Betts Farms in Westfield, NY, grows 185 acres of Concord grapes and has been working on breaking the mold of how the space between their Concord grape rows (middle rows) is managed for over a decade. The standard practice in Concord grape production is to burn down all living grass and weeds in late spring to ensure optimum fertility for the Concord grapes, which typically produce twice the yield of wine grape varieties. But this practice is slowly changing. Growers like the Betts are establishing cover crops in the middle row space to alleviate soil compaction, reduce erosion, build soil organic matter, and foster life in the soil. Initially, the Betts were motivated to plant cover crops because they were worried about the negative effects of soil compaction on infiltration of water, root proliferation, and vine productivity. But they soon realized that cover crops were providing additional benefits for soil structure and the biological health of the soil. In 2011, Betts Farms
decided to try cover crops in a 5-acre block of their vineyard before expanding across the whole farm. After a few years of experimenting, the Betts were convinced and decided to incorporate cover crops on all 185 acres.

Here’s their story:

In 2011, Betts Farms experimented with their first winter annual cover crop, tillage radish. They planted it in several middle row alleys (pathways between the concord vines) to help alleviate soil compaction. Radishes are brassicas that form a thick taproot, like a carrot, and are well known to break up soil compaction and scavenge excess nitrate in the soil. When the radish dies, its large and decaying taproot leaves tunnels in the soil that allow for increased water infiltration and gas exchange. The farm planted tillage radish in every other middle row, where they had just put in tile drainage. They wanted the soil pores left by the radish roots to help channel the water infiltrating to the tile lines below. Not only were the Betts impressed by the water infiltration benefits that the radishes provided, but also by the amount of biomass they produced. They decided to add another species to their cover crop experiment – annual ryegrass.

The following year (2012), Betts Farms seeded annual ryegrass and radish in bands seven inches apart, totaling nine bands within each between-row alley. The idea was that the annual ryegrass would complement the large holes that the radishes left behind, and they hoped that it would stabilize the ground during wet periods to allow for easier tractor access in the vineyard. But, the radishes grew so big that they crowded out the ryegrass. This is a common occurrence if the radish seeding rate is too high (one extra pound of radish seed per acre can make a huge difference) or there is high residual nitrogen in the soil.

Fortunately, that same year, the National Resource Conservation Service (NRCS) was subsidizing cover crop efforts to combat soil erosion and improve soil health through the Environmental Quality Incentive Program (EQIP). The Betts Farms took advantage of this and planted cocktail mixes varying from three to seven different species in the middle row alleys. Working with the Lake Erie Regional Grape Program (LERGP), they added control fallow plots within their experimental block where they did not plant cover crops in sections three panels long (24 feet per panel) and three rows wide (9 feet between each row). This experiment has now been ongoing for eleven years.

The Betts Farms cover crop program has helped address many practical concerns on the farm, including preventing erosion, improving moisture retention in the summer, and suppressing weeds. A unique aspect is using an I & J roller crimper to terminate their cover crops, which is not a common practice in Concord grape vineyards (they began using this 5-foot wide tool in 2015).

The aboveground portion of the cover crop protects the soil from the impact of rain droplets, and the cover crop roots hold soil in place during periods of intense rainfall. These help decrease runoff and erosion that may carry pesticides, valuable nutrients, and topsoil away from the grapevines. Figure 1 shows a mat of rolled cover crop biomass protecting the soil from a heavy rain in mid-summer.

One concern with cover crops is competition with the grapevines for soil moisture during times of drought. But the reverse is happening as the cover crop is terminated with a roller crimper in early June, and the mat of biomass shades the ground and leaves it wetter than bare soil. Cooler temperatures also promote better soil microbe habitat than hot, dry soil without cover crops.
Both the actively growing cover crop and the resulting mat of biomass help suppress weeds. Weed suppression is especially important for problematic annual weed species such as Marestail, which is commonly resistant to glyphosate (Roundup). While Marestail was a significant problem in non-cover cropped rows, it was hardly noticeable in cover cropped rows (Figure 2). The Betts Farms roller crimping has also allowed them to reduce reliance on glyphosate since it can be an effective cover crop termination strategy in some years. If it doesn’t provide effective termination, then they will go back and apply the herbicide.

Betts Farms started their cover crop journey to reduce soil compaction but ended up with excellent soil health benefits. Visual observations showed increased soil life—especially earthworms which pull plant litter into the soil, acting as nature’s plow. As earthworms eat, soil and decomposing organic matter are mixed together in their gut. They then deposit these “casts” of stable assemblages of organic and mineral particles at the top of their burrows. They are more fertile than the surrounding soil and help increase nutrient availability to the shallow-rooted grapevine roots. Furthermore, the Betts have noticed that this promoted lateral root growth of the Concord grapevines into the middle row alleys.

**Soil Health Benefits:**

How is the Betts Farms cover cropping program impacting soil health? Let’s put some numbers to this. In May 2021, the farm worked with Cornell’s New York Soil Health Initiative to collect four composite soil samples from the cover crop (CC) and non-cover crop (NCC) treatments for a standard soil health assessment at the Cornell Soil Health Lab. Composite samples were collected from two locations within the experimental area. The soil was collected from an area classified as a Barcelona silt loam that has approximately 13% sand, 60% silt, and 27% clay. The sampling protocol required six 0-6 inch soil slices for each composite sample.

The soil samples from the cover cropped plots had consistently higher soil respiration (27% increase) and aggregate stability (58% increase) compared to the non-cover cropped plots (Table 1, Figure 3). The higher soil respiration indicates that inputs of cover crop biomass are fueling microbial activity. This means that microbes are converting organic residues into mineral accessible nutrients, such as nitrate and ammonium, at a faster rate than the non-cover cropped plots.

The higher aggregate stability measurements confirmed our observations that the soil under cover crops appeared much better aggregated compared to the non-cover cropped soil, which was very poorly aggregated and compacted (Table 1, Figure 3). Research has demonstrated that living roots, their associated mycorrhizal fungi (brassicas do not host AMF), and increased organic matter inputs all help build and maintain stable aggregates. Improved aggregate stability translates into greater infiltration of water and reduced erosion of topsoil. Figure 3 shows the respiration and aggregate stability values and SH scores for the treatments on Betts Farms compared to pastures and perennial fruit (orchards and vineyards) on silt loam soils in New York. The perennial fruit data provide relevant benchmarking for Betts Farm, and pasture data shows the potential upper limit for what is possible for that soil type.

High initial soil organic matter levels and inherent variability at the site may explain why no significant differences were observed in soil organic matter content.

---

**Figure 2.** Weed concerns being reduced: Marestail coming up in a non-cover cropped area, but not in the cover cropped portion behind it.
Table 1. Cover crop (CC) vs. non-cover crop (NCC) treatment effect for the Betts Farms vineyard in 2021. These values reflect the mean of two composite soil samples per treatment.

<table>
<thead>
<tr>
<th>Year</th>
<th>Trt</th>
<th>SOM %</th>
<th>Active Carbon mg/kg</th>
<th>Resp mg CO₂/g</th>
<th>Agg Stab %</th>
<th>pH</th>
<th>P ppm</th>
<th>K ppm</th>
<th>Mg ppm</th>
<th>Fe ppm</th>
<th>SH score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>CC</td>
<td>4.4</td>
<td>693</td>
<td>0.95</td>
<td>30</td>
<td>6.7</td>
<td>2.3</td>
<td>170</td>
<td>302</td>
<td>7.7</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>NCC</td>
<td>4.6</td>
<td>728</td>
<td>0.75</td>
<td>19</td>
<td>6.5</td>
<td>1.7</td>
<td>136</td>
<td>289</td>
<td>5.6</td>
<td>75</td>
</tr>
</tbody>
</table>

Figure 3. Soil health benchmarking of Betts Farms soil respiration (a) and aggregate stability (b) compared to other pastures and perennial fruit systems on silt loam soils in NYS.

and active carbon. There is indication in the data that P and K are more available due to the cover crops, which could help drive increases in vine productivity.

Vine Productivity Benefits:

The final test of any new management system is to ensure that it does not negatively affect crop productivity. It may even be possible to find win-win solutions where management improves soil health and also leads to higher crop productivity. We measured the effects of cover crops on vine productivity through pruning weight measurements between 2019-2021. These assess the one-year-old growth removed from dormant vines as an indicator of larger vine size and potential crop yield. To the Betts’ excitement, cover crops consistently had higher pruning weights compared to non-cover cropped plots (Table 2). Therefore, cover crops are improving soil health and nutrient availability, which in turn supports better vine growth. Conversely, loss in vine size would have indicated that the addition of cover crops caused competition for water and nutrients with the vines. In the future, we’ll be working with the farm to analyze their Concord grape yield data to see if these trends hold.
Table 2. Pruning weights for cover cropped and non-cover cropped areas between 2019-2021.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cover Cropped Area Pruning Weights lbs/ft</th>
<th>Non-Cover Cropped Area Pruning Weights lbs/ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>0.23</td>
<td>0.18</td>
</tr>
<tr>
<td>2020</td>
<td>0.33</td>
<td>0.27</td>
</tr>
<tr>
<td>2021</td>
<td>0.39</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Conclusion:

Betts Farms began their cover cropping journey to reduce soil compaction, but it has led to more soil health and vine productivity benefits. It has also sparked further research questions that the Betts want to pursue. They first worked in a trial area to test how cover crops in the middle row alleys would affect their operation, and are now confident in the benefits. Working with the Cornell Lake Erie Research and Extension Laboratory, NRCS, New York Soil Health Initiative at Cornell, and the New York Farm Viability Institute helped Betts Farms improve vineyard soil health and obtain their farm goals. Stay tuned for exciting cover crop innovations from Betts Farm.

Acknowledgements:

Authors:
Jennifer Phillips Russo  
*Cornell Cooperative Extension Lake Erie Research and Extension Laboratory*

Bob Betts  
*Betts Farms, Westfield, NY*

Joseph Amsili  
*Soil and Crop Sciences & New York Soil Health Initiative, Cornell University*

*Cornell Cooperative Extension*  
*Lake Erie Regional Grape Program*