A regular feature to inform industry about research projects being undertaken for their benefit. Newly approved projects (when available) are briefly summarised and longer reports will describe what has been achieved so far. When completed, each project will be reported in full detail with references, on nzwine.com

Misha's Vineyard

Research Supplement

Information and updates on Bragato Research Institute research projects.

Quality Wine Styles for Existing and Developing Markets

Breaking the quality-productivity seesaw in wine grape production (Pinot Noir Programme)
University of Auckland, Plant & Food Research and Lincoln University (various) jointly funded by NZW and MBIE

Prevention of quercetin instability in bottled wine
Villa Maria Wines Limited (O Powrie)

The effect of winemaking decisions on polysaccharide content in wine
University of Auckland (B Fedrizzi)

The importance of green: understanding 'green' and 'herbaceous' characters in Pinot noir wine and their role in driving judgements of perceived quality
Lincoln University (D Torrico)

Exploring reductive aromas in Pinot noir
University of Auckland (B Fedrizzi)

Precipitation of calcium tartrate and other compounds in wine
University of Canterbury (K Morison)

Potential applications of nanotechnology for wine growing in New Zealand
University of Auckland (M Kah)

National Vine Collection Virus Eradication
Bragato Research Institute (D Lizamore)

Pests and Disease

Improving remedial surgery practices for control of grapevine trunk disease to increase vineyard longevity
Linnaeus (E van Zijll de Jong), South Australian Research & Development Institute (M Sosnowski)

Weevils in New Zealand vineyards
Bragato Research Institute (P Epee)

Cost Reduction/Increased Profitability

Long spur pruning as an alternative to cane pruning for Sauvignon blanc in Marlborough
Bragato Research Institute (C Vasconcelos)

The Vineyard Environment

Microbial Responses to Under Vine Treatment
Bragato Research Institute (M Barry)

Shared Vision for Land Use in Marlborough
Bragato Research Institute (M Barry)

Regenerating Vineyard Soils - Phase One
Bragato Research Institute (M Barry)

Development of an anaerobic chain-elongation bioprocess for grape marc valorisation
University of Auckland (S Yi)

Evaluating ecologically sustainable ways to disrupt the wētā-vine association
Plant & Food Research (J Vereijssen)

Weather and Climate

Sauvignon Blanc Grapevine Improvement Programme
Bragato Research Institute (D Lizamore)

Microbial community and vine responses to increasing temperatures in the New Zealand context
University of Auckland (S Knight)

Evaluating water use efficiency and drought tolerance of various rootstocks grafted to Sauvignon blanc
Bragato Research Institute (C Vasconcelos)

Tuned Vines
Bragato Research Institute (D Lizamore)

PINOT NOIR PROGRAMME

Field Trials: Yield-quality interactions found in individual vines

Martin D, Grab F, Scofield C, Schurmann M, Yang L, Stuart L, Moore T, Zhu J, Grose C (Plant & Food Research)

Results from the Pinot Noir Programme support the view that the viticultural practices used by some of New Zealand's premier Pinot noir producers, especially with regard to yield management, provide an effective means of ensuring a high proportion of vines meet a given grape quality specification.

A key research aim within the programme is the 'Ideal Vine', which covers a study network that comprised 12 commercial vineyards. Of these, eight produced single-vineyard, high-value 'Icon' wines and four contributed to multi-vineyard 'Affordable' blended wines (Table 1).

Vineyard ID	Region	Subregion	Block area (ha)	Year planted	Row spacing (m)	Vine spacing (m)	Pruning system	Target yield (kg/m)	End-use class
OA	Otago	Bannockburn	0.30	2000	2.20	1.13	2-cane	1.3	Icon
OB	Otago	Bannockburn	0.13	2008	1.60	0.90	2-cane	1.1	Icon
OC	Otago	Bendigo	0.50	1996	1.50	0.90	2-cane	1.1	Icon
OD	Otago	Pisa Range	1.56	2008	2.40	1.50	10-spur	2.3	Affordable
MA	Marlborough	Brancott	0.08	1993	1.50	1.25	2-cane	1.0	Icon
MB	Marlborough	Brancott	0.72	2006	3.00	1.40	2-cane	2.5	Affordable
MC	Marlborough	Waihopai	4.62	2013	1.60	1.25	2-cane	2.0	Affordable
MD	Marlborough	Wairau	0.75	2005	1.80	1.15	2-cane	1.1	Icon
WA	Wairarapa	Martinborough	0.28	2003	2.00	1.20	2-cane	1.0	Icon
WB	Wairarapa	Martinborough	0.67	2009	2.40	1.40	2-cane	1.8	Affordable
WC	Wairarapa	Te Muna	0.30	1998	2.40	1.25	2-cane	1.6	Icon
WD	Wairarapa	Te Muna	0.95	1999	1.60	1.20	2-cane	1.0	Icon

Table 1. Summary details for the vineyard blocks selected for the New Zealand Pinot noir Ideal Vine study.

Of the eight Icon wines, several are among New Zealand's best examples of Pinot noir. In the context of this study, we have assumed that the vines that directly contribute to the production of these Icon wines are a reasonable population from which to derive aspirational quality targets for the Affordable vines for grape berry size and basic berry composition parameters (Table 2). From 50% of the observations from Icon vines over five seasons (N = 286), we established benchmark specification ranges for the following six grape parameters: berry mass; Total soluble solids (TSS); Titratable acidity (TA); pH; OD280 (berry total phenolics) and OD520 (berry colour). Care was taken to ensure that the specification ranges were also aligned with established oenological berry composition targets for red table wine production.

In parallel, the remaining single-vine x season dataset (N = 707) which included the remaining 50% of the Icon vines (as validation data) and all Affordable vines was classified by yield into weight classes (Table 3).
The berry parameters for this dataset were, in turn, classified according to the parameter ranges established for the Icon subset. The quality classification was a simple 'yes/no' depending on whether the measured parameter was within range or not. Vines were considered to be within an overall Icon quality specification 'In-Spec' if their berry weight and basic berry composition parameter values fell within their corresponding range for at least five out of six parameters. Highly significant negative linear relationships were established between vine Yield class and the frequency of In-Spec vines in the monitored population (Figure 1).

Five years ago, we embarked on the Ideal Vine study in a search to find individual Pinot noir vines within New Zealand vineyards that produced good commercial yields and met benchmark quality standards. We were successful in achieving our overarching aim. Within the three study regions (Wairarapa, Marlborough and Central Otago) 13% of the vine x season combinations (93/707) simultaneously achieved yield and quality metrics.

		Berry mass (g)	TSS (°Brix)	TA (g/L H_2T)	pH	OD280	OD520
All years	Mean	1.1	22.6	7.8	3.30	1.41	0.36
	Max	1.7	25.8	11.5	3.87	2.55	0.70
	Min	0.6	18.6	4.9	2.94	0.37	0.15
	Median	1.1	22.7	7.7	3.27	1.48	0.33
	SD	0.2	1.3	1.1	0.14	0.52	0.12
	Upper	1.3	25.0	9.0	3.50	1.80	0.60
	Lower	0.8	22.0	6.5	3.20	1.10	0.30
	N	286	286	286	286	286	286

Table 2. Target specification ranges for grape berry weight and basic berry composition parameters of the New Zealand Pinot noir Ideal Vine study network.

These vines prove that yield and quality are not mutually exclusive and represent the Ideal Vines within the study population.

Because Icon vines were typically targeted for low yields, only 20% of vines within that population (57/287) achieved the industry-advised 'commercial viability' 2.0 kg/m yield threshold, but of those, 60% also met the quality benchmark. At yield classes lower than 2.0 kg/m, there was only a small increase in the proportion of vines that met the quality standard. The situation was reversed for the Affordable vine group, in which 64% (267/420) achieved the yield threshold but only 22% of those met the quality benchmark. At yield classes lower than 2.0 kg/m, the proportion of Affordable vines that met the quality threshold practically doubled from 22% to 42%.

The data infer that there is a lower yield threshold for Icon vineyards below which there would appear to be little or no gain in the proportion of vines that reach the quality benchmark. This limit would appear to be situated around 1.5 kg/m when leaf area is above 10 cm^2 per gram of fruit, no other major limiting factors are present, and mean berry size remains below 1.2 g.

From a vineyard profitability perspective, there would appear to be financial gains available and little risk to quality if Icon producers could achieve as many vines as possible in their vineyard producing at a rate

Yield category (kg/vine and kg/m)	mid-point (kg)	Yield category (kg/m^2)	mid-point (kg)
0 <=> 0.875	0.75	0.0 <=> 0.4	0.2
0.875 <=> 1.125	1.00	0.4 <=> 0.6	0.5
1.125 <=> 1.375	1.25	0.6 <=> 0.8	0.7
1.375 <=> 1.625	1.50	0.8 <=> 1.0	0.9
1.625 <=> 1.875	1.75	1.0 <=> 1.2	1.1
1.875 <=> 2.125	2.00	1.2 <=> 1.4	1.3
2.125 <=> 2.375	2.25	1.4 <=> 1.6	1.5
2.375 <=> 2.625	2.50	1.6 <=> 1.8	1.7
2.625 <=> 2.875	2.75	1.8 <=> 2.0	1.9
2.875 <=> 3.125	3.00	2.0 <=> 2.2	2.1
3.125 <=> 3.375	3.25	2.2 <=> 2.4	2.3
3.375 <=> 3.625	3.50	2.4 <=> 2.6	2.5

Table 3. Yield categories and mid-points used for the berry composition benchmarking.

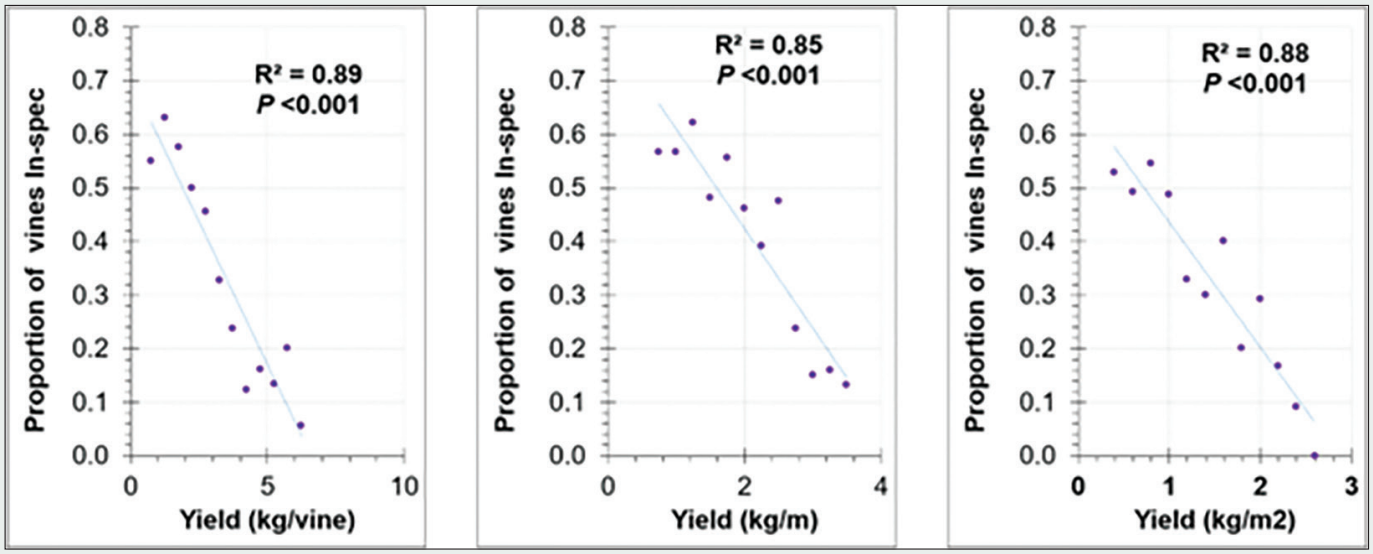


Figure 1. The proportion of "In-Spec" vines plotted against the mid-point of the Vineyard Yield class is expressed as yield per vine (a), yield per linear metre of vine row (b) and yield per unit of land area (c).

equivalent to 1.5 kg/m. Within the Icon vine population, 59% of the vines yielded less than 1.5 kg/m, with these vines having an overall mean yield of 0.9 kg/m. An uplift in yield of 0.6 kg/m (to reach 1.5 kg/m) across half the sub-optimal vines would result in an extra 15% yield, or approximately 1.0 T/ha at the mean (Icon vineyard) row spacing of 1.83 m.

These vines prove that yield and quality are not mutually exclusive and represent the Ideal Vines within the study population.

Our data also indicate there is an upper yield for Affordable vines around 2.75 kg/m above which there is a rapid decline in the proportion of vines that meet the quality specification. The yield sweet spot for commercial Pinot noir producers is therefore situated between the Icon target (1.5 kg/m) and the Affordable upper limit of 2.75 kg/m, again with the condition that means berry size remains below 1.2 g.

In the population of Affordable vines studied only 162/420 (39%) yielded within this range. The results suggest that a more intensive and accurate approach to bud load and yield targets at the individual vine level would reap important quality benefits. If all vines in an Affordable vineyard were managed to be within a yield range of 1.5–2.75 kg/m, the proportion of In-Spec vines would be likely to double, against a small overall decrease in the mean yield of 2.5 kg/m to 2.2 kg/m. This 'reduced' yield still sits above the viability threshold for Affordable Pinot noir vineyards established by the programme industry advisory group. We can reasonably and confidently forecast these generic target yield ranges based on results from the programme, but cooler seasons and regions will necessitate some downward adjustments.

There is still plenty of scope for further optimisation because the programme results also clearly show that individual vines can meet quality specifications at yields well above 2.0 kg/m. It was not, however, the same individual vines that achieved Ideal status each year. This observation hides complex and interdependent relationships between vine performance, individual vine management and season that we have not fully unpacked.

PROGRAMME ACKNOWLEDGEMENT

The Pinot Noir Programme was a multi-year partnership between New Zealand Winegrowers and the Ministry for Business, Innovation and Employment that was managed by Bragato Research Institute and conducted by Plant & Food Research. The research programme ended in September 2022, aiming to grow returns through disassociating quality from yield in New Zealand Pinot noir production. This article concludes the findings of research aims relating to Research aims 2.5 and 2.6 – Ideal Vines and Ideal Wines.
The authors would like to thank the 11 participating wine companies for providing the study vineyards and grape samples. This type of research is made possible by the intellectual contributions and passion of winemakers and viticulturists.
For more information about the programme and these research aims, including full reports and methods used, please visit the research library in the members' section of nzwine.com.

PINOT NOIR PROGRAMME

The quest to find ideal vines...

Martin D, Grab F, Scofield C, Schurmann M, Yang L, Stuart L, Moore T, Zhu J, Grose C (Plant & Food Research)

Can we find individual vines that produce acceptable commercial yields (above 2.5 kg per vine or 9 tonnes per hectare) with grape and wine composition comparable to 'Icon' labels?

WHAT THIS EXPERIMENT IN THE PINOT NOIR PROGRAMME HAS TRIED TO CONTROL:

- Rootstock (3309C)
- Pinot noir clone (Abel)
- Training system (VSP)
- Pruning system (2-cane mostly)
- Vine age (partially)
- GTD and virus (visually)
- A mix of 'Icon' (single-vineyard, high-value wine) and 'Affordable' (larger volume varietal blend)

The different vineyards (12) and seasons (five) provide the replication for this trial. The design also allows scope to look at regional effects, although this is not the main goal. Our goal is to identify and understand if/how yield affects grape and wine composition predictably and consistently at every location, under a range of vineyard management regimes, and across multiple seasons.

The 20 individually monitored vines within each vineyard are the base unit where the (uncontrolled) vine-to-vine variation is yield studied. Yield and other data can be statistically analysed at different scales (e.g. Vine < Vineyard < Region < Product < Year)

THESE TYPICALLY DO NOT CHANGE FOR VINES WITHIN A VINEYARD:

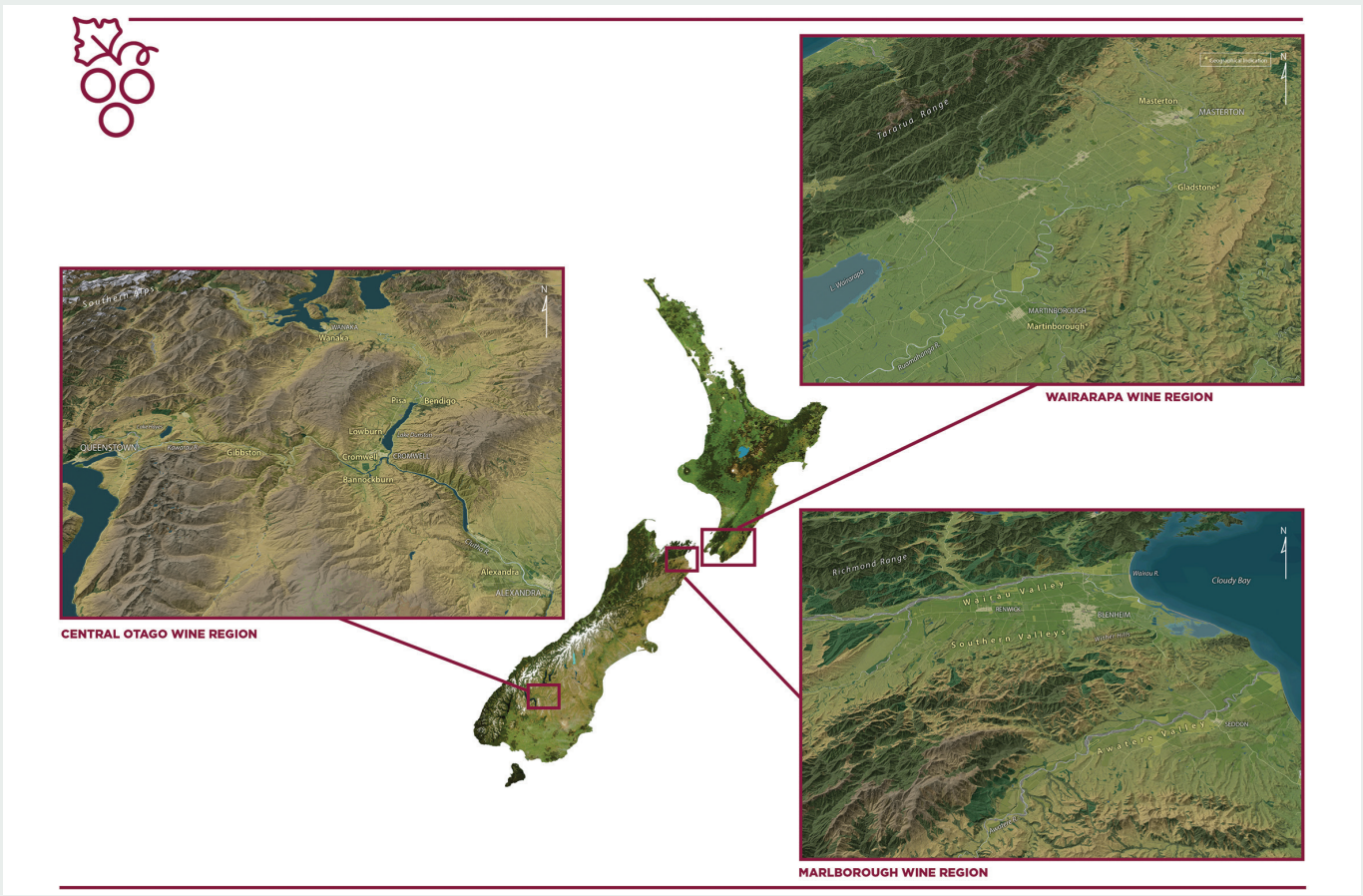
- Overall management approach (i.e. biodynamic, organic, conventional)
- Target product type (i.e. Icon, Affordable)
- Target (block) crop load (mostly)
- Timing and intensity of general vineyard operations
- Irrigation and fertiliser strategies/ inputs

THESE DO NOT CHANGE FOR AN INDIVIDUAL VINE BETWEEN SEASONS:

- Root volume and soil properties
- Vine capacity
- Long-term disease status (GTD, virus – although symptom expression could differ)
- Relative topoclimate compared with adjacent vines.

We can therefore eliminate the above factors as responsible for variations in performance when we compare individual vines within a vineyard or between years.

For more information about the Pinot Noir Programme and these research aims (2.5 and 2.6), please visit nzwine.com/research.



Pinot Noir Vineyard Trial Map

Potential applications of nanotechnology for winegrowing in New Zealand

Dr Melanie Kah, Nikolai Siimes and Jon Dominic Habito (University of Auckland)

Nanotechnology is a broad area of science aiming at engineering matter at a very small scale. Nanoparticles have a size between 1 to 100 nanometres, which is a billion times smaller than a metre, about 1,000 times smaller than the width of a hair. Undetectable by the human eye, nanoparticles can exhibit significantly different physical, chemical and biological properties to their larger counterparts, with potential applications in a wide range of fields from cosmetic and food packaging to electronics.

The application of nanotechnology in agriculture is currently receiving substantial attention worldwide. The most common idea is to exploit the novel properties of materials developed at the nano scale to design novel agrochemicals with superior properties to the products currently used. For instance, nanoencapsulation can be used to deliver pesticides or fertilisers at the right time and at the right place, in line with the principles of high precision agriculture. There are also reports that nanocopper and nanosulphur can protect crops against pathogens through different mechanisms than conventional copper and sulphur.

Through a range of strategies, nanotechnology can thus reduce the amount of chemicals that needs to be sprayed to achieve crop protection and/or nutrition. Other potential advantages include reduced labour and increased or prolonged efficacy leading to higher productivity. There is a consensus that potential applications and benefits are abundant. To harness its full innovation potential and

impact, the development of nano-agrochemicals needs to be carefully guided so that products that are beneficial to end-users are effectively developed and applied in a sustainable way.

NANOTECHNOLOGY AND THE WINE INDUSTRY

It is currently not known how nanotechnology can specifically benefit the wine industry and help improve its sustainability. Similarly, impact assessments and regulation of nanopesticides have been discussed globally; however, no studies have yet investigated conditions representative of vineyards, which is needed to ensure that nanopesticides and nanofertilisers are safe. Researchers at the University of Auckland have started looking into these knowledge gaps, funded by Bragato Research Institute. The team led by Melanie Kah at the University of Auckland aims at establishing the missing foundations that will promote the responsible and sustainable development of nanotechnology in the wine growing sector in New Zealand. The project is still in its early stages, with two key activities conducted so far.

The first activity is led by Jon Habito, doctoral researcher at the University of Auckland, who looks at screening the existing scientific literature to identify nanoagrochemicals that may be particularly promising for wine growers in New Zealand. These include nanodelivery systems that may provide prolonged protection against mildew or enzyme-responsive lignin nanocarriers for the curative treatment of trunk disease. The second activity is led by Nikolai Siimes, another doctoral researcher at the University of Auckland. Nikolai looked into the acceptability of vineyard nanotechnology use in New Zealand though a series of interviews across the sector, recently published in the journal NanoImpact.

While Australia conducts more technological research, New Zealand has historically been a fast mover in embracing cutting-edge technology. Early adoption comes with more market risks but can be highly successful when the technology is sound, and the risks are carefully managed. The New Zealand Screwcap Wine Seal Initiative is a case in point.

FINDINGS SO FAR

Nikolai's initial research suggests that there is considerable interest in nanotechnology in New Zealand wine circles among those who are aware of its potential. From a technical perspective, winemakers, viticulturists, and industry authorities are interested in nano-enabled solutions to pressing issues such as labour, pest and disease management, and sustainability. These industry actors see nanotech as compatible with the highly technical modes of viticulture that are already common in New Zealand. More generally, some see nanotechnology as "interesting" and "cool" and are intrigued by the possibility of going further to develop a nanotech logo label. Others are more cautious and advocate a 'wait and see' approach – wait for others to take the plunge before risking the reputation of 'Brand New Zealand' but prepare to move quickly should market and regulatory barriers prove insubstantial. Obviously, there is concern with regulatory considerations. Regulatory approval (both nationally and in key export markets) will be needed prior to nanotechnology adoption.

The New Zealand study to date suggests that if nanotechnology is effective and aligned with environmental goods and solid sustainability outcomes it will have greater acceptance.

Market acceptability is less clear. The risks of nanotechnology to human health are a concern, but nano-scale does not inherently make something a danger. However, we cannot predict how consumers, tastemakers, and other intermediaries will react to nano-enabled viticulture. Early adopters will need to initiate discursive and narrative management ahead of adoption at the producer, wider industry, and media level.

There are many unknowns about the efficacy of nano-enabled solutions to existing wine-industry problems. These need to be addressed through research. The full opportunity set needs to be investigated. However, in terms of existing knowledge, the primary known risks of adopting nanotechnology are to do with market acceptance and thus brand reputation. These risks are greater for those who rely on stories of wine as natural, traditional, and sustainable. The use of nanotechnology could disrupt those marketing narratives.

The New Zealand study to date suggests that if nanotechnology is effective and aligned with environmental goods and solid sustainability outcomes it will have greater acceptance. The attitudes of key intermediaries and thought leaders such as buyers, sommeliers, and wine writers will play a large role in convincing industry of its value and shaping public understandings of what is acceptable. The research is proceeding on the grounds that technically there are both efficiency and sustainability gains to be had from nano-enabled solutions. The eco-benefits of nanotechnology need to be researched and communicated to consumers and those along the supply chain as a first step in preparing for adoption.

ABOUT THE PROJECT

The aim of this three-year project is to identify and assess promising applications of nanotechnology to increase the sustainability of the winegrowing sector. Led by Dr Melanie Kah at the University of Auckland and funded by BRI, the research will analyse how these issues could be addressed by nanotechnology and grower's perception of nanotechnology.