Short Term Discomfort for Long Term Gain

Nigel Sowman

Kellogg Rural Leadership Programme

Course 36, 2017

ACKNOWLEDGEMENTS

I wish to thank the Kellogg Programme Investing Partners for the support provided to putting on the programme:

STRATEGIC PARTNERS

DairyNZ

beef+lamb new zealand

FMG Advice & Insurance

AGMARDT THE AGRICULTURAL AND MARKETING RESEARCH AND DEVELOPMENT TRUST

PROGRAMME PARTNERS

Ministry for Primary Industries Manatū Ahu Matua

FAR

Farmlands co-operative

Horticulture New Zealand

Zespri Kiwifruit

NZX Agri

LIC

Allflex Identify the Difference

TIAA GLOBAL ASSET MANAGEMENT

OCULAR.co.nz

Short Term ~~Pain~~ Discomfort for Long Term Gain

From Conventional to Conversion through to Organics: A Case Study

Observations from Conventional, to eight years post conversion to Organics, covering 150 Ha on a Vineyard in Marlborough, New Zealand

Nigel Sowman

Kellogg Rural Leadership Programme

November 2017

Executive Summary.

This case study looks at the changes seen over the first eight years post conversion to organic viticulture and covers the first 150 hectares of converted vineyard area on a vineyard in Marlborough, New Zealand. The motivation behind this case study has come wanting to know what changes have happened on the vineyard in question since the conversion to organic management. The best way to understand and examine these changes, is to look back to before conversion and track the changes to see if there have been any trends forming. This case study has focused on the cropping, soil and plant changes for the period of 2002 to 2017 with the process of organic conversion starting in March 2009. Not all information has been available for this length of time, however consistent information was available from before conversion with regards to all of the parameters studied. This report has not gone in to the financials of the business.

With continued growth in the organic sector all over the world, and the increasing restrictions on new and existing agrichemicals, the direction towards future proofing vineyards, environmental stewardship and increasing quality go hand in hand with organic production principles. These have all been implemented on the vineyard covered in this study.

Cropping data was available for total yield of each individual block and yield per hectare, from 2003 to 2017. A reduction in yield is one of the most concerning factors for growers wishing to convert to organic production, however there was no decrease in yield on the vineyards studied. The main reason for there being no decrease is that the focus on quality, from conventional to organic management, has not changed. Quality is distinctly influenced by crop load, so crop thinning is carried out in years where there is excessive crop, either by shoot thinning early in the season or bunch thinning later in the season. This has happened in every season covered in this study.

Soil data analysis for some parameters was available from 2002 to 2017, where other parameters data was only available from 2008. Analysis of the biological parameters was not undertaken. There was no change in the pH or the Bulk density over the study period, however increasing trends were observed in the CEC and Organic Matter values, starting from around the time of conversion to organic management. One of the most interesting results was the increasing trend in available K from around the time of conversion, even though no K fertilizers have been applied. Potassium can be a major limiting factor in ripening of grapes later in the season, so this increase is very encouraging. Increasing trends have also been shown in Fe, Mn, Zn, Cu and B, though the data for these results were only available from 2008, one year before the conversion to organic management.

Plant tissue analysis data was consistently available from 2007 to 2017 and shows a definite decreasing trend for petiole Nitrate-N, right down to unreportable levels. This is directly related to the pale green leaves seen across most organic vineyards. However, the pale green leaves and the reduced canopy size has had no effect on the ability of the grape vine to fully ripen the crop retained by the management. Even with the decrease in petiole Nitrate-N, the total nitrogen percentage within the leaf blade remains constant. Increasing trends have been shown in the trace elements Fe, Mn, Zn, Cu and B though results are only from 2008 to 2017.

One of the key out comes from this study does not directly relate to the analysis of the data collected, but comes from the lessons learnt on the journey through conversion to organic management. Many of the techniques used for combating weeds and pests can be used, and have been used, in the areas of the vineyard that are still considered to be under conventional management, which is a major positive outcome for environmental stewardship.

Table of Contents.

Foreword.

"It takes 3 years to gain certification and 7 years to ask forgiveness" – James Millton

I was first introduced to biological farming in 2006, at a 2-day seminar held by Graham Sait in Marlborough, New Zealand. I had studied viticulture and oenology at Lincoln University and had been employed in the viticulture sector since 2000. However, it was the introduction to biological farming that seemed to answer many of the questions I had been asking myself, really captivating me and propelling me along this journey into organic production.

This journey has had me cross paths with some of the most respected viticulturists, organic practitioners and researchers in the New Zealand industry. I have undertaken this research to gain a better understanding of the path I have come down and to try to answer the statement above. James Millton - Millton Vineyards and Winery were the first producers to attain BioGro certification for organic wine production in 1989 (millton.co.nz) - first said this to me back in 2012, when the vineyard I work on gained its first full organic certification. At first it puzzled me, but then it made me think of all the possibilities I would see once I hit the 'magic' 7-year mark. Looking back, I can 'see' the changes that have happened, but you never see them as they happen, as with all long-term approaches. In this report I will endeavour to show these changes through data that I have collected and observations I have made.

"Good things take time."

Acknowledgements.

I would like to acknowledge my employers Ivan and Margaret Sutherland, for their financial support and allowing time for me to undertake this Kellogg Rural Leadership Programme. Also, for having the vision to take such a beautiful property through organic conversion and have me be a part of the journey.

To Marc Greven from Plant and Food Research, the ability to bounce ideas off and guidance on presenting results, has kept the direction of the project relevant and cohesive.

To my wife Kathy, whose understanding of the course, and the commitment required to get the most out of it, has been an unwavering and a constant source of motivation.

To the Kellogg course providers, Anne Hindson, Scott Champion, Patrick Aldwell and the strategic and programme sponsors that make the programme run. Thank you for making this possible.

1. Introduction.

1.1. Global perspective and New Zealand's place in it

Worldwide the growth in organic agriculture land has increased by 360% since 1999 to 50.9 million Ha in 2015, which constitutes 1% of the total worldwide farm land (Willer and Lernoud 2017a). 2015 statistics from New Zealand show there is 74,000 Ha of organic agricultural land, 0.7% of the total agricultural land area (Willer and Lernoud 2017a) (OANZ report puts this 0.52% of total agricultural area). The Growth of the global organic grape area has increased from 87,655 Ha in 2004 to 332,905 ha in 2015, which accounts for 4.7% for the total world grape growing area, (this includes wine, table and dried grapes) (Willer and Lernoud 2017b). This is mostly dominated by Europe, and in particular Spain. New Zealand horticultural land area under organic certification increased by 128% in the three years from 2012 (11,188ha) to 2015 (25,476ha), reflecting significant growth principally in certified organic pipfruit and vineyard production (Freshfacts 2016) (OANZ 2016).

In New Zealand, the growth in certified organic vineyard area has been steady, though starting from a small base. In 2015 there was 2022 Ha of vine plantings under organic certification, a total of 5.78% of all vineyard area in New Zealand (OANZ 2016).

1.2. New Zealand Wine and certification

New Zealand wine (NZ Wine) has an export focus, with $1.66 billion in export revenue and a target of $2 billion by 2020 (nzwine.com), this will not be reached by share volume alone, but the increase in the value of the products sold. With such an export focus, growers are reliant on the rules and regulations of the consuming countries to set the allowable maximum residue limits (MRL's) within which they can operate. It is then up to NZ Wine and the certifying bodies to enforce these restrictions. With current trends showing tighter MRL guidelines, the ability of growers to use the available chemistry has been severely affected into some of New Zealand's export markets.

Sustainable Winegrowing New Zealand (SWNZ) is NZ Wines sustainability programme, with 98% of New Zealand vineyard area certified to this voluntary programme. It had its start back in the mid 1990's and is now a world leader around sustainability certification. The programme sets benchmarks to provide measurable targets but views sustainability as a journey of continual improvement. Central to their sustainability policy is a commitment to keep improving, as new research is undertaken, and new technologies are developed (nzwine.com). Self-audits are carried out every year on-line and on farm audits are carried out every three years.

There are two organic certifiers in New Zealand, BioGro and AsureQuality. These also certify to the world recognised IFOAM accreditation and any country-own organic programmes (e.g. COR, USDA and EU Regulations). The standards set are rigorous and thorough with on farm audits carried out every year, in line with international best practice. Demeter is the specialist Biodynamic certifying body in New Zealand and around the world.

1.3. Thoughts behind the decision

In 2008 the decision was made to convert 150 Ha of established vineyards on the studied property over to organic management practice as certified by BioGro New Zealand. The decision was not based on a marketing outcome, but the culmination of observations and foresight by the owners. “The conversion to organic viticulture initially came from a desire to farm in a more natural way and a strong dislike for the conventional way, with its excessive use of foliar sprays and herbicides. Other important drivers were a perceived improvement to soil and plant health along with creating a healthier working environment for our family and staff. With the marketing of our wine over the latter years it has become very noticeable that consumers are questioning the origins and composition of the products, along with the type of farming regime practiced. Ultimately, we want to leave the land and its environs in a vastly improved state and strongly believe we have a social and environmental responsibility to achieve this” (pers. com. Ivan Sutherland). With a vision towards long-term benefits over short-term gains, organics was seen by the owners as a better fit to the vineyard ethos and the decision to convert all 150 Ha proved to be a key driver. The outcome was to bring organic management practice to the fore, becoming how the vineyard was managed, not just an experimental sub block within a larger vineyard. This decision was instrumental with the staff who were more accustom to the conventional way of management. New skills were learnt around mechanical weeding, pest control and vine health. The area converted to organic production was mainly made up of vineyard blocks on the valley floor but did incorporate hill slopes as well.

The vineyard has been a part of SWNZ since 1998 and while the programme has had a positive impact on the grape and wine industry, there was one aspect that helped to convince the owners of a move to organic certification. SWNZ has a very broad brush, there is no differentiation between growers at the peak of sustainability and those that were doing the minimum to pass the certification. Because the vineyard was already at the forefront of sustainability, the step to organic certification was small. Organic certification was a differentiation away from the least sustainable of the SWNZ accredited vineyards. When the decision was made there was only minimal use of synthetic fungicides and fertilisers being used, however it was the move away from herbicides that proved the largest paradigm shift, but has also provided the greatest benefit. Moving from bare under-vine strips to under-vine strips that contained weeds and grasses was, at the least, a visual barrier for vineyard tidiness which the owners hold high. While in the first few years weeds were a concern, mainly due to a shortage of machinery to cover the area, this have become less of a challenge. Weed species and management practices have changed and now weeds present less of a problem. Grazing by sheep in the winter and then under-vine cultivating once the sheep have left in spring give the vineyard very good weed control leading into each new season. Two-four passes by the under-vine cultivator through the vineyard are typical throughout the spring and summer period.

Fruit from this vineyard is sold to both organic and non-organic wineries, thus price premiums for organic certification are not sought. Quality is the overarching factor behind any higher prices paid by the wineries supplied.

Future proofing the vineyard by increasing resilience and decreasing dependence, is the long-term goal for the owners and their family. Economic, social and environmental sustainability are always at the forefront of decisions, with no one driver being dominant over the others.

1.4. Future of the industry

Clark, 2011 presents the argument that the future is organic because the design drivers that have shaped and moulded the current agri-food system are changing, demanding a wholly new, and largely organic, approach to agriculture. Norton and Reid, 2013 write about sustaining native biodiversity in agricultural landscapes, with organic farming having on average 30% more species richness. On average, organisms were 50% more abundant in organic farming systems, particularly birds, predatory insects and soil organisms. This can also hold true for the current conventional viticulture model, where high input viticulture has impacted the ability of predatory insects to control the populations of non-predatory insects. Conservation biological control is focused on in a case study about the 'Greening Waipara' project (Norton and Reid, 2013), manipulating field margins or establishing flower strips allowing shelter and nectar for natural predators and parasitoids.

Reliance on synthetic fertilisers, fungicides and herbicides has become common place in New Zealand agriculture and horticulture. With the increase in resistance by diseases to single site fungicides, and the emergence of Glyphosate resistant weeds, a move away from these products in the long-term is inevitable. Tighter maximum residue limits (MRL) for export regulations, the phasing out of once allowed chemicals (due to new research and residue testing) and an increasingly prescriptive resistance management strategy (NZ Wine spray schedules 2004/2005 to 2017/2018) (nzwine.com), indicates that the current model of high input conventional viticulture needs to change. Organic practices such as under-vine mowing, or cultivation will become more common place in viticultural operations, as the struggle to chemically control weeds becomes more difficult. While 5.78% of the vineyard land is certified organic, 12.5% of New Zealand grape growers had at least one certified organic vineyard (OANZ 2016). With large companies (e.g. Villa Maria) investing more and more into organic conversion, and the focusing of production not only towards their high-end products, but to their more affordable ranges, can only bring the organic landscape across New Zealand to the forefront of sustainable viticulture. Both environmentally and economically.

With the count of countries banning Glyphosate currently at four (Malta, Sri Lanka, The Netherlands and Argentina) (Back to the Roots, 2016), and further countries imposing bans on its public sale and use in public spaces, an agricultural world dependant on this management tool, will need to look to the past to forge solutions into the future.

2. Aims and Objectives

2.1. Study Question

"After eight years of commercial organic viticulture, are there changes or trends we can see developing in the in the cropping, soil or plant characteristics"

In addressing this question, we need to look back to see if any trends had started before the implementation of organic conversion. This poses many challenges with consistency and detail of data, and needing to bear in mind the changes in management philosophy.

The motivation behind this report to was to gain a better understanding of, if and how, the conversion to organic management has benefitted the vineyard after a sustained period. Can we formulate a better understanding of what changes to expect if organics is implemented on a wider scale across New Zealand, so there can be better information available for education and training, taking the fear of the unknown out of the equation?

Knowledge of natural systems will play an ever-increasing role in New Zealand's agricultural and horticultural landscape. Natural, regenerative systems will be at the forefront for a push towards a cleaner greener primary industry. Will we still put short-term gains ahead long-term benefits?

2.2. Limitations of the report

This case study is not meant as a comparison between organic viticulture and conventional viticulture, but rather the observations of a vineyard from before organics through the first eight years after organic management implementation. It is not designed to influence one system over another but to show the start of trends through the soil, plant and cropping on this vineyard. Data has been collected and analysed from as early as 2002 where possible, through to 2017. The data is not complete but gives indications of some emerging trends that have also been seen in other studies. The analysis and reporting of this case study has been carried out by the viticulturist who has been with the vineyard since 2002.

Direct comparisons between organic and conventional are not possible from this vineyard as all areas that have enough comparative data, have since been converted to organic production. This study covers vineyard blocks included in the first 150-hectare (Ha) conversion in 2009.

This study has not gone into the costs of the conversion process or financials of running the business. Many studies have been conducted on this. Two New Zealand examples of this are 'The Organic Focus Vineyard Project' focused on the three-year conversion process, and the New Zealand Wine - Ministry of Primary Industries (MPI) 'Viticulture Model Vineyard Benchmarking Report'. The latter is a long-term study that goes into the yearly financials of 38 vineyards in Marlborough, of which there are four certified organic and two others that have trial areas of organically grown grapes (Viticulture Model Vineyard Benchmarking Report', 2016).

http://www.organicfocusvineyard.com/

http://www.mpi.govt.nz/dmsdocument/13356-viticulture-model-vineyard-benchmarking-report-marlborough-2016

3. Timeline for Conversion to Organics.

This timeline represents the conversion process and how it progresses.

The first vines on the vineyard were initially planted in the early 1970's. The oldest remaining vines date back to 1981. The vineyards covered in this study have been progressively planted over this time.

Winter 2008 – Decision to convert to organics

March 1st 2009, official start date of conversion to organics (BioGro classification C0). The growing season 2008/2009 was run as conventional.

March 1st 2010, first harvest after 1 full season of organic management (BioGro classification C1)

March 1st 2011, second harvest after 2 full seasons of organic management (BioGro classification C2)

March 1st 2012, first official harvest of fully certified organic grapes after completing 3 full seasons of organic management.

4. Methods.

Although long-term scientific experiments in the US and Europe have collected long-term data, they have been primarily designed as scientific experiments (Wheeler and Crisp, 2009). However, the data available from the present study comes from a commercial vineyard where the company's main goal is to achieve an economic profit. The management personal has not changed over the time of the study, so these influences have been kept to a minimum.

Access to data as far back to 2002 was allowed, and comprised of consistent yield data, soil analysis and plant tissue tests. Therefore, the ability to show the transition from conventional management through conversion to organic, then into five years post the conversion process was available. The raw data was categorised by year and where applicable categorised by test performed. All data has been analysed to show trends over time more so than at any specific point in time.

4.1. Yield

Yield data was available from 2003 through to 2017. Most of this data has high integrity however some blocks within the vineyard have changed in either their variety or clone through redevelopment. For this study I have only included years where the data deals with mature vines. Growing systems (the increase or decrease in fruiting wood retained after pruning) or end use direction (quality parameters with reference to crop load) play a role in the final yield of a block and these have changed throughout the years, however I do not believe this has had a significant impact on the overall trends seen in the research data. Data was available for total yield and yield per hectare. Exclusions were made for two varieties where only small areas are grown, focusing on the three main varieties, Sauvignon Blanc, Pinot Noir and Chardonnay.

Crop reduction has been used consistently within this vineyard across all varieties as a means of quality control. The data from before crop reduction – either by shoot removal or removal of fruit directly – has not been collected and stored, as these are only serve as rough estimates of what yield the vine is carrying, and create an initial picture of what thinning should occur. More accurate estimates are carried out later in the season for accurate crop manipulation prior to veraison and ripening. These are not stored with any great accuracy and were not used for this study.

Data was collected across 75 individual blocks, 11 Sauvignon, 17 Chardonnay and 47 Pinot Noir. The high number for the Pinot Noir was due to each clone having yield information collected on it. Sauvignon Blanc accounted for 45% of the total area, Pinot Noir 30% and Chardonnay 25%.

4.2. Soil

Soil chemical analysis data was available from 2002 to 2017 with two exceptions (2009 and 2014). Years 2003 to 2008, the soils samples were analysed by ARL Laboratories and years 2002, 2010 to 2017 were analysed by Hill Laboratories. Consistent tests were carried out for certain parameters between the two laboratories, and extra data collection has been included since 2010 with the change to Hill Laboratories. Data from 2009 was analysed at DHM Laboratories and has not included in this study as it was deemed too inconsistent in relation to the other years results. In 2014 no soil samples were taken on the vineyards covered in this study. The management decisions in relation to soil amendments were based around trying to achieve certain ratios between the base saturations for the major cations. A calcium to magnesium ratio of 7:1, and a magnesium to potassium ratio of 4:1. Attention was paid to the overall balance of the other cations analysed for and small amendments were used where necessary. Focus has been placed on the soil biology and the preservation and growth of these organisms with the choice of fertilisers and other soil treatments (e.g. compost tea and humic acid applications) used on the vineyard. Soil foodweb tests were carried out, however the results of these relied on too many factors (e.g. time of year, soil moisture, soil temperature) to be considered as an accurate guide to changes in the soil biology over the conversion to organics.

While Olsen P data can be shown as far back as 2002, in general it is not possible to convert results from different laboratories test methods, as differences in procedures (including soil:extractant ratios, extraction times, filter papers, instrumentation etc.) mean the results will not be comparable (Hill Laboratories Technical notes). However, pH, CEC, Base saturation, Bulk Density and Organic matter tests are standardised across providers and give a better indication of long-term trends.

K, Mg, Ca and Na were expressed in milli equivalents per 100g (me/100g) and as percentage base saturation (%BS) in both the ARL Laboratories tests and the Hill Laboratories testing.

Data was collected from 4 sites, each covering a wide area. More detailed samples were taken in the earlier years, but this was cut to 4 when testing showed similarities across neighbouring blocks. Site 1, covers 33 Ha, Site 2 covers 76 Ha, Site 3 covers 21 Ha, and site 4 covers 13 Ha. There is a mixture of varieties and clones across these sites.

4.3. Plant

Leaf Petiole and blade analysis has been consistently carried out with the same suite of tests since 2008, one year before the start of conversion. Data has been collected for each sub block and each different variety. Samples were collected at time of flowering with all macro nutrients shown as percentages and micro nutrients shown as mg/kg. All nutrients were shown in leaf blade analysis, with nitrate-N, phosphorus, potassium and magnesium also shown in petiole analysis. Petiole analysis best indicates the current movement of nutrient towards the leaf blade, and is sensitive to the status of 'mobile' nutrients such as N, P, K and Mg. Leaf blade analysis indicates the overall status of all nutrients including 'immobile' ones such as Ca and trace elements Mn, Zn, Cu, B (Hill Laboratories Technical notes). Nitrate-N Values reported as <100 mg/kg were standardised at 50 mg/kg for consistency.

Data was collected for Sauvignon Blanc across 9 sites, Pinot Noir across 8 sites (mixed clonal) and Chardonnay across 11 sites (mixed clonal).

5. Results and Analysis.

5.1. Yield

Yield data was analysed for all varieties and broken down into, with regards to the Pinot Noir and Chardonnay, older plantings on the flat valley floor and the more recent (2000-2002) hill side plantings. For this study, only the mature plantings on the flat have been shown. Figure 1 provides a graphical overview of the tonnage per hectare as averaged across all blocks for the three varieties. Blocks on the flat are planted at a rate of 1852 plants per Ha, there has been no adjustment for missing vines as the rate is below 5%.

This data shows no significant yield differences from before the conversion to organics to eight years after conversion across the three varietals. When we look at the deviation around the average for Sauvignon Blanc, as shown in Figure 2, we see a possible weak trend towards in increasing tonnage per hectare. What we are most likely seeing is the impact weather and thinning decisions have on the final yield. Most high and low yields can be attributed to climatic data. The high yields in 2011 and low yields in 2012 for an example can be attributed to warm flowering periods through December 2010 (for harvest 2011) and a cool, low light flowering in December 2011 (for harvest 2012) (Table 1). The full potential of how large a crop could have been is unknown, due to crop thinning being employed in all years to limit the production for quality reasons. The target cropping load for Sauvignon Blanc is 10 tonnes per hectare.

5.2. Soil

Coll, et al. 2011, show in their long-term study differences in, P, CEC, Bulk Density (BD aka. Volume weight), K and Organic matter, the results from this study show similar trends. With data available from 2002 to 2017, Figure 3 shows stable results across pH and BD, while CEC and Organic Matter show a definite increasing trend (figures 4 and 5) across all four sites. Abnormal results in 2007 for CEC unfortunately cannot be explained, sample error can be ruled out with all four sites showing the same spike and there was no change in the laboratory conducting the testing. Both CEC and Organic Matter graphs show an increasing trend starting around the time of conversion to organics, where organic soil amendment practices had started even before decision to go organic. The CEC increase is reflective of the increase in organic matter (Hill Laboratories Technical notes). Increases in available K content were reported in Coll, et al. 2011, and this trend has been seen the results of this study (figure 6), even though there has been no application of K fertilisers to the blocks. The only notable exception is Site 4 which stared with a slump after conversion in 2009 but has slowly increased. The main difference between these sites is Site 4 is on hill sides where the predominant soil type is wind-blown loess and is characterised by tight packed, high clay content soil where release of tightly-held or ''fixed'' K only slowly becomes plant available (Hill Laboratories Technical notes). Trace element data has only been collected by Mehlich 3 testing protocol consistently since 2011 but we are already seeing upwards trends in Fe, Mn, Zn, Cu and B (figure 7). The most significant of these upward trends is seen in Cu, however the values of 4.6-9.4 mg/L are still well below the values of 50-1500 mg/kg of Cu found in vineyard soils in Europe where long-term application of Bordeaux mixture ($CuSO_4$+$Ca(OH)_2$) has led to accumulation in the soil (Chaignon, et al. 2003), thus the trend is concerning but a 'wait and see' approach of monitoring future trends is the only action required at this stage.

5.3. Plant

The largest and most obvious trend we see from the large amount of data available is the decrease in petiole Nitrate-N (figure 8) across all three varieties. Individual blocks show spikes in Nitrate-N, most of which can be attributed to cultivation of the inter row for re-sowing or cover cropping, however if these are averaged across all blocks within their varieties they stay consistent with the trend. The pale green leaves often seen in organically managed blocks can be directly correlated to this decline in leaf and petiole nitrate concentration. Even with Nitrate-N significantly decreasing in the petiole, results of Hill Laboratory tests show the percentage of Nitrogen within the leaf blade (figure 9) is being maintained. Figure 9 also shows the convergence of leaf Nitrogen levels post the organic conversion. Starting from 2008 (prior to organic conversion), micro nutrients Fe, Mn, Zn, Cu and B have either stabilised or are showing a slight trend upwards (figure 10). This a direct correlation to what is seen in the soil testing results. While Cu shows a steep increase in 2016, possibly due to copper sprays used before flowering, the vineyard will use a cautious 'wait and see' approach to see if this trend continues or if it is an anomaly in sampling.

6. Discussion.

6.1. Observations

These are the personal thoughts and observations of the author.

6.1.1. Weed Changes

Herbicides impose a great degree of selection pressure on weed populations – and if the same herbicide or herbicides with the same mode of action are used repeatedly, herbicide-resistant or herbicide-tolerant species can build up in the population after several years (ANR Publication 8493, 2013).

With the discontinued use of herbicide at this vineyard, changes to the type and species of weeds has been quick. Previously the vineyard under-vine herbicide strip was dominated by Mallow (*Malva sylvestris*), Black Nightshade (*Solanum nigrum*), Redroot (*Amaranthus powellii*), Fathen (*Chenopodium album*), Dovesfoot Geranium (*Geranium mole*) and Willow Herbs (*Epilobium spp.*). These have been largely replaced by native grasses, clovers and yarrow (*Achillea millefolium*). These lower growing weeds pose less of an issue with cultivation and the soft stems do not interfere with the sensor bars that operate the hydraulics on the under-vine weeder. The first of the weeds to become less apparent were the willow herbs, Redroot and Dovesfoot Geranium which responded well to the soil disturbance of the under-vine cultivator. The weeds that took longer to get control over, for different reasons, were the Mallows and the Fathen. Mallow, with a large seed bank that can last for years and a deep tap root, took longer to gain control over. However, as the soil became more friable, biology and calcium levels increased this weed has been seen less and less. Fathen has also taken longer to get control over, due to growing well in friable soil and having a large seed bank. It is a fast-growing spring/summer germinating annual weed, so controlling it early in its growth phase, before the hard stem gets too tall, is key to keeping on top of this weed.

6.1.2. Soil Changes

Soil has a major impact on the composition of the grapes being produced and the resultant wine, however with only 4-5% of the plant being made up from soil based minerals, soil quality is paramount. With regards to the paper by Coll, et al., 2011, their study demonstrated that a transition period of 7-11 years, depending on the considered indicator, was needed to clearly separate Conventional and Organic farming practices in Southern French vineyards. It can be very difficult to identify soil changes without constant and detailed analysis of the soil structure, biology and chemical composition. These two direct observations and are personal experience of the author, no tests were performed, or analysis sought, just pure observation and conversation.

The first observation was made in 2010 when we first put the under-vine weeder across one of the hillside blocks. The loess soil in this block is very prone to erosion and we had had issues with under runners and scouring out of trenches when we irrigated. We thought the soil under the vine, once disturbed by the under-vine weeder would be washed down the hill when we irrigated, however the opposite was found. Irrigation was able to soak into the broken soil rather running over the hard crust that had formed using herbicide. Rain was also able to better penetrate the soil and as a direct result of organic practices we no longer suffer from erosion on this hill side

This second observation was made in the winter of 2016. The vineyard owners had newly purchased land, 200m along the same ridge as one of the hillside blocks included in this study. After typical winter rain I was walking through the newly purchased block of grapes, when I noticed water pooling up with every step I took. The ground wasn't abnormally wet, but it reminded me of walking along one of the original ridges located on the vineyard in 2007, cattle had been in part of the vineyard and really pugged up the ground. Walking through the block (even where the cattle had not been) without slipping was difficult, and water was pooling underfoot up as you took a step. I had asked one of my more experienced tractor drivers who had been working on these hill sides for many years, if he could drive a tractor on the block or how long before we would be able to. The reply was not for a long time without the risk of a tractor sliding into a row of grapes, becoming stuck or damaging the interrow strip before the coming spring. This was the same at the new block in 2016, we would not have been able to get a tractor on it without a long spell of drying weather. With what I had seen, I returned to the same ridge I was on in 2007 expecting the same conditions but knowing they were different. When I arrived there the soil did not look as wet, I jumped up and down looking for the same pooling of water, but none came up. We were able drive a tractor over this soil without fear of becoming stuck or slipping. The soil seemed to hold the water and keep its structure even with the soil saturation being at or above 'full point'. Trying to figure out when these changes first started to appear, I interviewed the same person I had asked the initial question too. According to him the soil had become progressively easier to drive on and he had gained more confidence in wet conditions over the years since converting to organic management.

6.1.3. Plant Changes

As seen in the results, the levels of nitrate in the leaves has steadily been decreasing. The result of this has been the pale green leaves synonymous with organic vineyards. Also, the canopies are no longer as large and vigorous as they were before organic conversion and only require one main trim (hedging), and possibly one other tidying trim if required. However, this has not altered the ability of the vines to fully ripen the fruit at the cropping level desired be the management. These smaller canopies of pale green leaves require a visual shift in what we perceive as healthy when it comes to growing vines.

Disease is another change that has been observed within the plants. Mainly with regards to *Botrytis cinera,* no botrytis specific fungicides have been applied on the vineyards included in the study since 2011. Favourable seasons, and canopy management is all that has been required as the plants have been able to redevelop their self defence mechanisms.

6.2. Opportunities

Techniques learnt during the organic conversion and the years after that have been used to great effect over other parts of the conventional vineyard. The use of the under-vine weeder to remove glyphosate resistant rye grass and other weeds showing herbicide resistance has been a major tool for the vineyard. The planting of flowers (including Buckwheat and Phacelia) to encourage parasitic wasps for the control of leaf-roll caterpillar has meant the removal of insecticides for combatting this pest.

This has also been seen by Wheeler and Crisp, 2009 where they state, one of the greatest benefits of the estate implementing organic viticulture was the externality effect. As managers eliminated insecticides and pesticides from the certified blocks, they realised that they did not need to apply certain chemicals in the conventional blocks, and hence changes to their practices elsewhere. Knowledge and learning from the organic blocks resulted in positive environmental externalities as a whole, and such is a strong benefit for organic viticulture that cannot be quantified (sic).

6.3. Challenges

There are many perceived challenges in converting to organic production, however with a little planning and fore-thought these can be easily over-come.

6.3.1. Weeds

Weed control is the most visible and thus most confronting challenge. Purchasing an under-vine cultivator or under-vine mower before the removal of herbicide is a positive step. Learning how to use the machine on bare soil is much easier than with an already weedy soil. This was an experience we had at the vineyard; we had underestimated the lead time in purchasing our first machine and then also over estimated how much ground it could cover. Consequently, the machine arrived too late and weed growth was well under way. Because of this we were always chasing the blocks with the tallest weeds and never keeping in control or getting ahead. Purchasing of new machines and hard grazing with sheep over the winter brought back the control we desired. Spring weeding is always a challenge on our hillside blocks, the steeper sites are often too slippery after rain, however this just requires planning and the ability to move into blocks as soon as the ground conditions allow.

Soil conditions and soil type play a large role in the effectiveness of the under-vine cultivation. Across the vineyard the soil ranges from clay loess on the hills to clay loam and silt loam on the flats, with varying degrees of river stones in the profile. Knowing the soil type and how weather conditions affect the structure, will help in assessing which block will be the most suitable to weed at whatever stage. Increased weeding in the first few years is common, as weeds selected for by herbicide use are generally harder to control. As the soil changes and the weed species change, a reduction in the number of passes by the under-vine cultivator is typical.

6.3.2. Nitrogen

Often nitrogen management is over looked when the decision to convert to organics is made. As is relatively common practice in New Zealand viticulture, fertigation or fertilisation with nitrogen is undertaken throughout the growing season. Simply 'turning off the tap' with nitrogen application, can have short term detrimental effects on the vines ability to grow healthily. A healthy soil with good amounts of nitrogen-fixing bacteria is paramount within organics, as nutrient cycling is the main form of nutrition. Application of nitrogen fertiliser limits the growth of nitrogen-fixing bacteria, so planning for this before conversion is key. Application of bacteria foods, reduction of nitrogen inputs and increasing of legumes in the interrow before the conversion to organics is a positive start for the health and nutrient cycling capabilities of the soil.

6.3.3. Perception

Decreased yield, increased disease, higher costs, lower returns, are just some of the perception challenges organic growers face. From experience at this vineyard, these perceptions on the first two have been dealt with, by no specific decrease due to a focus on quality, and no botrytis specific fungicides used since 2011 and no significant threat from this disease being recorded. Thus, the question needs to be asked, "can the industry continue along the same path of a high input farming system for the foreseeable future"?

There has been no decrease in yield from pre to post organic conversion on this vineyard due to the same thinning decisions being carried out by management, however yearly variability has remained. The main driver of this has been the focus on quality, which can be subjective at best, between growers and wineries. Iselborn, et al. 2016, finds that lower yield might also be caused by quality orientation rather than organic impact. Since strong quality orientation is accompanied by a reciprocal relation between quality (price) and yield.

The perception that under organics you simply stop spraying and hope you will not be hit with disease needs to be highlighted. Powdery mildew has become more prevalent in New Zealand with the arrival of the sexual stage of the disease, correctly identified in 2014. The ability for the fungus to sexually reproduce has meant that resistance strategies for single site fungicides have become more rigorous, as these are more prone to mutations affecting their efficacy. Single site chemistry is prohibited under organic certification so the opportunity for resistance is greatly reduced. Increased levels of this disease have been seen in both organically and conventionally managed vineyards and consequently, an increase in spraying has occurred across both management types. Botrytis is another destructive grapevine disease that can spread rapidly throughout a canopy in wet summers and autumns before harvest. At this vineyard we have seen a decrease in the incidence of Botrytis, even in wet years with heavy disease pressure such as 2017. No botrytis specific fungicides were applied to the organic blocks in this study in the 2016/2017 season and botrytis was not seen as a major issue at time of harvest. No botrytis specific fungicides, including soft options, have been applied to the vineyard included in this study since 2011.

This case study does not go into the specifics of the financial costings, however, after the initial capital expenditure for the under-vine management tools, no significant extra costs were observed outside the current expenditure. This topic is also covered in the ‘Organic Focus Vineyard Project’ and the ‘Viticulture Model Vineyard Benchmarking Report’. These reports also cover the perceived lower returns. Due to a typically higher quality product targeted by organic growers, price per hectare is most commonly higher than those of conventional growers for the same volume.

7. Conclusions.

Overall, this study has found that the conversion to organic viticulture on this vineyard has had a net positive effect. There has been no decrease in the yield from the vineyard, however anecdotally the quality has increased, though this was not covered in this study. There is some evidence that the conversion to organic viticulture has led to an increase in CEC and organic matter content in the soil, and there has been a steady rising trend in the available K content, even where no K fertilizers have been applied. Increasing trends have also been seen in the availability of trace elements such as Fe, Mn, Zn, Cu and B. Decreasing levels of Nitrate-N in the leaf have caused pale green leaves and reduced canopy size, however this has not affected to ability of the grape vine to ripen the crop load that has been retained after thinning. There are stable levels of leaf nitrogen and a trend of increasing trace elements within the leaf blade. Management techniques learnt through the conversion to organics and the subsequent years have been applied to the areas of the vineyard which are still considered conventional. This has been a positive outcome for the entire vineyard through a reduction on chemical use and an increase in biodiverse practices making for a healthier environment.

Patience is a virtue, it takes time for the plants and soil to regenerate to a stage where they are once again not requiring aid from synthetic fertilizers. The conversion process is just that, converting from reliance on external inputs towards a regenerative system. The real benefits show a few years after the conversion process is finished.

8. Recommendations

Organic viticulture is very well suited to the production of high quality grapes. Lower cropping due to an inherent focus on quality and vine health, and a commitment to crop thinning for maintaining a yield:quality balance, go hand in hand with open canopies and lower botrytis disease levels.

The key recommendations that have come from this study are:

1. Planning is essential. Start any changes to management before the conversion process begins, especially under-vine management. Buy any equipment needed before you need it.
2. Phase out systemic fungicides and removal of nitrogen or acid fertiliser products prior to conversion.
3. Run a chemical substitution program for the first few years. Over time you will learn what sprays you can drop out.
4. Add soil inoculants like mycorrhizal fungi and humic acid. These help grape vine roots access nutrients and feed the soil microbes. Under conventional management fungi can be compromised due to herbicide and fertiliser use.
5. Start deep watering to encourage active roots at depth. Surface roots are cut, when under-vine cultivators are used (if used). Shallow watering promotes surface roots and the vines will rely on these to access nutrient and water.

6. If you are thinking about organics, do not trial it, action it. It is future proofing your vineyard.

While many consider trialling small areas for organic management within larger vineyards, this vineyard took the approach of converting the majority of the vineyard area. This succeeded in making organic management the norm, not just a trial amount that is always forgotten or needs special treatment. These small trial areas are most often destined to fail because they do not get the full buy-in of the staff.

Organic management should not be the decision of a marketing team, but one born out of the vineyard and an ethos of an entire company to do better.

9. References.

ANR Publication 8493, 2013. Selection Pressure, Shifting Populations, and Herbicide Resistance and Tolerance. University of California Agriculture and Natural Resources. http://anrcatalog.ucanr.edu/pdf/8493.pdf

Chaignon, V., Sanchez-Neira, I., Herrmann, P., Jaillard, B., and Hinsinger, P. 2003 Copper bioavailability and extractability as related to chemical properties of contaminated soils from a vine-growing area. *Environ. Pollut.* **123**: pp. 229-238

Clark, E.A. 2011. *The Future is Organic: But it's more than Organic*. University of Guelph, Ontario, Canada

Coll, P., Le Cadre, E., Blanchart, E., Hinsinger, P. and Villenave, C., 2011. *Organic Viticulture and Soil Quality: A Long-term study in Southern France.* Applied Soil Ecology **50** pp. 37-44

http://www.freshfacts.co.nz/files/freshfacts-2016.pdf

Hill Laboratories Technical Notes,

Olsen P Soil Tests https://www.hill-laboratories.com/file/fileid/50335

Grape Vine Tissue Analysis https://www.hill-laboratories.com/file/fileid/45632

CEC and Base Saturation https://www.hill-laboratories.com/file/fileid/15507

Soil Potassium https://www.hill-laboratories.com/file/fileid/51614

Iselborn, M., Szolnoki, G., and Szabo, Z., 2016. Implementing organic viticulture as a business strategy: A case study. *9th Academy of Wine and Business Research Conference.* pp. 60-67

Norton, D. and Reid, N. 2013. *Nature and Farming. Sustaining native biodiversity in agricultural landscapes.* CSIRO Publishing: Collingwood, Australia pp. 28-29; 136-137

Organics Aotearoa New Zealand, 2016 New Zealand Organic Market Report pp.41-43

Relevant web pages from NZ Wine:

https://www.nzwine.com/media/4206/nzw_sustainability-as-a-culture.pdf

https://www.nzwine.com/media/3233/2014-ap-group-9-against-botrytis-resistance-management-oct-14.pdf

https://www.nzwine.com/media/3235/2015-powdery-mildew-resistance-management-strategy.pdf

Rozsa, M., 2016 Back to the Roots. 'A Complete List of all Countries that have Banned Glyphosate' August 28th, 2016

Viticulture Model Vineyard Benchmarking Report. Marlborough 2016.

Wheeler, S.A., Crisp, P., 2009. 'Evaluating a Range of the Benefits and Costs of Organic and Conventional Production in a Clare Valley Vineyard and South Australia. *Australian Agricultural and Resource Economics Society (AARES).*

Wheeler, S.A.,Crisp, P., 2011. Going organic in viticulture: a case-study comparison in Clare Valley, South Australia. *Australasian Journal of Environmental Management* **18:3**, 182-198

Willer, H., and Lernoud, J., 2017 a 'The World of Organic Agriculture. Statistics and Emerging Trends 2017. FiBL-IFOAM Report. Research Institute of Organic Agriculture(FiBL), Frick, and IFOAM–Organics International, Bonn, Germany. pp 25-31

Willer, H, and Lernoud, J, 2017 b 'Organic Viticulture Worldwide 2015. Research Institute of Organic Agriculture(FiBL), Frick, Switzerland (www.fibl.org) pp 10-14

10. Appendix.

Figure 1. Tonnes per Hectare for each varietal from 2003 (pre-conversion) to 2017 (post-conversion)

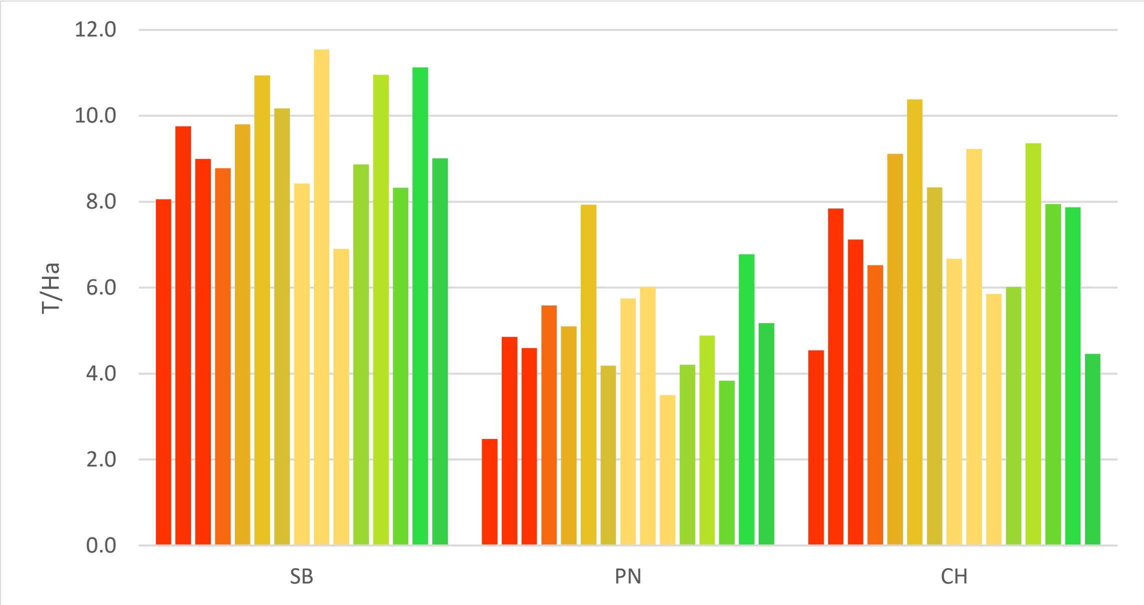

Figure 2. Deviation from the average of 9.4 T/Ha in Sauvignon Blanc

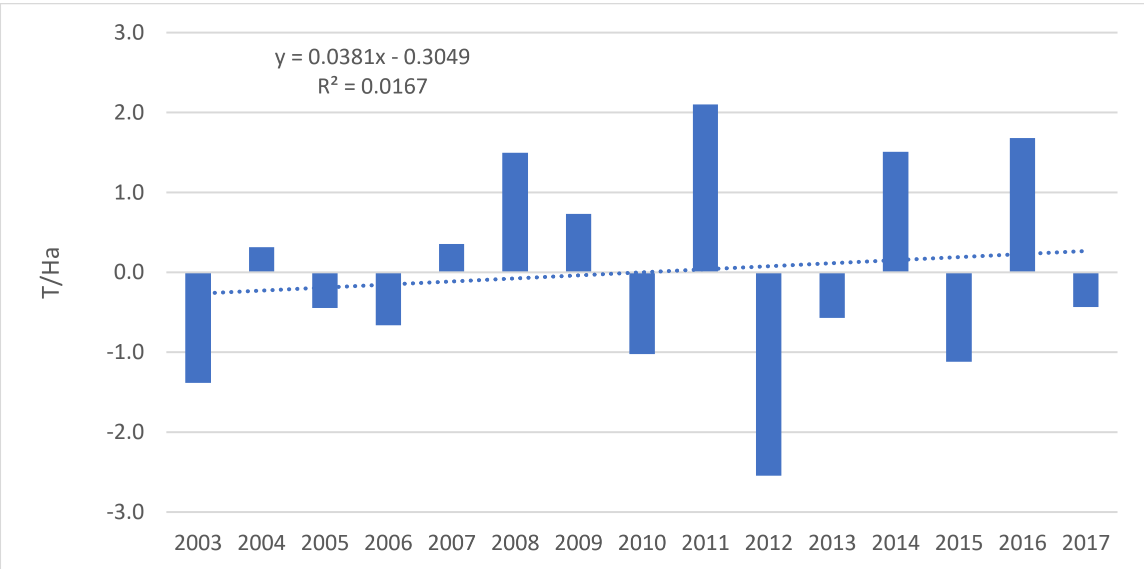

Table 1. December weather data against long term average.

	December		LTA
	2010	2011	1986-2016
Rainfall Total mm	131.6	103.8	47.3
Mean Max Daily °C	23.0	19.9	21.9
Mean Min Daily °C	13.3	12.1	11.6
Mean Radiation Daily mj/m^2	24.4	20.3	23.7
Total Radiation Month mj/m^2	755.1	628.4	734.2
Mean Sun Daily Hours	7.3	5.4	8
Total Sun Hours Month	225.0	167.4	248.8
GDD Daily Mean >10	8.2	6.0	
GDD Total Monthly	252.7	185.4	

Information summarised from the Marlborough Research Centre Weather Data for Blenheim.
http://www.mrc.org.nz/category/weather-data/blenheim-weather-data/

Figure 3.

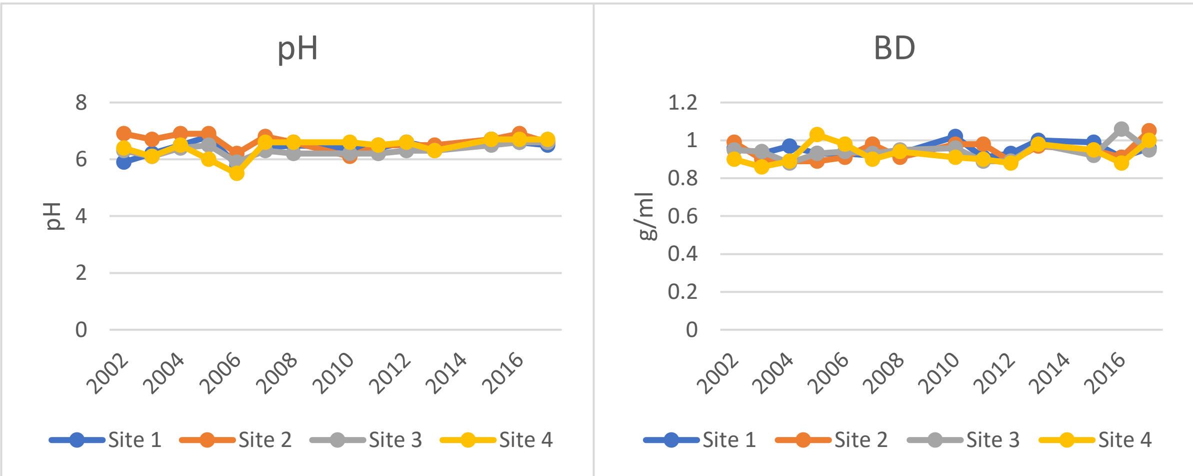

Figure 4. CEC

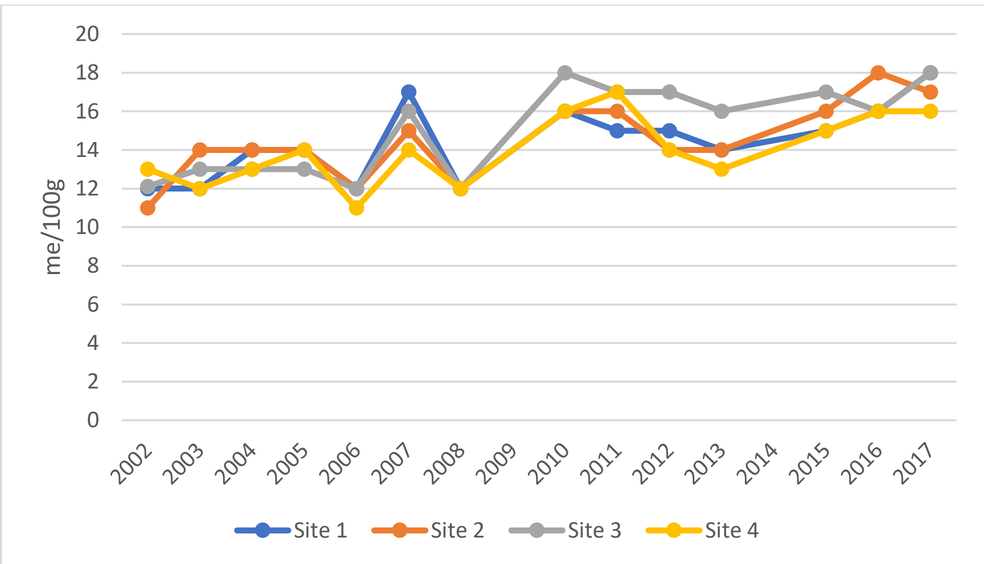

Figure 5. Organic Matter

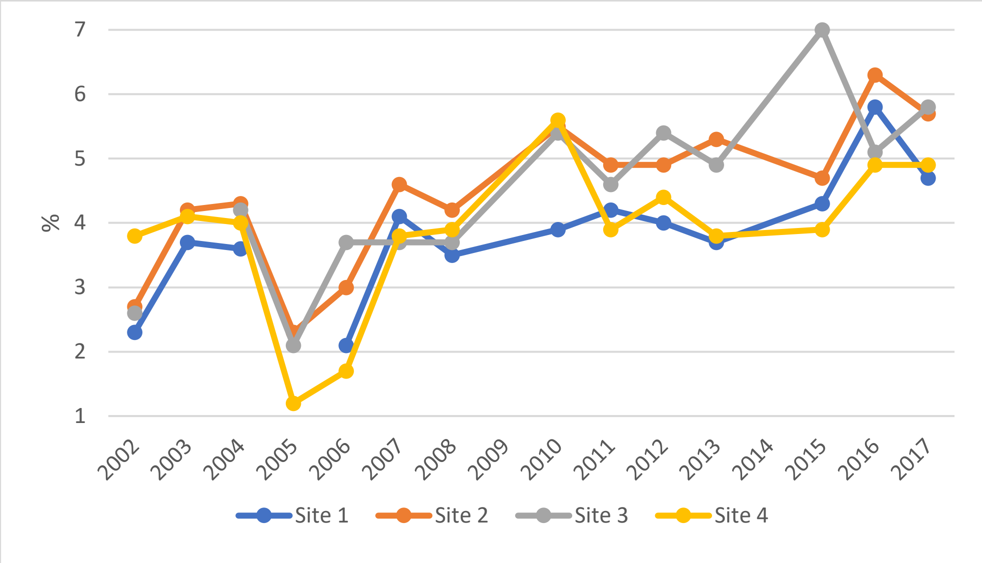

Figure 6. Potassium (K)

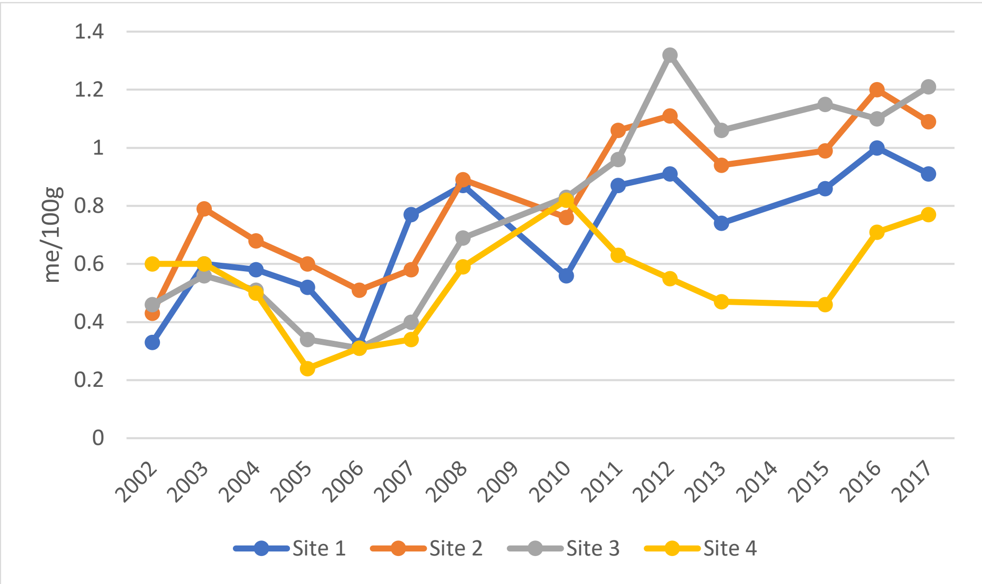

Figure 7. Micro nutrient concentrations as conducted using Mehlich 3 protocol.

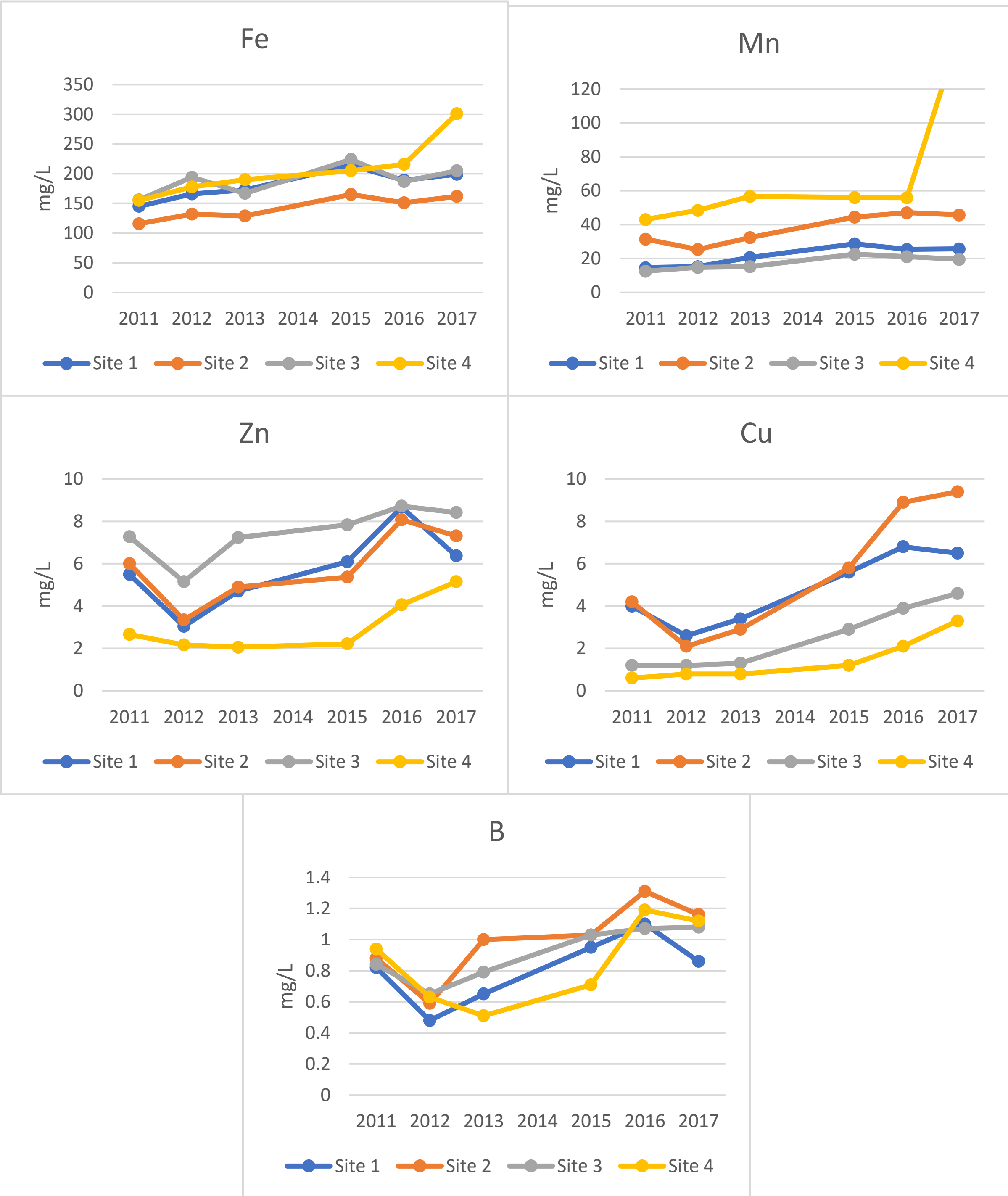

Figure 8. Petiole Nitrate-N, showed for each varietal and an average across all blocks.

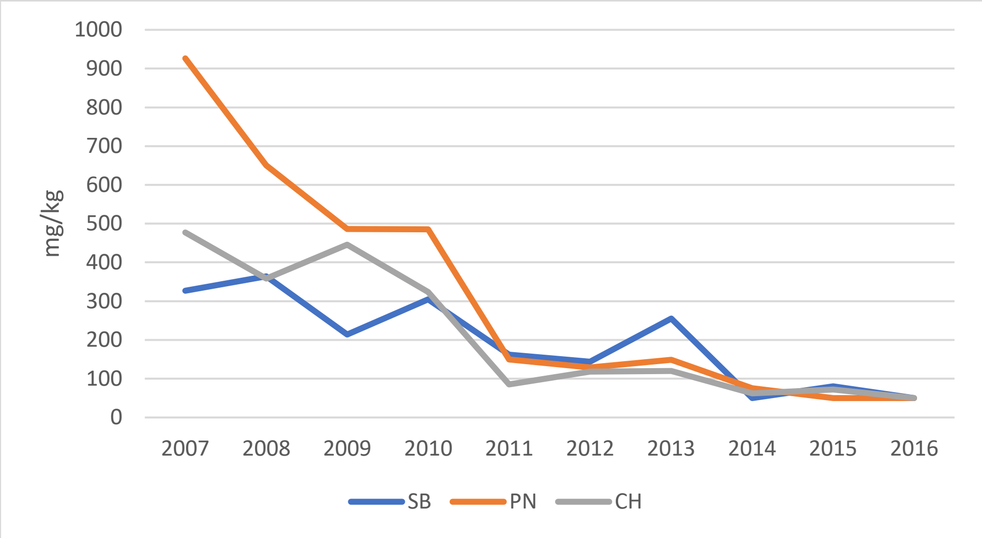

Figure 9. Percentage Leaf Blade Nitrogen content

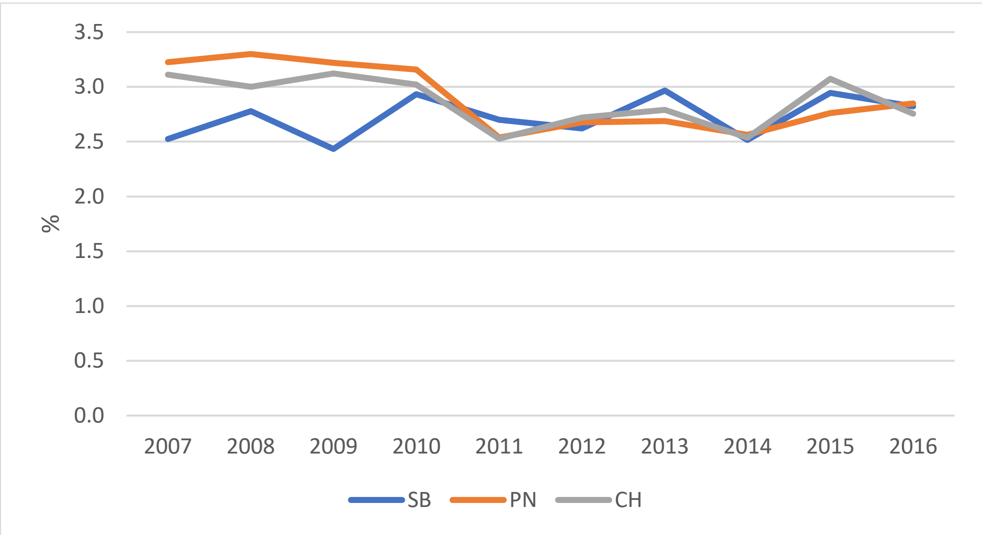

Figure 10. Micro nutrient concentrations as shown in Leaf Blade tests.