# VINEYARD: Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VINEYARD</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Vineyard Overview</strong></td>
<td>3</td>
</tr>
<tr>
<td>History</td>
<td>3</td>
</tr>
<tr>
<td>Outline of the Vineyard Section</td>
<td>4</td>
</tr>
<tr>
<td>Management Practices 2000-2018</td>
<td>8</td>
</tr>
<tr>
<td>Data Management</td>
<td>13</td>
</tr>
<tr>
<td><strong>Site Preparation</strong></td>
<td>16</td>
</tr>
<tr>
<td>Topography &amp; Layout</td>
<td>16</td>
</tr>
<tr>
<td>Ripping &amp; Terracing</td>
<td>17</td>
</tr>
<tr>
<td>Soil Analysis &amp; Amendments</td>
<td>18</td>
</tr>
<tr>
<td>Trellis Systems</td>
<td>20</td>
</tr>
<tr>
<td>Irrigation System</td>
<td>23</td>
</tr>
<tr>
<td><strong>Planting &amp; Replanting</strong></td>
<td>26</td>
</tr>
<tr>
<td>Selecting Rootstocks &amp; Vines</td>
<td>26</td>
</tr>
<tr>
<td>Planting and Growing first 3 years</td>
<td>29</td>
</tr>
<tr>
<td>Data Management</td>
<td>29</td>
</tr>
<tr>
<td><strong>Soil &amp; Vineyard Floor Management</strong></td>
<td>33</td>
</tr>
<tr>
<td>Cover Crop</td>
<td>33</td>
</tr>
<tr>
<td>Tilling &amp; Ripping</td>
<td>33</td>
</tr>
<tr>
<td>Mowing</td>
<td>34</td>
</tr>
<tr>
<td>Weeding</td>
<td>35</td>
</tr>
<tr>
<td><strong>Plant Management</strong></td>
<td>36</td>
</tr>
<tr>
<td>Pruning</td>
<td>36</td>
</tr>
<tr>
<td>Grafting</td>
<td>38</td>
</tr>
<tr>
<td>Trellis Management</td>
<td>39</td>
</tr>
<tr>
<td>Shoot Management</td>
<td>39</td>
</tr>
<tr>
<td>Cluster Thinning</td>
<td>44</td>
</tr>
<tr>
<td>Data Management</td>
<td>46</td>
</tr>
<tr>
<td><strong>Nutrition Management</strong></td>
<td>48</td>
</tr>
<tr>
<td>Irrigation System Management</td>
<td>48</td>
</tr>
<tr>
<td>Irrigation</td>
<td>49</td>
</tr>
<tr>
<td>Identifying Nutrition Requirements</td>
<td>50</td>
</tr>
<tr>
<td>Soil Amendments &amp; Fertilizers</td>
<td>53</td>
</tr>
<tr>
<td>Foliar Sprays</td>
<td>54</td>
</tr>
<tr>
<td>Data Management</td>
<td>54</td>
</tr>
<tr>
<td><strong>Pest Management</strong></td>
<td>57</td>
</tr>
<tr>
<td>Pesticide Spray</td>
<td>57</td>
</tr>
<tr>
<td>Animal Control</td>
<td>61</td>
</tr>
<tr>
<td>Netting</td>
<td>65</td>
</tr>
<tr>
<td>Data Management</td>
<td>67</td>
</tr>
<tr>
<td><strong>Weather Monitoring</strong></td>
<td>71</td>
</tr>
<tr>
<td>Growing Degree Days</td>
<td>71</td>
</tr>
<tr>
<td>Why then do we need our own weather station?</td>
<td>72</td>
</tr>
<tr>
<td>Data Management</td>
<td>73</td>
</tr>
</tbody>
</table>
This section describes how we manage the vineyard at Chateau Hetsakais
Vineyard Overview

This page provides an overview of the Vineyard section. We cover the history of the vineyard, provide an outline of the section, review our practices over the last 20 years and describe what we measure and how we manage with the collected data.

History

The use of the property has evolved over the last 70 years: It morphed from an orchard to a horse property to a vineyard and, finally, to a vineyard with the winery. These pictures from Google earth provide an aerial view of the evolution:

1948 Orchard with house

1991 House with pool, garden & horse facilities

2000 First picture showing lower vineyard

2007 Starting construction on the winery

2013 Winery completed

2015 Planting upper vineyard
We acquired the property in 1996 and planted the first vineyard in 1997 in the Lower Field (right in picture). Being new to the area in 1997 and babes-in-the-woods what regards vineyards, we followed the recommendation of a friend to hire an expert in establishing and maintaining vineyards: Ron Mosely, then at Cinnabar Vineyards & Winery. Ron designed and planted it with Cabernet Sauvignon vines, and he managed the vineyard for the first 3 years – so we were not really involved in the process. In 2007 we decided to build a small winery (to the left of the Lower Vineyard). In 2014 we decided to plant a second vineyard for 2 reasons: first the yields in the Lower Field were dropping due to diseases; second, we wanted to augment our grape choices for blending the Cabernet Sauvignon with Merlot, Cabernet Franc and Petit Verdot to get more of a Bordeaux style wine. We planted the Upper Field on our own with some consulting support from Ron Mosely.

Outline of the Vineyard Section

This section starts with 2 pages on how we established the vineyards:

1. **Site Preparation** describes what it takes to prepare the terrain for planting a vineyard
2. **Planting & Replanting** describes the decisions and activities in planting the vines

The pages which follow describe the annual tasks in managing a vineyard. We group these tasks into 4 pages, described in more detail below

3. **Soil** management
4. **Plant** Management
5. **Nutrition** management, and
6. **Pest** management

A final page in this section covers how we monitor the weather and why *(7. Weather Monitoring)*

Vineyard management is structured around the annual cycle of a vine which the following graphic summarizes:

We distinguish between the following steps, starting in November each year:

- Leaves are falling while the vine above ground goes dormant.
- By mid-December, all leaves have dropped, and the plant goes dormant until March. The vines accumulate carbohydrates in the canes, and roots develop further.
- In late March new buds swell and break out.
- In April through May new shoots are emerging from the buds.
- In late May the vine flowers (pollination of grape berries).
- In June the flowers set to berries, the berries get larges and shoots grow longer through early August.
- In August the berries turn from green to red (veraison), start to soften, and build up sugar. Chlorophyll in the berries is being replaced by Anthocyanins.
- Through late September the berries ripen, accumulating sugar and tannins.
- In late September / early October the berries have reached full ripeness and are ready to be harvested.
- In October the leaves remain, and some turn red.

These pictures illustrate what a single vine looks like going through the year

1 November: Vine without grapes after picking

2 January: Leaves have fallen off
3 Mid-January: Canes have been pruned halfway
4 Mid-March: Canes pruned down to 2 buds every 6-8 inches
5 Early April: Budbreak – first new growth
6 Late April: growth requires shoot thinning which reveals Eutypa infection
7 Early May: front arm cut off due to Eutypa infection
8 Late May: further shoot thinning and start of removing lateral shoots
9 Late June: Shoots have reached target length and are clipped at the top
10 Late July: Veraison started, nets have been put on
In the context of this annual cycle, we divide Vineyard Management into 4 groups of activities and tasks:

- **Soil & Vineyard Floor Management** involving ripping & tilling, mowing and weeding
- **Plant Management** involving: pruning, shoot-thinning, hedging, shoot-positioning, trellis repair, lateral removal, leaf-thinning, cluster-thinning, and replanting & grafting.
- **Nutrition Management** involving soil and foliar testing, soil amendments, foliar sprays, irrigation maintenance and irrigation.
- **Pest Management**: involving netting to protect berries from birds and insects, spraying fungicides (mostly against mildew) and preventing ground animals (gophers, squirrels, rabbits, deer, coyotes and turkeys) from harming the vines and their roots.

The following chart shows how the listed tasks align time-wise with the annual growth cycle.
Management Practices 2000-2018

2000 – 2009 Getting Started: During the first 10 years, we moved from outsourced vineyard management to doing everything ourselves.

- The vineyard was planted in 1997 and managed for the first 3 years by Ron Mosley under contract. We basically watched the vines grow and organized the picking crew for the first harvest in 2000.
- Starting 2001, we engaged Rick Anzalone to support and teach us how to manage the vineyard ourselves. In 2002 we applied for an Operator Licence and started reporting the spray activity directly to the Santa Clara County Dept of Agriculture. Vintages 2002 and 2004 were dropped because of our failure to spray sufficiently against mildew. Until 2004 we sprayed by hand with backpacks and hoses.
- In 2006 we took over all the work in managing the vineyard. We discontinued using herbicides (Roundup) under the vines and started tilling instead. Unfortunately, we did not fight an invasion of gophers which ended up eating the roots of 40+ vines in 2007 & 2008. We continued to keep poor records on our vineyard management practices.
- In 2009 we replaced 47 dead vines with new plants. We did more shoot thinning and leaf thinning to reduce mildew and the necessity to spray. We were far more aggressive in pruning the old vines back in order to increase grape quality. This backfired however as we did not protect the large cutting wounds properly and the vineyard got heavily infested with Eutypa ("Dead Arm Disease"). As a consequence, we had to cut off and regrow most of the cordons over the next 5 years which dramatically reduced crop yield.
The following table summarizes the vineyard practices 2000 – 2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Vineyard Management</th>
<th>TASK</th>
<th>Vineyard Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>managed by Ron Mosely</td>
<td>Fertilizing</td>
<td>no records</td>
</tr>
<tr>
<td></td>
<td>2001</td>
<td>Replanting</td>
<td>47 CSV 337 on 4453 roots</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>Pruning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2003</td>
<td>Tilling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>Wild Life Issues</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>Bud Break (start Date)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shoot Thinning</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flowering (start Date)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Positioning, Lateral Removal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Eutypa Control</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fruit Set (start Date)</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Leaf Thinning</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bunch thinning</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Veraison (mid Date)</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grape Thinning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2006</td>
<td>Bird Defense</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maturity Assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harvest (Date)</td>
<td>black nets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Harvest Crew</td>
<td>Brix</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td></td>
<td>22-Oct</td>
</tr>
<tr>
<td></td>
<td>2008</td>
<td></td>
<td>Crew 10:</td>
</tr>
<tr>
<td></td>
<td>2009</td>
<td></td>
<td>Mitchell,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Morrissey,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Terry,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Anderson, Hill,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crew 9:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Rossi, Martin,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Agarwal, Pashe</td>
</tr>
<tr>
<td></td>
<td>2010</td>
<td>Crop</td>
<td>1.86 tons</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>26-Oct</td>
</tr>
<tr>
<td></td>
<td>2011</td>
<td>Crop Sale</td>
<td>all to Clos Tita</td>
</tr>
<tr>
<td></td>
<td>2012</td>
<td></td>
<td>11-Oct</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2014</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2015</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2016</td>
<td>Weather Summary</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spray Program</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9 Sprays</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Champ/Thiolux,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pristine,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stilet, Pristine,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Kaligreen/Rubigan,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thiolux, Thiolux/Ralley,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pristine, Pristine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irrigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2017</td>
<td></td>
<td>8 Sprays</td>
</tr>
<tr>
<td></td>
<td>2018</td>
<td></td>
<td>Champ, Thiolux,</td>
</tr>
<tr>
<td></td>
<td>2019</td>
<td></td>
<td>Pristine, Pristine,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Stilet, Pristine,</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Thiolux, Thiolux/Pristine</td>
</tr>
</tbody>
</table>

2010 – 2015: Better data collection & improving practices: During the next 6 years 2010 – 2015 we further improved our practices. The following table provides detail during this period.

- In 2012 we started to take detailed notes on our vineyard practices. We finally succeeded in keeping the deer out and the gophers under control. We started to remove
all laterals to control canopy growth. In 2012 we switched to pruning with electric shears. We removed most laterals to control canopy growth, and we thinned the crop to even out maturity. 2013 produced the highest quality fruit.

- In 2014 we started pruning in 2 passes to limit further new Eutypa infections which we continue to fight. We bought another 50 new plants with the idea to replace Eutypa damaged vines, this time Merlot. We also started to monitor berry development during final maturity with an experimental measurement of Anthocyanins.

- In 2015 we started using Vitiseal, a new sealant for cutting wounds against Eutypa and other fungi. The first results are very encouraging. Unfortunately, we were distracted with planting the upper vineyard and failed to spray early in the season, so we got significant mildew infections which led to poor fruit set and significant mildew damage.
### Vineyard Management inhouse

<table>
<thead>
<tr>
<th>TASK</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>12 yrs compost</td>
<td>50 lbs Hydrophyl, 2 sprays VF-11 20*3,</td>
<td>50 lbs 15*3, 18 yrs horse compost, 2 sprays VF-11</td>
<td></td>
<td></td>
<td>40 yrs mushroom compost, 4800lbs Lime, 650lbs PotassiumS, 300lbs Phosphate Bone Meal 13lbs ZincS, 5lbs Sodium Borate</td>
</tr>
<tr>
<td>Replanting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50 Merlot Ueber vines clone 3 on 110R in note</td>
</tr>
<tr>
<td>Pruning</td>
<td>by hand, aggressive</td>
<td>by hand, soap protect</td>
<td>electric, topsin protect</td>
<td>electric, 2 pass, Feb 20 &amp; Mar 30, Tonsin protect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tilling</td>
<td>rototill</td>
<td>rototill</td>
<td>2 passes</td>
<td>2 passes</td>
<td>2 passes</td>
<td></td>
</tr>
<tr>
<td>Wild Life Issues</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bird Break (start Date)</td>
<td>25-Mar</td>
<td>20-Mar</td>
<td></td>
<td></td>
<td></td>
<td>8-Mar</td>
</tr>
<tr>
<td>Shoot Thinning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7-Mar</td>
</tr>
<tr>
<td>Pin Warriors (start Date)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>76-Apr</td>
</tr>
<tr>
<td>Positioning, Lateral</td>
<td>limited</td>
<td>many laterals</td>
<td>all laterals removed</td>
<td>all laterals</td>
<td>all laterals</td>
<td></td>
</tr>
<tr>
<td>Removal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eutypa Control</td>
<td>none</td>
<td>removed 25% arms</td>
<td>removed 40% of arms</td>
<td>removed 30% arms</td>
<td>removed 30% arms</td>
<td>removed 15% arms</td>
</tr>
<tr>
<td>Fruit Set (start Date)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf Thinning</td>
<td>limited</td>
<td>removed leaves to 4th</td>
<td>removed leaves to 3rd</td>
<td>removed leaves to 2nd</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunch thinning</td>
<td>none</td>
<td>none</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Veraison (mid Date)</td>
<td></td>
<td></td>
<td>75-11</td>
<td></td>
<td></td>
<td>75-11</td>
</tr>
<tr>
<td>Grape Thinning</td>
<td>none</td>
<td>none</td>
<td>green bunches</td>
<td>green bunches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bird Defense</td>
<td>white nets</td>
<td>white nets failed system</td>
<td>green nets</td>
<td>green nets</td>
<td>green row netting + hard roller</td>
<td>green nets</td>
</tr>
<tr>
<td>Maturity Accomplishment</td>
<td>Rix 20-Oct</td>
<td>Rix 4-Nov</td>
<td>Rix &amp; ICV 7-Oct</td>
<td>Rix &amp; ICV 7-Oct</td>
<td>Rix &amp; ICV 7-Oct</td>
<td>Rix &amp; ICV 7-Oct</td>
</tr>
<tr>
<td>Harvest (Date)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harvest Crew</td>
<td>Crew 11: Daniels, Healy,</td>
<td>Crew 7: Muhr, Rossi, Mairose, Smith, Anderson, Gaulther, Heissel, Fryburger</td>
<td>Crew 16, Robins, Martin, Agarwal, Rossi, Rossi, Mairose, Fryburger, Crosby, Lapinski</td>
<td>Crew of 24 Fenyvesi, Martin, Rossi Sr, Rossi Jr, Crosby, Agarwal, Wong, Steele, Beder, Ogle, vonMeiss, Guld, Carlitz</td>
<td>Crew of 16 Fenyvesi, Martin, Rossi Sr, Rossi Jr., Crosby, Grant, Chilcoat, St.Pierre, Ogle, Vonderheyden, Guld</td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>1.2 tons, 22Brix, 3.5pH</td>
<td>0.6 tons, 21.5Brix, 3.46pH</td>
<td>1.0 ton, 23Brix, 7.9TA, 3.46pH</td>
<td>1.1 ton, 25Brix, 3.45pH</td>
<td>0.85 tons, 24.5Brix, pH 3.55, TA 5.4</td>
<td>0.49 tons, 25 Brix, pH 3.3, TA 8.5</td>
</tr>
<tr>
<td>Crop Sale</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Weather Summary</td>
<td>late hotspike</td>
<td>rain through May, cool</td>
<td>wet winter, dry</td>
<td>exceptional</td>
<td>dry winter, warm spring</td>
<td>warm winter, cool spring</td>
</tr>
<tr>
<td></td>
<td></td>
<td>summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray Program</td>
<td>4 sprays: Thiolux, Thiolux, Stylet, Thiolux</td>
<td>7 sprays: Kaligreen, Thiolux, Thiolux, Thiolux, Thiolux, Thiolux, Vintre</td>
<td>5 Sprays: Champ/Vintre, Kaligreen/Vintre, Thiolux, Thiolux, Thiolux, Thiolux/Manganese</td>
<td>4 sprays: Ralley/Thiolux, Ralley/Thiolux, Pristine, Thiolux</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**www.chateuhetsakais.com**

Page 11

Snapshot: January 13, 2019
2016 onwards: managing multiple varietals: In late 2014 we decided to plant a second vineyard in the upper field with vines that complement Cabernet Sauvignon for Bordeaux blends: Cabernet Franc, Petit Verdot and Merlot. The vineyard was planted in spring 2015. The next 5 year period is mostly about further improving the vineyard practices and getting a handle on keeping more useful records.

- In 2016 we updated the irrigation for the new and weaker plants, and we continued training new arms off the main trunks on Eutypa infested vines. The retraining succeeded beyond expectations as the crop rebounded after 4 years of decline from a low of 1000 lbs in 2015 to over 2400 lbs in 2016. In the Upper vineyard, we decided against dropping the second year fruit as the vines grew faster than expected. We also started to record time spent on each task in a spreadsheet. The graphic on the right shows the first result for 2016.

- In 2017-18 we focussed on retraining the new arms in the Eutypa infested plants in the lower field, and we brought the upper field on stream. The graphic above shows how the Cabernet Sauvignon yields in the lower field continued to rebound from the 2015 lows, and how the blocks in the upper field (Merlot, Cabernet Franc and Petit Verdot) started
to produce. When, in 2017, we started tracking activities for the 6 different vineyard blocks we realized that we hit a brick wall in data management with Excel and Word. So, 2016 was the last year for comparison. By 2018 we completed a rough first version of the relational database for the vineyard activities. It does not yet have a facility to show vineyard activities across multiple vintages.

### Data Management

Managing a vineyard of our size is much more based on qualitative observations than quantitative measurements. You monitor whether a plant looks and feels OK, rather than measure data and optimize results. This is a challenge for an engineering mind. We recorded our actions in word documents and tables through 2016 and experienced increasing challenges in making practical use of the records. So, in 2018 we started to track our activities in the database. It will take some years to see the benefits of this effort.

<table>
<thead>
<tr>
<th>TASK</th>
<th>2015</th>
<th>2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Field</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizing</td>
<td>40 yds mushroom compost, 4800lbs Lime, 650lbs PotassiumS, 300lbs Phosphate Bone Meal 13lbs ZinicS, 5lbs Sodium Borate</td>
<td>none</td>
</tr>
<tr>
<td>(Re)planting</td>
<td>77 Cab Sauv, 25 337 on 110R green, 52 337 on 101-14 bare-roots</td>
<td>15 Cab Sauv 337 on 110R in pots form 2015</td>
</tr>
<tr>
<td>Pruning</td>
<td>by hand, 2 passes</td>
<td>none back to trunk except Ueber Merlot weeding by hand</td>
</tr>
<tr>
<td>Tilling</td>
<td>electric, 2 pass, Vitiseal protect 3 passes</td>
<td>Vitiseal protect 2 passes gophers</td>
</tr>
<tr>
<td>Wild Life Issues</td>
<td>7-Mar yes</td>
<td>15-Mar yes</td>
</tr>
<tr>
<td>Shoot Thinning</td>
<td>4-May yes</td>
<td>16-May all lateral</td>
</tr>
<tr>
<td>Flowering (start Date)</td>
<td>all laterals</td>
<td>all laterals</td>
</tr>
<tr>
<td>Positioning, Lateral Removal</td>
<td>removed 15% arms</td>
<td>removed 10% of arms</td>
</tr>
<tr>
<td>Eutypa Control</td>
<td>15-May</td>
<td>25-May</td>
</tr>
<tr>
<td>Fruit Set (start Date)</td>
<td>removed leaves to 2nd bud yes, mostly mildew removal</td>
<td>removed leaves to 1st or 2nd bud 5% on early verasion &amp; mildew 27-34</td>
</tr>
<tr>
<td>Leaf Thinning</td>
<td>4-Aug</td>
<td>row nets</td>
</tr>
<tr>
<td>Bunch thinning</td>
<td>Brix, ICV &amp; Anthos 26-Sep</td>
<td>Brix, ICV &amp; Anthos 8-Oct</td>
</tr>
<tr>
<td>Veraison (mid Date)</td>
<td>Crew of 16 Fenyvesi, Martin, Rossi Jr., Rossi Jr., Crosby, Grant, Chilcoat, St.Pierre, Ogle, Vonderheyden, Guldi</td>
<td></td>
</tr>
<tr>
<td>Grape Thinning</td>
<td>0.49 tons, 25 Brix, pH 3.3, TA 8.5</td>
<td></td>
</tr>
<tr>
<td>Bird Defense</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Maturity Assessment</td>
<td>warm winter, cool spring</td>
<td>cooler year with heat spikes</td>
</tr>
<tr>
<td>Harvest (Date)</td>
<td>5 sprays: Kaligreen, Ralley, Vintre, Microthiol, Pristine in Jan &amp; June</td>
<td>4 sprays: Pristine, Ralley, Vintre &amp; Pristine</td>
</tr>
<tr>
<td>Harvest Crew</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop</td>
<td>0.2 tons, 25 Brix, pH 3.5, TA 6</td>
<td>none</td>
</tr>
<tr>
<td>Crop Sale</td>
<td>cooler year with heat spikes</td>
<td></td>
</tr>
<tr>
<td>Weather Summary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray Program</td>
<td>5 sprays: Kaligreen, Ralley, Vintre, Microthiol, Pristine</td>
<td>4 sprays: Pristine, Ralley, Vintre &amp; Pristine</td>
</tr>
<tr>
<td>Irrigation</td>
<td>weekly all plants</td>
<td>weak plants: weekly</td>
</tr>
</tbody>
</table>
Following are screenshots of the “REVIEW: Vineyard Actions” – layout. The first lists all the individual activities of 2018, the substances added and the manhours spent on each (note the list is longer than what the screenshot reveals). The second provides an overview of the “substances added”, the Sprays and Soil Amendments. The third shows the cumulation of manhours by vineyard block and type of activity, and the last screenshot summarizes the weather conditions.
Site Preparation

Site preparation consists of 5 steps:

- **Topography & Layout**: choosing the site and orienting the vineyard rows for optimal sun and wind exposure.
- **Ripping & Terracing**: loosening up the soils, removing old stumps and terracing the surface if necessary.
- **Soil Analysis & Amendments**: sampling and analyzing the soil to determine what fertilizers need to be added for a healthy vineyard.
- **Choice of Trellis System**: choosing a trellis system which defines the spacing of the vines and the relationship between the rooting area and the crop density.
- **Irrigation System**: Laying out the irrigation pipes, valves and drip lines.

The following paragraphs expand on these 5 steps and explain the differences between the choices made between the Lower and the Upper Fields.

### Topography & Layout

The following picture shows the two vineyard layouts projected onto a Google map.

![Vineyard Layout](image.png)

The Lower Field vineyard was planted in 1997 in 14 rows running south-west to north-east adapting to the contours of the land. The direction of the rows was dictated primarily by the
topography. The 333 plants are spaced 6 feet with rows 10.5 feet apart. The total area covered is $333 \times 6 \times 10.5 = 20,979$ sqft or 0.48 acres.

The Upper Field vineyard was planted in spring of 2015 with 16 rows running approximately north-south. The topography allowed a north-south direction of the rows with minimal terracing. The 256 plants are spaced 6’ with rows 9 feet apart. The total area covered is $256 \times 6 \times 9 = 13,824$ sqft or 0.317 acres.

The following picture shows the two vineyards in topographical maps indicating elevations.

Ripping & Terracing

Ripping is necessary to loosen up the soil 2 feet deep, remove dead tree stumps and other debris and destroy networks of old gopher tunnels. Terracing is advisable to facilitate easy access with tractors for spraying and mowing between the rows.
The Lower Field was ripped and cleaned by Ron Mosley in 1997. We terraced outside the south-west endposts later to allow easier turning after we introduced tractors for field maintenance in 2000.

We had the Upper Field ripped 2 feet with a big bulldozer by a contractor (Peter Mesa 408-438-1016). Then we terraced it with a box-scaper attached to our tractor to accommodate for the slope, particularly on the east side.

Soil Analysis & Amendments

A good starting point for soil composition in California is the online soil map by UCDavis:
http://casoilresource.lawr.ucdavis.edu/gmap/

The first step in site preparation is to take soil samples and send them to a laboratory for analysis which highlights deficiencies in nutrients. Soil analysis is done before ripping and terracing, but the amendments are added after.

For the Upper Field, we followed the excellent instructions for taking soil samples at http://www.growyoursoil.org and then submitted samples of top-soil and sub-soil to A&L Westen Laboratories (http://www.al-labs-west.com/services.php?section=Soil%20Analysis ). We took 2 samples – one a mixture of 12 topsoil locations spread around the site, the other a subsoil sample at 2.5 feet in the middle of the site. We then had the soil analysis reviewed by GrowYourSoil and by our vineyard consultant, Ron Mosley. Their recommendations were consistent and are summarized in the table.
We spread all additions evenly across the vineyard acreage during the winter rains after ripping and terracing the site.

**Lower Field**

We have no records of the original soil analysis and amendments by Ron Mosley in the Lower Field in 1997. After we ripped out 70 weak plants in autumn of 2014, we did a soil analysis in January of 2015 which indicated a very low pH, or high acidity. Following recommendations by John Beeby, we made the additions suggested during tilling in the cover crop.

### SOIL Amendment

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Organic Matter (%)</th>
<th>Nitrogen NO3-N ppm</th>
<th>Phosphorus Weak Bray ppm</th>
<th>Phosphorus NaHCO3 ppm</th>
<th>Potassium K ppm</th>
<th>Manesium Mg ppm</th>
<th>Calcium Ca ppm</th>
<th>Sodium Na ppm</th>
<th>Sulfur SO4-S ppm</th>
<th>Zinc Zn ppm</th>
<th>Manganese Mn ppm</th>
<th>Iron Fe ppm</th>
<th>Copper Cu ppm</th>
<th>Boron B ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH Vineyard Upper Field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CH Vineyard Upper Field

- **Potassium K**: ppm 72 (159-420) ideal 170-420, add 2.5lbs potassium sulfate (potassium & sulfate) 1.4 lbs/acre
- **Manesium Mg**: ppm 1592 (1267-260) ideal 260-390, add 4lbs gypsum (calcium & sulfite) 2.2 lbs/acre
- **Sodium Na**: ppm 2254 (2080-2800) ideal 2800-3200, add 4lbs gypsum (calcium & sulfate) 2.2 lbs/acre
- **Sulfur SO4-S**: ppm 5 (4-30-50) ideal 30-50, sufficient sulfate will come in through fertilizers
- **Zinc Zn**: ppm 0.3 (0.8-1.5-10) ideal 1.5-10, add 0.5oz zinc sulfate 0.25 oz
- **Manganese Mn**: ppm 2 (11-15-50) ideal 15-50, add 0.2oz manganese sulfate 0.1 oz
- **Iron Fe**: ppm 9 (18-20-40) ideal 20-40, add 0.2oz iron sulfate 0.1 oz
- **Boron B**: ppm 0.4 (0.2-1.5) ideal 1-1.5, add 0.5oz of borax 0.25 oz

### Decision

- **SubSoil** Vs TopSoil: ideal per 100sqf $4.4/50lbs bag, $288.0/42/40lbs bag
- **Grow Your Soil Recommendation**: 40 yards mushroom compost 360 lbs for area
- **Ron Mosley recommendation**: 1089 lbs/acre for area
- **Total Cost**: $240.0/area
We purchased the fertilizers from Sierra Pacific Turf Supply (www.sierrapacific turf.com) in San Jose and the compost from B&D Mushrooms in San Martin (through Gordon Hodges Trucking 1-408-888-9291).

Trellis Systems

Vines have a complex system of roots below ground and a highly crafted architecture of trunks, arms, cordons and shoots above ground. The picture on the side provides an excellent view of a carefully excavated mature vine. From http://disciplegideon.files.wordpress.com/2012/07/grapvine-roots.jpg
Above ground, the trellises hold up the vines and allow to expose the grape bunches and leaves evenly to sunshine and air movement. We use the following vocabulary (adapted from Fundamentals of Grapevine Pruning by Ed Kwiek, Feb/March 2014 Winemaker Magazine) for describing different parts of the vine:

- Trunk: a permanent, vertical stem of the vine (above ground)
- Arm: permanent horizontal extensions of the trunk connecting the trunk to the cordons
- Cordon: wood that is 2 or more years old, trained along a wire
- Cane: a mature shoot after leaf fall
- Spur: a cane that has been pruned back to 1, 2 or 3 buds (a compound bud)
- Node: location of a compound bud
- Bud: an undeveloped embryonic shoot
- Shoot: new green growth with leaves, tendrils and flower clusters developing from a bud of a cane or spur. Each shoot produces 2-3 clusters of grapes.
- Lateral: a branch of a shoot
- Sucker: a shoot growing from old wood on the trunk, arms or cordons (rather than from shoots or canes)
- Tendril: a twisting, threadlike part of the shoot which that wraps around wires and other shoots to provide support

There are many different types of trellis systems.

For the **Lower Field**, Ron Mosley chose a quadrilateral trellis system. The picture below illustrates what this means. The trunk of the vine splits into two arms each of which splits again into two cordons. Endposts delineate the end of the rows and trellises after every third plant support the guide wires. This is a complex system which has the advantage of widely spaced rows for tractors without giving up too much crop density. It only works in soils where a single root system can support a large plant. The disadvantage of quadrilateral trellises is labour intensive pruning, canopy management and netting because you can only access the fruit zone from one side of the cane curtain.
For the Upper Field, we chose a bilateral trellis system. It allows easy access to the canopy and fruit zone from both sides of the vine. This simplifies pruning and canopy management, but it bilateral systems have lower crop density if the rows are spaced widely to allow easy tractor access.
Irrigation System

**Lower Field Irrigation:** The irrigation system has 2 manually switched drip lines for the vineyard, one for the northern half, the other for the southern half. In addition, there are 2 electrically switched lines for the roses at each endpost east and west, and there are two switched lines for irrigating the border plantings south and west. In 2015 we extended the irrigation system for the roses into the vineyard rows with drip tubing, so the roots of the newly planted vines can be irrigated more frequently than the mature vines.
Upper Field Irrigation: Each row has 2 driplines: one is for surface drippers, the other for 3 feet soaker hoses buried under each plant. The root soakers can be regulated individually. The rows are divided into areas for different grape varieties (Merlot, Cabernet Sauvignon, Cabernet Franc and Petit Verdot), and each of these areas has a remote-controlled valve. At each endpost there is drip irrigation for roses; this circuit is also on a remote-controlled valve. Furthermore, there is a live line and a switched line going to the east and west borders for irrigation. The following chart shows the layout as well as the component assemblies for the vine and rose irrigation lines.

Previous page: Overview
Top of page: Go
Next page: Planting & Replanting
Last updated: December 5, 2018
Planting & Replanting

New vines are best planted in early spring, and for the first three years thereafter they are managed not for fruit production but for growing their root systems and strengthening their trunks, arms and cordons. Grapes can be harvested starting the end of the third season, but their quality is not optimal until the end of the 6th or 7th season. In the meantime and thereafter vines are lost due to diseases and destruction by animals, so a vineyard needs to be replenished with new plantings every 4-5 years. This page describes:

- How we select rootstocks and vines and what we planted and replanted first in the Lower Field, then in the Upper Field
- How we planted the vines and how we take care of them during the first 3 years.

Selecting Rootstocks & Vines

Ever since the phylloxera epidemic over a century ago, standard practice is to graft a grapevine selected for its fruit on a rootstock selected for its resistance to pests and adaptability to soil conditions. Thus we need to select combinations of a rootstock with a vine suitable to our climate, soil condition and grape variety.

- A comprehensive list of grape vines registered in the US can be found here: [http://ngr.ucdavis.edu/varietylist.cfm](http://ngr.ucdavis.edu/varietylist.cfm). UC Davis runs Foundation Plant Services ([http://fpms.ucdavis.edu/](http://fpms.ucdavis.edu/)) a service which produces, tests, maintains and distributes virus and disease tested plant material for propagation by nurseries.

The selection of grape varieties is large, but relatively few are widely used. Furthermore, the final rootstock/vine selection is often restricted by what is available at the nurseries nearby.

**Lower Field:** Ron Mosley planted 340 vines in July 1997. He, unfortunately, lost the original planting documents, so the following is from his memory as of 2013 and comparison of anthocyanin concentrations in berries in 2015.
- Some of the 7 long rows in the south west (34 plants each) were planted on "Freedom" roots with 337 cabernet clones; the other rows were planted on "4453" roots, also with 337 cabernet clones.
- The 7 short rows in the northeast (14-16 plants each) were planted on “110R” rootstock with "Dr Emmet Rixford" cabernet clones. The Rixford clones have a lineage back to La Questa, a historic vineyard in the South Bay. They trace their history back to Margaux in Bordeaux and are currently propagated by Mount Eden Vineyards.

Due to gophers, which we failed to eliminate in time, we lost around 50 vines in 2006 & 2007. The lost spots were replanted in 2009 with 50 CabSauv vines clone 337 on 4453 roots. The following graphic shows the locations.

By 2014 more vines were lost due to Eutypa, gophers and rototiller malfunctions, so we decided to initiate another significant replant in 2015 with cabernet clones 337 on 101-14 roots which we purchased (dormant bare roots) from Vintage Nurseries. When many of these bare root plantings failed due to false instructions from Vintage Nurseries we needed to replant them with new green plants of clone 337 on 110R roots.
For the 2015 replanting, we modified the irrigation system so the new vines could be irrigated automatically every week.

**Upper Field:** In spring of 2015, we planted grape varietals which complement Cabernet Sauvignon in typical Bordeaux blends. With advice from Ron Mosley and given availability at different nurseries, we settled on the following clone / rootstock combinations:

- 26 Cabernet Franc clone 214 on 101-14 roots from Mercier Groupe (dormant potted),
- 51 Petit Verdot clone 02 on 110R roots from Vintage Nurseries (dormant bare roots)
- 122 Merlot clone 15 on 101-14 roots from Vintage Nurseries (dormant bare roots), and
- 49 Merlot clone 3 on 110R roots “Ueber”-vines from Duarte Nurseries (green potted).

The green potted Merlot “Ueber”-vines from Duarte were planted in 5-gallon pots in spring 2014 and replanted in the upper field in April 2015. The bare roots were delivered in May boxed in moist sawdust.
Planting and Growing first 3 years

The original instructions from Vintage Nurseries were: “The bare root vines are warmed up to bud-swell and planted in a 14” pre-irrigated hole. The graft union is set around 4” above soil level. Then a mound of loose soil is built over the vine 1” above the tip of the vine. This mound protects the vine from drying out until the roots take hold. When green growth is showing, about 2 weeks later, the mound is removed, and a shelter tube is put over the vine for the remainder of the planting season”. Unfortunately, these instructions were wrong, 50% of the vines needed to be replaced! Vintage Nurseries provided replacements and new instructions: The bare root vines are acclimated for 2-3 weeks then soaked for 4-6 hours in water before planting. No mound of dirt is needed for summer plantings; the plants are protected with a shelter tube from the getgo.

During the first summer, new vines need moist soil, so we irrigate twice a week with 1 gallon/plant through the buried soaker hoses. Plants that struggle get another 1 gallon twice a week with a surface drip.

Data Management

Four tables in our database define and track the planting of vines:

- PlantDefinitions defines which vine-rootstock combination we use
- PlantingActions records which plant is planted or removed at a given location
- FieldLocations records on a map which location holds a particular vine at a given date
- HarvestBlockDefinition describes for each vintage how we delineate and describe harvest blocks.

The layout “ALL:PlantDefinitions” shows the field we use to describe a vine. Here are screenshots of the layout with the field names and a table listing all the records.
The layout “ALL:PlantingActions” shows the fields we use to describe planting and removal locations. We use this table also to rename the plant and the block. Note, this table has over 700 records, each describing when we planted a new vine and, if it has already been replaced, when we removed it. The second screenshot show only a part of the full tale.

The table FieldLocations shows the map of the vineyard and what exactly is planted where at given points in time. This table is also used to track fruit loads (see Winemaking section). The following screenshots show the names of the over 630 fields in the table (ALL: FieldLocations) and how the table is used to visualize the map and plantings on a particular date (REVIEW: FieldLocations)
The HarvestBlockDefinition table defines harvest blocks for each vintage. The following screenshots show the field names and, for example, the LFLR block for 2015.
Plantings and replantings are recorded as individual new entries in the PlantingActions table and in total as an entry in the VinyardActions table under the caption “Plant Management”. Here is a screenshot of “INPUT: VineyardActions” – layout for the recording of the June 2009 replantings of 50 Cabernet Sauvignon vines in the lower vineyard.

Previous page: Site Preparation
Top of page: Go
Next Page: Soil & Vineyard Floor Management
Last updated: December 8, 2018
Soil & Vineyard Floor Management

On this page we review the annual tasks (except fertilising) for maintaining the soil and vineyard floor:

- **Cover Crops** are plants, mostly grasses and legumes, that cover the vineyard floor
- **Ripping & Tilling** is about removing weeds from the vineyard floor and aerating the soil
- **Mowing** is about keeping the cover crop dense and short to see rodent activity
- **Weeding** is about removing vegetation that competes for nutrition and sunlight

**Cover Crop**

During winter we grow a cover crop on the vineyard floor, mostly perennial clover. This prevents erosion during the winter rains, replenishes the soil with nutrients (mostly nitrogen). The selection of cover crops and the practices to manage them are complicated, and I don’t yet understand them adequately. The resources section refers to a good book on the subject: “Cover Cropping in Vineyards”. We introduced cover crops around 2005 when we decided to stop spraying the vineyard floor with herbicides to control weeds (not a healthy practice).

**Tilling & Ripping**

After pruning round 1, usually late February, we till in the cover crop and weeds under each row of vines with a rotary tiller that can be manoeuvred around the vine trunks and trellis posts ([Weedbadger Model 4000-SST](https://www.weedbadger.com/products/weedbadger Model 4000-SST) attached to a John Deere [3720](https://www.johndeere.com/)). Prior to 2004, we used pre-emergents and weedkillers (Roundup) to prevent the growth of cover-crop under the wines. While this was efficient in terms
of labour, we realized it was harmful to the vines and vegetation around, so we switched to mechanical tilling.

In May we re-till under the vines with a small hand-held tiller on wheels to eliminate the remaining grasses and regrowth (we use a Stihl MM55C).

We rip the ground between the vines every 5-10 years to reduce compaction from the tractor, to aerate the soil, which helps to keep it healthy and to destroy gopher burrows. We can only rip in late spring when the soil is still moist – in summer; the soil is too hard to get the ripper to a depth of 2 feet, in winter the soil is too soft for the heavy the tractor.

**Mowing**

From January through April we mow the cover crop every 1-2 weeks between the vine rows to promote growth and to detect gopher mounds (we use a John Deere X749). There are two benefits of regular mowing: a) the cover crop grows more densely and b) when the grass is cut low you can easily identify the new gopher mounds (see Wild Life Control)
Weeding

We remove weeds under the vines. In the lower field, we do that by mechanical tilling as described above. In the upper field, we weed by hand because of the terracing. This is very labour intensive. The picture shows the upper vineyard after the rows have been tilled between the vines and the weeds have been removed under the vines (only the cover crop, clover remains).
Plant Management

On this page we describe the annual tasks tending the vines and maintaining the structure that supports them. We cover

- **Pruning**: cutting back last year’s shoots
- **Grafting**: adding new cane buds (possibly from a different varietal)
- **Trellis Management**: maintaining the structure that holds up the vines
- **Shoot Management**: managing the individual shoots
- **Cluster Thinning**: thinning out unwanted berry-clusters

We conclude this page with a note about **Data Management**.

**Pruning**

Pruning is about cutting back last year’s canes to one or two buds where new shoots are expected to grow in the current season.

Since 2014 we prune in two steps – before we pruned in one. In the first round, in February, we cut last year’s canes down to 6-inch stubs. In the second round, in March, we cut the remaining stubs leaving a 2-bud spur on nodes around 6 inches apart. In both rounds, after cutting each row, we paint all cuts with a solution of Topsin M WSB (Thiophanate-Methyl Fungicide, EPA No. 73545-16-70506) by United Phosphorus to prevent infection with Eutypa. Following the second round, we spray the entire vineyard with Rally 60W to further protect against Eutypa. In 2015 we started using a new protectant Vitiseal Safecoat (by Vitisal International LLC, [http://www.vitiseal.com/Home.html](http://www.vitiseal.com/Home.html)), which proved to be more effective than the Topsin / Rally combination; it claims to not only seal but also fight Eutypa and other wood diseases and cankers. Rain spreads the Eutypa and canker spores which infect the cutting wounds. The two steps allow starting pruning early, beginning of February, while it still rains. Infections don’t invade the wood more than 1 inch per month; thus any new infection can be safely cut off in round two in late March. The following pictures illustrate the before and after step 1 and step 2.
We learned about the hazards of Eutypa the hard way. In 2008 & 2009 we decided to prune the vines back more than before, but we did not know about the danger of Eutypa infestations when leaving large cuts exposed without protection. As a consequence practically every vine got infected. It took over 6 years to detect and cut out the bulk of the infected arms, and we lost over 50% of the fruit-bearing potential in 2010-2015 until new growth replaced what needed to be cut out. The following graphic illustrates the extent of the damage done by early 2013; it shows the percentage of Eutypa infected cordons cut out and replantings due to gopher and Eutypa damage. We continue to have to cut out infected cordons.

For pruning, we use electric pruning shears (Electrocoup F3010 by Infaco) as they make cleaner cuts and are less fatiguing than hand clippers. On completion, we chip all cut off
material into mulch for ground cover.

On completion of pruning it useful to reattach the arms to the guide-wire. I used a battery powered tying machine (A3M v2.0 by Infaco) for very loose ties of young arms in the past, but the metal wire turned out to be more harmful than useful. So now, I tie the arms with a plastic tie by hand or with one of the two tie-tools pictured on the right.

**Grafting**

Grafting is about inserting a dormant bud into a cut on a live vine during late winter / early spring. The bud is encouraged to connect and grow into a new cane by pruning off the stem of the live vine just above the inserted bud. The primary purpose of grafting is to switch the clone or varietal of the vine.
We have not done any grafting yet, so no further info.

**Trellis Management**

We deployed two different trellis systems: quadrilateral for the lower vineyard and bilateral for the upper vineyard. We started out with over-the-canopy nets deployed at veraison and removed after harvest. Because they are a pain to put on and take off, we replaced them with permanently installed side-nets in 2016-2019. The trellis also carries the irrigation hoses. So, altogether it’s a complex system of poles, wires, hosed and nets which takes a fair amount of upkeep. The maintenance is best performed after pruning when the vines are compact without shoots, and the ground is still soft.

**Shoot Management**

Shoot Management is very labour intensive and covers a multitude of tasks:

- **Shoot Thinning**: eliminating excess new shoots
- **Cane Positioning**: positioning shoots vertically between trellis wires without crossing each other
- **Lateral Removal**: removing secondary shoots which crowd the canopy
- **Leaf Thinning**: removing leaves in the fruit zone
- **Hedging**: limiting the length of shoots to 3-4 feet.

The goal of shoot management is an even and airy canopy with evenly distributed grape clusters each getting approximately the same exposure to the sun. Proper airflow limits mildew infections, uniform sun exposure helps all fruit to mature at around the same day (harvest day)

**Shoot Thinning**

Our vines have very vigorous growth due to the choice of root-stock, the climate and the fertility of the soil. The advantages are that the plants can recover well from diseases and the many
shoots provide more options for positioning; the disadvantage is that the vines need a lot of spring thinning and pruning because they produce far too many new shoots every year.

We start to shoot thinning in late April when the longest new shoots are ~ 2 feet. The goal is to eliminate all new shoots which are not positioned well or are deemed excessive for the ultimate density of grape bunches desired. We try to keep one spur with 2 canes every 8 inches. We further cut out all fruit on the small shoots which we do not expect to grow enough to ripen the fruit fully.

Thinning by hand is labour intensive and can often not be justified in commercial operations – the first round takes me about 45 hours for the lower vineyard. The following pictures show the before and after for a single vine:

![Before](image1.png) ![After](image2.png)

This is also the perfect time to inspect the vine for Eutypa or “dead-arm disease”. The symptom to look for is stunted shoot growth with small yellowing leaves. Eutypa is a fungus which attacks the wood of the vine and ultimately kills the plant. Early detection and removal of the infected wood are essential if you want to save a plant. For more detail see this webpage: http://www.extension.org/pages/31525/eutypa-dieback-or-dead-arm-of-grapes, We had a lot of Eutypa in 2009-11 after we pruned the vines too aggressively without protecting the open cuts. Whenever any cut is made we now paint the open wound with a solution of VitiSeal which not
only protects the wound (defensive) but supposedly also fights the already established fungi (offensive). The following pics show a typical progression of cutting out Eutypa

![Eutypa Symptom](image1)
![First Cut, still has Eutypa slice](image2)
![Second Cut, clean](image3)

**Cane Positioning**

Cane positioning is about putting all canes between the guide wires, so they point up vertically and do not cross each other. We usually start in early May when the shoots have reached an average length of ~2 feet. Ideally, the first round is done before bloom so that the flowers don’t get disturbed by the abrupt movements and develop successfully into berries. The purpose of cane positioning is threefold:

- first to create an airy canopy, so infections by powdery mildew are less likely, and spraying is more effective;
- second to give all bunches approximately equal exposure to sun and shade, so the grapes develop more evenly; and
- third to manage and equalize the length of each cane, again to manage balanced maturing of the grapes.

The first round of cane positioning takes me about 12 hours for the entire vineyard. We put the canes between the bottom guide wires which are then held together with C-clips.
As the canes grow, more rounds of positioning are required over the next 6 weeks to do the same with the middle and the top guide wires.

**Lateral Removal & Leaf Thinning**

Our vines have a lot of vigour which needs to be contained and channelled into producing optimal grapes. Earlier in the year, we contained growth by eliminating shoots which the vines pushed out beyond the 2 buds we pruned to grow new canes every 8 inches. Now we need to contain the growth on these canes we decided to leave standing. Unattended these canes will not only grow and carry 2-3 bunches of grapes and 10-12 leaves each to support them, but each cane will grow additional “lateral” canes at each leaf joint – and if not removed, each of these lateral canes would, in turn, grow to carry second tier bunches and leaves. So we need to pinch off all laterals at each leaf joint before they get big. Doing so opens up the canopy again for air circulation (which helps to prevent mildew), and it forces to vines to channel their energy to the primary grape clusters.

At the same time we eliminate all laterals, we continue with positioning the canes between the upper two guide-wires and we remove the first 2-3 leaves on each cane (up to and including the leaf opposite the lower bunch) to expose the grape bunches to direct sunlight which promotes tannin development and to prevent leaves getting tangled into bunches. The pictures on the right show a typical “before and after” on a single vine.

We start hedging when 50% of the canes have grown more than 2 foot beyond the top guide wire. Lateral removal is critical for effective hedging – if laterals had not been removed before, a cane which has been topped of would accelerate the growth of the laterals at each leaf node, and these laterals would grow secondary grape bunches. The consequence would be a very dense canopy with fruit of uneven maturity.

Lateral removal and leaf thinning are usually started in mid-May during full bloom. It is very labour intensive, taking me about 100 hours for the entire vineyard in two rounds. Hedging is a
continuing effort until nets are put on because smaller canes continue to grow until they pass 
the ones that have already been hedged.

**Grape & Cane Thinning**

The goal of grape thinning is to optimize the quality of grape bunches that the vines are believed 
to be capable of bringing to full maturity. The final quality depends on the current state of the 
bunches as well as on the capacity of the vines to fully mature them. The weather year to date 
defines how much crop and what quality of bunches are available now; the age of the vines and 
the arms defines what amount of grapes the vine can expect to fully mature assuming average 
weather patterns during the remainder of the year.

Our target is to harvest 1.2 tons of grapes for our own wine production and sell the remaining 
crop to a local winery. We estimate that in a great season with mature, healthy vines 
throughout, the vineyard should be able to produce about 2 tons, or 2.7 tons/acre, of high-
quality grapes. In an average year, we are happy with a harvest of 1.2 to 1.6 tons/acre. Eye-
balling the current crop load and comparing that estimate to the target significantly influences 
how aggressive we are at dropping bunches at this time.

Our general rules for dropping bunches and canes are:

1. We drop bunches which have reduced or mediocre fruit set (i.e. not well developed or 
   damaged fruit)
2. We drop all bunches on canes which are now less than 1 foot long (i.e. the cane would 
   not have the capacity to mature the fruit). We also cut out the weaker of two canes on a 
   node if either of them is less than a foot long (the idea is to focus the vine’s energy on 
   growing what is needed next year).
3. We drop all bunches except the best developed on canes which are now between 1 and 
   2 feet long (i.e. the cane would not be able to mature more than one bunch)
4. We drop all bunches except the two best developed on canes which are now over 2 feet 
   long, except for extremely strong canes which are allowed to carry a max of 3 bunches if 
   those bunches are well separated in space.
5. We cut off pronounced wings on all remaining bunches (berries on wings tend to mature 
   later rest of bunch)
Clearly, these rules have room for interpretation. The interpretation in any one year depends on how much excess fruit the season has produced to date and how much tonnage we want to drop overall.

The picture illustrates the health of the vineyard in early June 2013. It shows the average lengths of the canes for each side of each plant. Clearly the short canes are mostly on the young vines (which were replanted a few years ago due to gopher damage) or on the new arms (which grew to replace the Eutypa cut-outs).

Cluster Thinning

At Veraison the grape berries turn from green to purple-blue as the chlorophyll is replaced with anthocyanins. This turning of colour provides an excellent opportunity to compare the maturity of the grapes across the vineyard. Ideally, veraison should happen for all grapes at the same time, but it does not – some turn colour early, others turn colour late. Because we will pick the matured grapes all at the same time, we end up picking grapes at different levels of maturity. To narrow the range of final maturity at picking time, it is advisable to drop the first 5-10% of bunches that have turned colour and, a couple of weeks later, drop the last 5-10% of bunches.
which are still green. Doing so should narrow the range of grape maturity left on the vine. This assumes that the early birds would not slow down their development and the late bloomers would not accelerate their maturing and catch up.

The following graphics show the progression of veraison in the vineyard from July 21 to August 4, 2013. On July 20 only 1% of berries show blue colouring. By July 26 that percentage increased to 20%. By July 30 60% of berries have turned and by August 4 the level of veraison has reached 86% on average.

Note, the development is uneven: the short rows and the east side of row 1 lag behind in development about 5 days. One potential remedy for next year is to start pruning the short rows first, before long rows (in 2013 we pruned from south to north).

The graphic on the right shows how veraison progressed in 2013. The mid-point at 50% veraison happened around July 29.
With veraison 90% complete, we start cutting out the remaining green grapes – green thinning so as get more even maturity for the remaining grapes at harvest time. The general rule is to cut out all bunches which at this point show no sign of veraison. The following graphic shows the crop load on each vine after grape thinning. The loads are graded 0 (for no grapes on the vine) to 8 (full grape load).

Interesting article on crop thinning and overcropping:

Data Management

All plant management tasks are recorded in the database through the “INPUT: VineyardActions” layout. Other than the date of the activity and the time it took to complete, we record no data except occasional commentaries. These tasks do not lend themselves to a lot of measurements. Here is a screenshot of the layout recording cluster thinning for August 20, 2018, in the short rows of the lower vineyard. Upon entry, the layout shows aggregate manhours spent on the vineyard blocks and for the task type.
Previous page: Soil & Vineyard Floor Management
Top of page: Go
Next Page: Nutrition Management
Last updated: December 28, 2018
Nutrition Management

This page describes how we manage vine nutrition. It is divided into six sections:

- **Irrigation System Management** deals with annual maintenance and ongoing adoption of new technologies
- **Irrigation** describes when we irrigate and how
- **Identifying Nutrition Requirements** deals with measuring the available nutrients in the ground and in the vines.
- **Soil Amendment** deals with dispersing nutrients to the soil
- **Foliar Sprays** describes how we spray nutrients directly on the plant leaves
- **Data Management** describes what we record and report on

The following link leads to a good general presentation on grapevine nutrition:
http://www.uvm.edu/~fruit/grapes/gr_horticulture/GrapevineNutrition.pdf. Our past and current approach to nutrition management is still very dilettante. We irrigate when the plants look stressed. We send soil and plant samples to third-party laboratories to test for nutrition deficiencies, but we are not yet confident how to interpret the results and take corrective action. We amend the soil with fertilizers, and we spray nutrients onto the leaves based on recommendations from consultants and experienced vineyard managers.

### Irrigation System Management

Irrigation systems are complex and fragile. They require a fair amount of upkeep because of earth movements and erosion, interference from animals, general wear and tear and evolving technologies. There is a never-ending effort to use less water and be more efficient. In our region, the bulk of the necessary water comes from the rain in the winter and is stored in the clay soils. Our long-term goal is to supply each vine with the estimated amount of water it needs without wasting any in evaporation from the vineyard floor or underground drainage. As each plant sits in slightly different soils, has different exposure to sun and wind and varies in size and maturity – the ideal solution is to measure each plant’s requirement in near real-time and regulate the supply accordingly. This is not yet economically feasible but should be achieved within the next 10 years at an investment of less than $10 per vine. In the meantime, we estimate the demand and regulate the supply manually by vineyard block.
Irrigation

As a general rule, mature vineyards need little irrigation. The vines’ root system should reach deep enough to get to the required moisture. Excess irrigation of mature vineyards prevents the roots from growing deep and makes the grapes watery. Irrigation is needed for the first 3 years after planting to help the young vines with shallow roots survive the summer heat – that is the principal reason for the drip irrigation system built into the trellis.

There are four exceptions to the rule:

1. We irrigate the vineyard thoroughly once right after harvest when the vines have been stressed by the summer heat and now need to start focusing on growing the roots.

2. We irrigate the vineyard a few days before extreme heat-waves when temperatures are expected to exceed 95 F for more than a day. This assumes we get good weather forecasts and can supply the plant ahead of time with extra water reserve. This happens a few times a year.

3. We irrigate the vineyard in the final days of berry maturation when we detect an imbalance between sugar levels and phenolic maturity of the grapes. In unusually warm years the sugars accumulate faster, and the maturity of the skins and seeds may lag behind. In this instance, intermittent irrigation during the last weeks before picking allows to grapes to mature fully and prevents premature shrivelling and keeps the sugar levels in check.

4. We irrigate new replacement vines for the first 3 years every 1-2 weeks. This has to be done plant by plant. We used to use 5-gallon buckets which have a 1/16th-inch hole at the bottom, so they release water only very slowly. The buckets were placed next to each young vine and manually filled by a hose. The picture shows the setup. Since it is time-consuming to refill the buckets by hose every week, we added a second irrigation line controlled to only provide water to the new plants. That line is on a timer for automatic irrigation.
Identifying Nutrition Requirements

There are three basic approaches to understanding whether plants need nutrition supplements:

- Visual inspection: looking for visual clues signalling nutritional deficiencies or excesses.
- Soil Testing: measuring the availability of nutrients in the soil
- Petiole testing: measuring the nutrients taken up from the soil and stored in the plant

Experienced farmers and vineyard managers can look at a plant and identify nutritional deficiencies. Typical clues are the abnormal colouration of leaves or stunted growth.

Every 3 years or so, we test the soils for their nutrient and trace metals. We take about a dozen soil samples 3 to 12 inches from the surface in each block and mail them to a testing laboratory. Testing laboratories provide good instructions on how to take the samples and how to send them in. A week later we get the results by email. Following is a typical soil test report.
Testing soils is easy, interpreting the results and taking appropriate action is far more difficult. Each soil type has vastly different characteristics for water and chemical extraction. The challenge is to understand how the plant’s roots interact with which types of soil under different humidity and temperature conditions. Furthermore, the soil characteristics can vary greatly even over short distances. To complicate things even further, fertilizers take the better part of a season to sink into the ground and distribute, and the plants take another year or two to extract and react fully.

We have used an excellent consultant (http://www.growyoursoil.org) to interpret soil tests prior to planting when we added significant amounts of soil amendments to pastures (see Soil Analysis & Amendments on the Site Preparation page).
The difficulties in interpreting soil analysis results and correcting with fertilizers have led to an alternative approach: analyse the plant tissues instead. We collect around 50 petioles (stems of leaves) from plants in each block and mail them to a testing laboratory. Following is a sample of a resulting plant analysis report.

We then correct the shortages of nutrients in the tissue by spraying chemicals directly onto the leaves — not a very natural remedy, but quicker and more effective. For the primary nutrients (Nitrogen, Phosphorus and Potassium), foliar sprays are only a band-aid, for micronutrients (iron, zinc, boron, manganese) they are preferred application method.
Soil Amendments & Fertilizers

The primary nutrients (N, P and K) can be sourced from inorganic (usually mined) or organic materials (collected on farms). Inorganic materials such as gypsum (Calcium Sulfate), or lime (Calcium Oxide) release the nutrients faster than organic materials such as compost or manure. So, the challenge is not only to understand how much of which component needs to be added but also how long does it take until that component can be absorbed by plants at what growth stage before it is washed away, evaporates or disappears otherwise. Note, excessive addition of Nitrogen ends up in the groundwater and is a significant source of pollution (see https://www.cdfa.ca.gov/Is/ffldr/frep/pdfs/GrapeBrochureWeb.pdf for a good summary on nitrogen application in vineyards). Another good source of general information is the International Plant Nutrition Institute (http://www.ipni.net/). The best summaries of fertilizers and soil amendments I have come across are from the University of Maryland https://extension.umd.edu/sites/extension.umd.edu/files/_images/programs/hgic/Publications/HG42_Soil_Amendments_and_Fertilizers.pdf and the Colorado State University: http://extension.colostate.edu/topic-areas/yard-garden/choosing-a-soil-amendment/.

We don't yet have a solid program for applying fertilizers and soil amendments. Instead, we rely on recommendations from consultants following soil tests or from experienced vineyard managers on an ad-hoc basis. Following is a list of what we have used in the past:

- YaraVera Urea (46-0-0)
- Mini-prilled Calcium Sulfate from Art Wilson
- Mono-Ammonium Sulfate from Simplot (11-52-0)
- Greenbelt Fertilizer from Romeo (25-14-14)
- Potassium Sulfate from Yara (0-0-50)
- Rapid release limestone from ArtWilson
- Maximo 360 Zinc Sulfate
- Ferreous Sulfate from EcoFusion
- SuperIron 11% from Simplot
- Sodium Borate / Solubor from US Borax
- Manganese from PrinceMinerals
- Bonemeal from Kellog Garden
- Mushroom compost from a nearby mushroom farm
• Horse manure from a nearby farm
• Hydroprill 20-20-20. On the day after harvest, we put one spoonful of Hydroprill under each dripper and irrigate for 4 hours (recommendation by Rick Berg)

Clearly, there is much room for improvement.

**Foliar Sprays**

With foliar sprays, we apply nutrients directly to the leaves. Most of the time, foliar sprays are combined with Pesticide Sprays (see next page). We currently use:

• Eleanor’s VF-11 (Nitrogen 0.15%, Phosphate 0.85%, Soluble Potash 0.55%): general plant food for foliar feeding.
• LIG-Calcium+B: Calcium Lignosulfate: Foliar Nutrient to add Calcium & Boron. to promote flowering and even fruit set , increases fungal resistance.
• LIG-Trace: Complexed Lignosulfate: Foliar Nutrient to add trace elements to sulphate-based sprays

**Data Management**

There are 5 data management tables and related layouts covering nutrition management

• NutrientTest is used to record results from soil tests and foliar tests as well as recommendations for soil enhancement based on the test results
• SoilAmendments contains the descriptions of soil amendments that are currently in inventory and used
• FoliarNutrients contains the descriptions of foliar sprays currently in inventory and used
• The REVIEW: NutrientTests”-layout shows the results from soil and foliar tests over time for a given Harvest Block.
• The “INPUT: VineyardActions “-layout is used to record nutrition management tasks

The “ALL: NutrientTests” layout can be used to input results from foliar tests. The screenshots shows the results from a foliar test on Nov 10, 2014 in the Me2 block
The REVIEW: Nutrient Tests layout summarizes the results of soil and foliar tests over time for a given Harvest Block (not yet completely designed)
The ALL: VineyardActions layout is used to record the addition of a soil amendment. This screenshot shows the addition of 1,400 lbs of mushroom compost to the LFLR block in April 2018.
Pest Management

This page describes how we contain pests, i.e. protect from and eradicate diseases, and protect from animals which tend to damage grape vines. The best starting point for any farmer in California is the website managed by the University of California on Integrated Pest Management. Here is the link to the section covering grape vines: http://ipm.ucanr.edu/PMG/selectnewpest.grapes.html. Other valuable websites are:

- The listing of other Pest Management Websites: http://ipm.ucanr.edu/GENERAL/links.html
- The U.S. National Pesticide Information Center: http://npic.orst.edu/NPRO/
- The California Dept of Pesticide Regulation: https://www.cdpr.ca.gov/docs/label/labelque.htm
- The OMRI database of organic products: https://www.omri.org/omri-lists

In addition, the TTU Vineyard Advisor application from the Texas Tech University is a handy tool for mobile devices. It can be downloaded free from the Apple Store or the Google Play store.

Because there is so much good and well-organized information about pest management readily available on the web, we concentrate here on the practical aspects and what we do about:

- Pesticide Sprays: what we spray, how
- Animal Control: how we keep damaging vertebrates out of the vineyard.
- Netting: how we protect the maturing grapes from birds and yellow jackets
- Data Management: how we record what we do

Pesticide Spray

In the beginning, we used to spray with a manually operated back sprayer, then we switched to a tank with a pump and long hose, and finally, we graduated to a Gearmore Venturi Air sprayer (http://www.gearmore.com/gearmore/orderportal/catalog_presentation/by_group/0/163/0/0/0/0/0/0 ) attached to a tractor. In the process, we cut down application times from 5 hours to 1/.2 hour!
The application of pesticides is strictly controlled in California and subject to a license from the Department of Food & Agriculture. We apply annually as a Private Applicator for an Operator Identification Number, and we submit a monthly Agricultural Pesticide Use Report to the Agricultural Commissioner within 10 days of the month following application. The license is required to purchase pesticides.

The best use of pesticides is as a preventative; once a disease has infected a vineyard, only eradicants can help, and they tend to be less wholesome. Prevention is like paying insurance premiums if you don’t get hit by a disease you never know whether you actually needed it. In the beginning, the early 2000s, we sprayed aggressively; then we relaxed and got hit by mildew and canker diseases. So now, we are more diligent and spray following an annual program, keep better records and when possible, use organic products.

The table on the right (from the IPM website [http://ipm.ucanr.edu/PMG/r302902111.html# EFFICACYCONV](http://ipm.ucanr.edu/PMG/r302902111.html# EFFICACYCONV)) shows the suggested timing of pesticide applications for the prevention of specific diseases depending on the development state of the vine. We are mostly concerned with Powdery Mildew, Dead Arm and...
Eutypa Dieback. The following two tables (from the same website) show the efficacy of different commercially available pesticides against different diseases

<table>
<thead>
<tr>
<th>Pesticide Name</th>
<th>Tannin</th>
<th>Eutypa</th>
<th>Botrytis</th>
<th>Powdery Mildew</th>
<th>Gray Mold</th>
<th>Black Rot</th>
<th>Gray Mold</th>
<th>Powdery Mildew</th>
<th>Eutypa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product A</td>
<td>85%</td>
<td>70%</td>
<td>60%</td>
<td>50%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Product B</td>
<td>90%</td>
<td>80%</td>
<td>70%</td>
<td>60%</td>
<td>50%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
</tr>
<tr>
<td>Product C</td>
<td>95%</td>
<td>90%</td>
<td>80%</td>
<td>70%</td>
<td>60%</td>
<td>50%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
</tr>
<tr>
<td>Product D</td>
<td>80%</td>
<td>70%</td>
<td>60%</td>
<td>50%</td>
<td>40%</td>
<td>30%</td>
<td>20%</td>
<td>10%</td>
<td>5%</td>
</tr>
</tbody>
</table>

Our spray program is still evolving as we only started to rationalize our approach in late 2018; before, we sprayed by the seats of our pants more or less following external advice or reacting to infestations.

Our current guidelines are:

- Start with a dormant spray in late February before Bud Break and follow up with subsequent sprays every 2 to 3 weeks through veraison
- Prefer natural/biological products over chemical products (see tables above)
- Alternate among products with different modes of action (FRAC#) to reduce the chance of buildup of natural resistance (see table below)
- Follow best practices for protecting bees (see [http://ipm.ucanr.edu/mitigation/protect_bees.html](http://ipm.ucanr.edu/mitigation/protect_bees.html)) and consider bee precaution pesticide ratings (https://www2.ipm.ucanr.edu/beeprecaution/)
- Adjust suggested spray volumes per acre to the size of the canopy in each block (as measured by curtain-feet)
- Enhance efficiency of application with adjuvants where recommended (Adjuvant is a broad term describing any additive to a spray tank that enhances pesticide activity.)
Examples of adjuvants are surfactants, spreader stickers, crop oils, anti-foaming materials, buffering agents, and compatibility agents.

- Combine Pesticide spray with Nutrient/Foliar spray when required
- Establish a baseline “Spray Program” each winter and adjust it according to weather conditions and field observation during the season.

The following screenshot of the website http://ipm.ucanr.edu/PMG/r302900211.html shows the general properties of fungicides used in grapes

<table>
<thead>
<tr>
<th>Systemic (Groups)</th>
<th>Check-in class</th>
<th>Activity</th>
<th>Mode of action</th>
<th>FRAC Group No.</th>
<th>Resistance controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjuvants (Groups)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surfactants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spreaders</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop oils</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anti-foaming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffering agents</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compatibility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Combine Pesticide spray with Nutrient/Foliar spray when required
- Establish a baseline “Spray Program” each winter and adjust it according to weather conditions and field observation during the season.

The Spray Program for 2018 is described in the Data Management section below.

In the past, we rotated through the following pesticides to prevent a range of diseases and a buildup of resilience (i.e. different FRAC numbers).

- **Champ** by Agtrol, US94.023.04. Copper hydroxide flowable agricultural fungicide to prevent powdery & downy mildew. 1-2.5 pts/acre
- **Thiolux** by Syngenta EPA Reg. No 100-1138. Dry flowable micronized sulfur to control powdery mildew and but-l, blister- & red spider-mite.
- **Microthiol** by United Phosphorus EPA Reg No 70508-187. Micronized wettable sulfur to control blister, bud & red spider mites, phomopsis and powdery mildew 3-10 lbs/acre
• **Rally** 40WSP by Dow AgroSciences, EPA Reg no. 46719-410pp. Myclobutanil soluble powder used to prevent antinacnose, black rot and powdery mildew.

• **Rubigan** EC by Dow AgroSciences, EPA Reg No 62719-134. Systemic fungicide to control powdery mildew.

• **Pristine** by BASF, EPA No. 7969-199. Fungicide to target angular leaf spot, anthracnose, black & ripe rot, downey & powdery mildew, leaf blight and phomopsis.

• **Stylet-Oil** by JMS FlowerFarms, EPA Reg No.65564-1. Paraffin oil for control of fungal diseases, aphid-transmitted plant viruses and phytophagous insects and mites.

• **Kaligreen** by Otsuka Agritechno, EPA Reg No.70231-1. Potassium Bicarbonate soluble powder used as a curative contact fungicide for control of powdery mildew.

• **Topsin M WSB**, by United Phosphorus, EPA Reg 73545-16-70506. Thiophanate-Methyl Fungicide for control of Botrytis and Eutypa.

• At times we add the following surfactants (except with Kaligreen and Stylet Oil):
  - **No Foam B** by Creative Marketing Research, CA Reg No. 1070775-50008-AA. Surfactant blend to act as spreader-activator & buffer.
  - **Vintre** by Oro Agri, CA Reg. No. 72662-50004-AA, a surfactant to improve distribution and efficacy of miticides & fungicides.

### Animal Control

Wildlife is adorable, but it can interfere with agriculture. We are concerned with the following vertebrate pests:

• **Deer** eat the foliage of vines and thus kill the plants top down. They are protected in our area (i.e. illegal to shoot). Thus the only solution is to keep them away with a 10-foot fence surrounding the property

• **Gophers** eat the roots, particularly of young vines and are thus particularly harmful in new plantings – they kill the vines bottom up. They are hard to detect because they live underground in extensive burrow systems

• **Ground Squirrels** can damage vines by eating the bark of established vines, and they dig extensive burrow systems, particularly at the perimeter of vineyards. They also expand abandoned gopher holes

• **Rabbits** eat the foliage of young vines but given their reach are only harmful in very young plantings. Their burrows, however, can be destructive.

• **Wild Turkeys** have recently been introduced in our area to add more diversity to the wildlife. They can be very destructive due to their size; they disrupt the ground cover and damage the canopy.

• **Yellow Jackets** have become a recent nuisance. They slice open maturing berries and suck out the sweet juice.
• **Birds** eat the almost ripe berries before they are ready to pick and thus must be kept away late in the season.

There are other animals (voles, wild pigs etc.) which can do significant harm but they are less prevalent in our area. Of course, there is also highly beneficial wildlife, just to mention bees for pollination and owls which eat gophers.

The following paragraphs explain how we dealt and continued to deal with each of the 7 pests mentioned above. Note, certain vineyard practices mentioned earlier (like planting roses at row ends for early detection of mildew and planting cover-crops for soil maintenance) attract these pests; there is clearly a complex interplay between different practices.

**Deer**

Deer presented a significant problem during the early years until we secured the property by a 10-foot fence and discouraged them from revisiting their old habitat by crashing through the fence.

**Gophers**

Gophers continue to be our biggest constant challenge as surrounding fields are their natural habitat, and they cannot be fenced out. They are hard to detect and harmful because they live underground and eat the roots of living plants. Not knowing this at first we lost about 15% of all vines to gophers and needed to replant with new ones. Gophers signal where they are by leaving mounds at the end of their underground tunnels when they surface at night. To notice the mounds easily and fast it is essential to keep the ground finely tilled or evenly moved. We also planted roses at the end of each vineyard row, because of gophers like their roots even more than roots of vines. In spring we survey the vineyard every morning for new mounds, starting around the roses. When we find a mound, we try to kill them with one of the following methods.
**Traps:** Cinch Traps are the easiest and least time-consuming to deploy. Just load the trap and stick it into the hole after the mound has been swept aside. Best to do this in the early morning. This website sells traps and explains how to deploy them: http://www.gopherslimited.com/index.html.

**CO2 gassing:** Sometimes the Gophers get smart and dig around the cinch traps. When that happens repeatedly we escalate to CO2 gassing, i.e. we attach a hose to the exhaust pipe of the tractor and feed CO2 into the tunnel for 15 minutes. The problem with this method is there is no immediately visible proof of success.

**Detonation:** when neither cinch traps nor gassing works we escalate as a last resort to blowing up the gopher tunnels with a Varmit Getter Original. The contraption mixes propane with oxygen and injects a small amount of the mixture into the gopher tunnel and then ignites the tunnel remotely.
We catch 50-100 gophers each season; that is after our feral barn cats had their go. It is essential to keep the gopher population under control; otherwise they dig extensive tunnel systems and become harder to catch before they eat the roots of the vines.

**Ground Squirrels**

Live in nearby woods and have become a nuisance because the expand abandoned gopher burrow systems at the periphery of the vineyard. They are not a protected species, and we have been successful by spreading lethal bait around their holes (Tomcat, PCQ Ground Squirrel Bait, made by Bell Laboratories, Madison, WI). An alternative is to catch the squirrels in above ground cages; this website sells a good cage: [http://www.gopherslimited.com/index.html](http://www.gopherslimited.com/index.html)

**Rabbits**

Rabbits invade the vineyard from surrounding fields. They are less of a problem for vines than they are for rose bushes (which help in detection of mildew). We have not been very successful in trapping them, so we tend to fumigate their nest at the periphery of the vineyard with CO2 from the tractors.
Turkeys

Turkeys have become a pest only since 2018 after the government decided to repopulate our area with them to enhance wildlife. They now appear in spring in large flocks (often 20+) and stay through autumn, before the hunting season. Because of their size and lack of familiarity with vineyards they can be very destructive to trellises and fences – they also pick maturing grapes right through the nets. We have not yet found a legal way to get rid of them.

Yellow Jackets

Wasps, and particularly Yellow Jackets, have become an increasing nuisance. They are attracted by the high sugar content during the final maturation period and slice the grape skins. While bees help in the pollination, Yellow Jackets don’t and provide no benefits in the vineyard. The best way to keep them away is to use tightly woven nets.

Birds

Birds represent a significant challenge shortly before harvest – they devour grapes after veraison when their sugar content rises. We are located in an area with a wide range of trees and bushes attracting lots of birds of all kind. The following section on Netting explains how we prevent them from eating the fruit.

Netting

Birds will start eating grapes as soon as they turn colour. The most effective way to prevent the birds eating the crop is to put a net over all the vines. Unfortunately, the nets would make grape thinning towards the end of veraison very difficult. So, we need to delay netting until grape thinning is completed and still keep the birds away. This, we accomplish by installing a device which produces bird distress calls – effectively fooling the birds into believing that their brethren in the vineyard are in distress and it's better to stay away. We use a BirdBard Pro Plus Combo purchased from JWB Marketing (see suppliers). It’s a unit which generates distress calls of selected bird species electronically and disperses the sound over two loudspeakers on top of a
high pole. The unit is powered by a car battery which in turn is trickle-fed by a solar panel on top of the pole. We initially thought this would be enough of a bird deterrent eliminating the need for netting. Unfortunately, the birds learn that they are being fooled, and when the vineyard is in an area with a dense bird population – like where we are – their learning curve is fast, and the fake distress calls cease to be effective after 2 weeks. This is still long enough to wait with netting until the veraison is complete.

We used woven nylon netting Bare-Hand Flex Bird Nets from Plantra, Inc (651) 686-6688 which is 17 feet wide and comes in 1250 foot rolls. The nets are cut to the lengths of the vineyard rows and stored during the year in plastic containers.

Right after grape thinning, the nets are draped over the top of the dual canopies with a netting applicator attached to the back of a tractor. Then the nets are closed under the vines with two detachable wires hooked to the trellising trunks and held together with hog clips. The nets are held away from the top of the trellising structures by metal tubes in the form of walking sticks.

Right before picking, the detachable closing wires are dropped to the vineyard floor, and the nets are flipped on each side over the top of the canopy to provide access to the grapes. After picking the nets are removed by reversing the application process – i.e. by pulling the nets off the canopy with the help of the netting applicator. Net application and net removal take around 5 hours each for 3 people: one person driving the tractor, one person in the netting applicator and one person on the opposite side of the row.

In 2016 we started replacing the seasonal draped-over-the-top nets described above with permanently installed side-nets (Permanets from SpecTrellising https://www.spectrellising.com/). These nets are more expensive and tedious to install at the outset, particularly on quadrilateral cordons. But they have significant advantages:
They take only minutes to put up or take down (vs hours with traditional nets)
They are expected to last longer (10 years vs 3-5 years)
They have a finer mesh which not only keeps birds out but also wasps
They can easily be removed temporarily to take grape samples in the final weeks of maturation.

The following graphic illustrates the switch from Over-the-top Nets to Side Nets.

![Switch from Over-the-top Nets to Side Nets](image)

Time will tell how long they last and whether they are worth the installation effort.

### Data Management

Data management for pest control involves the following tables and layouts:

- **Pesticides** holds the descriptions of the pesticides currently in use and inventory
- **Adjuvants** holds the descriptions of the surfactants currently in use and inventory
- **SprayProgramEntry** holds the contemplated entries for pesticide, adjuvant and foliar sprays planned for the upcoming growing season
- **REVIEW: SprayProgram** shows the summary of all SprayProgramEntry records for the upper and lower fields in a season
- **VineyardActions** is used to enter pest management activities
The screenshot on the right shows the “ALL: Pesticides”-layout for the pesticide Rubigan EC. The table holds information generally found on the product label. Note, we convert the standard dosage, usually given in lbs/acre, into g/curtain foot, assuming a standard vineyard has 6000 feet of canopy per acre. Our lower vineyard with the quadrilateral trellis has 8,300 feet of curtain, or canopy, per acre. Our upper vineyard with the bilateral trellis has 4,800 feet of curtain per acre. In our view, curtain feet are a better measure for the amount of vegetation to be protected than acreage. Further note that the table also contains the critical FRAC numbers and directions for spray applications.

The next screenshot shows the “ALL: Adjuvants”-layout for Vintre, a surfactant used in combination with pesticides and nutrient sprays. Surfactants improve the effectiveness of sprays by breaking down the surface tension in the spray droplets and thus improving the contact and adherence to the leaves. The dosage is given in grams per gallon of spray volume.

At the beginning of each season, we set up spray plan, specifying when which pesticide, adjuvant and foliar spray will likely be used and in what amount. Entries to this spray program are made in the “ALL: SprayProgramEntry”-layout which has a record for each spray action in the lower field and the upper field respectively. This screenshot shows the record for spraying a combination of Microthiol and LIG-Calcium in the upper field on April 28, 2018.
The following screenshot of the layout “REVIEW: Spray Program” shows how we combined pesticide, surfactants and foliar sprays in 2018. Each line in the tables represents one Spray Program Entry.

All Pest Management actions are recorded in the “ALL: VineyardActions”-layout. The following screenshot shows the Microthiol + LIG-Trace application on May 23, 2018. We sprayed 800 g of Microthiol and 600g of LIG-Trace with 27 gallons of purified water in the upper field.
Weather Monitoring

We monitor key weather variables (temperature, humidity, rainfall) in the vineyard for 4 purposes:

1. To estimate the anticipated picking date early in the season in order to plan and schedule picking. This is done by tracking temperature in hourly intervals and calculating / graphing Growing Degree Days
2. To estimate the vulnerability of the vines to diseases, particularly mildew in order to schedule spraying with fungicides. This is done by tracking a Mildew Pressure Indicator derived from temperature and humidity.
3. To evaluate the need for irrigation.
4. To provide a narrative for the weather at the end of the year to characterize the grapes and resulting wine

We started collecting weather data consistently only in late 2012. For this, we use a Vantage Pro2 weather-station from Davis (http://www.davisnet.com/weather/products/weather_product.asp?pnum=06152) to collect rain, temperature and humidity data.

Growing Degree Days

Growing Degree Days (GDD) measure the warmth plants have been exposed to over a season. The assumption is that grapes develop commensurate with the temperature multiplied by the time they are exposed to that temperature. The temperature needs to be above 55°F to start counting and is maxed out at 95°F. In simple terms, 1 GDD is accumulated when a plant is exposed to 58 °F for 8 hours (i.e. 58-55) * 1/3rd day). To calculate GDDs with reasonable accuracy, we need long histories of consistent hourly temperature readings and compute the sum of Growing Degree Hours divided by 24. Reliable data is available free at the National Oceanic & Atmospheric Administration (NOAA)’s website http://www.nc°C.noaa.gov/. For temperature data go to http://gis.nc°C.noaa.gov/map/viewer/#app=cdo&cfg=cdo&theme=temp&layers=1, select a location and download the data for the required time period.
Why then do we need our own weather station?

Long, high-quality time series of climate data is generally collected at airports only. We downloaded hourly data for the nearest airport (San Jose Airport, SJA) for 12 years and then computed the Cumulative GDDs. The graph on the left shows the result. The little red squares indicate the dates each year when we picked them. Note, at San Jose Airport, approx. 15 miles away, CGDDs reach somewhere between 2000 and 2400 by the time we pick at Chateau Hetsakais. If the San Jose Airport CGDDs measured ripeness accurately, then all red squares should theoretically lie on a horizontal line. To look at this more closely, we computed the difference of each year’s CGDD curve with the average of all 12 years. The result is shown in the graph in the middle.

Again, the red squares should lie on a steeply sloping line, because we would expect to have picked earlier in relatively warmer years and later in relatively cooler years. But it does not look like we did. There could be 3 different reasons for this “disconnect”: Either the GDD theory is not valid (I doubt it), or we did not pick at the same level of ripeness each year (possible), or the weather is different at SJ Airport when compared to our vineyard (probable).

To test the latter we checked the correlation of average daily daytime and nighttime temperatures between San Jose Airport and temperatures collected at our vineyard (only available for 2013. This graph on the right shows the result. Clearly, the relationship is not very tight with linear regressions showing R-Squares of less than 0.95. My conclusion is that we cannot rely on historical data collected at San Jose Airport. Instead, we need to collect our own data history. This is why we need our own weather station.
Data Management

We purchased a Vantage Pro2 weather-station from Davis and collected our own hourly weather data since mid-2012.

At this juncture, we only track and analyze hourly temperature and humidity data. In the future, we plan to collect and analyze a wider range of data, including humidity, rainfall, UV intensity, etc. From the hourly data we compute:

- Average temperature between 9am & 9 pm (day-time)
- Average temperature between 9pm & 9am (night-time)
- Average humidity between 9am & 9 pm (day-time)
- Average humidity between 9pm & 9am (night-time)
- Highest and Lowest temperatures for the day
- Cumulative Growing Degree Days with 55dF and 95dF cutoff points
- Average data for 2012 through 2017 for every day of the year
- 7-day moving averages of all the above

Then we enter this data into the “WeatherData” table of the database. On the right is a screenshot of the day’s data for August 6, 2018. The following screenshot of the “Weather”-tab in the “REVIEW: VineyardActions”-layout illustrates how we use the weather data to summarize weather conditions during the growing season.
Previous page: Pest Management
Top of this page: Go
Next Page: Winery OVERVIEW
Last updated: January 2, 2019