Glendale Ranch Vineyard, CA

COVER CROP DEMONSTRATION TRIAL CASE STUDY

2021–2025

TRIAL TREATMENTS

Treatment	Description
Conservation Cover	No cover crop planted; mow and till resident vegetation in alleyways
Cover Crop	Plant winter cover crop mix; mow every alleyway, till alternating alleyways

DEMO FARM OVERVIEW

Alternating alleyway tillage on the Cover Crop field. Tillage occurred on the right alleyway; the left alleyway was not tilled.

PAUL LUM, AFT

County	Napa, CA
Watershed	Napa River Basin
Crops in Trial	Wine grapes (Cabernet Sauvignon, Merlot, and Petit Verdot)
Cover Crops in Trial	"Bee Friendly" mix,[1] containing many clover species
Trial Size	40-acre vineyard (14-acre study area)
Soils	Clay on hills with 9–30% slopes
Annual Precipitation	30 inches
Elevation	575 ft

TRIAL GOAL

To evaluate cover crop use with reduced tillage for soil function and farm profitability, compared to using conservation cover (resident vegetation). As **first-time cover crop adopters**, Andrew Green and Lindsey Wiseman (operators of Glendale Ranch Vineyard) wanted to **evaluate whether cover crops would be a viable practice to adopt across their vineyard**.

KEY TAKEAWAYS

- Because of their participation in this trial, Andrew and Lindsey found that **cover crops are a beneficial addition to their operation**. They observed lush cover crop growth full of beneficial insects, lower runoff, as well as extensive cover crop root systems that they anticipate will build soil health over time. Committed to investing in their soils, they envision planting cover crops across all their vineyard blocks in the future.
- **Soil test results did not differ between Conservation Cover and Cover Crop fields**, aside from initial field differences, likely due to the short time in the trial and lack of replication.
- While the Cover Crop treatment had **lower tillage costs** compared to Conservation Cover, the cost saving was outweighed by the **lower yields and added cover crop seed and planting costs**.
- **Lower yields and resulting lower net income in the Cover Crop field cannot be attributed to the cover crop treatment** because the trial was non-replicated and was conducted on different fields with different wine grape varieties and sun aspects. Additionally, this **trial did not evaluate grape quality or flavor**; high yields are not necessarily the primary goal for wine grape growers.

MARGARET NISSEN

"In recent years in the Napa Valley we've seen major flooding across the valley where we didn't 20 or 30 years ago. As we've increased cover cropping and now rotational tillage, we're having a lot fewer issues on our own road systems and fields in terms of water runoff and saturation—I think the cover crop is really helping in that." **—LINDSEY WISEMAN**

"For so long, we only looked at what was above the ground, and we realized that we were missing a huge component, probably the biggest component. Soil health is both what is good for the plants or the crop, but also what is good for the whole ecosystem, including soil microorganisms." **—ANDREW GREEN**

American Farmland Trust

Andrew Green and his wife, Lindsey Wiseman, operate Glendale Ranch Vineyard, a picturesque property situated between two ridges on the flanks of the Howell Mountains in Napa Valley. A portion of the 2,000-acre property has been in the Wiseman family for more than 80 years. The farm was historically a cattle ranch. Today, most of the land is in rangeland or forests. The now 40-acre vineyard was started in 2004 and consists of multiple varieties, including Cabernet Sauvignon, which is the primary grape variety for their renowned Blue Label Cabernet wines. A reservoir located on the ranch, fed by two creeks, provides water via drip irrigation to their vineyard.

Andrew and Lindsey use soil health practices on the vineyard, such as applying green waste compost every year and maintaining a conservation cover (resident vegetation) in the alleyways. The conservation cover requires mowing and tillage passes in the spring, with additional mowing and tillage passes in summer and fall to manage vegetative growth without herbicides.

The use of resident vegetation in a vineyard's alleyways is a common practice in the region to protect the soil's steep slopes during the winter months when the vines are dormant. Tillage is generally used to suppress weeds and level the soil surface to facilitate equipment access. Intense tillage destroys soil structure, causing compaction and damaging the habitat and function of the soil's biological community. In the case of Glendale Ranch Vineyard's clay soils, reducing tillage must be accomplished carefully, and in conjunction with other soil health practices such as cover crops, to prevent compaction and other issues.

Andrew and Lindsey were curious to try planting a diverse cover crop mix to add biomass and diversity to their vineyard. The cover crop mix they selected was a "Bee Friendly" mix[1]—a mix of several clover species. This mix provides an extended growth period and adaptation to winter weather fluctuations. The legume species help fix atmospheric nitrogen, which can provide increased soil fertility and reduce fertilizer inputs. Finally, this cover crop mix provides a diverse habitat that attracts beneficial insects that can help suppress crop pests, which can lead to reduced pesticide use.

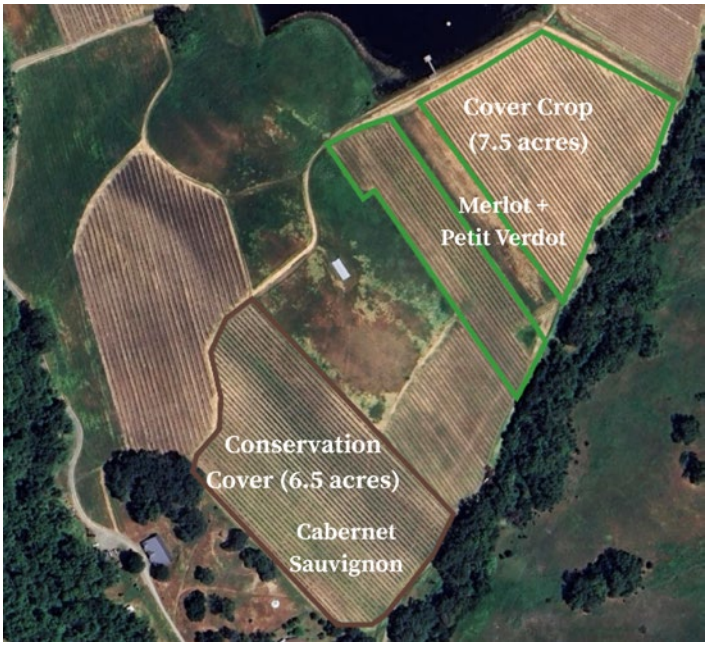
California has experienced increasingly dry winters, which have slowed adoption and reduced maintenance of covers, both cover crops and resident vegetation. This trial aimed to quantify soil health and economic impacts of planting a winter cover crop mix and reducing tillage by 50% to help Glendale Ranch Vineyard and other nearby farmers make more informed decisions.

TRIAL DESIGN

The demonstration trial (non-replicated) was established in two nearby fields with different grape varieties: Cabernet Sauvignon in the Conservation Cover field (6.5 acres), and a mix of Merlot and Petit Verdot in the Cover Crop field (7.5 acres) (Figure 1).

The Cover Crop field alleyways were planted to a cover crop mix each fall. The cover crop was managed the following year by mowing every row and tilling in alternating rows; the alternating tillage pattern was changed each year, so rows

FIGURE 1: TRIAL DESIGN MAP



"Vineyards have always proven to be a good wildfire break. But after a cover crop is mowed, the ground is covered in dead organic material. Even if it's not that much material and the fire moves quickly, damage to the vines can be irrecoverable. So that's a trade-off, in my mind. Tilling every other row just feels a little better." **—ANDREW GREEN**

TABLE 1: CROP AND COVER CROP ROTATION. Resident vegetation was allowed to grow in the Conservation Cover treatment alleys. All Conservation Cover alleys were tilled in spring, which terminated the resident vegetation. Every other Cover Crop alley was tilled in spring, shown in table with green stripes, which terminated those alleys. Untilled alleys in Cover Crop desiccated by about mid-June, effectively terminating the rest of the cover crop.

Conservation Cover	Cabernet Sauvignon Grapes				
	Resident veg in alleys	Resident veg in alleys	Resident veg in alleys	Resident veg in alleys	
Cover Crop	Merlot + Petit Verdot Grapes				
	Cover Crop in alleys	Cover Crop in alleys	Cover Crop in alleys	Cover Crop in alleys	
Year	**2021**	**2022**	**2023**	**2024**	**2025**



PAUL LUM, AFT

Left: Cover Crop treatment. *In the fall, every row was planted in cover crops. In the spring, every alleyway was mowed, and every–other alleyway was tilled.* ***Center: Conservation Cover treatment.*** *Resident vegetation was allowed to grow over the winter. In the spring, every alleyway was mowed and tilled.* ***Right: Compaction measurement with a penetrometer*** *in the Conservation Cover treatment. A measurement of 254 psi at 8" soil depth indicates compaction, a soil resource concern. May 2022.*

were only tilled once every other year. The farmers did not want to eliminate tillage completely due to wildfire and gopher concerns. On the other hand, the Conservation Cover field used resident vegetation as cover, with mowing and tillage passes in all rows every year, the typical practice used on Glendale Ranch.

Data Collection

Soil health indicators were analyzed annually in the field using both the qualitative observation-based NRCS In-Field Soil Health Assessment (IFSHA) and soil samples collected in the springs of 2021 through 2025. Data from 2021 reflect baseline conditions prior to treatments. Cornell Soil Health Lab provided the quantitative Comprehensive Assessment of Soil Health (CASH). Data from 2021 reflect baseline conditions prior to treatments. Annual field operations data, including machinery, inputs, input costs, and yield, were provided by the farmer in the cover crop years (2021-2025) and used alongside published machinery costs and crop prices to estimate average annual per-acre net income by treatment. See Technical Note[2] for methodology details.

Trial Expectations

Previous research indicates that soil health benefits tend to take longer than five years to accrue. Given the ranch's hot, semi-arid climate, the clay-dominant soils, lack of replication, and the short duration of the trial, it was expected that the Cover Crop field would show only slight improvements in soil health from the introduction of the cover crop mix and reduction in tillage. From an economic standpoint, it was expected that the reduction in tillage in the Cover Crop field would provide some machinery cost savings for the farm, but that cover crops would add to costs.

"We anticipated having additional gopher or other rodent pressure by having a thicker, denser cover crop on the ground for a longer part of the year, especially with reduced tillage, but we ended up not having that problem." **—ANDREW GREEN**

Without a replicated design, observed differences cannot be confidently attributed to the treatment effect as opposed to field variability or other factors. Replicated trials allow for more confident analysis; however, they can be difficult to implement on a commercial operation.

SOIL HEALTH CHANGES

Due to the demonstration trial not being a replicated research design, **the analyses below are for general comparisons only** and should not be used to draw formal conclusions about what caused any identified differences. See Technical Note[2] for methodology details.

In-Field Soil Health Assessment (IFSHA)

There was no difference in the IFSHA results between treatments. The IFSHA consistently indicated all four resource concerns (compaction, soil organism habitat loss, soil organic matter depletion, and aggregate instability) were present from 2022 to 2025. Baseline (2021) IFSHA results indicated soil organism habitat loss and aggregate instability as the only two resource concerns for both treatments. The variation in resource concerns identified from baseline values may be due to the variability of the qualitative assessment, differences in soil conditions, and differences in environmental conditions when the assessments were made.

Comprehensive Assessment of Soil Health (CASH) Report

The CASH report analyzes 12 indicators (four physical, four biological, and four chemical indicators, listed below) and provides indicator-specific and overall soil health scores (0–100, 100 being best).

Over the relatively short time period of this trial, **there was no difference between treatments for any of the indicators, aside from initial field differences.** We typically see soil health indicator differences due to treatment effects in replicated field trials extending over five years.

Overall Soil Health Score

The overall score increased from **medium** to **very high** for the Conservation Cover field, and **high** to **very high** for the Cover Crop field from 2021 to 2025 (Figure 2). Very high

"When you walk through the cover crop, it's so thick and there's so much life—so many insects—that are not in the other blocks. From a soil standpoint, the cover crop mix has deeper root penetration which helps get more organic matter into the soil and break up the hard pan without having to deep rip the soil mechanically." **—ANDREW GREEN**

overall scores indicate that management has been effective at maintaining soil health compared to farms with soils of similar texture. The Cover Crop field started with a higher overall score, which remained higher throughout the project. Both fields also increased their overall score from 2021 to 2025 at a similar rate of change.

Physical Soil Indicators

There were no notable differences between treatments in any year for any of the four physical indicators. The average scores for the physical indicators (predicted water holding capacity, aggregate stability, surface hardness, and subsurface hardness) fluctuated between **medium** and **very high** (Figure 2). A medium score indicates a need for improvement with a risk of soil constraints. The higher scores in 2023 were due to a penetrometer malfunction which resulted in no surface or subsurface hardness scores being taken; these indicators were typically low to very low. **Predicted available water capacity increased for both fields over time.** There were no notable differences between treatments in any year for any of the four physical indicators.

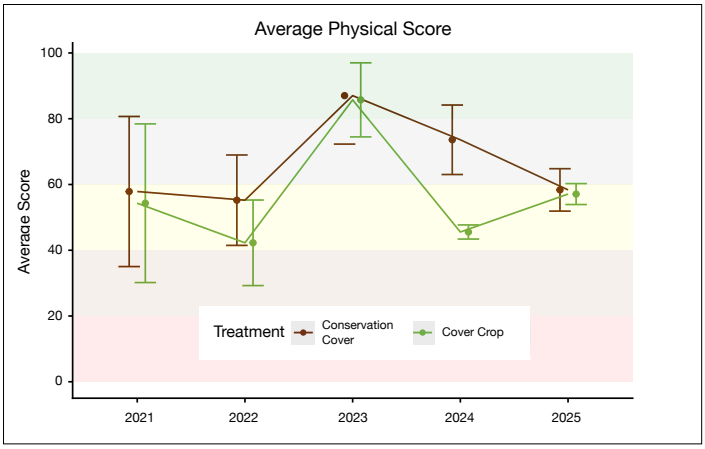
Biological Soil Indicators

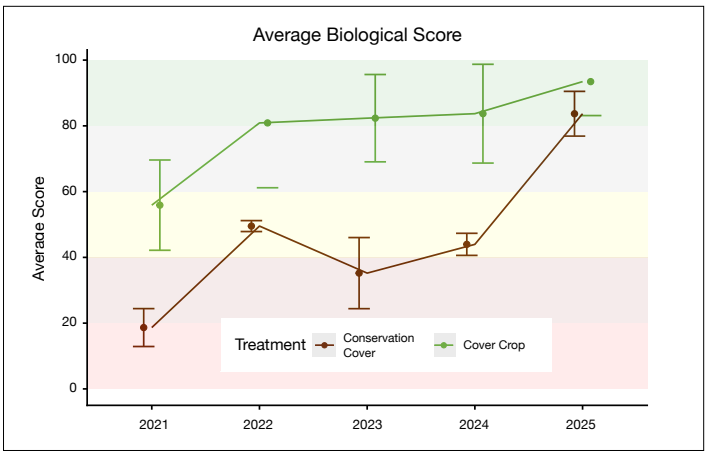
The average scores for the four biological indicators (organic matter, ACE soil protein index, soil respiration, and organic carbon) increased from **medium to very high** in the Cover Crop field and from **very low to very high** in the Conservation Cover field from 2021 to 2025 (Figure 2). The biological indicators remained different between treatments, starting with higher baseline scores for the Cover Crop field for each indicator. **Both fields showed increases in organic matter, ACE soil protein index, and soil respiration during the course of the project.**

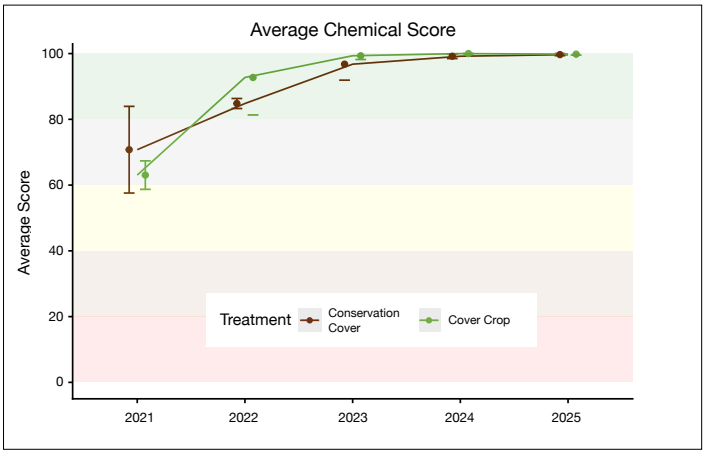
Chemical Soil Indicators

The average scores for the chemical indicators (phosphorus, pH, potassium, and minor elements) were in the **high** range initially and consistently in the **very high** range 2022–2025 (Figure 2), indicating they were not limiting for plant growth nor excessive for environmental degradation. This finding is common for CASH analyses, since the assessment and management of soil chemical constraints are well researched, standard practice on farms, and relatively easier to manage compared to other soil health indicators. **Phosphorus and pH scores improved over the course of the project.** None of the four indicators were notably different between treatments in any year.

FIGURE 2: AVERAGE OVERALL, PHYSICAL, BIOLOGICAL, AND CHEMICAL SOIL HEALTH SCORES BASED ON CASH REPORT. To represent sample variation within each field, errors bars are present to indicate one standard deviation. Red = very low, Orange = low, Yellow = medium, Light green = high, Dark green = very high.







ECONOMIC CHANGES

We calculated per-acre **cover crop costs, value of production** (crop yield times crop price), and **net income** (value of production minus all machinery and input costs) to analyze the effect of the treatment on annual economic outcomes (costs versus benefits). We assumed the same crop price across all

wine grape varieties. No statistical comparisons were made for economic calculations due to the side-by-side, non-replicated trial design, and the difference in wine grape variety between treatments. See **Technical Note**[2] for methodology details.

Note that **while this trial examined yield**, premium wine grape growers in Napa County do not aim for high yields, but rather **farmers often "devigorate" (intentionally lower yield) to improve fruit quality and flavor profiles**. For simplicity and consistency across multiple cover crop trials in other cropping systems in our project, we did not measure grape quality as part of the economic analysis.

Overall, **the cost of cover cropping was a small addition for this vineyard operation** ($84.45/ac on average) where standard field operations cost upwards of $1,000/ac. **Wine grape yields were lower in the Cover Crop field each year** (50%, 7%, and 27% lower, respectively), but the lower yields cannot be attributed to the cover crop treatment because the **trial was non-replicated and occurred on different fields with different sun aspects and varieties**. Net income was consistently lower on the Cover Crop treatment due to the lower yield. **A replicated trial design would be needed to determine the yield and quality impacts of cover crops.**

Cover Crop Costs

Cover cropping costs were the same in three of the four cover crop years, with only a $3/ac lower cost in the first year due to the use of a slightly different bee-friendly cover crop mix that included alfalfa. Planting was performed by a no-till seeder for a cost of $27.20/ac.

Note that the cover crop termination machinery costs included mowing every row and tilling every other row. The Conservation Cover field received mowing and tilling in every alleyway to manage the resident vegetation, therefore **the termination machinery costs for cover crop management were not an added expense**. This is accounted for in the net income section below.

Net income

Net income (value of production minus costs) differed due to variation in grape yields and cover crop costs.

In the first year of the trial, the **Conservation Cover field had a much higher net income** ($2,308.11/ac), with the Cover Crop treatment being 90% lower. **This large difference in net income is due to the high value of wine grapes, making yield impacts highly sensitive.** In this case, the Cover Crop field's lower net income was a result of the 1.5 ton/ac ($1,995/ac) lower yield in this field.

Year two held the lowest difference in net income with Cover Crop net income $275.19/ac (-13%) lower than Conservation Cover net income. In the final trial year, we saw the second largest wine grape yield difference with Cover Crop field yield being 0.67 tons/ac lower, resulting in a $904.47/ac (-48%) lower Cover Crop net income.

Across all three years that net income was calculated, **lower tillage costs ($17.78/ac lower on average) were outweighed by the lower yields on the Cover Crop field and the added seed and planting costs of the "Bee-Friendly" cover crop mix ($84.45/ac on average)**.

Our **net income calculations only included yield measurements, not grape quality**, and are based on published machinery data, not the farmer's actual machinery and input costs. Despite these yield-based net income differences between fields shown in our calculations, **Andrew and Lindsey anticipate substantial benefits after multiple years of experiencing cover crop management that they believe outweigh the additional costs of cover crops.**

"Cover crops can lower the temperature of the soil, so you have less radiant heat. That's important for wine grapes. We had a spell three years ago where we were hitting almost 120 degrees. That kills the grapes—they do not produce sugar after that. I think it would be interesting to explore if cover crop can help buffer those high temperatures."
—ANDREW GREEN

FIGURE 3: COVER CROP COSTS BY CROP YEAR. Cover crop termination machinery (mowing every row and tilling alternate rows) shown in this graph were not added expenses for cover crop management; the Conservation Cover field received mowing and tilling in every alleyway to manage the resident vegetation.

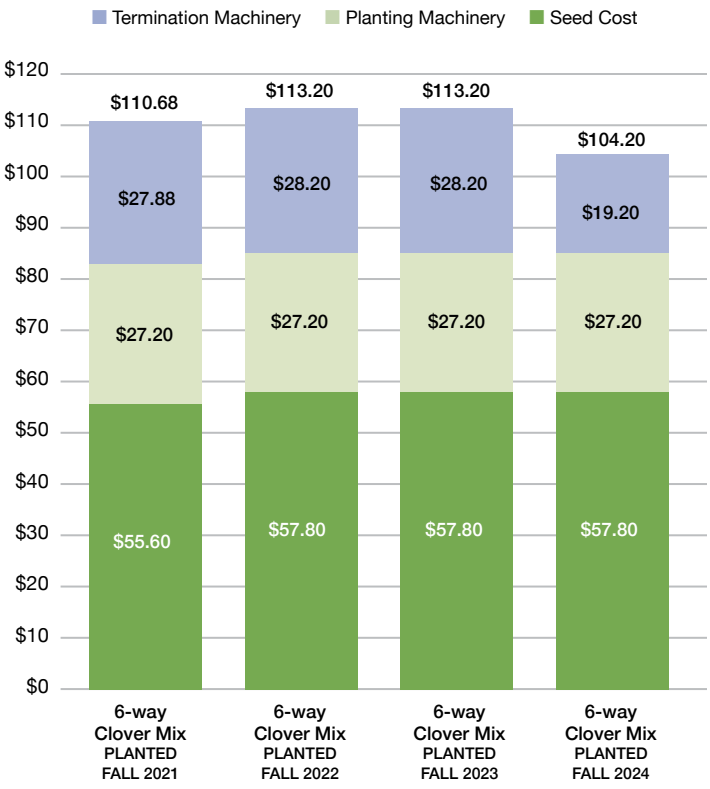
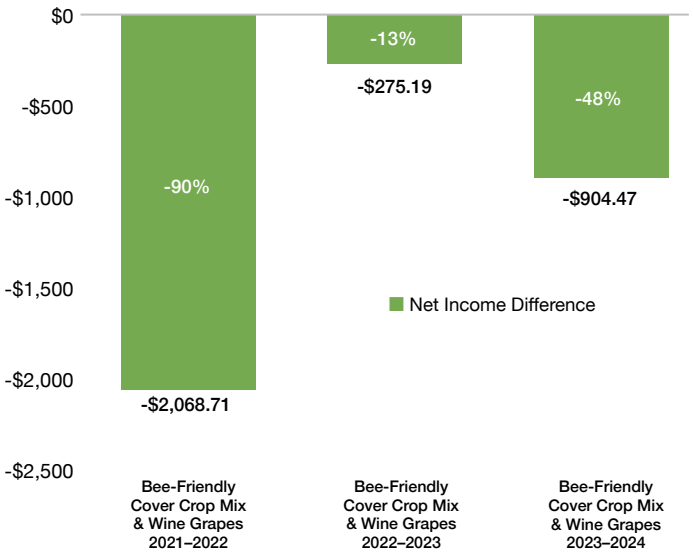


FIGURE 4: DIFFERENCE IN NET INCOME ($/AC) OF COVER CROP COMPARED TO CONSERVATION COVER BY CROP YEAR. Average net income of Conservation Cover each crop year was $2,308.11/ac, $2,075.96/ac, & $1,889.29/ac, respectively. Negative values indicate Cover Crop had a lower net income than Conservation Cover.



CONCLUSIONS

After this trial, Andrew and Lindsey are convinced that cover crops are a beneficial addition to their operation, and envision planting them across all their vineyard blocks in the future. Changes to soil health take time and commitment, and Andrew and Lindsey are confident they are moving in the right direction by adopting cover crops. While cover crop planting can be a little tricky to time with the weather, Andrew notes that the seeding itself is a relatively fast tractor operation, making it feasible to cover their full acreage each year.

"Cover crops feel like the right thing to do. It feels like we're farming in a way that is better for the vineyard in the long term because we are returning so much more to the soil and we are building the soil rather than depleting it." **—ANDREW GREEN**

"We raise our children here. It was really interesting to see their interest in what was going on. We ended up bringing groups of school kids to look at the cover crops and at their root systems. It got us involved in the conversation in a bigger way, not just in our ranching community, but with our kids. I'm very interested in education and raising the next group of ranchers, farmers, and land tenders."
—LINDSEY WISEMAN

When we asked what advice he would give to a producer interested in trying cover crops, Andrew noted to think carefully about the cover crop seed you pick and be sure you know the purpose of every seed in a mix. There are many cover crop mixes available, so you want to be sure you find a good fit for your operation. Along with that, think about how you intend to terminate the cover crop and be on top of timing.

His other piece of advice is to pay attention to changes caused by the cover crops that you might not expect. He and Lindsey learned the hard way—their cover crop got so thick that it grew up and around the drip irrigation hose under the vines. When they used their under-vine cultivator, it pulled the drip hose out, creating a bit of a mess. To remedy the issue, they moved the drip irrigation hose further up the vines by about two feet.

Despite the negative economic results calculated as part of this non-replicated trial, Andrew and Lindsey observed enough benefits, such as less water runoff, more beneficial insect activity, and more biomass on the vineyard floor and deeper rooting in the soil, that they are confident that cover crops are the way of the future for Glendale Ranch Vineyard.

NOTES

1 "Bee-friendly" cover crop mix contained multiple clovers (yellow sweet blossom, crimson, rose, white, Persian, and balansa), and in one year also contained alfalfa (planted Fall 2021).

2 For more information about the methods used for these analyses, see the Technical Note at https://farmlandinfo.org/publications/cover-crop-demonstration-trial-case-studies.

This material is based upon work supported by the U.S. Department of Agriculture, under agreement number NR213A750013G009. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the U.S. Department of Agriculture. In addition, any reference to specific brands or types of products or services does not constitute or imply an endorsement by the U.S. Department of Agriculture for those products or services. USDA is an equal opportunity provider and employer.

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