015). Perception and acceptance of white wines by consumers belonging to different age groups. OENO One, *49*(3), 217–230. https://doi.org/10.20870/oeno-one.2015.49.3.78

Beis A. and Patakas A. (2012). Relative contribution of photoprotection and anti-oxidative mechanisms to differential drought adaptation ability in grapevines. Environmental and Experimental Botany, 78, 173-183. https://doi.org/10.1016/j.envexpbot.2011.12.038

Borg, M (2023). Owner and chief winemaker of Markus Divinus Winery, Dingli, Malta. (A. Copper, Interviewer October 2023).

Chrysargyris A., Xylia P., Antoniou O. and Tzortzakis N. (2018a). Climate change due to heat and drought stress can alter the physiology of Maratheftiko local Cyprian grapevine variety. Journal of Water and Climate Change, 9(4), 715-727. https://doi.org/10.2166/wcc.2018.226

Chrysargyris A., Xylia P., Litskas V., Mandoulaki A., Antoniou D., Boyias T., Stavrinides, M. and Tzortzakis N. (2018b). Drought stress and soil management practices in grapevines in Cyprus under the threat of climate change. Journal of Water and Climate Change, 9(4), 703-714. https://doi.org/10.2166/wcc.2018.135

Copper, A. W., Johnson, T. E., Danner, L., Bastian, S. E., & Collins, C. (2019). Preliminary sensory and chemical profiling of Cypriot wines made from indigenous grape varieties Xynisteri, Maratheftiko and Giannoudhi and acceptability to Australian consumers. OENO One, *53*(2). https://doi.org/10.20870/oeno-one.2019.53.2.2423

Constanti, C. (2023). CEO of Constanti Consulting- Expert social & political analysis, project management & research. Nicosia, Cyprus. (A. Copper, Interviewer October 2023).

Constanti, A. and Kyrikades, G. (2023). Chief Winemaker and owner of Vasilikon Winery. Kathikas, Cyprus. (A. Copper, Interviewer October 2023).

Ecovineyards: growing resilience naturally. Accessed June 2024. https://ecovineyards.com.au/

Fraga H., García de Cortázar Atauri I., Malheiro AC. and Santos JA. (2016). Modelling climate change impacts on viticultural yield, phenology and stress conditions in Europe', Global Change Biology, 22(11), 3774-3788. https://doi.org/10.1111/gcb.13382

Gargat, K. (2024). Australian Riesling: An underrated, pristine joy. Accessed June 2024, https://worldoffinewine.com/news-features/australian-riesling-underrated-white-wine#:~:text=One%20problem%20can%20be%20perceptions,tend%20to%20the%20bone%2Ddry.

Gavalas, N. (2023). Owner and chief winemaker at Fragospito Winery, Heraklion, Crete, Greece. (A. Copper, Interviewer November 2023).

Gürbüzatik, G. (2024) Co-convenor of Root, Origin and Soil conference, Istanbul, Turkey. (A. Copper, Interviewer June 2024).

Hirsch (2015). Before grapes became wine. Accessed June 2024, http://ithaka-journal.net/als-trauben-noch-nicht-zu-wein-wurden

Ioannou, M. (2023). Owner and chief winemaker at Nelion Winery, Paphos wine region, Cyprus. (A. Copper, Interviewer October 2023).

Jarvis C., Darbyshire R., Goodwin I., Barlow EWR. and Eckard R. (2019). Advancement of winegrape maturity continuing for winegrowing regions in Australia with variable evidence of compression of the harvest period. Australian Journal of Grape and Wine Research, 25(1) 101-108. https://doi.org/10.1111/ajgw.12373

Johnson ZF., Chikamoto Y., Luo J-J. and Mochizuki T. (2018). Ocean impacts on Australian interannual to decadal precipitation variability. Climate, 6(3). https://doi.org/10.3390/cli6030061

Kapnisis,P. (2023) owner of Kapnisis Vineyards, Agios Mylos, Cyprus. (A. Copper, Interviewer October 2023).

Karatas, H. (2024), Professor, Dicle University, Diyarbakır, Turkey. (A. Copper, Interviewer June 2024).

Kataiftsi, N. (2023). Chief winemaker at Messimvria Winery, Thessaloniki, Greece. (A. Copper, Interviewer October 2023).

Koundouras, S. (2023). Associate Professor, Aristotle University of Thessaloniki, Thessaolniki, Greece. (A. Copper, Interviewer October 2023).

Kyrikadis, A. (2023). Owner and founder of Vouni Panayia Winery, Panayia, Pafos wine region, Cyprus. (A. Copper, Interviewer October 2023).

Lazarakis, K. (2005). The wines of Greece. Hachette UK Publishing

Lelieveld J., Proestos Y., Hadjinicolaou P., Tanarhte M., Tyrlis E. and Zittis G. (2016). Strongly increasing heat extremes in the Middle East and North Africa (MENA) in the 21st century. Climatic Change, 137(1), 245-260. https://doi.org/10.1007/s10584-016-1665-6

LeMieux, A. (2021). The essential guide to Turkish wine. LeMieux Publishing Istanbul.

Litskas VD., Irakleous T., Tzortzakis N. and Stavrinides MC. (2017). Determining the carbon footprint of indigenous and introduced grape varieties through Life Cycle Assessment using the island of Cyprus as a case study. Journal of Cleaner Production, 156, 418-425. https://doi.org/10.1016/j.jclepro.2017.04.057

Long, J., Mezei, L. V., Souza-Gonzaga, L., Johnson, T. E., Corsi, A., & Bastian, S. E. P. (2023). Australian red wines made from non-traditional, emerging red grape varieties: distinguishing sensory profiles and consumer perceptions. OENO One, 57(4). https://doi.org/10.20870/oeno-one.2023.57.4.7323

Makarounas, T. (2023). Co-owner and Chief winemaker at Makarounas Winery, Pafos wine region, Cyprus.

Marbach, C., Botezatu, A., and Hall, C. (2024). Exploring the impact of phonetic pronunciation guides on wine choice and perceived sophistication. Wine Business Journal. https://doi.org/10.26813/001c.94058

Mezei, L., Johnson, T., Goodman, S., Collins, C., & Bastian, S. (2021). Meeting the demands of climate change: Australian consumer acceptance and sensory profiling of red wines produced from non-traditional red grape varieties. OENO One, 55(2), 29-46. https://doi.org/10.20870/oeno-one.2021.55.2.4571

Mylona, A. (2023). Independent winemaker and consultant, Athens, Greece. (A. Copper, Interviewer October 2023).

OIV- International Organisation of Vine and Wine (2017). Distribution of the world's grapevine varieties. Accessed June 2024, https://www.oiv.int/public/medias/5888/en-distribution-of-the-worlds-grapevine-varieties.pdf

Patakas A., Noitsakis B. and Chouzouri A. (2005). Optimization of irrigation water use in grapevines using the relationship between transpiration and plant water status', Agriculture, Ecosystems & Environment, 106(2), 253-259 https://doi.org/10.1016/j.agee.2004.10.013

Robinson, J., Harding, J. and Vouillamoz, J. (2013). Wine Grapes. A complete guide to 1,368 vine varieties, including their origins and flavours. Penguin (UK) and Ecco (US) Publishing.

Remenyi, T. A., Rollins, D. A., Love, P. T., Earl, N. O., Bindoff, N. L., and Harris, R. M. B. (2019). Australia's Wine Future - A Climate Atlas, University of Tasmania, Hobart, Tasmania. ISBN: 978-1-922352-06-4 (electronic).

Tsiakkas, C. (2023). Owner and founder of Tsiakkas Winery, Pitsillia wine region, Cyprus. (A. Copper, Interviewer October 2023).

Webb LB., Watterson I., Bhend J., Whetton PH. and Barlow EWR. (2013). Global climate analogues for winegrowing regions in future periods: projections of temperature and precipitation. Australian Journal of Grape and Wine Research, 19(3), 331-341. https://doi.org/10.1111/ajgw.12045

Webb LB., Whetton PH. and Barlow EWR. (2007) Modelled impact of future climate change on the phenology of winegrapes in Australia', Australian Journal of Grape and Wine Research, 13(3), 165-175. https://doi.org/10.1111/j.1755-0238.2007.tb00247.x

Wine Australia (2023a). National vintage report 2023. Accessed June 2024, https://www.wineaustralia.com/getmedia/024889d1-06f8-436c-bec3-e24d15c055e1/MI_VintageReport2023_summary_F.pdf

Wine Australia (2023b). Australian wine sector at a glance 2023. https://www.wineaustralia.com/market-insights/australian-wine-sector-at-a-glance

Wine Australia (2024a). Sustainable winegrowing australia, Accessed June 2024, https://www.wineaustralia.com/sustainability/sustainable-winegrowing-australia

Wine Australia (2024b). Market bulletin number 310. Accessed June 2024, https://www.wineaustralia.com/news/market-bulletin/issue-310

Wine Australia (2024c). Australian market insights report 2024. https://www.wineaustralia.com/getmedia/464497fe-db24-47de-b217-4e2d20c89a21/Australia-market-insights-report-2024_v2.pdf