Applying regenerative agriculture practices in viticulture

Proponents of regenerative agriculture often point to the importance of improving soil health as a way of safeguarding food production systems from climate change. Some even suggest that improving soil health will slow the progression of climate change through carbon bio-sequestration. In this column, AWRI Senior Viticulturist Robyn Dixon explores the benefits of improving soil health and how regenerative agriculture can be adapted to viticulture.

Q: What is soil health?

Soil health can be defined as 'the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals, and humans' (Moebius-Clune *et al.* 2016). It is directly correlated with soil functions such as the storage and release of nutrients; carbon sequestration; the infiltration, storage, and filtration of water; the suppression of pests, diseases and weeds; and the detoxification of chemicals. It is influenced by processes such as the decomposition of organic matter by soil organisms to form soil humus.

A set of soil health benchmarks for viticulture was developed by the Victorian Department of Environment and Primary Industries (now Agriculture Victoria) and CSIRO (Edwards 2014). These include physical properties such as aggregate stability or dispersion and soil consistence; chemical properties such as pH, electrical conductivity, exchangeable cations (Ca, Mg, K) and exchangeable sodium percentage; and biological properties such as soil organic carbon, microbial biomass and, potentially mineralisable N.

The level of organic matter and biological activity in the soil has a significant effect on the health and function of the soil. Plant roots and fungal hyphae help bind aggregates together, and soil organisms produce organic glues (polysaccharides, fats, and waxes) during the organic matter decomposition process, which stabilise soil aggregates and improve soil structure. Weakly structured soils have reduced water infiltration rates and decreased water drainage rates; they are more easily eroded or compacted and have a reduced capacity to sustain plant growth and productivity.

Q: How would improving soil health benefit my vineyard?

Historically, many Australian vineyards were monocultures, with cultivation and/or herbicide applications used to maintain bare vineyard soils and synthetic fertilisers used to maintain vine growth and productivity. The theory was that other plants in the vineyard would compete with vines for water and nutrients. However, over time these practices have contributed to soil erosion, salinity, sodicity, acidity and structural and organic matter decline. Degraded soils require more irrigation and nutrient inputs to maintain vine productivity.

Water and nutrient stress can reduce yield and carbohydrate storage in vines, as well as their ability to deal with abiotic stresses such as drought and frost. These stresses can also weaken the immune response of vines to fungal pathogens and increase disease symptom expression in vines infected with Grapevine leafroll-associated virus 3 and the fungal pathogens associated with young vine decline (*Cylindrocarpon, Phaeomoniella, Phaeoacremonium and Botryospheria*).

Improving soil health in vineyards can increase water infiltration, storage and availability; nutrient cycling, storage and availability; and water and fertiliser use efficiency. These functions can help buffer vines from climatic fluctuations, providing a more stable environment – a factor described by White (2003) as key to the production of quality wine.

Q: How does regenerative agriculture increase soil health?

Regenerative agriculture is described as a system of farming practices that increases biodiversity, enriches soils, improves watersheds and enhances ecosystem services. The key principle is to improve soil health by using practices that build and maintain the biological activity of the soil rather than deplete it. These practices include balancing soil nutrition limitations primarily but not exclusively through organic inputs; keeping the soil covered with living plants or organic material all year round; minimising soil disturbance; increasing plant and microbial diversity; and integrating livestock.

Promoting and maintaining plant and microbial diversity is a key component of regenerative agriculture because of the role plants and microorganisms play in the formation of soil organic matter. Plants absorb CO_2 from the atmosphere and incorporate it into organic compounds via photosynthesis. Some organic compounds are exuded into the soil around the plant's roots, providing a food source for soil microbes. The blend of organic compounds exuded by each plant is unique and varies depending on the plant's needs. The greater the diversity of plants, the greater the diversity of microbes.

Plants also form symbiotic associations with mycorrhizae fungi. The fungi improve mineral uptake from the soil by the plant roots and the plants provide the fungi with a carbon source. The mycorrhizal fungi then channel carbon from plant exudates and decomposing plant and animal material into soil mycelial networks, where a portion is combined with biologically fixed nitrogen and converted to stable humic compounds. The carbon stored in the soil increases the ability of the soil to absorb and hold water and provides a food source for other soil microbes.

Q: Can regenerative agriculture practices be used in viticulture?

In response to research conducted in Australian vineyards, many growers have already moved away from the bare earth, heavily cultivated or herbicided monocultures of the past and soil health is improving.

Maintaining vineyard floor cover through the use of mid row cover crops and permanent swards has reduced erosion, suppressed weeds, improved

soil structure and drainage and reduced dust. Practices such as direct drilling when establishing cover crops minimise soil disturbance. The use of nitrogen fixing cover crops undervine to suppress weeds and improve water infiltration can also improve yields and pruning weights over time (Penfold, 2018).

Multi-species swards can increase numbers of beneficial insects, increase biological activity in the soil and provide more consistent cover. Research findings show that plant diversity supports predators of pest organisms such as light brown apple moth (LBAM) and scale, increases fungal diversity in the soil and can produce a higher biomass than single-species crops (Thompson and Penfold 2012, Richards et. al. 2020)

Incorporating species diversity into vineyards with existing swards does not have to be difficult or costly. Planting floral cover crops such as buckwheat in alternate rows or at even greater distances was found to be effective at reducing LBAM numbers in New Zealand vineyards. Direct drilling multi-species crops into existing mid row swards and side throwing the mid row slashings can increase diversity in the mid row and undervine area. Tools such as the Soilkee renovator can be used to incorporate multiple seed species into narrow mulched strips within existing swards.

The University of Adelaide and Wine Australia have developed an online Cover Crop Finder tool to help growers choose suitable cover crops for their specific situation. When trialling any new soil management practices, it is important to assess the impact of the practice on soil health. The Northern Rivers Soil Health Card is an example of a practical tool that growers can use to measure soil health.

For more information about improving soil health in vineyards, please contact the AWRI helpdesk on 08 8313 6600 or helpdesk@awri.com.au. For a list of further reading associated with this article, please contact the AWRI library on infoservices@awri.com.au.

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