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Rural Leadership
PROGRAMME

Hitting the Marc in Marlborough

Grape Marc is set to increase by 50% in ten years, are our current practices sustainable and if not, what does a sustainable solution look like?

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Executive Summary

Grape marc in the Marlborough region is set to increase in production by 50% in ten years. This increase in quantity could be tolerated by the multiple types of practices that currently exist, if expansion plans are in place. Comparing Marlborough to other industries or other wine regions within New Zealand and off shore is difficult as there are many unique factors involved. Council regulations are changing, and consequence for non-compliance has recently been aggressive; a strong contributor to the need for a change in culture around the issue.

Waste disposal in any industry is of environmental concern, and sustainable practices should be clearly defined so all procedures involved in handling, storage and use will have no adverse effect on the community, environment and businesses involved. Reutilising excess materials offers an environmentally conscious solution and provides the industry with another positive story.

There is room for more research and development of technology which can help make systems easier and more effective. Collaboration between industry members, industry bodies and governing bodies is essential to the success story that is grape marc in Marlborough.

Acknowledgements

Thank you to all industry members who had conversations with me around the current and future situation of grape marc in Marlborough.

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Introduction

Wineries must follow legal legislation with regards to disposal of waste products, which can be split into two categories; solid and liquid. Grape marc is a solid wine industry bi-product composed of grape skins, seeds, stems and remaining pulp that can't be converted into wine. The traditional methods of marc disposal are composting or distilling (*Zhang et al, 2017*).

The disposal of winery waste products has no recoupable costs making it an expense that wineries aim to minimise where possible *(Rankine, 1989).* In parts of Europe it is law to send grape marc from wineries to distilleries to produce ethanol *(Bustamante et al, 2007).* One of the most challenging factors of winery waste disposal is the creation of large amounts in a short time frame *(Bustamante et al, 2007)* being March – April in New Zealand. Marlborough has unique logistical problems as it is predominantly planted in a single variety leading to majority of the region being ready to harvest at the same time.

In 2016 a total of 436,000 tonne of grapes were crushed nationally (figure 1). This is a 212% increase in production in ten years. Marlborough as a region crushed 323,290 tonne, accounting for 74% of the country's production (*NZWG Annual Report, 2016*).

BY REGION (TONNES)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Northland	203	204	148	178	111	92	130	210	203	92
Auckland	1,241	1,604	1,615	1,325	1,464	1,220	789	1,392	824	1,267
Waikato/Bay of Plenty	212	192	202	118	51	7	12	63	ND	18
Gisborne	26,034	23,911	23,093	18,316	14,450	15,590	15,567	16,192	17,280	15,944
Hawke's Bay	41,963	34,284	40,985	38,860	35,533	32,793	38,829	44,502	36,057	42,958
Wairarapa	1,949	4,105	4,421	3,942	3,598	4,271	4,798	5,743	3,559	5,049
Marlborough	120,888	194,639	192,128	182,658	244,893	188,649	251,630	329,572	233,182	323,290
Nelson	5,190	7,002	7,740	5,963	7,854	6,129	7,777	10,494	6,777	10,028
Canterbury/Waipara	1,699	6,881	5,476	5,870	9,485	7,079	8,348	10,962	5,395	12,170
Central Otago	3,434	9,495	6,218	6,196	7,104	8,115	8,407	10,540	8,951	9,177
Other			421	19	49	0	0	0	159	363
SURVEY TOTAL	202,823	282,352	282,447	263,445	324,591	263,944	336,337	429,669	312,387	420,356
INDUSTRY TOTAL*	205,000	285,000	285,000	266,000	328,000	269,000	345,000	445,000	326,000	436,000

Figure 1: Total tonne harvested by region. Sourced from NZWG annual report 2016

Marc produced from an annual harvest sits around 20% of the total tonne crushed. This percentage can differ between variety; smaller berries have a higher skin to flesh ratio, or processing type e.g. all stems left intact with whole bunch fruit or destemming in the field. From 2015 to 2016, Marlborough's grape marc increased by 13,000 tonne *(Preece, 2016)* which shows the significant rate in which production is increasing in the region.

Water is 60% – 70% of the content weight. Dried weight average for other components are; 51% skin, 47% seeds and 2% - 11% stalks as seen in figure two (*Zhang et al, 2017*).

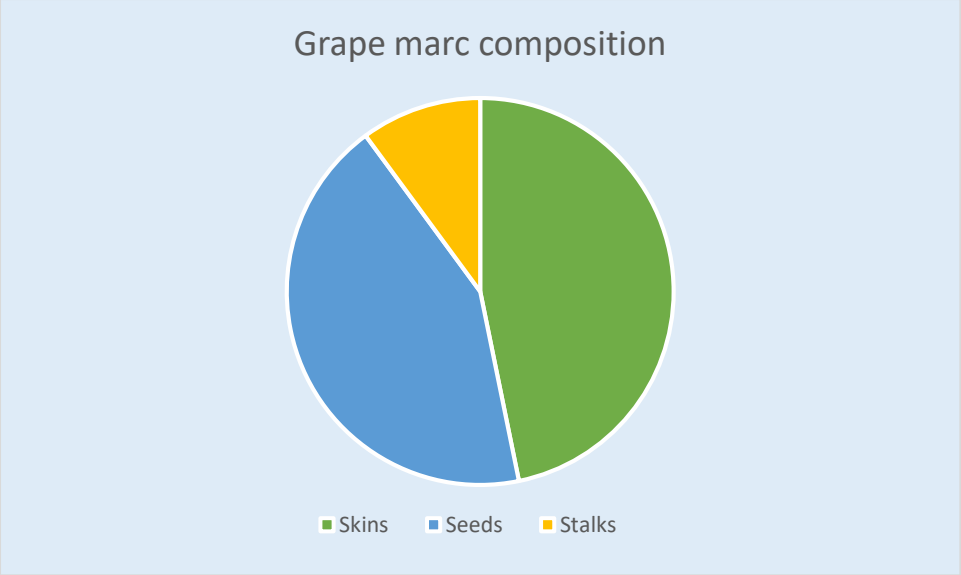

Figure 2: Representation of dried marc composition

Ultimate analysis is presented in figure three as the range and average in percentage.

C	H	O	N	Cl	S	Ash
47.22–54.90	5.83–6.33	30.40–38.63	1.86–2.37	0.05	0.03–0.21	4.20–9.50
52.91	5.93	30.41	1.86	0.05	0.03	8.81

Figure 3: Ultimate analysis (Zhang et al, 2017).

Variations will occur for many reasons. Variety, climate and soil influence the berry composition in the vineyard; winemaking processes exploit different characteristics of that composition depending on a desired style. Red marc is higher in alcohol and lower in sugar content as it often goes through fermentation while white varieties are separated after pressing. (*Rankine, 1989*).

Winery waste treatment practices in Marlborough have recently been put into the spotlight by the district council as many wineries show non-compliance in their annual monitoring. Problems are usually seen with leachate from incorrect storage practices and pH levels under recommendation at storage or application sites *(Preece, 2016).*

Leachate is the liquid run off from the stored grape marc or composting grape marc. It should be treated as a raw waste product and must be treated to reach a desirable pH and meet other factors as laid out in local council policy before it can be applied to the land.

With a significant increase in production predicted it is widely believed that the industry has not only a legal but a moral and environmental responsibility to find solutions for appropriate waste disposal *(Jerram, 2016)*.

The intention of this report is to describe current practices for disposal of grape marc in Marlborough, compare them with other wine regions and industries and discuss their suitability for a region which is growing at a significant rate.

Literature Review

Wineries produce three main types of waste each year; marc, lees and sludge. Marc is strictly made up of stems, skins and seeds. Lees are made up of natural grape solids or from additions used in wine stabilisation and fining which settle out of juice or wine. Sludge is considered the final waste product as it is produced from reducing the lees in a treatment facility. In this process, sludge is created alongside a water product which can be suitable for irrigation purposes.

Large wineries with an onsite treatment facility will have all three of the above waste products, smaller wineries have their lees removed by a third party for treatment. All wineries will have grape marc.

Other types of vineyard and winery wastes such as broken posts, used barrels, crates and general rubbish are not explored in this review.

Application to the soil

Research exploring the use of grape marc and other winery waste products as compost are numerous and proves the use of winery solids as fertilisers is the traditional method of disposal.

The chemical properties of raw winery waste are incompatible with agriculture use before a conditioning treatment such as composting. pH, organic matter, heavy metal content and macro nutrient levels are not at a level that is considered agriculturally beneficial (*Bustmante et al, 2007*).

Vineyards can benefit from composted winery waste because of the chemical composition and physiochemical characteristics it offers (figure four). The compost directly increases organic matter, nutrient levels, microbial biomass and physical soil properties such as water holding capacity (*Ioannis et al, 2006*). Figure three shows the chemical composition of compost made from winery wastes.

Element	Values
n (%)	2.14–3.74
P (%)	0.18–0.52
Ca (%)	3.17–14.3
Mg (%)	0.3–0.61
Fe (%)	0.5
Zn (mg kg^{-1})	77–109
Cu (mg kg^{-1})	30–46
Ni (mg kg^{-1})	9.1–17.6
Cr (mg kg^{-1})	23.4–147
Pb (mg kg^{-1})	8–19
Cd (mg kg^{-1})	0.2–0.4

Figure 4: Chemical composition of winery waste compost (Ioannis, 2006).

Combining winery sludge with grape marc at a 1:2 ratio is possible with compost conditions of 55% moisture, 65°C maximum temperature and oxygen levels higher than 5%. Marc which is ground before adding to the compost allows piles to reach higher temperatures quicker and has an

improved carbon nitrogen ratio (*Bertran et al, 2004*). This form of composting is of interest as it uses multiple winery waste streams.

Grape marc compost with stems has a higher germination success rate in ray grass than compost without the stems (*Moldes et al, 2007*). Marlborough grape marc typically has few stems in it due to the way it is harvested which leaves majority of the stems in the field.

Spreading raw grape marc onto land increases wild yeast populations and encourages dominant yeast species to thrive in a site. This is beneficial as it is thought to contribute to a vineyard sites 'terrior'. If spread thinly, the material will dry out quickly which will reduce the presence of vinegar flies; a pest at the winery that can spoil wine (*Rankine, 1989*). As raw grape marc is high in acidity, it is an environmentally sensitive method of disposal. Pollution or toxicity is possible with high concentrations (*Krzywoszynska, 2013*).

Energy Regeneration

Combustion is defined as the process of burning something which produces heat and light, pyrolysis is the decomposition of a product with high temperatures producing energy as heat and bio char, bio oil and bio gas. Composting grape marc doesn't exploit the energy content contained the way that combustion or pyrolysis does. Pyrolysis is superior to combustion in terms of energy regeneration as it produces quantities of bio char and bio oil as well as energy (*Zhang et a, 2017*).

Pyrolysis is used in multiple fruit industries such as mango, banana and watermelon and these examples are an exceptional feedstock for conversion to more useful bio oil, bio gas and bio char products (*Lam et al, 2015*).

The stalk component of grape marc is the desirable portion for energy regeneration as it can be easily burnt after drying. Stalks can be separated at the winery with a conveyor that allows berries to fall through cracks or a blowing system over a conveyor belt (*Rankine, 1989*).

Extraction

The winemaking process doesn't extract all the phenolic compounds in grapes making grape marc a cheap source of antioxidants for the nutritional supplement industry. The natural antioxidants in grapes are considered safer for human consumption than synthetic variations which have an undesirable effect on the enzymes of human organs (*Ioannis et al, 2005*).

The quantity of antioxidants present in grape marc is influenced by variety, irrigation practices, the winemaking process, maturity level at harvest and climate. Seeds, skin and stems each contain different concentrations of polyphenolic compounds (*Alvarez-Casas et al, 2015*).

Red varieties contain double the phenolic content of white varieties because of the pigment anthocyanins in the skins. 65% of the phenolic content is in the skins of reds compared to 10% in the skins of white varieties (*Rankine, 1989)*.

Water can be added to marc after pressing which aims to recover any residual sugars for a second and much weaker fermentation that produces a low-quality alcoholic drink, known as *piquette* in France (*Krzywoszynska, 2013)*. If stalks have been separated for drying, they can be rinsed with water first to further recover any residual sugar for the same purpose *(Rankine, 1989)*.

In parts of Europe it is a legal requirement for wineries to send their marc to distilleries which can be a financial burden for small and medium wineries as the cost of freight exceeds the cost received for

the marc. This legislation constrains the use of grape marc, not allowing any recycling to the land. It has not gone uncontested, and there are cases of winery/distillery arrangements where false receipts exaggerate quantities sent to the distillery in favour of the marc being spread in the vineyard (*Krzywoszynska, 2013*).

Separating seeds for the reproduction of the grape vine is not practiced as there are so many seeds produced at harvest and little demand for growing such vine species from seed. Grape seed oil, crystals of calcium citrate, tartaric acids and tannins are examples of other extractable components of grape marc (*Krzywoszynska, 2013*).

Conclusion

Based on the literature available, grape marc can be recycled to the earth preferably after composting in one form or another. It is particularly good for vineyards as it contributes to what is depleted during a season and is a preferred option in Europe where strict legislation forces marc to be sent to a third-party processor. Energy regeneration and extraction techniques require high capital and are intensive methods of disposal compared to returning the marc to the land.

Materials and Methods

This report was compiled using published information, statistics and conversations with industry members.

The context of this report is personal development by increasing knowledge on an unfamiliar topic. Conclusions have been made with the application of critical thinking to all sources of information. Ultimately, the report highlights current practices and future possibilities which all industry members can relate to.

Discussion

Grape marc is set to increase by 50% in ten years

Marlborough is home to 67.7% of New Zealand's viticulture land totalling over 25,000 hectares in 2017 – figure six. From this planted land the total tonne harvested grapes sits near 300 thousand, a 150% increase in 10 years. Correspondingly, planted land has increased by 160% in the same time frame – figure seven.

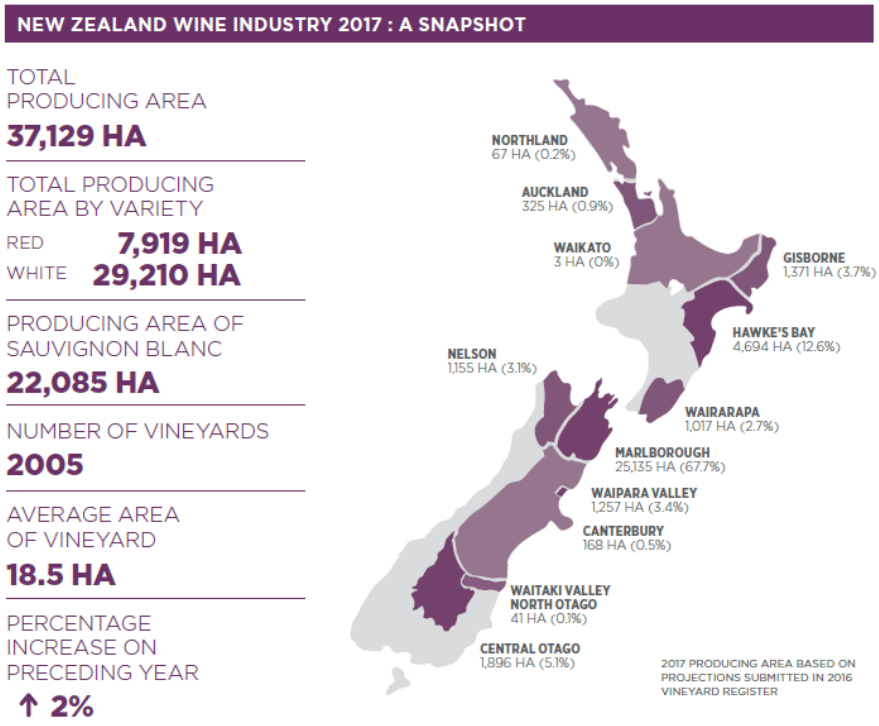

Figure 2: Retrieved from NZWG annual report, 2017.

BY REGION (HA)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017**
Auckland/Northland	534	543	550	556	411	414	392	403	387	392
Waikato/Bay of Plenty	147	147	147	147	24	24	25	16	3	3
Gisborne	2,142	2,149	2,083	2,072	1,635	1,599	1,915	1,440	1,350	1,371
Hawke's Bay	4,899	4,921	4,947	4,993	5,030	4,846	4,774	4,638	4,641	4,694
Wairarapa	855	859	871	882	979	991	995	1,003	1,005	1,017
Marlborough	15,915	18,401	19,295	19,024	22,956	22,819	22,907	23,452	24,365	25,135
Nelson	794	813	842	861	1,011	1,095	1,123	1,141	1,135	1,155
Canterbury/Waipara	1,732	1,763	1,779	1,809	1,371	1,435	1,488	1,428	1,419	1,425
Central Otago	1,552	1,532	1,540	1,540	1,917	1,959	1,932	1,942	1,880	1,896
Waitaki Valley North Otago									41	41
Other & Unknown	740	836	1,374	1,516						
TOTAL*	29,310	31,964	33,428	33,400	35,334	35,182	35,551	35,463	36,226	37,129

Figure 3: Total hectares by region. Retrieved from NZWG annual report, 2017.

Industry bodies and individual members agree that New Zealand wine is on track to meet the export target of $2 billion by 2020. This is statistically backed up by (figure eight) the 2017 export value of $1.6 billion and the increase of around $100 million every year since 2011 (*NZWG Annual Report,* 2017). Estimations can be made for future expansion of the region with the assistance of industry reports made available by New Zealand Wine Growers, Ministry for Primary Industries and Colliers International.

New Zealand Wine Exports By Market (2008 - 2017)

		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TOTAL	L	88.636	112.647	142.032	154.661	178.880	169.669	186.889	209.419	213.371	252.962
	NZ$	797.797	991.721	1,040.529	1,093.973	1,176.847	1,210.525	1,328.358	1,424.461	1,569.515	1,662.968

Note: All figures are in millions
Source: Statistics New Zealand

Figure 4: Wine industry export value retrieved from NZWG annual report, 2017

Sharp increases in price per hectare of both bare land and existing vineyards shows the demand is surpassing current availability in the region (*Marlborough Vineyard Values,* 2016). Land purchasers are exploring land previously thought to be unviable for viticulture in terms of climatic conditions (*Viticulture Model Vineyard Benchmarking Report*, 2016) with an estimated 8000 hectares available for planting and 2000 hectares planted but not yet producing fruit (*Dudley*, 2017).

At the current average yield of 14 tonne per hectare (*NZWG Marlborough benchmarking report,* 2017) this could see Marlborough produce a further 140 thousand tonne from the 10 thousand hectares not currently producing. At a rate of 20% of the total production, this would see grape marc quantities increase from 64 thousand tonne to 95 thousand tonne, a 47% increase (Table 1).

However, if it is assumed that the 10 thousand hectares is planted in Sauvignon Blanc and is cropped at the 2016 average of 16.5 tonne per hectare (*Viticulture Model Vineyard Benchmarking Report*, 2016) it would be a 165 thousand tonne increase. Vineyard age is contributing to the increase in replanting throughout Marlborough, with top grafting of less profitable varieties to more productive varieties and high-density planting to better utilise existing viticultural land. Forecasting the exact increase in production for Marlborough is difficult with many possible variations to consider in regard to both unplanted land and existing viticultural land, market demands and environmental influences on crop levels.

	2016	2017	*2025*
Producing vineyard area (hectares)	24,365	25,135	*34,000*
Average yield per hectare (tonne)	15	14	*14*
Marc production (tonne)*	64,658	60,479	*95,200*

Table 1: Increase in production current actual and ten-year estimate.

**Marc production calculated as 20% of total tonne harvested.*

Are current practices sustainable

Current practices in Marlborough

After pressing, grape marc can be carried by conveyor belt to a designated storage area at a winery. This area is ideally a concrete pad with bunding or a slight slope that allows for collection of leachate. White and red grape marc differ so in some cases will be kept separate within the storage area. Marc designated for stock feed must be reasonably dry to reduce leachate issues at the farm and is transported at a per tonne cost.

Seasonal factors such as rainfall will influence the condition of the marc at the collection point and at the delivery point if these are not covered. Marc pits are a breeding ground for unwanted pests such as vinegar flies so long-term storage close to the winery is undesirable.

Grape harvesting in Marlborough takes place in a three to four-week window in early Autumn which provides a logistical challenge in terms of storage and transportation, with trucks being predominantly used to cart fruit from the vineyard to the winery. Marlborough can be considered a monoculture region due to the vast area of land dedicated to viticulture and is predominantly planted in a single variety creating a uniquely congested harvest.

Compliance

In 2016, the Marlborough District Council (MDC) combined the regional policy statement and the regional resource management plans to create the Proposed Marlborough Environment plan (PMEP). The PMEP is currently in the hearings stage and is expected to be operative from June 2018.

The document has four key sections which are applicable to the wine industry as summarised in table 2, and cover all aspects of winery waste disposal. The rules for discharge of liquid and solid waste (sections 3.3.25 and 3.3.26) had an immediate legal effect when issued.

Section details	***Section header***
3.3.25.	Application of compost or solid agricultural waste into or onto the land
3.3.26.	Discharge of agricultural liquid waste (except dairy farm effluent) into or onto land
3.3.33.	Making compost or silage in a pit or stack, or stockpiling agricultural solid waste
3.3.34.	Storage of compost not in a pit or stack

Table 2: Summary of PMEP sections relevant to the wine industry

All four sections have redefined the rules of location to be 10m from a dwelling on a separately titled property, 50m from a bore and 20m from a significant body of water e.g. a river. Other key changes to each policy are;

<u>Application of compost or solid agricultural waste</u>

- An increase in total nitrogen loading from 100kg to 200kg per hectare per year.

<u>Discharge of liquid waste</u>

- Must not occur on a soil sensitive area
- Must not occur on sloped land i.e. an average slope of 7°
- pH of the liquid must be between 4.5 and 9, with records kept

- No ponding is to occur so all reasonable measures must be taken to limit this e.g. not discharging if the soil moisture is at field capacity
- There are no longer measurable limits on biological oxygen demand, faecal coliforms and free available chlorine.

<u>Making compost</u>

- A compost *stack* must not occur in a free draining soil area; a compost *pit* must not be in a free draining or loess soil area.

<u>Storing compost/agricultural waste</u>

- If stored longer than three months, it must be completely covered and cannot be in any soil sensitive area.

A new feature of the policy is the classification of soil sensitive areas. Figure nine is a snapshot of the mapping tool available on the MDC website which shows where the sensitive areas are. There are 3 types of soil sensitivity; free draining, loess and impeded soils.

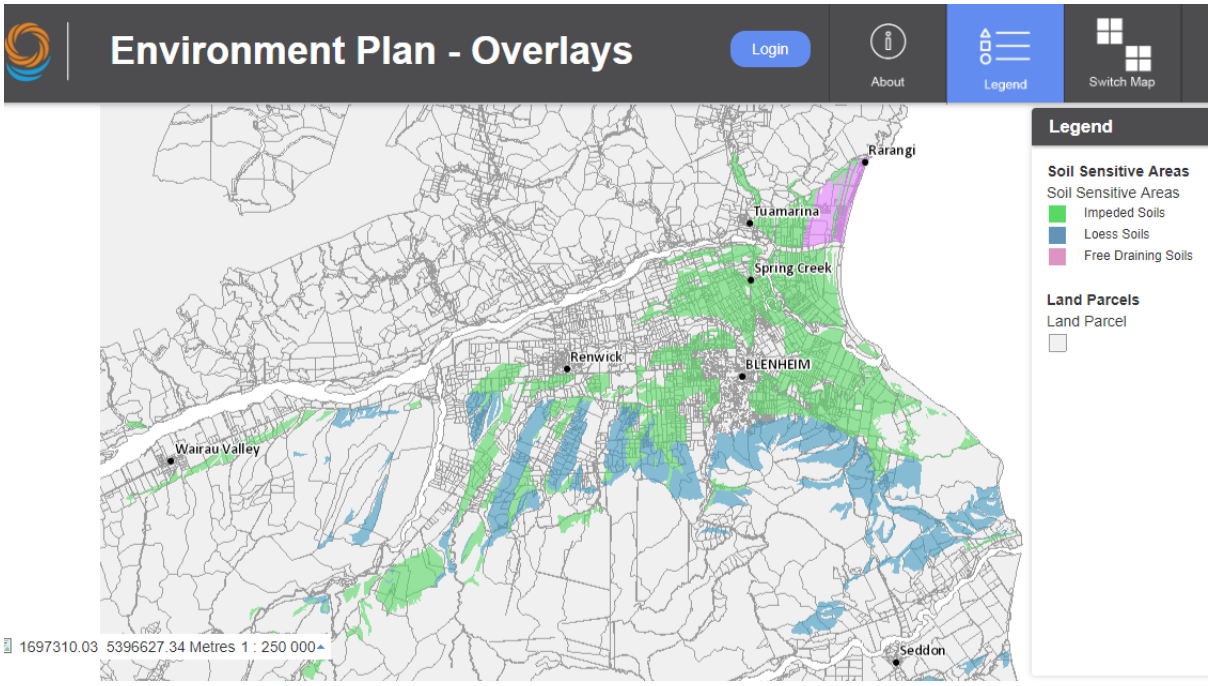

Figure 5: Soil sensitive areas defined by the MDC. Retrieved from https://maps.marlborough.govt.nz/smaps

The changes in policy aim to address significant issues with storage and leachate discharge seen by the council in 2016, which led to prosecutions.

Council compliance is monitored by a winery waste environment committee which produces an annual report of the compliance levels (table 3 & 4). The statistics they produce come from 38 wineries who discharge wastewater onto land with resource consents or within PMEP permitted activities. This is only 27% of all wineries in Marlborough (*NZWG Annual report, 2017*). The report specifically excludes wineries in the industrial zones which discharge to trade waste and wineries that have their wastewater taken offsite. There is no figure provided for how many wineries are excluded because of these factors, if it is the balance of wineries in Marlborough it would be interesting to compare their practices against wineries working with the consent process.

Grape marc storage is monitored at the 38 wineries that are in the wastewater monitoring list. In 2017, ten wineries composted their marc on site for their vineyards, eight spread their marc without a conditioning treatment and 18 had their marc collected by a third party for disposal.

The committee conduct inspections in the peak of harvest. Wineries that have had no previous non-compliance, are less than 2000 tonne capacity and have not had any changes to their systems are not inspected at this time.

After the 2017 harvest 55% of monitored wineries were classified as significantly non-compliant (figure 10). This level of non-compliance is high, but is an improvement on 75% from 2014. While the levels of non-compliance have fluctuated since 2014 (figure 11), levels of compliance have shown an increase every year, from 18% to 33% in 2017.

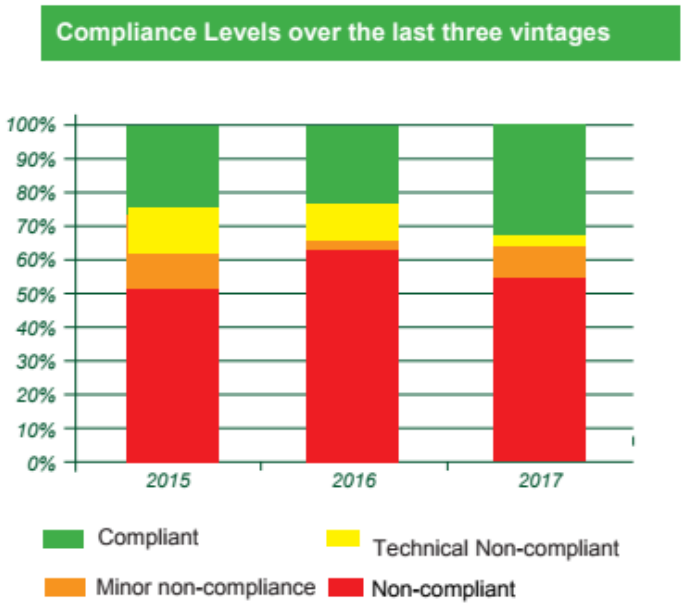

Figure 6: Sourced from MDC compliance snapshot, 2017

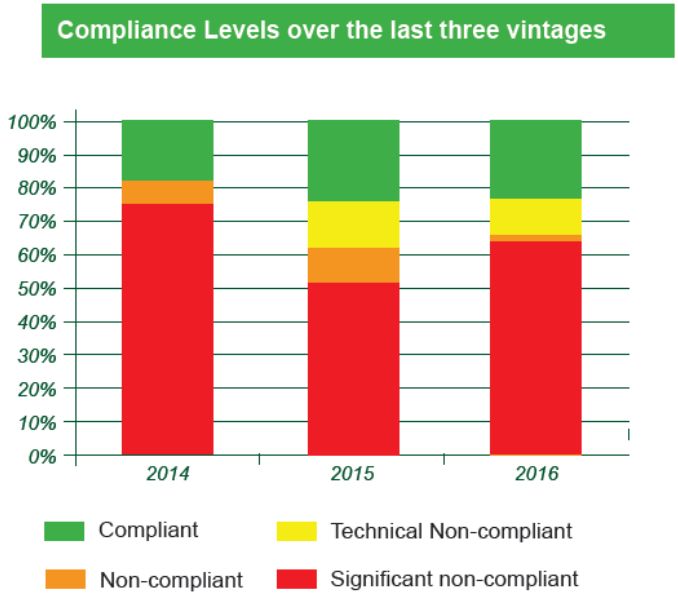

Figure 7:Sourced from MDC compliance snapshot, 2016

The compliance level awarded to a winery is the lowest level of compliance achieved by any condition, for example if a winery has 20 compliant conditions and one non-compliant condition, their consent is rated as non-compliant.

Included in these statistics are 13 wineries who are operating with non-compliance under the PMEP, but are legally entitled to do so under existing use rights of the Resource Management Act 1991 (RMA) because their procedures were permitted before the introduction of the PMEP. Once the PMEP is fully operative, these wineries will need to apply for resource consent to continue. If these wineries were excluded from the report, the compliance picture would change significantly (tables 3 & 4) .

	Compliant on all conditions	Non-compliant on one or more conditions
Number of wineries	12	26
Percentage	33%	67%

Table 3: Statistics published in the monitoring report

	Compliant on all conditions	Non-compliant on one or more conditions
Number of wineries	12	13
Percentage	48%	52%

Table 4: Statistics removing 13 non-compliant wineries covered by RMA

In December 2016, the MDC prosecuted five wine companies or individuals for offences under the RMA (*Lewis, 2016*). This is the first-time action has been taken against the industry in relation to its management of grape marc and MDC chief executive has described the decision to make prosecutions a last resort action against offenders (*Lewis, 2016*). There were no additional prosecutions sought after the 2017 harvest (*Neal, 2017*).

Sustainable Wine Growers New Zealand (SWNZ) is an accreditation programme run by industry body New Zealand Winegrowers (NZW). In their definition, a sustainable wine industry is one which enables the natural environment, the business and the communities to thrive (*NZWG sustainability report, 2016*).

SWNZ certification is achieved by vineyards and wineries which meet the guidelines set. In terms of waste disposal, there is a code of practice for winery waste management practices (*2010*). The recommendations listed in this report for grape marc use are raw spreading, composting and stock feed. The report also highlights the importance of leachate collection. Recently, a change to online scorecard submissions has enabled the SWNZ programme to gather more comprehensive data, allowing in-season benchmarking and improved reporting quality (*Green, S. 2016*).

Among the many measured factors within SWNZ guidelines is the monitoring of waste disposal. In 2016, over 92 thousand cubic meters of waste was diverted from landfill (figure 12). Unfortunately, there is no data available on the trend for this as 2016 is the first year the report has been published. The specific uses of grape marc are not a reported statistic in any NZWG reports.

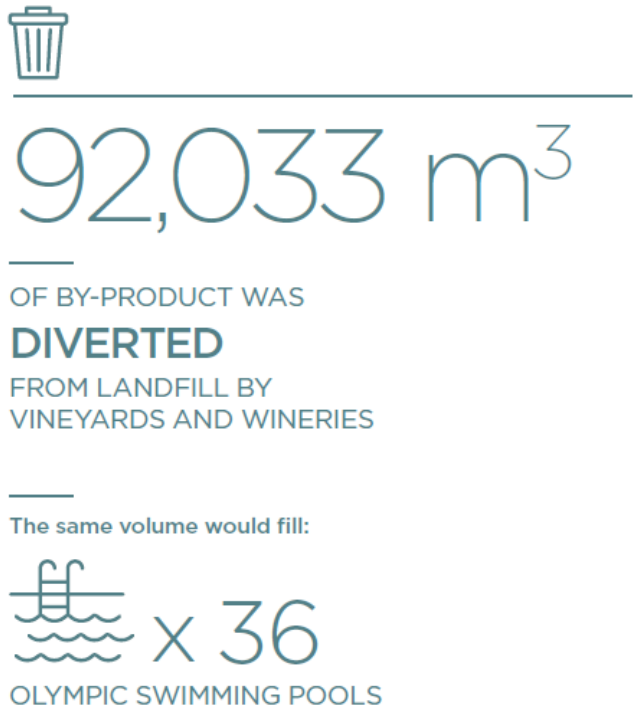

Figure 8: Retrieved from NZWG Sustainability report, 2016

NZWG have committed to improve their best practice guidelines based on current research and developing technologies (*Green, S. 2016*) and show dedication to addressing waste not only through their thorough accreditation programme but also their sustainability continuous improvement project team which was responsible for initiating meetings and workshops on the topic including industry communications around the changes to council policies (*Benge, T. 2017*). Overall, they have a strong interest in waste from a sustainability and marketing point of view.

Composting

There are several companies in Marlborough composting their grape marc for application to the vineyard. Until 2017, Yealands was responsible for composting grape marc sourced from multiple wineries, but this has been discontinued as the quantity being received was exceeding the locations capabilities (*Goodsir, 2017*).

Aerobic composting in a 1000 cubic metre ex silage pit was the composting starting point for Giesen. Working closely with the MDC, Giesen have evolved their operation with the ultimate desire of running their composting situation in the most effective and efficient way (*Poff, 2017*).

If a composting site is near urban areas there are social issues around the smell and traffic levels associated with the operation. Permeable covers can be used to decrease the odour and if that is not sufficient anaerobic composting can be implemented. Anaerobic composting of grape marc is said to retain a higher quantity of the nutrients in the raw products giving a compost of better quality (Arnst, 2016). In this form of composting the leachate is pumped into a waste water treatment facility as opposed to pumping it back over the compost pile repeatedly.

Both forms of composting require spreading equipment to close the loop. An estimate of the cost of composting can be seen in table five. The costs listed can be reduced in a couple of ways;

- Freight. Location of the compost site relative to the winery and the vineyards the compost is destined for will impact this cost.
- Spreading. Own spreading equipment will remove the need for an external contractor.

Not listed as a cost consideration is the capital requirements for establishing the operation. These include site preparation, resource consents, investment in equipment, any training required, waste water facility (if anaerobic), irrigation set up and control (if aerobic).

Cost per tonne	Description
$7*	Process costs i.e. staff, tools and equipment, inputs
$22	Freight - winery to compost site
$22	Freight - compost site to location for spreading
$25	Spreading by contractor
$76	

*Table 5: Potential costs associated with own composting (Hynd, 2014). *An estimate based on conversations with Tarac Technologies*

Compost available for purchasing varies greatly in cost and quality, but averages can be taken for comparison against running your own compost facility. This is summarised in table six.

Cost per tonne	Description
$50*	Compost
$22	Delivery fee
$25	Spreading by contractor
$97	

*Table 6: Potential costs associated with purchasing compost (Hynd, 2014). *Compost prices between $35-$70 so average of $50 used.*

There is no survey to determine exactly how many companies are composting their own grape marc, the only published statistic is the MDC figure of 10 out of the 38 wineries they monitor. It would be interesting to know exactly how many tonnes of grape marc is currently composted by individual companies and if any are preparing to do so in the future.

Phenolic extraction

3500 tonne of marc is used at a local extraction company who specifically seek the skins of red varieties and the seeds of white varieties for their polyphenolic compounds. The extracted products are used in a range of supplement capsules, food products and cosmetics.

Red marc is sourced from non-fermented Pinot Noir that was used in the rose or bubbly style of winemaking. All water-soluble compounds are collected in the 'cooking' process leaving an exhausted marc which is spread on a local farm and is praised for its quick breakdown without the need for composting. White marc is sourced from Sauvignon Blanc for only the seeds which is 12% of the weight received. The undesirable portion of the white marc is sent away for composting or mulch. While the supply of marc for extraction purposes is free, there is a freight charge in the collection of grape marc and the disposal of exhausted and unused marc which is covered by the extraction company.

Expansion is currently being investigated and the company hopes to significantly increase its use of Marlborough grape marc, sourcing only from vineyards that have a SWNZ accreditation (*Turner, 2017*).

Stock feed

A local transport company is responsible for moving 10 thousand tonne of grape marc per year to farmers in the Marlborough, St. Arnard and Murchison areas. These clients receive the product during the harvest period and store or distribute as compost or stock feed on their farms when required (*Hall, 2017*). The cost associated with this form of disposal is freight; around $22 per tonne.

GrowCo is set to create a 1.6-hectare grape marc storage site after gaining council approval in 2017. The large site features a 1 metre thick concrete pad and an impermeable pond for leachate collection. The company has stated it will use the grape marc for stock feed on farms close by and plans to receive a large majority of the regions grape marc in the future (*Nicholson, 2017*).

Other

Australian company Tarac technologies investigated the possibility of establishing itself in Marlborough but encountered several problems. To be viable for establishment Tarac required a minimum grape marc input of 90 thousand tonne and an arrangement with the local wineries to then buy back the compost product while a market for wider distribution was established. The economic value of this arrangement cost more than what most wineries are currently paying for disposal making it an undesirable option (*Patterson, 2017*). The costs associated with Tarac are summarised in table seven.

Cost per tonne	**Description**
$7	Gate fee
$22	Freight to Tarac
$22	Freight back to vineyard
$25	Spreading by contractor
$76	

Table 7: Costs associated with Tarac technologies if a Marlborough site was established (Hynd, 2014).

The current practices discussed have been summarised for a winery in table eight. This is shown as the maximum per tonne cost, excluding any capital spending required for establishing set up.

Disposal option	**Total cost per tonne**
Own composting	$76
External composting with buy-back agreement	$76
External composting without buy-back agreement	$29
NZ Extracts	$0
Stock Feed	$22

Table 8: Cost comparison of all current practices

Practices outside of Marlborough and the wine industry

Brewing

Beer brewing by a boutique brewery in Marlborough is a quick process in comparison with wine making. The four ingredients per brew are water, yeast, malt and hops which are not seasonal in the same way grapes are allowing the process to occur at a steady rate throughout the year. The solid waste product after the brew is complete is a spent grain mix that local farmers and stock both appreciate (*Chambers, 2017*).

Brewery spent grain is a food source for livestock without the need for a conditioning treatment due to its protein, fibre and energy content (*Westendorf, 2002*). The product can be marketed as wet or dry therefore adding no essential secondary process between discharge at the brewery and delivery to the farm. This option of disposal is not as simple for grape marc, therefore practices within the beer industry are not the solution for the wine industry.

Hawkes Bay

Approximately 200 thousand tonne of plant waste is produced annually in Hawkes Bay (*Wilson, 2017*) most of which ends up as stock feed. The source of the plant waste comes from many horticulture industries including orchards, vineyards, food processing facilities and pack houses. The ability to use such a large quantity of waste as stock feed is owed to the increase in dairy farming, the proximity of farms and the developed culture within the waste disposal network.

Dairy farmers in the region have access to a grape marc based stock feed. Baling the stock feed produced ensiled marc, a product with improved marketability due to increased longevity. The compost product has been researched and marketed with an educational approach to help with the initial reluctance from farmers (*Wilson, 2017*).

Hawkes Bay harvested around 42,000 tonne of grapes in 2016, less than a quarter of the production of Marlborough (figure 3, appendices). This statistic alone illustrates the extreme difference in production of the two regions. Since the annual production of grapes in Hawkes Bay has not changed significantly in 10 years (figure 3, appendices) the quantity of grape marc produced in the region will not have changed, making the waste stream a non-issue in the region.

Australia

South Australia (SA) is the largest wine region in Australia, accounting for 44% of the national production (*National Vintage Report, 2017*). The 2017 harvest saw over 860,000 tonne crushed in SA, double the total of New Zealand's annual harvest. Considering these figures, grape marc produced in South Australia must be double what New Zealand produces in total and their disposal options must be designed to accommodate such quantities.

Tarac Technologies is a large operation in SA taking grape marc and other winery waste products to produce alcohol, tannins, tartaric acid, juice concentrate, grape seeds, stock feed and compost (*tarac.com.au/products*). Australian Tartaric Products (ATP) is another large operation in SA using winery waste including marc to produce tartaric acid products and alcohol. ATP is a closed loop operation as it burns its spent marc to produce energy to run the site (*australiantartaric.com.au*). Figure 13 shows the overall use of grape marc in Australia with Tarac and ATP falling into the processed category (*Zhang et al, 2017*).

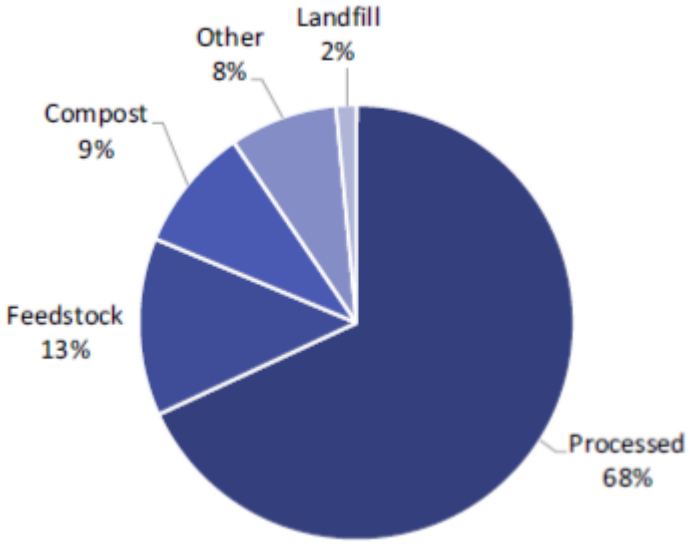

Figure 9: The breakdown of Australian grape marc utilisation (Zhang, et al 2017)

Points for consideration are the differences in grape varieties planted and winemaking style which produces grape marc of different composition to Marlborough. The difference in geographical area and population allows the logistics of production and transport to be easier.

It is difficult to compare Marlborough's grape marc situation with other wine regions within New Zealand or abroad because of how unique the situation is. Other industries may have some learnings which are applicable to Marlborough, but a solution is not found in what brewers practice locally.

Drivers for change

When change is required for any issue it is important to identify the party or parties best suited to address it. In 2005, Waste Management Institute New Zealand, Ministry for the Environment, Standards New Zealand and representatives from 15 associated organisations created the New Zealand Standard for Composts, Soil Conditioners and Mulches (*Quality Compost, 2005*). The list of associated organisations is diverse and are displayed in figure 14. This shows a diverse group can implement positive changes to practice.

Neil Barton	Federated Farmers of New Zealand
Andy Black	Bio Dynamic Farming and Gardening Association
George Fietje	Living Earth
Brian Gallagher	Timaru District Council
Dave Hanan	Delta Utilities Ltd, South Island Organic Recycling Training Group
Chris Keenan	Ministry for the Environment
Margaret Leonard	Institute of Environmental and Scientific Research Ltd. on behalf of the Ministry of Health
Mike Lord	Perry Environmental Ltd.
Ian Mason	University of Canterbury
Patricia Naidu	New Zealand Earthworm Association
Miljenko Pavlinic	HG Leach & Co. Ltd.
Cherryle Prew	Soil Foodweb Institute
Craig Ross	Landcare Research
Bruce Smith	Yates New Zealand Ltd
Michael Spiers	HortResearch

Figure 10: Committee members that developed the New Zealand Standard for Compost, Soil Conditioners and Mulches (Quality Compost, 2005).

In the case of grape marc in Marlborough, there are many parties involved.

Wineries and grape growers

In a broad explanation, vineyards produce fruit for delivery to the winery and wineries produce grape marc during their wine making process. Traditionally, the disposal of grape marc has been up to the winery to facilitate.

With the increase in grape marc and the pressure to be disposing of it in a sustainable and economically viable way it could be time to revisit the ownership of the product between the grower and the winery. If composting is the method of disposal, it is logical that it goes back to the vineyards. This becomes difficult when wineries such as contract facilities don't have own vineyards, or wineries have multiple contract growers supplying small quantities of fruit.

Local council

The council has a responsibility to ensure the environment is not adversely affected by the waste streams but doesn't have to provide the solution to the industry (*Jerram, 2016*).

Prosecutions by the MDC against individuals for non-compliance shows the council is strictly enforcing policy rules. While the council do not create the product, the rules they set for the

treatment of it directly affects the way it is managed and the actions they take against non-compliance impacts the development of a culture.

The monitoring committee includes 13 wineries with known non-compliance in their reports, despite their operations being legal. They also have a very small monitoring base accounting for only 27% of wineries in Marlborough. Both facts negatively impact the overall compliance level of the industry.

Industry bodies

SWNZ certification has been accredited to 98% of all vineyards and wineries in New Zealand (*NZWG Sustainability report, 2016*). With such a large member base, SWNZ is the perfect place to communicate and enforce best practice guidelines for grape marc disposal. They are also well equipped to gather information regarding the specific quantities and uses of grape marc.

In 2014, a group made up of industry representatives formed to create the Marlborough Grape Marc Group. The groups intention was to collectively find a solution for the forecast increase in grape marc and met with NZWG, MDC and local industry body Wine Marlborough (WM) to work through potential uses for the product. No one solution was reached with the group, but the discussions highlighted the importance of the issue with most agreeing it needed to be addressed. This is proof that collaboration is possible within the industry.

Research

Research projects increase understanding around a topic. NZWG funds several research projects through the levies paid by industry members. Other research facilities with an interest in the wine industry include Plant and Food Research, Lincoln University, Auckland University and other polytechnic facilities around New Zealand. Currently, there is no research on grape marc uses funded by NZWG.

There are at least two examples of individuals looking at grape marc with their personal development achievements. Young Viticulturist of the Year (2008) winner Simon Bishell created a report on the use of grape marc to create a bioethanol fuel. This report on the current situation in Marlborough is completed as part of the Kellogg Rural Leadership programme.

What does a sustainable future look like

Recommendations

Salvage operations occur in multiple food processing industries, if not by design then by necessity. An oversupply of carrots in Western Australia lead to the investment of a juicing facility which is now a big part of the business in that they sell everything they make (*Wilson, 2017*). Grape marc is only one aspect of a waste stream that is growing as the industry grows. Broken vineyard posts used in the trellis system are a concern, with up to 1800 tonne of posts going to landfill every year (*Preece[a], 2017*). A pyrolysis company with interest in the treated posts has begun the resource consent process to establish themselves in Marlborough. There is evidence of pyrolysis being a viable option of disposal for grape marc as described in the literature review, there is no reason that pyrolyzing grape marc and vineyard posts couldn't exist on the same premise.

Suitability of current practices

There is already evidence that individuals are expanding their current facilities to accommodate the expected increase in grape marc. The establishment of a new, large scale stock feed operation is confirmation that there is demand for what is already in place. Compliance levels are on the rise and it would be reasonable to assume this will continue.

Support from local council and industry bodies will help with the development of a sustainability focussed culture. Communication and education presented by these organisations will continue to increase understanding of issues and acceptance of change where required.

Cost

The most cost-effective way to dispose of marc is composting for own land (*Krzywoszynska, 2013*). This excludes the capital spending required to set up but is a long-term solution to a waste stream that a winery produces every year.

The cost of the compost operation could be reduced again by introducing a rotation contract where all grape suppliers would be expected to take a percentage of the compost biannually or similar.

There are plenty of examples of a salvage operation generating a return. Following the New Zealand standard for composts, soil conditioners and mulches will allow companies to create a quality compost. With the appropriate resource consents, any surplus compost could be sold.

Relationships can be built with extraction facilities or other third-party users to share the cost burden with freight and /or final disposal if an exhausted grape marc product is produced. Sharing the cost would allow these companies to expand quicker.

Research, development and technology

Further research on methods of best practice will help evolve the culture around marc disposal. New technology should be encouraged; destemmer units are common on harvesters now, perhaps the future includes press facilities on board those same harvesters. VitiFuel as described by S. Bishell is another possible industry that doesn't currently exist in Marlborough.

Conclusion

Grape marc quantities are increasing in Marlborough which is providing concern about whether the disposal of it is sustainable.

Members of the wine industry are aware of the issue, and many are planning expansion because of it. Monitoring of grape marc by industry bodies and local council is not very specific and there is room for improvement within these reports.

With expansion, current practices are suitable for the sustainable disposal of grape marc in the future. Ideally, a large portion of the marc should remain in the hands of its producers to be returned to the soil. Bio waste products such as grape marc are elements of their environment and should be viewed in a more positive light to remove the negative stigma associated. In this, the term waste should be replaced with excess materials. Reutilising materials rises from good environmental consciousness which in turn can be marketed as good business.

It is an industry issue, but effects a wider audience than just the wineries. Collaboration between all parties involved in the production, treatment, legislation and reporting of statistics should be employed to ensure the uptake of best practice procedures.

The future can be difficult to predict but it is not unreasonable to assume that the above points will lead to a sustainable future for grape marc in Marlborough.

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