Choosing a training system

• Performance (Yield)
• Quality (Fruit Chemistry)
  – UMN cultivars: Manage Acidity
• Cost: Time and Money
  – Labor
Vines in a ‘Box’

Tools
- Vine Spacing
- Training system
- Irrigation
- Nutrition
- Canopy Management
  - Shoot thinning
  - Leaf removal
  - Hedging
- Crop Management
  - Pruning severity
  - Cluster Thinning

- Space
- Vigor
- Shoot density
- Shading
Vine Capacity and Vigor

- Soil depth, texture
- Water Holding Capacity
- Organic matter/Fertility

Vigor
  = Rate of shoot growth

Vine Capacity
  = Sustainable cropping level

Crop Load
  = Ratio of exposed leaf area to crop
Annual Growing Costs/Acre

Total = $3,610
Variable = $2,210

Source: Gerald White ‘Cost of Establishment of V. vinifera in Finger Lakes 2010’
Labor Hours /Acre

Total = 93

Canopy Management
• Shoot thinning
• Shoot positioning
• Cluster thinning
• Leaf removal (mech)
• Summer hedging

Harvest not included
• Machine = 240/acre
Annual Growing Costs/Acre

Source: Gerald White ‘Cost of Establishment of *V. vinifera* in Finger Lakes 2010’
Shoot thinning Costs

**TIME**
- 15 sec/vine
- 6x9 spacing = 806 vines/acre
- 202 min/acre = 3.35 hours/acre
- X $12/hour = $40.20

**CROP**
- Cabernet Franc @ $1500/T
- 0.5 T/acre removed
- $750 lower receipts

Need: $790.38/acre more in ‘quality’
Training Systems Trials
Marquette and Frontenac

**Vertical Shoot Positioning (VSP):**
- Midwire cordon with catch wires
- Shoot position, shoot tip, leaf removal
- *Intensive canopy management.*

**Top Wire Cordon (TWC):**
- High cordon
- ‘shoot combing’
- *Moderate canopy management.*

**Umbrella Kniffen (UK):**
- 3-4 long canes arched and tied to middle wire.
- No additional canopy management
- *Minimal canopy management.*
Training Systems Trials
Marquette and Frontenac 2013

June 15

May 27

August 17
Shoot Combing
Frontenac Top Wire Cordon 8/17/2013
## Marquette 2013
### Yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (T/A)</th>
<th>Yield (lb/vine)</th>
<th>Clusters Per Vine</th>
<th>Cluster wt. (g)</th>
<th>Berries per cluster</th>
<th>Berry wt. (g)</th>
<th>Adj. # of shoots</th>
<th>Yield (g) per shoot (adj)</th>
<th>Clusters Per shoot (adj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWC</td>
<td>4.3 b</td>
<td>13.8</td>
<td>83.5 b</td>
<td>76.6 a</td>
<td>63.2 a</td>
<td>1.21 ab</td>
<td>36.9 b</td>
<td>178.1 a</td>
<td>2.3 a</td>
</tr>
<tr>
<td>VSP</td>
<td>2.3 c</td>
<td>7.4</td>
<td>69.4 c</td>
<td>49.2 b</td>
<td>43.4 b</td>
<td>1.13 b</td>
<td>36.3 b</td>
<td>94.2 b</td>
<td>1.9 b</td>
</tr>
<tr>
<td>Umbrella</td>
<td>5.0 a</td>
<td>16.1</td>
<td>101.3 a</td>
<td>72.5 a</td>
<td>59.2 a</td>
<td>1.23 a</td>
<td>41.0 a</td>
<td>178.8 a</td>
<td>2.5 a</td>
</tr>
</tbody>
</table>

### Marquette Yield

![Marquette Yield](image_url)

- **Tons/Acre**
  - **2012**
  - **2013**

- **Legend**
  - TWC
  - VSP
  - Umbrella
## Marquette 2013

### Yield Components

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (T/A)</th>
<th>Yield (lb/vine)</th>
<th>Clusters Per Vine</th>
<th>Cluster wt. (g)</th>
<th>Berries per cluster</th>
<th>Berry wt. (g)</th>
<th>Adj. # of shoots</th>
<th>Yield (g) per shoot (adj)</th>
<th>Clusters Per shoot (adj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWC</td>
<td>4.3 b</td>
<td>13.8</td>
<td>83.5 b</td>
<td>76.6 a</td>
<td>63.2 a</td>
<td>1.21 ab</td>
<td>36.9 b</td>
<td>178.1 a</td>
<td>2.3 a</td>
</tr>
<tr>
<td>VSP</td>
<td>2.3 c</td>
<td>7.4</td>
<td>69.4 c</td>
<td>49.2 b</td>
<td>43.4 b</td>
<td>1.13 b</td>
<td>36.3 b</td>
<td>94.2 b</td>
<td>1.9 b</td>
</tr>
<tr>
<td>Umbrella</td>
<td>5.0 a</td>
<td>16.1</td>
<td>101.3 a</td>
<td>72.5 a</td>
<td>59.2 a</td>
<td>1.23 a</td>
<td>41.0 a</td>
<td>178.8 a</td>
<td>2.5 a</td>
</tr>
</tbody>
</table>

### Graphs

- **Marquette Clusters Per Vine**
- **Marquette Cluster Weight**
- **Marquette Berries/Cluster**
- **Marquette Berry Weight**
TWC vs VSP

Marquette 2014
Marquette Harvest 2013
Marquette Fruit Composition

**Marquette Brix**

- 2012: TWC, VSP, Umbrella
- 2013: TWC, VSP, Umbrella

**Marquette pH**

- 2012: TWC, VSP, Umbrella
- 2013: TWC, VSP, Umbrella

**Marquette TA**

- 2012: TWC, VSP, Umbrella
- 2013: TWC, VSP, Umbrella

**Titratable acidity (g/l)**

- 2012: TWC, VSP, Umbrella
- 2013: TWC, VSP, Umbrella

**Brix**

- Graph showing the Brix values from 8/19 to 9/26 with different varieties labeled as TWC, VSP, and Umbrella.

**Marquette pH**

- Graph showing the pH values from 8/19 to 9/26 with different varieties labeled as TWC, VSP, and Umbrella.

**Titratable Acidity**

- Graph showing the titratable acidity values from 8/19 to 9/26 with different varieties labeled as TWC, VSP, and Umbrella.
### Frontenac Fruit Composition
#### 2013

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>3.02</td>
<td>3.04</td>
</tr>
<tr>
<td>2013</td>
<td>3.06</td>
<td>3.08</td>
</tr>
<tr>
<td><strong>TWC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>21.5</td>
<td>22.0</td>
</tr>
<tr>
<td>2013</td>
<td>22.5</td>
<td>23.0</td>
</tr>
<tr>
<td><strong>VSP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>23.0</td>
<td>23.5</td>
</tr>
<tr>
<td>2013</td>
<td>24.0</td>
<td>24.5</td>
</tr>
<tr>
<td><strong>Umbrella</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>0.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2013</td>
<td>4.0</td>
<td>6.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TA (g/L)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>10.0</td>
<td>12.0</td>
</tr>
<tr>
<td>2013</td>
<td>14.0</td>
<td>16.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brix</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>10.0</td>
<td>12.0</td>
</tr>
<tr>
<td>2013</td>
<td>14.0</td>
<td>16.0</td>
</tr>
<tr>
<td><strong>TWC</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>8/26</td>
<td>9/10</td>
</tr>
<tr>
<td>2013</td>
<td>9/16</td>
<td>9/26</td>
</tr>
<tr>
<td><strong>VSP</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>8/26</td>
<td>9/10</td>
</tr>
<tr>
<td>2013</td>
<td>9/16</td>
<td>9/26</td>
</tr>
<tr>
<td><strong>Umbrella</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>8/26</td>
<td>9/10</td>
</tr>
<tr>
<td>2013</td>
<td>9/16</td>
<td>9/26</td>
</tr>
</tbody>
</table>

### Statistical Analysis
- p = 0.6174
- p = 0.4564
- p = 0.7189
- p = 0.6934
- p = 0.7440
Shaded vs Exposed Clusters

Marquette 2014

- 6 vines
- 5 exposed and 5 shaded
- Individual Brix, pH, TA

### Brix

- Exposed: 24.0
- Shaded: 21.8

### pH

- Exposed: 3.28
- Shaded: 3.25
- Exposed: 9.5
- Shaded: 9.5

### Titratable Acidity (g/l)

- Exposed: 11.0
- Shaded: 9.5
Exposed vs Shaded Clusters

Marquette 2014
Conclusion:

• Cropping level affects total soluble solids (brix)
• Reducing crop does not help reduce TA.
• Exposed clusters have higher brix, lower TA than shaded clusters, whatever the training system.

Manage vines to provide light exposure to clusters
On the Bright Side of VSP

John Thull
Vineyard Manager
University of Minnesota
February 10th, 2015
Benefits of Vertical Shoot Positioned Trellising

• Fruit and Work Zones are in Good Ergonomic Position
• Upward Tendencies of Young Shoots Naturally Fit VSP
• Good Fruit and Cane Ripening Takes Place
• Narrow Canopies Dry Faster from Rain or Dew
• Effective Spray Coverage Lowers Disease Pressure
• Shorter Trunks are Easier to Keep Clean and Straight
• Air Flow and Floor Management are Improved
• More Tasks can be Mechanized
• Retraining Vine Structure is Quick after Cold Injury
• Harvest is Fun for All Ages
Drawbacks of VSP Trellising

• Not All Varieties Have the Upright Tendency
• More Wires will Add Cost to the Installation
• Tendril Prone Varieties are Hard to Pull Out of the Catch Wires
• Upright Training can Excessively Increase Shoot Vigor in Certain Situations – Lower Yields Result
• Fruit Predation by Raccoons may Increase

Note: VSP is not Recommended for Procumbent Varieties that will Grow on Fertile Soil
Vertical Shoot Positioned (VSP) Training

- Generally each shoot carries 2-3 clusters.
- Clusters are found at the base of the shoot within the 2nd and 6th nodes.
- There are exceptions.

Fruiting Zone

- Cane pruned
- Spur pruned
- 7 shoots
- 11 shoots
Trellising for VSP

1 High Tensile wire for wind

Movable Catch wires - 14 ga.

Use C-clips

Fruiting Wire
High Tensile 12.5 ga

Wood Post
- 24’ to next wood post

Metal Post
- 18’ to next metal post

4” x 8’
Young Frontenac gris Fruit Zone around 40’’
Frontenac gris on VSP – Spur Pruned

VSP Vines are Very Comfortable to Prune
Certain Varieties Want to Naturally Grow Vertically
Choose Well-Positioned, Upright Spurs

Downward Canes were Pruned Away

Marquette
Gravitropism Causes Shoots to Bend Upward in Spring
Many Varieties Fit on Both VSP and High Wire Trellises

Vine Vigor Should Help You Decide on the Trellis Style
Procumbent Vines Will Not Like VSP

The Growth Habits of Brianna and Edelweiss Resist Upward Training on VSP Trellis Systems
Fruit and Wood Ripening is Hastened on VSP
Periderm Development Along the Shoot

Ripening is Dependent Upon Available Carbohydrates for Fruit and Shoots

Wood Ripening Stops after Hard Frosts
High Cordon Vines Can Yield More, but…

Understand Your Soil Fertility and Water Availability
...Ripening of the Canes May Suffer
Many Traditional Wine and Table Grapes Produce Better from Canes Rather Than from Spurs

The Table Grape ‘Centennial’ after Cane Pruning in the Spring
Could Increase Yield with 2 Parallel Canes
2 Fruit Wires Installed 4” Apart

Pinot gris

4 Fresh Canes Needed for This System
Frontenac Family Yield is High on VSP

Heavier Crops will only Lead to Poor Juice Chemistry and Green Flavors; esp. for more Northern Vineyards
La Crescent Loves to Hang in Full Sun
High Cordon Needs More Leaf Removal

La Crescent’s Terpene Production Suppressed
VSP Vines Seem to Harden Off Sooner

Naturally Senescing Leaves Allows for More Carbohydrate Reserves
High Cordon Training Can Help De-Vigorate Vines
High Cordon Vines can be Wide and Shady
Diseases Will Thrive in Dense Canopies
Narrow, Open Canopies Dry Out Faster

[Image of grapevines]

Marquette

©Thull 2015
Spraying is More Effective with VSP

Keeping Vines Cleaner and Healthier
High Wire Trained Vines Require Sturdier Support Stakes

Good for Straightening Vines and Correcting Cordon Dead Zones
Short VSP Trunks Need Less Work

- Spur
- Renewal Cane
- Cordon
- Arm
- Head
- Trunk
- Cane from Previous Year
Shoots are Up and Out of the Way
Allowing for Good Air Flow
and Easier Weed Control in VSP Vineyards
Sunny Grapes are Happy Grapes

Riesling
# Vineyard Management Schedule

<table>
<thead>
<tr>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bud Swell</strong></td>
<td><strong>Bloom</strong></td>
<td><strong>Véraison</strong></td>
<td><strong>Harvest</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suckering</td>
<td>Shoot Thinning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaf Removal</td>
<td>Tucking and Catch Clips - VSP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combing - HC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hedging or Skirting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fruit Thinning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pruning Starts in Late Winter Followed by Tying**
Every Effort is Made for High Quality Fruit

Siegerrebe
Mechanical Pre-Pruning is an Option

Saves Time and Labor

Marquette

©Thull 2015
Shoot Thinning and De-Suckering
Shoot Tucking can be Mechanized

Check Out Shoot Binders or Laubhefter

Marquette
Shoots can be Trimmed with Hedgers

Shoot Tipping Done Before Shoots Lean or Blow Over
Mechanical Leaf Removal is Possible

Leaf Pulling Only Around Fruit Zone

La Crescent
Determine How Many Leaves to Remove
Shoots Should Reach 15+ Nodes, 4.5ft

Marquette Hedged
Leaves and Laterals Removed
Many Vines were Cold Damaged in 2014

La Crescent
Vines can be Re-Trained to Produce in 1 yr Bearing Units (i.e. Fruiting Canes) Establish Faster for VSP Vines Because of the Shorter Trunks
Pinot gris with 2 Canes Doubled Up
High Quality Wine Needs High Quality Fruit
High Quality Wood Ripening is also Needed

Fruit and Shoots are Well Exposed
Like the Late ‘60s, “Let the Sun Shine In”
Find the System that Fits Your Site

• Understand Your Soil’s Potential for Growing Vines
• Learn the Nuances of Each Variety Before Planting
• Weigh Your Time and Labor Costs Against Ripening and Quality Benefits
• Closely Watch and Record How Your Vines React to Your Pruning Methods and Cultural Practices – Adjust as Needed
Acknowledgements to The HRC Team

- Jenny Thull, Assistant Vineyard Manager
- Peter Hemstad, Grape Breeder, Scientist
- Dr. Jim Luby, Professor and Director of Fruit Breeding Program

2014 Vineyard Laborers
Matt Ericksen, Alanna Robinson, and Randi Kemble
Thank You to the Northern Grapes Project

2/10/2015 ©Thull 2015 70

Everyone Loves Harvest Time!
Background/History

• Grape grower and winemaker
  – We use everything we grow
  – 8 acres, most very young

• Planted Frontenac vines 2005
  – Second year it was obvious to use GDC due to vine vigor

• Planted Frontenac Gris vines 2006
  – On GDC

• Planted Frontenac Blanc vines 2010
  – On GDC

• Everything with “Frontenac” in its name is on GDC
Background/History

- Planted LaCrosse, LaCrescent, St. Pepin, and Brianna 2006
  - Started with VSP
  - Converted to single hi-wire 2011
- Failed varieties
  - Taminette
  - Marechal Foch
  - Lemberger
- Added Marquette and Petite
  - Started on single hi-wire

For the following reasons!
Advantages (in priority order)

• Reduced varmint predation
  – Raccoons
  – Opossums
  – Turkeys

• Reduced labor
  – VSP too much time tucking vines
    • Hybrids are not well behaved like vinifera
    • Extra time training new vines
  – VSP too much time pruning
    • Tenacious tendrils

• Reduced direct cost
  – Less wire
Frost Protection

• Late spring frost damage
  – Noticed that just 2-3 feet elevation difference was significant
• Added a “cold air drain” in 2014
  – Wanted as much elevation margin as I could get.
Frost Protection
Disadvantages?

- Grape exposure to birds
  - Not noticeably worse than VSP
- Sunshine/Grape ripeness
  - Not perceived as a problem at my location

<table>
<thead>
<tr>
<th>Variety</th>
<th>Tons/acre</th>
<th>Brix</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontenac</td>
<td>8.3</td>
<td>23.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Petite Pearl</td>
<td>4.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marquette</td>
<td>--</td>
<td>24.6</td>
<td>3.2</td>
</tr>
<tr>
<td>Frontenac Gris</td>
<td>5.0</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>LaCrosse</td>
<td>3.8</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>LaCrescent</td>
<td>4.1</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>St. Pepin</td>
<td>4.5</td>
<td>21.6</td>
<td></td>
</tr>
<tr>
<td>Frontenac</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Disadvantages?

• In hind sight - end post load
  – Higher wire creates more moment on posts
  – I need stronger end posts

• Almost all work is overhead
  – Problem for my short wife
Conversion

- 5 year old vines
- Selected the two strongest shoots
- Took them up to the top wire
- Cut off everything else
- First year yield reduced, but not as much as expected!
- Additional suckers not a problem
Conversion
Questions?