These are questions asked by farmers over time. You will find them useful in your journey into regenerative /organic agriculture.

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Soil Organic Metter – what forms do they take, how stable are they.

Most literature is carried out on industrial agricultural soils that are already damaged from excessive cultivation, constant use of synthetic chemistry, erosion, loss of soil water/moisture, and loss of microbial activity in the soil. Any amendment will work on a damaged soil. Any organic matter will provide microbial food although the first decomposition of fresh material increases CO2 emissions over those that are aged and stable.

Fresh organic material which is the labile form breaks down by bacterial action initially. While heat is being generated in pasteurising process, the resulting material is still unstable and will react with other organic material. Only when the pasteurising process is completed and temperature of the remaining organic material has returned to ambient, can the maturing process begin, and stable humus be formed (Insam & de Bortoldi (2007). It is the stable humus/compost that is the black gold for vine health.

Any organic matter can be composted over time. Rate of composting is related to size of material, availability of moisture and carbon:nitrogen ratio. Nitrogen source can be manures or any green material. Carbon sources are any brown woody materials.

How to improve organic matter quickly and cheaply in sandy soils of inland wine regions?

Sand is lacking in nutrients and organic matter. It needs to be introduced and maintained such as a 100% green cover 100% of the time. Permanent cover crops stabilise the sand, increase organic matter and nutrients and the plant root exudates keep the nutrients in the root zone. Continual living plant cover is required to maintain and increase organic matter in sandy soils. Addition of clay into compost is useful and is what we do in the Saharan sand agriculture in the UAE and in Egypt. Chay binds nutrients from the compost and holds them in the root zone. Adding compost is useful. (Tahir & Marschner, 2017). Sandy soils are an increased challenge to maintain organic matter in the rootzone, but permanent cover makes this possible.

What are the benefits of plant cover compared to bare earth on different soil types from a scientific perspective.

Bare earth is not natural in nature except where there has been a disturbance. Bare earth is bacterially dominated supporting fast growing primary colonising plants. These plants protect the bare earth from erosion and allow time for perennial plants to emerge and colonise. Plant cover 100% of the time keeps the soil organic matter moist and continual activity of mycorrhizal colonisation of plant roots (Baumgartner et al, 2005: Gougoulias et al, 2014; Abad et al, 2020; Qiu et al, 2021).

Cover crops that are permanent will be fungal dominated because the roots will be infested with mycorrhizal and saprophytic fungal hyphae if the soil profile is not disturbed (Steenwerth & Belina, 2008; Lopez- Vincente et al, 2008; Willcox 2022). Ploughing or disturbing the plant roots by removing the plant from the ground takes the fungal biomass with the roots. The bare ground remaining is then bacterial dominated until plant cover can be regained. Between 1.3 and 2.5 tonnes per hectare of CO_2 is lost from bare and ploughed soil. Having a plant cover in the vine row will allow the soil biota to transition from bacterial dominated bare ground to fungal dominated plant cover. The transition from bacterial (bare soil) to fungal (plant cover) population domination in soil is as rapid as it takes plant roots to establish in the area. This infestation rate is based on the removal of synthetic chemistry particularly NPK. A healthy soil has a balance of soil biota, each functional group being in balance with all other functional groups. Phototropic soil bacteria are just one of the myriads of functional groups in a well aerated soil (Crouzet et al, 2020). To remediate a soil, aeration and drainage must be dealt with first. Have a quantitative biology test carried out or do a qualitative test using a microscope.

Why is aeration of soils important and what impact does it have on soil biology and compaction?

Most beneficial soil biota are aerobes. Aeration allows air, water, and nutrients to enter deeper into the soil, allowing plant roots to grow deeper and become more resistant against changes in soil moisture and air temperature. Compaction is generally caused by excessive equipment use or regular ploughing causing a hard pan at some depth. Fungal species are all aerobes except for yeasts, so saprophytic and mycorrhizal fungi require aerated soil for healthy population growth (Roper & Gupta, 1995; Company et al, 2010; Postma-Blaauw et al, 2010). The more oxygen into the soil, the further down earthworms will carry organic matter and plants penetrated down carrying mycorrhizal fungi and its associated glomalin down with them. Better water holding capacity and cooler soil temperatures result.

How does soil microbiology affect water holding capacity and soil structure?

Effective and functioning soil biota produce good soil structure through aggregate formation. Increased plant root growth and its accompanying mycorrhizal fungal biomass hold water in the root zone as well as carbon. If the soil is undisturbed and the fungal biomass increases, then the soil structure will remain in good condition. Ploughing and excessive tilling destroys the fungal biomass leading to a proportionally higher bacterial biomass and release of higher amounts of CO2 to the atmosphere. No till or minimal tillage is recommended for good soil structure (Feeney et al, 2004; Company et al, 2010; Wei, et al, 2020; Steiner et al, 2023).

How to activate soils that have had no remediation over time.

Soils respond to aeration with minimal disturbance. Using spiked drums, tines such as the Yeoman's plough or similar or any implement that will open but not turn over the soil, causing least disturbance to plant roots and fungal biomass around those roots. Then applying compost, compost tea or microbial foods such as fish, kelp molasses will stimulate the soil. Cover crops or perennial plants will maintain 100% cover 100% of the time leading to increased moisture retention and cooler

soil in which the vine roots are growing. A dusting of rock dust across the vine and midrow will provide the slow-release elements the vines and cover plants will need for healthy balanced growth. Repairing soil is a succession of microbial activities. Provide the conditions and soil will stabilise to the requirements of the plants growing in it.

Impact of ground covers on nutrient availability.

Ground cover giving soil protection of 100% for 100% of the time, cools soil, improves water holding potential, increases fungal biodiversity, and improves plant health overall. Plant cover can be weedy species, mixed crops or native forbs and grasses -any plant that maintains a cover on the soil at all times. Resultant organic matter increase provides nutrients for soil biota which in turn recycle and mineralise organic matter back to plant available forms (Baumgartner et al, 2005; Gougoulias et al, 2014; Abad et al, 2020; Qiu et al, 2021).

Benefits to soil carbon stocks, water storage, humus creation, humic/fulvic acid differences from the introduction of these methods.

Best biological practice in any farm enterprise will result in water storage in the mycorrhizal fungal biomass around the plant roots – the mycorhizosphere. Increased humus through decomposition of roots, and organic matter applied as compost and finally, progressive increase in carbon storage as the fungal biomass grows with time and nutrient status. Biological farming practices mean that the soil is less disturbed, more plant cover is maintained, biota populations have time to increase where necessary or stabilise, leading to improved soil and vine health.

Increased carbon can be considered as an alternative economic stream but that would need to be negotiated with the carbon trading companies. They are all different.

How to reduce the effects of water logging and compaction and restore soil structure.

Water logging is initially a drainage problem. Determine the cause of the water logging by introducing in-ground drainage pipes, constructing swales to redirect water, and, finally, consider if the area is suitable for growing the crop of interest.

Compaction results from over cultivation, overuse, or use of vehicles when weather is not appropriate. Compaction leads to anaerobic conditions in the soil and loss of air pockets which are necessary for earthworm movements and growth of fungal hyphae. With the loss of fungal activity and increasing anaerobic conditions in the soil, there is a parallel loss of soil structure – loss of viable aggregates.

Deal with reason for water logging; aerate the soil; reduce vehicle use in bad weather; refrain from cultivation; have 100% cover 100% of time so that soil organic matter continues to increase over time (Steiner et al, 2023).

External inputs into the soil

How to calculate NPK are present in the soil.

Baseline information on the chemical profile of a soil is required prior to planting a crop. All soils have a farming history, so it is necessary to know what chemical profile as soluble, available and, importantly, total pool. Full chemical analysis is required for accurate information. Very often soluble and available pools are depleted especially in a synthetic chemical soil. The total pool may be more than enough elements that are not plant available without the presence of soil microbes. Chemical analysis of soluble, available, and total pools can be completed by EAL, Lismore. Synthetic nitrogen has a negative impact on soil biota (Philpott, 2010).

How to transition use of rock dust to replace synthetic fertilisers and how long will it take? Where to start, access, what constitutes good rock dust, how much to apply and when.

Rock dust will vary depending on its source, but all will have the elements that make up lava from the centre of Mother Earth: it will be the ratios that differ depending on the age of the material on the Earth's surface. Rock dust acts as a slow-release fertiliser source for microbes. The microbes respond to plant exudates by mineralising elements at the rate at which the plant requires them. Never in excess as with periodical dumps of synthetic chemistry.

All rock dust is good (unless it has been contaminated in some way once on the surface) because it has the elements that life of Earth has evolved to use.

Following a chemistry and biology test to know the baseline availability of elements in the soil and corresponding biological response, then soil should be aerated and remediations made following some rainfall in spring and/or autumn (Hennig, 2020). The baseline chemistry and biology will dictate the amount of rock dust required. How long it takes to see a response depends on how much damage has been done to the soil.

Why is gypsum bio toxic to microbes and what are the alternative options?

Gypsum is only required on a damaged soil. Careful consideration of all literature around gypsum use, address the improvement gypsum use has on broken, degraded soil. None address the reason for gypsum being required in agricultural soil – poor soil management practices usually comprising regular cultivation of the soil, intermittent if at all, plant cover, input of synthetic fertilisers, and compaction.

Gypsum may be necessary in soils that have been mined and destroyed by over working from ploughing and overuse of synthetic chemistry. Soil structure has been destroyed as has the capacity to hold water. Crusting often results in these soils causing erosion. Soil microbiology has largely been depleted by mistreatment, so gypsum is added to adjust soil structure (Pereg et al, 2018).

The obvious alternative is to withdraw the synthetic input that is causing the damage in the first place and apply compost or organic matter to lift the potential for soil microbiology to return and multiply. Feeding soil biota will improve water holding capacity of the soil, soil fertility, and soil

structure because of the bacterial and fungal capacity to form soil aggregates. All of this provides the soil structure with soil health and plant health (Smith et al, 2011).

Gypsum changes soil structure but does not improve the soil health because microbes cannot return as needed (Amaranthus et al, 2009; Zimmer, 2016., St John, 2000).

Gypsum has an indirect effect on soil biology – industrial farming versus biological farming. Improve soil structure with organic matter. Address the problem not the result of the action.

What are the benefits of biochar and what is the best way to apply it in an agricultural system?

Biochar will improve the structure of soils that have been subjected to synthetic chemicals and lost their structure, texture and microbial activity. In an industrial agriculture/viticulture environment, biochar will improve the soil and lead to increased microbial activity if synthetic chemistry is withdrawn (Lehmann et al, 2011).

A sounder solution is to use an organic/biological approach to the enterprise and use green manure plants to improve the soil biological which will improve the nutritional balance to the soil without inputs such a biochar being necessary.

Biochar would make a better addition to a good thermal aerobic compost to be applied as compost or compost tea to vines or plants generally. Biochar is a better addition than synthetic chemistry. The question then is, is the biochar production environmentally friendly. Biochar requires very high temperature pyrolysis. Thermal aerobic composting is more environmentally friendly, and the same volume and source of raw materials can be dealt with in the process.

How to repair compact soils from over cultivation, high magnesium, low soil carbon, low Ph, and sodicity issues.

This is a description of an overworked soil. Initially, aerate the soil by spiking or use of tines at 100mm and then 300mm where space allows. Reduce or eliminate use of synthetic inputs and use organic matter in whatever form is available: compost, compost tea, aged mulch, planting mixed species plants which can be crimped or mown. Apply rock dust, preferably paramagnetic basal rock dust. Address any drainage issues. This recovery will take at least one year. Maintain 100% cover 100% of the time. Do not plough. This destroys the fungal:bacterial balance (Haack, et al, 1995; Cole, 2020; Brandon et al, 2021; Cole & Cavallo, 2022). Remember repairing soil using soil biota is a successional progression. It will take time for the soil to rebalance to the requirements of the crops to be grown.

Use of inputs such as mulches, composts, and manures for increasing organic matter in the soil

Any plant material will help to increase organic matter in the soil. Mulches, composts, and manures have different effects on the soil in the first instances. The first decomposition is bacterial with loss of organic matter as CO_2.

If growers have access to organic waste products from other industries, then these should be considered carefully to fit into a biological paradigm. Examples may include sawdust from a local timber industry that can be composted and become a resource. Both Eucalyptus and Pinus species material must be composted so that antibiotic volatiles can be dissipated. Manures and litter from feedlots and commercial chicken raising must be composted before use because of contamination from Escherichia coli and Salmonella species and contamination from antibiotics. Worm farming is another method of composting organic matter, but the product is different from thermal aerobic compost because the resultant matter has been through the worm guts it may be higher in bacterial population (Kannangara et al, 2013).

Mulches may be thrown from midrow into the vine row helping to protect the usually bare earth from crusting, drying, and compaction. High bacterial activity is generated early in decomposition often causing significant nitrogen drawn down from the soil. Bacterial respiration releases large amounts of CO_2 into the atmosphere.

True compost is matured thermal aerobic compost that is stable humus. This can be applied to soil without any negative impact on soil biota. If applied as a surface mulch, then it can compact if not worked into the soil surface either by using a scarifier or drilled in using a Yeomans plough or similar. Finished/matured compost is better applied a little, often – spring and autumn for vineyards (Preusch et al, 2002; Amaranthus & Simpson, 2010; Lazcano et al, 2021; Brandon et al, 2021).

Manures may contain antibiotics if fresh and *Escherichia coli* and *Salmonella* species. Fresh manure of any sort should not be used directly on soils for this reason. Manure composted and matured should be free from the pathogens, E. coli and Salmonella spp and it releases less CO2 to the atmosphere than does fresh manure.

Project C-12300 SV currently with Agpath Pty Ltd is to address how compost, feedlot manure and FOGO (fresh kerbside food waste and green waste) can be made into commercially available fit-for-purpose products for all agriculture. This project report is to be completed by June 30th, 2024.

Cover cropping or introduction of permanent vegetation reduces the need for compost and other products. These can be used in lower volumes to maintain the cover vegetation in the absence of synthetic chemistry. One hundred percent cover 100% of the time guarantees a fungal dominated soil environment with less CO2 moving into the environment (Lanyon & Bramley, 2004; Ward, 2009; Hayman & McCarthy, 2012; Hayman et al, 2012; van der Werf, 2020).

Compost and compost tea

Details on the preparation and use of compost teas - how and when to feed, what with and at what rates?

The definition of true compost is the thermal aerobic breakdown of organic matter through pasteurisation followed by a period of maturation to produce humus with high microbial activity (Diaz et al 2007).

All organic matter will compost over time and return the organic elements resulting from photosynthesis back to recycled in their inorganic form where they are plant available. Not all compost is equal when considering the product for pest and disease management and soil health. Compost may be made in small discrete rings, long windrows, in static piles such as the Johnson Su method, anaerobically in static piles or commercial retorts. Each of these methods produces a product that is high in organic matter and useful as an organic amendment on or in soil. This organic matter then feeds the soil biota leading to healthier soil, better plant available elements, better water holding capacity and improved aerated soil structure.

Compost tea is only as good as the compost from which it is made. Thermal aerobic compost carefully produced to temperature and moisture parameters in a cubic metre ring and matured will provide the greatest diversity and highest population suitable for compost tea and disease protection. There are many recipes for compost tea available. Use may be for foliar spray following pruning: foliar protection following a primary infection notice. Rates depend on the reason the compost tea is being used.

Is it being used to replace fungicides or pesticides in vine management? Is it being used as a post-harvest/pruning vine drench? Is it being used as a soil biota remediation? Compost and compost tea can be applied at almost any rates because neither will cause problems on or in the soil. However, there is a cost of time and resources in making good compost and compost tea. Therefore, in the same way a farmer/grower will have a soil chemistry test or vine nutrient test done before purchasing and applying synthetic chemistry, then so should a baseline soil chemistry and biology be carried out so that the correct recipe can be applied when making the compost or compost tea. There are very many compost tea recipes, and Dr Elaine Ingham's YouTube presentations are the most comprehensive and useful (Dr Elaine Ingham compost tea Audio, YouTube – Innovative farmers; Elaine Ingham Soil Food Web Compost and Compost tea YouTube – Matt Powers the permaculture Student).

Compost and compost tea resources aim to feed the different organisms' groups. Food resources that feed bacteria may include simple sugars, yeasts, kelp, fish hydrolysate and fruit pulp. Fungal foods may include simple sugars, kelp & fish hydrolysates, fruit pulp, humic acids, protein meals such as soybean, bran, oatmeal, barley meal, rock dust powder and yeast.

A basic bacterial tea may include: 10kg bacterial compost, 800mL molasses, 750mL kelp hydrolysate, fish hydrolysate and fruit pulp can be added.

A basic fungal tea may include: 10kg fungal compost, 900mL humic acids; 750mL kelp hydrolysate; 750 fish hydrolysates; 250mL a plant extract such as yucca.

The compost must be matured. Water must be clean and not chlorinated. The pump must be strong enough to keep the volume agitated so that the dissolved oxygen stays above 6ppm so that the

volume remains aerobic. Compost tea should be used immediately it is made and must be kept agitated.

Composts and compost teas made to the specifications dictated by the individual soil biology tests for an enterprise are more effective and less wasteful of resources.

www.agpath.com.au/information is a good start for recipes and information on these topics. There are many podcasts that describe the process also.

How to make compost effectively using windrows, what is involved and how much should be applied?

Compost in windrows requires a tractor with a front bucket to turn the windrow when temperatures reach 65°C. Windrows should be no more than 1.5m high and two buckets deep (for convenience) and as long as space allows. Any organic material will compost over time, but rapid composting occurs if the carbon to nitrogen is 25-30:1 and moisture is 40-50% and the materials are around 1cm in dimensions. A small but strong chipper is used. Twigs and small limbs up to around 2-3cm in diameter can be mulched. Larger chippers obviously will allow large wood to be processed. Cardboard, paper, egg cartons are all wood products and can be wetted, pulled apart and form part of the brown (fungal) food. The amount applied is determined by the results from the biology and chemistry test.

The difference between mulch and compost and why is this important?

Mulch is fresh or uncomposed green material. It may be hot because of bacterial activity. It may be dry plant material. Both are very high in carbon and when applied to the soil in a pasture, vineyard, or vegetable garden, can cause nitrogen draw down which is detrimental to vines in a vineyard. As the mulch moistens, microbial activity will begin breaking down the plant material. The only source of biota is in the soil below. Saprophytic fungi and bacteria move from the soil to the mulch/soil interface to commence the breakdown of the plant material. This makes nitrogen the limiting factor. This move to a different food source causes a short-term depletion on nutrients, particularly nitrogen, in the vine root area. To avoid nitrogen drawdown from mulch, first apply a thin layer of finished/matured compost and then lay down the thicker layer of mulch as weed management or just to increase organic matter in the vine row while cover plants are establishing.

Economics of compost applications when made on site versus purchased in.

Using all the organic resources from a property that were previously considered waste, means a good compost can be prepared at no cost. All cardboard, paper, food scraps, fallen twigs/limbs, pruning's, chicken, or animal manure can be composted by considering the C:N ratio to have a reasonably rapid conversion and access to clean water.

Local chicken enterprises and feed lots must pay to dispose of their effluent and shed waste. This is usually free to be collected. Rock dust may need to be purchased but is very cheap if collected and not delivered. Cost of electricity to run the pump may be offset if the enterprise has solar panels. If the pump is run on diesel, then this is a cost. Water should be tank or dam or bore so that it is free of chlorine.

Can you get to a point where the ground cover area has such good organic matter and biodiversity that there is no benefit to adding compost which uses diesel and compacts soil?

Any soil that is cared for over time will arrive at maintenance point in a couple of years. This time depends largely on the amount of previous damage from synthetic chemistry, over working, overuse of vehicles, weather patterns to provide soil moisture and enthusiasm of the farmer to embrace the regenerative, biological, organic, biodynamic, permaculture paradigm. Applying compost tea then becomes a 6 monthly exercise at the change of the seasons, autumn, and spring in vineyards (Lanyon & Bramley, 2004; Ward, 2009, Hayman & McCarthy, 2012).

Is dried seaweed useful in thermal compost?

Seaweed is low in nitrogen and phosphorus but contains all of the trace elements that come originally from the land sand, silt, and clay. Seaweed does not need washing because the sea adhering contains many of the trace elements. As well as trace elements, seaweed contains plant growth hormones such as gibberellin, auxins, all of which are beneficial to soil biota. A useful seaweed tea can be made by steeping the seaweed in clean water for a few days stirring regularly. Good foliar spray for vines, garden, and orchard.

Bacterial and fungal ratios

Importance of fungal to bacterial ratios: should a vineyard be fungal or bacterial dominated?

Fungal to bacteria ratios for perennial plants such as vines is 5:1. (Fact sheet 2021). To increase the fungal population in the vineyard, management must maintain a 100% plant cover across the vineyard from headland to headland including the vine rows. Management techniques that feed the soil biota by way of compost, compost tea and biological foods such as rock dust, fish, kelp, and molasses. Balanced vines result from an active soil biota which helps to express the soil characteristics of the region (Lui, 2020).

When the soil health and vine health is balanced then the wine quality improves and more expresses the regional distinctiveness of the wine. (Liong et al, 2019; Lui et al, 2020). Improved soil and vine health manifests in the quality and vibrancy of the wine. Increased brix levels can be measured in the photosynthesising plant parts during the season as well as in the fruit towards harvest. As the soil comes into biological balance, so does the vine. The balance is shown in the acid, aroma, sugar profile coming together at the same time leading to more consistent fruit quality(Liong et al, 2019; Lui et al, 2020).

Perennial plants require fungal dominated soils in which to thrive. Detailed explanations of the role of the groups of soil biota is best read from the Soil Food Web Primer (Ingham,2014) If the vineyard has full plant cover in the vine rows and the windrows, and use of synthetic chemistry is suspended, then the soil biota will be fungal dominated. Feeding with compost, compost tea if available, fish kelp, molasses, rock dust, and humates will keep the soil biota in the a high active fungal range. Once synthetic chemistry is removed, and the biological products are applied probably monthly in the first year, then the change will be rapid. A baseline biology should be carried out in Autumn or Spring or both and then again at the same time each year. These data showing the shift in microbial group populations indicate whether the recipe being used is improving the activity and whether the recipe

can be amended in the light of improved populations. Fungal dominance under vine increases as the plant population in the vine row establishes and covers the area with photosynthesis potential and the soil is filled with roots building up an arbuscular mycorrhizal population. Perennial cover crop plants are most appropriate for the midrow and vine row because they will create an equilibrium and stabilise the mycorrhizae biomass in the root zone. Bare soil will quickly become bacteria dominated so it is important to maintain a plant cover 100% of the time.

What is the role of phototrophic soil bacteria in soil remediation projects and plant health?

Phototropic bacteria are just one group in the diverse populations that are a healthy soil food web. A well-balanced soil resulting from applications of compost, compost tea, fish, kelp and/or molasses will have the phototrophic bacteria population in the range that it needs to be for the soil type and the season. It is not necessary to purchase any commercial biological products; it is much better to grow the species in the proportions that suit the soil in the vineyard. All the commercial species are similar to those in soils, and but the local soil biota is adapted to the vineyard conditions. They just need the chance to multiply.

How suitable are eucalyptus mycorrhizal communities for vines?

Eucalyptus and Pinus species carry ectomycorrhizal communities but may carry arbuscular mycorrhizae as well. Some mycorrhizal species are not host specific and there is anecdotal evidence that both forms have been fund on vine roots. Care needs to be taken if fresh mulch from either of these plant groups is available as mulch, such as from roadside tree management from councils. If this fresh material is available for free, then take as much as can be dealt with and make it into a windrow. Turn as per making compost and when the volatile oils can no longer be smelt, it is safe to use on the soil or as brown component of compost. The oils are what are distilled as antiseptic Eucalyptus and pine oils. These are antimicrobial so they will be detrimental to the soil biota as well.

Plant health

What would a natural ecosystem look like? One not reliance on , for example, sulphur and copper. How can that be done? Are there documented examples of this being done?

Copper and sulphur are the oldest used chemicals in vineyards. Copper is a heavy metal and can accumulate in the soil killing soil microbes that are important in plant health. Sulphur is toxic to beneficial mites and insects (Crisp et al,.2007) Dagostin et al (2011) found clay was as effective as copper on leaves and bunches. They found in the research, yucca extracts, *Salvia officinalis* extracts and the fungus, *Trichoderma harzianum* gave protection.

A healthy vineyard has less disease impact. Many biological controls are effective when the disease organism population is low. Milk, whey and Ecocarb were found to be as effective as sulphur in controlling powdery mildew when the disease pressure is low.

Manage the vineyard environment in the biological soil health paradigm. Have an effective scouting and monitoring program operating in the vineyard to pick up the primary infections as they occur, and the products mentioned above will be as effective as sulphur and copper and less damaging the environment.

Apply high quality compost tea through-out the season as a foliar spray to maintain high levels of beneficial organisms on the vines.

Talk to other growers who use biodynamic or regenerative practices and see what works for your region.

How to objectively assess improvements in soil and vine health.

The easiest way to assess plant health is to buy a second refractometer and use it daily at the same time of the day. Brix is directly related to photosynthesis so choosing a time in the afternoon around 2.30-3pm guarantees maximum sunlight. A refractometer and garlic press can be carried in a pocket. YouTube is a good source of instruction on how to use a refractometer. There are many instructional presentations that show better than words. Soil biology can be monitored qualitatively using a microscope or sending in soil for quantitative analysis at a lab such as Agpath. Participants attending workshops at Agpath are shown how to read a refractometer, making soil dilutions for qualitative analyses of soils. Agpath provides a service of soil analysis that includes a quantitative analysis of all the populations in the soil that relate to plant health (www.agpath.com.au/services).

Biological controls within a vineyard.

Scale and weevils cause problems under some climatic conditions. Vineyards may be fenced against foxes and rabbits. Flocks of Guinea Fowl, geese and chickens have all been used in various vineyards with mixed results. The birds are successful in dealing with the pests but fox proofing a length of fence over the long term is difficult and mortalities can be catastrophic when they occur. Scale can be a problem of unhealthy vines. Biologically healthy vines harbour less scale because of the diverse biota on the leaf surfaces. Eco oils and Neem oils are two product types that could be useful. Compost tea made with an oily fish hydrolysate would smother the scale if applied as a drench.

Applying biological sprays to reduce frost impact.

Frost damage can be significant in some regions and in some years. Plants grown in a biological system are stronger and more resilient to changes in temperature. Feeding with biological foods and spraying good compost tea heavy with beneficial microbes over at least 70% of the surface will help to minimise frost and heat damage but not sufficient alone. Trials with Crop Biolife in vineyards have shown useful management of frost damage (Mndzebele, 2019).

Weedy species

The role of weedy species as early successional pioneer/indicator plants and using non-chemical methods to manage them.

Weedy species are present because the soil is depleted of biology and bacterial dominated. Deal with the problem which is the soil. Improve the soil so that fungal domination takes over and weedy species become less a problem if at all. Good quality compost tea helps to shift the soil biota rapidly (Cole, 2002). Once the soil biota is fungal dominated then weedy species especially flat weeds do not grow because they are out competed by the more vigorous perennials. The poster presentation (Cole, 2022) shows the shift in soil fungal populations from bacterial to fungal at the Agpath farm and a near-by vineyard where capeweed is eliminated where fungal dominated compost tea is applied twice a year.

Understanding weeds within your vineyard or farming system.

Weeds are primary colonisers. They fill bare patches of soil following a fire or cultivation or some other damage where vegetation is removed from the soil surface. Weedy species can be deep or shallow rooted, but they are fast growing, quick to flower and seed and have highly viable seeds. Many weedy species are medicinal herbs so have an important role in the ecosystem. Broadleaf weeds tend to indicate an excess of potash relative to available phosphorus (McCaman, 2013).

Soil that is compacted or tight and anaerobic suit grassy species that like tight soil. This type of soil may have excess magnesium relative to calcium, so aeration is essential with applications of compost tea to increase fungal populations. Gypsum is not necessary, but this is a situation where it is often applied to the detriment of the soil biota. Aerate the soil and apply fungal dominated compost tea (McCaman, 2013).

The pros and cons of using organically certified weedicides to manage weedy species and their impact on soil microbiology. Controlling weeds with minimal intervention.

If weedy species are a problem in the vineyard, then the soil biology is out of balance for perennial plants. Deal with the problem not the result. Look at the soil biology balance and if it is not fungal dominated in the perennial vineyard then change the soil populations to fungal dominated with good quality compost and fungal dominated compost tea. Weedicides, organic or otherwise, are band aids for a soil imbalance problem. Do not let any unwanted plant flower. Mulch the plant and it will soon die because of lack of photosynthetic nutrient production. Once the soil is fungal dominated then remove the odd weedy species and make sure the soil has 100% cover 100% of the time.

Weeds are not all negative, grower understanding of the benefits of some weeds, why they may have certain weeds and how to avoid weeds would be useful. This question has been answered above.

How to achieve 100% green cover in balance with invasive weed problems.

Time taken to improve the general quality of the soil and increasing soil biology will result in a change in the plant composition. Applying organic matter – mulch, compost, or compost tea – regularly over time will improve the soil biota especially if the soil has been previously damaged through use of synthetic chemistry or over working. How much and how often is dependent on the result of chemistry and biology results. It is useful for growers to learn how to measure qualitatively their soil biota using a simple light microscope. A soil test will show what elements are locked into the total pool and biology baseline information will show what the biological baseline is and what expected rates would be for that plant species and the time of the year.

Biological management of invasive weed species.

There are many products available from outlets such as Bunnings and the farm supply outlets such as Muirs, Landmark and Elders. Herbicides are not necessary. Unwanted species can be smothered using cardboard, carpet, etc. Mowing before flowering and mulching followed by soil aeration and microbe feeding with compost tea or compost. Biological management may require more input of time in the first instance but over time, inputs reduce.

Monitoring

How to understand your soil biology, and next steps that can be taken.

Understanding soil biology requires training. Agpath Pty Ltd provides specific weekend workshops built around making high quality thermal aerobic compost suitable for making compost tea as a disease management product.

Participants are taught to use a simple light microscope and identify various soil biota groups. Agpath Pty Ltd runs these workshops generally bi-monthly (www.agpath.com.au/courses).

Online courses are also available through the Soil Food Web. Agpath provides a soil testing service for accurate quantitative soil biota assessments. Molecular biology, direct microscopy and qualitative analysis are methods of determining populations. Farmers are prepared to have soil samples taken before they purchase synthetic fertilisers. They need to be prepared to have the soil tested for the microbial populations if they wish to apply organic amendments at the rates at which their soil requires.

Dr Elaine Ingham has many courses online that can be an introduction.

Soil testing and assessment protocols / guidelines to assess soil microbiology.

There are many methods of assessing soil populations. Molecular techniques are reductive but will provide total population biomass. There are monitors now available that will give an indication of soil biological activity through gas exchange (Doran & Zander 2012; Gyawali et al, 2019). None of these methods gives a quantitative of each of the functional groups, however. They give an indication and are usual to build a trend. The quantitative method developed by Dr Elaine Ingham in her PhD thesis and used by Agpath Pty Ltd is a very accurate method because it uses direct light and fluorescent microscopy (Ingham 1981).

Understanding what is in your soil or in your brews.

A simple light microscope with some important basic features is all that is needed to look at soil biota qualitatively. This skill is taught at the weekend workshops run at the Agpath labs (www.agpath.com.a/courses). A basic microscope must have two adjustable light sources and a movable stage with slide holder clip on the stage. Microscopes now are digital so the image can be seen directly on the screen of a laptop or ipad. Microscope workshops allow growers to learn to recognise the different soil organisms. On-line You Tube clips are excellent training for using a microscope. Agpath also has a closed website that contains a large number of soil, compost tea and compost pictures with captions that can be accessed by participants who have attended a small microscope course at Agpath.

Applying compost, compost tea and measuring success.

Good quality compost should be sought if it is to be purchased. The volume to be used is directly dependent on results from baseline chemistry and biology tests. Applications are made based on data from baseline analysis. Six months or twelve months from the baseline reading the second reading will show the change in the biota population and diversity. The second data set is used to modify the initial recipe. It takes generally 12-18 months to settle a soil into a new biological state. Improved productivity, increased yield, elevated brix in tissue and change in vineyard floor vegetation.