# Case Study

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This case study analyzes the broad range of beneficial outcomes achieved with long-term management under AEA's regenerative program at Wilson Creek Winery and Vineyards in Temecula, California.

## Key Achievements:

- **366% ROI**
- **>5°C reduction** in soil temperature
- **257% increase** in soil health based on Haney analyses
- Significant increase in soil enzymatic activity
- Increased leaf surface density
- Smoother wine fermentation curve
- Better control of powdery mildew even with 50% fungicide reduction
- . . . and more!

# Contents



## Background

Wilson Creek Winery is a 90-acre vineyard and winery in Temecula, California, founded in 1996. Wilson Creek manages an additional 70 acres outside of their estate.

Prior to working with AEA, Wilson Creek Winery experienced many problems typical to grape growing: inconsistent yields and quality; inconsistent bunch size; diseases like powdery mildew, canker, Pierce's Disease, etc; pests like Grape Mealybug; severe soil compaction; poor water infiltration; and excessive water use.

With the goal of tackling these problems, Wilson Creek's vineyard manager Greg Pennyroyal started working with AEA in 2018.

Greg ran a few trials of regenerative management at different price points:

- One vineyard—Block 9—was started on an AEA trial, and compared to Wilson Creek's conventional protocol for three years.
- After seeing excellent results on Block 9, more blocks were converted to the normal AEA program, while Block 9 then began trialing an "all-out" AEA program with no regard for cost.
- Some blocks were left under conventional management as controls.

The success of Block 9 over the years, and the return on investment in that block, is a testament to the power and profitability of regenerative techniques in vineyards, and the the benefits that can be reaped by converting to regenerative management as quickly as possible.

## Protocol

Wilson Creek's AEA protocol has evolved over the years. In 2024, the "all-out" protocol consisted of:

- Cover crop and Soil Primer in spring and fall
- Soil amendments in spring
- 7 nutritional foliars
  - Applications timed to the crop's critical points of influence
  - Formulated based on sap analysis
- 3 fertigations

## Results

The results achieved at Wilson Creek Winery are a testament to the broad range of beneficial outcomes that AEA's protocol can provide. In this section, we'll analyze each outcome one-by-one, providing supporting data, charts, and photos.

What these data show is a quantifiable increase in soil biology function (measured by enzymatic activity, respiration, Haney tests, etc) and plant health (measured by disease prevalence, leaf density, etc).

Improvements in soil and plant health lead to greater productivity, lower costs on labor and inputs, more uniform fruit loads year-to-year, and in the end, more profitability. Testimonial evidence suggests that regenerative management also results in higher-quality wine, though we are still collecting data to confirm this.

The result is an undeniable portrait of the cascading positive effects achievable through regenerative agriculture.

## 1. Microbiological Activity

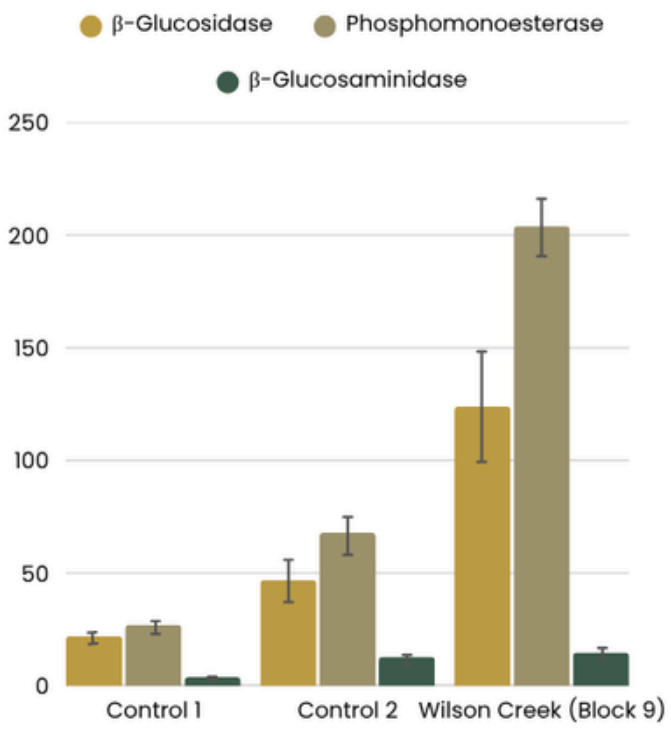
Microbial activity is necessary to improve soil organic matter (SOM). The ability of microbes to process organic matter, release nutrients from it, and transform it into more stable forms is dependent upon enzymes. Three key enzymes in these processes are:

- **beta glucosidase** (degrades cellulose)
- **beta glucosaminidase** (degrades chitin, which is related to fungal biomass)
- **phosphomonoesterase** (cleaves phosphorus into more plant-available forms)

These enzymes are directly related to C, C/N, and P cycling, respectively, in soils.

The soil in Block 9 at Wilson Creek had greater activities of all of these enzymes compared to a control at a neighboring conventional vineyard (though the difference was not statistically significant for beta glucosaminidase).

These results demonstrate that microbial communities responded favorably to regenerative management, which has positive implications for release of nutrients from SOM, future accrual of SOM, and soil microbial health.




## 2. Water Infiltration

Before working with AEA, the water Infiltration rate ranged from 20 to 44 minutes. Now it is less than 2 minutes.

## 3. Haney Soil Tests

Haney Soil Tests are a useful indication of soil health. The Haney test aggregates more than a dozen soil values, and can indicate the progress of soil health regeneration over time.

The chart below presents Haney test results from a number of blocks at Wilson Creek in June 2024.

- Block 9 had been under AEA management for 6 years at this point, and was currently using our "all-in" protocol.
- Blocks labeled "AEA" were under a variety of AEA protocols, including a "baseline" protocol, which we consider the minimum necessary—it's composed of a lighter soil primer, with fewer foliar and fertigation corrections.
- Blocks beginning "FY" were in their first year of a baseline AEA protocol.
- The control was under strictly conventional management.

The chart shows a clear trend: the more intensive the regenerative program, and the longer a block has been on that program, the healthier the soil.

| | H2O Organic N, ppm | Organic N: Inorganic N | Soil Respiration ppm, CO2-C | H2O Total Organic C | % MAC | Organic C:N | **Soil Health Calculation** |
|---|---|---|---|---|---|---|---|
| **Block 9** | 16.1 | 2.11 | 98.1 | 197 | 49.8 | 12.3 | **15.4** |
| AEA 1 | 14.9 | 1.07 | 95.0 | 177 | 53.8 | 11.9 | **14.5** |
| AEA 4 | 15.9 | 1.23 | 58.8 | 176 | 33.4 | 11.1 | **11.0** |
| AEA 11 | 14.6 | 1.24 | 52.3 | 168 | 31.1 | 11.5 | **10.1** |
| AEA 7 | 16.4 | 1.44 | 36.1 | 188 | 19.2 | 11.5 | **9.0** |
| AEA 3 | 13.5 | 1.25 | 30.6 | 154 | 19.9 | 11.4 | **7.5** |
| AEA 5 | 15.0 | 0.97 | 24.8 | 161 | 15.4 | 10.7 | **7.2** |
| AEA 6 | 14.5 | 0.97 | 24.6 | 150 | 16.5 | 10.3 | **6.9** |
| FY 1 | 10.2 | 1.76 | 23.2 | 151 | 15.3 | 14.9 | **6.4** |
| FY 3 | 8.3 | 1.69 | 29.5 | 114 | 25.9 | 13.8 | **6.1** |
| Control | 10.6 | 1.15 | 21.0 | 143 | 14.6 | 13.5 | **6.0** |
| FY 5 | 7.2 | 1.4 | 14.0 | 109 | 12.8 | 15.2 | **4.3** |

## 4. Cover Crops & Soil Temperature

A conventional vineyard will often keep the soil bare in the vineyard in an attempt to reduce competition, eliminate disease habitat, and simplify management.

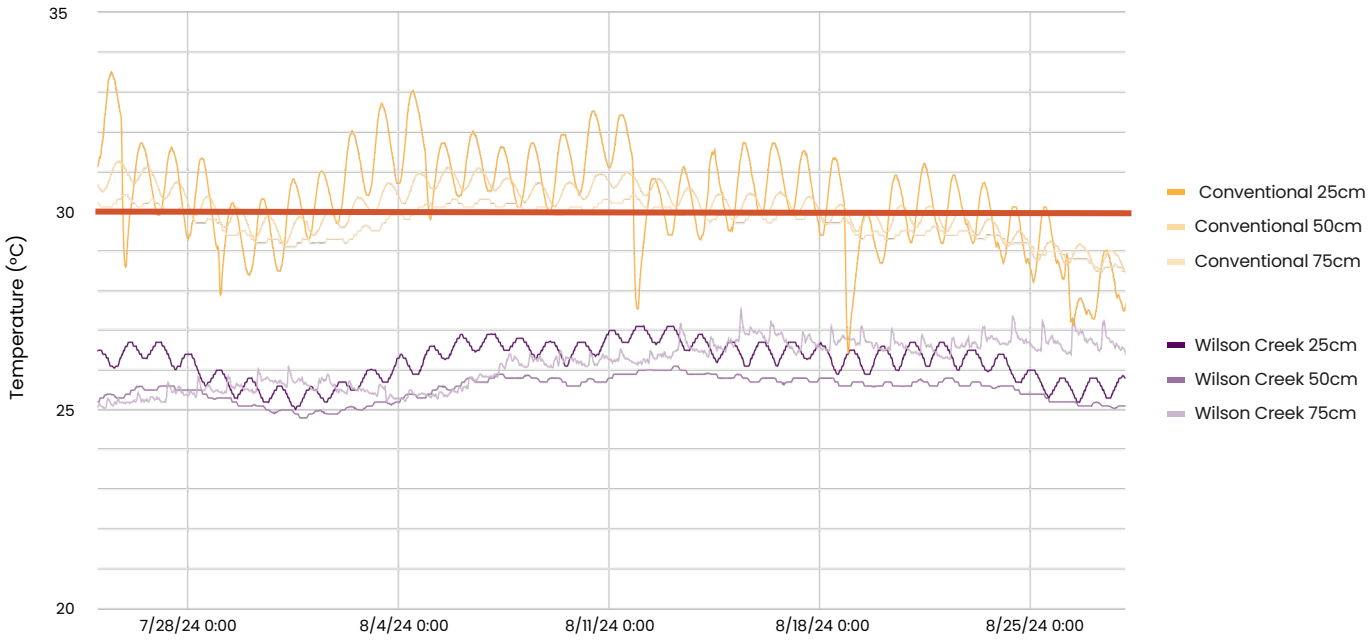
However, Wilson Creek plants cover crops throughout the vineyard to feed and shelter biology, prevent compaction, reduce erosion, and reduce soil temperatures.

A study conducted by the USDA's Agricultural Research Service (ARS) measured soil temperatures at Wilson Creek alongside two conventional wineries in Temecula over 3 years, from 2022 to 2024. Temperatures were logged every 30 minutes at various depths and distances from the vine.

Below is a sample of the data over a one-month span from July 25 to August 28, 2024, measured 3 ft away from the vine at depths of 25cm (~10 in), 50cm (~20 in), and 75cm (~30 in).

The red line marks the 30°C (86°F) threshold above which microbial communities become stressed. As the chart clearly shows, the covered soil at Wilson Creek stayed well below that threshold, while the bare soil at the conventional vineyard was frequently above it, even at depths of 75cm (30 inches).

*Contrasting views of vineyard rows with bare soil (top) and cover crops (bottom).*



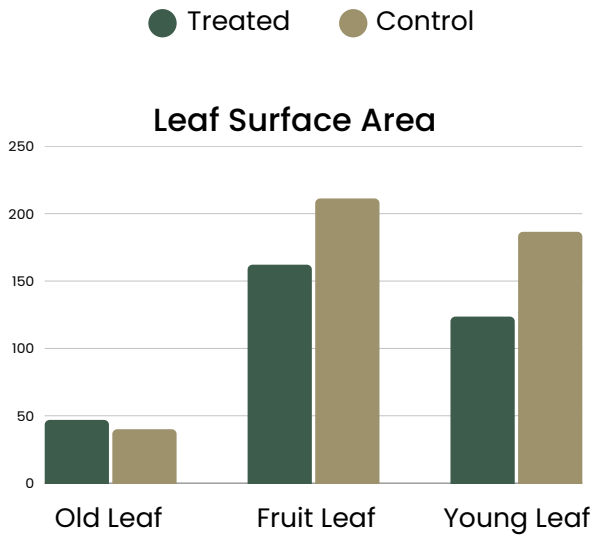
## 5. Leaf Size

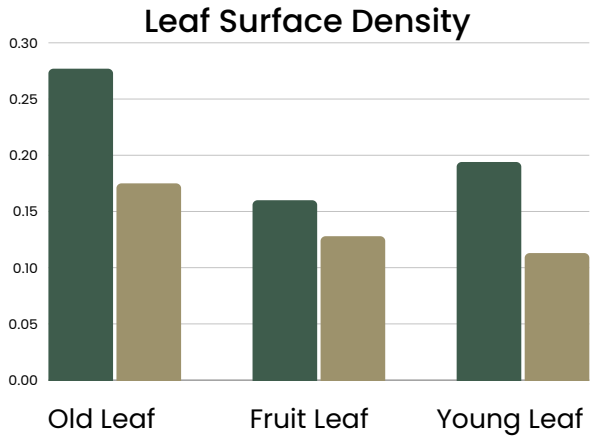
Leaf measurements taken during the vines' fruit fill stage on June 17, 2024 show that leaf surface area was bigger in the control winery than on the same varietal at Wilson Creek.

However, leaf density was higher at Wilson Creek, meaning the leaf had more weight in less surface area. Leaf brix was similar between the two blocks.

Taken together, these measurements indicate that the vines at Wilson Creek need less surface area to produce the same amount of photosynthates—a sign of increased efficiency in the regenerative blocks.

This study did not measure the amount of root exudates produced by the leaves, which could be a possible sink for the extra sugars produced, given that the regenerative blocks scored higher on Haney soil tests.

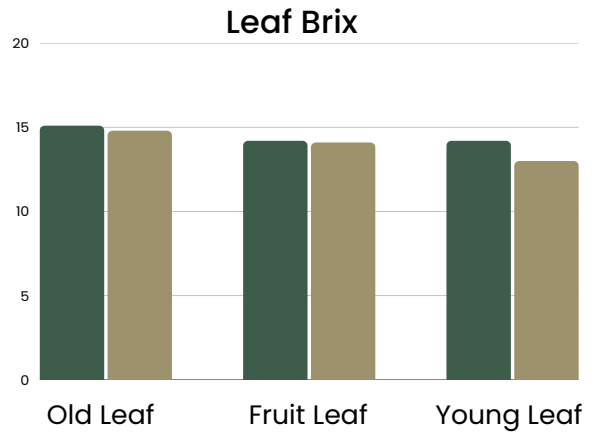



## 6. Controlled Vigor

Typical use of nitrogen fertilizers in vineyards result in a huge vine canopy that has to be thinned or hedged, resulting in high labor costs simply to manage excess leaves.

The vines on Block 9 don't have this problem. While that might seem to indicate low vigor, the vines actually have tighter internode spacing, with dark green glossy leaves, indicating more efficient energy allocation, rather than a lack of vigor. That results in major labor savings on leaf thinning and hedging, helping Block 9 to consistently be the most profitable block in the vineyard.



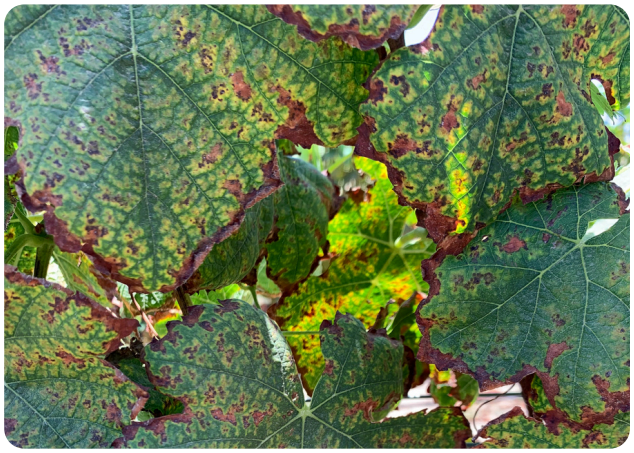
## 7. Pest and Disease Resistance

The only disease that Greg still finds difficult to control on Block 9 is Powdery Mildew. Other diseases, such as Red Blotch Virus, Leaf Roll Virus, Phomopsis, and Esca are present, but not significant problems. Trunk disease and root rot are much less prevalent. Trunk diseases are slow to manifest, with little or no new infections.

Greg has decreased Wilson Creek's fungicide applications by a minimum of 50% in the past 3 growing seasons, and is trialing novel approaches to controlling powdery mildew, which would make Block 9 completely disease-resistant.

In 2024, powdery mildew caused a near total loss in the region's vineyards, but Block 9 did fine, even with reduced fungicide applications. A large part of the ROI from this protocol is due to decreased fungicide expense.

*Photos taken on the same day showing grape clusters infected with powdery mildew on an untreated control (left), and untouched clusters on a block at Wilson Creek under AEA treatment (right).*



*Muscat leaves at a neighboring vineyard showing severe nutrient deficiencies (left), and healthy Chardonnay leaves under AEA treatment at Wilson Creek Winery (right).*

## 8. Avoiding Shatter

Shatter—the failure of grape blossoms to set fruit—is typically caused by micronutrient deficiencies. Block 9 doesn't experience shatter at all.

## 9. Uniform Fruit Loads

Grapevines tend to alternate bearing years, which results in variable yields each year. However, the vines in Block 9 consistently set two primary clusters per shoot, resulting in uniform fruit load year-to-year.

For instance, in 2024, cabernet vines did very poorly in the Temecula region, yielding only 50% of their 5-year average. The cabernet in Block 9 at Wilson Creek, in spite of the poor growing conditions, still yielded 90% of its historical average.

Consistent yields allow for consistent production and profitability, which is critical to the vineyard's success. "Yield stabilization is the biggest improvement," says Greg Pennyroyal.

## 10. Smoother Fermentation Curve

Wilson Creek's winemaker has noticed a smoother fermentation curve on wine made from Block 9's grapes, with no need to add an additional food source for the yeast, which results in higher-quality wine. While this observation is anecdotal, it has remained consistent over the years. We don't yet have data to understand the cause, but our hypotheses include:

- Higher levels of micronutrients for the yeast
- Adequate levels of Yeast Assimilable Nitrogen (YAN)
- Balanced sugar levels

## 11. Productivity

Greg's productivity goals are 3.7–4 tons per acre. Block 9 has reached these levels consistently. While the cost of investment has been higher, the ROI justifies the expenditures.

## 12. Return on Investment

Higher yields, more uniform productivity year-to-year, higher quality wine, as well as decreased costs for labor and fungicides have led to significantly increased profitability on Block 9, and an impressive return on investment, even considering the high cost of the "all-out" nutritional management program. Wilson Creek has the advantage of being fully vertically integrated from vineyard to tasting room, and so is able to capture the entire value chain and more effectively assess the overall benefits of the AEA program.

In 2023, Block 9 at Wilson Creek yielded 146% of the five-year regional average, compared to 66% for the rest of the region

On top of that, the wine was of excellent quality, justifying a 20% bottle price increase, up to $80-$100 per bottle.

Taken together, and compared to the increased costs of the regenerative management program, AEA's program yielded an impressive 366% return on investment.

| | |
|---|---|
| $144,401 | gross profit for Block 9 |
| $76,244 | gross profit for same-size blocks in rest of the vineyard |
| **= $68,157** | Increased profit on Block 9 |
| ÷ $18,600 | investment in materials and labor (sap/soil testing, inputs) |
| **366%** | **Return on Investment** |

## What's Next

Greg Pennyroyal and the team at Wilson Creek Winery are constantly pushing the envelope with regenerative agriculture to develop more profitable and effective ways to grow grapes. The success of the experimental Block 9 has led the company to aggressively pursue regenerative management across the entire vineyard.

Here's what's on the horizon at Wilson Creek:

**1. Study composition of Plant Secondary Metabolites**

In wine grapes, value comes from two factors: yield and quality. Increased yield is well proven in Block 9, but quality improvement is anecdotal thus far. In the future, Greg will be testing his hypothesis that regeneratively-grown grapes have higher levels of the compounds that lead to higher quality wine (and higher bottle price), including phenolics, flavonoids, carotenoids, terpenoids, stilbenes, etc.

**2. Control powdery mildew**

Being able to completely eliminate fungicide applications would be a major breakthrough for vineyard management.

- Fungicides are a major expense.
- Their application requires running heavy machinery through the vineyard that compacts the soil, countering the gains achieved through regenerative soil management.
- Extensive use of non-selective fungicides can have a detrimental effect on beneficial soil and phyllosphere microbiology.

From a systems perspective, reducing fungicide applications is an important piece of the regenerative puzzle.

While Greg has significantly reduced fungicide applications at Wilson Creek, complete elimination remains an elusive goal. Greg is constantly trying new techniques and is hopeful that elimination can be achieved in the near future.

**3. Rootstock evaluation**

Grape rootstocks have traditionally been chosen for disease resistance. But if nutrition can provide disease control instead, then a whole world of rootstock possibilities emerges. What if rootstocks could be selected for their symbiosis with soil microbiology? For their nutrition uptake? Or for a myriad of other beneficial traits, without regard for disease resistance? That's a new frontier in vineyard management full of exciting possibilities.

## Conclusion

The results of Wilson Creek Winery's regenerative management trials with AEA have been so impressive that the winery is eager to convert every block to regenerative as quickly as possible. Regenerative practices have improved the vineyard's yield, quality, and resilience to stressors, while cutting costs and delivering serious ROI.

The undeniable success of AEA protocol at Wilson Creek Winery shows that every winery should seriously consider adopting regenerative practices.

## About Advancing Eco Agriculture

Advancing Eco Agriculture (AEA) helps farmers succeed by empowering them to grow crops that are more productive, resilient and profitable. We provide data-based agronomic consultation and a range of powerful liquid mineral nutrition and biological products.

AEA is dedicated to a whole-systems approach to revitalizing soil and plant health, looking beyond symptoms by diagnosing root causes and providing treatments. This approach, informed by more than 18 years of data and on-farm experience, increases yields and crop performance, reduces or eliminates the need for pesticides and fertilizers, and generates immediate economic returns for farmers.

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