# Vineyard Management for Quality Wine

Andy Allen
Viticulture and Enology Program
Arkansas Tech University - Ozark

ARKANSAS TECH UNIVERSITY OZARK CAMPUS

Final wine quality is derived to a large degree from grape composition.

Grape composition is influenced by:

- Climate
- Cultivar
- Site characteristics
- Cultural practices

Quality wine is only made from grapes with good potential for wine quality, managed in such a way as to maximize their components that contribute to wine quality potential.

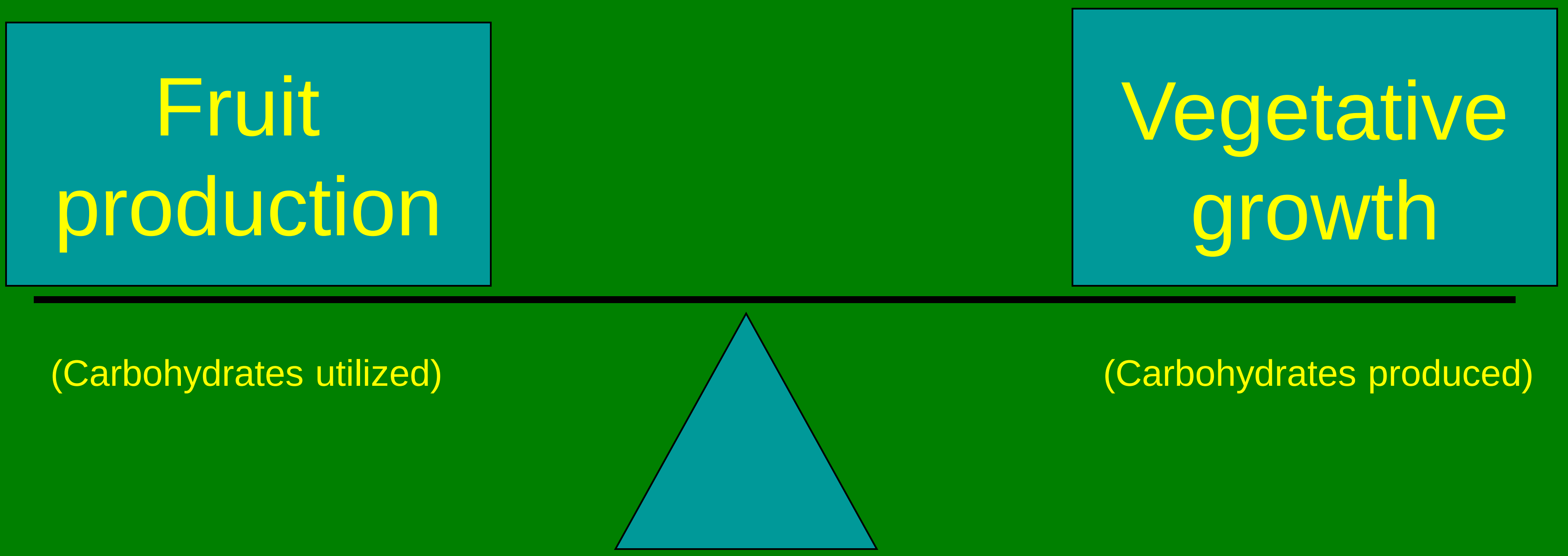
# Vineyard management practices for quality winegrapes

- Focus on:
  - Vine balance
  - Canopy management
  - Crop load management
  - Vine nutrition

# Balanced Vines

Balance has been achieved between vegetative growth and fruiting when a sustainable yield of high quality fruit is obtained each season.

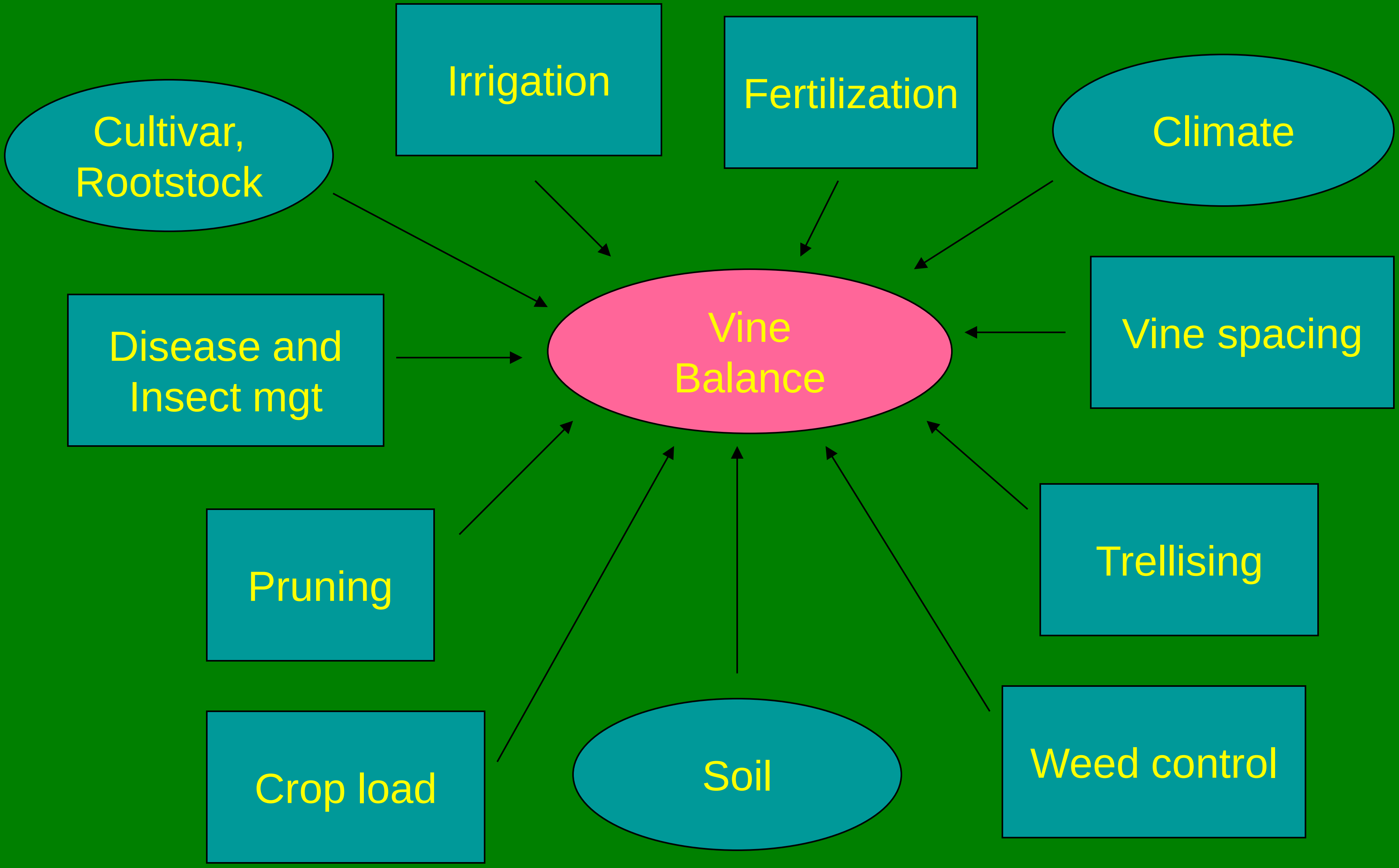
# The Balancing Act



# Indicators of Balance

- Pruning weight per foot of canopy:
  - 0.2 to 0.4 lbs
- Yield to pruning weight ratio (Ravaz Index):
  - Vinifera: 5-10
  - Native and hybrid: largely undetermined but considered to be higher
- Leaf area to fruit weight ratio:
  - 3 to 8 $ft^2$/lb

# Factors Affecting Balance



# Major Vineyard Management Factors

- Trellising
- Spacing
- Pruning
- Crop adjustment

# Trellising and Spacing

The vine must not only have enough leaf area, the leaves must be properly displayed to achieve maximum photosynthetic production.

# Spacing

- Row spacing
  - Has greater effect on yields per acre
  - Should be far enough apart to prevent row-to-row shading
- Vine spacing
  - Far enough apart to allow vine to express vigor
  - Shoot density

# Balanced Pruning

- Resulted from research on Concord in Michigan by Partridge and in New York by Shaulis
- Goal is to balance fruit production of the vine with vegetative growth (cane growth and maturation)
- Patridge proposed using pruning weights of live cane tissue from year one to predict upper limit of vine's capacity to produce and ripen crop in year two

# Balanced Pruning

- Estimate vine size and then prune the vine
- Weigh one year old cane prunings using a small spring scale
- Apply the weight obtained to a pruning formula to determine the number of nodes to retain per vine
- Upper limit to node number?

# Canopy management

- Cultural practices which modify the canopy density to improve vine microclimate:
  - Trellis choice
  - Vine/row spacing
  - Fertilization/irrigation practices
  - Vine health maintenance
  - Physical manipulation of canopy components*

# Canopy management practices

- Shoot thinning
  - Should be done when shoots are 2”-6” in length
  - Remove shoots from “non-count” positions
  - Improves canopy density
    - Reduces shoot density, leaf layer number
    - Increases proportion of canopy gaps, exterior leaves
  - Reduces crop load

# Canopy management practices

- Shoot positioning
  - Goal is to re-orient shoots into position appropriate for trellis/training system
  - Should be done when shoots are long enough to remain in place after positioning but before tendrils attach to neighboring shoots
  - May require more than one pass through vineyard
  - Improves environment around fruiting/renewal zone
  - Has benefits for other vineyard management tasks

# Canopy management practices

- Leaf removal
  – Should be done between fruit set and pea-size
  – Remove 2-6 leaves per shoot in the fruiting zone
  – Improves canopy microclimate by reducing leaf layer number
  – Possibly the most beneficial canopy management practice
    - Can improve fruit composition and color
    - Can reduce bunch rots


# Benefits of canopy management

- Improving the canopy microclimate to permit more light and air penetration into fruiting zone
  - Reduces disease pressure
  - Improves spray penetration
  - Allows more efficient photosynthesis
  - Improves fruit composition
    - Improves color
    - Reduces levels of methoxypyrazines
    - Improves development of flavor and aroma compounds
    - Improves sugar and acid composition

# Influence of leaf removal on development of bunch rot in winegrapes in Missouri in 1992.

| Treatment | Incidence | Severity |
|---|---|---|
| Vignoles | | |
| Leaf removal | 13.8* | 15.0* |
| Control | 28.7 | 25.1 |
| Seyval blanc | | |
| Nonsprayed | | |
| Leaf removal | 28.3* | 27.3* |
| Control | 42.8 | 31.2 |
| Sprayed | | |
| Leaf removal | 17.4* | 20.5* |
| Control | 34.1 | 32.1 |

English, et al. 1993. Plant Disease 77:1224-1227.

# Light environment effects on grape quality

- Good exposure of bunches to light increases terpenoids, phenolics, and color pigments
- Good exposure can decrease levels of methoxypyrazines
- Excessive heat can reduce color, phenolics and volatile aromatics

# Cluster exposure effects

- Cluster exposure of Traminette
  - Exposed (E), Light Shade (LS), Moderate Shade (MS), Heavy Shade (HS)
  - Leaf layer numbers 0, 1, 2, >3
  - E, LS and MS had higher Brix, lower pH and lower TA and HS
  - As shading decreased, PVT and total monoterpenes increased with E having ~30% higher concentration than HS

# Cluster exposure effects

- Cluster exposure of Golden Muscat
  - Exposed (58% - leaf removal) and Shaded (48% - shoot positioned)
  - Shaded clusters were darker than exposed
  - Exposed clusters had higher TSS (~2 °Brix)
  - Exposed clusters had phenolic content (350 mg/L vs 270 mg/L)
  - Shaded clusters had higher pH and $K^+$ content
  - Shaded clusters had higher FVT than exposed
  - Exposed clusters had higher PVT than shaded
  - Wines from exposed clusters were less acidic, had higher phenolics (24g/L) and greater PVT than shaded

Macauley and Morris. 1993. AJEV 44:198-204.

# Cluster exposure effects

- Cluster exposure of Shiraz
  - Shaded (5%), Moderate Exposure (10-40%), High Exposure (40-80%)
  - Shading reduced Brix, delayed ripening by 7 days compared with MET and HET
  - Shading reduced total anthocyanins compared to MET and HET
  - Total skin phenolics were higher in HET than MET and in MET than in ST
  - Skin tannins in ST were 30-40% lower than HET, tannins in HET were 10-20% higher than MET
  - ST wines were rated lower for mouthfeel and fruit flavor

Ristic, et al. 2006. Proc. ASVO Seminar ‘Finishing the Job’ – Optimal Ripening of Cabernet Sauvignon and Shiraz.

# Effect of one- and two-sided leaf removal on composition of Cynthiana juice and wine in three seasons in Arkansas.

| Year and treatment | Soluble solids (%) | pH | Titratable acidity | Tartaric acid (g/L) | Malic acid (g/L) | Total red pigment color |
|---|---|---|---|---|---|---|
| **1997** | | | | | | |
| None | 21.9 a | 3.58 a | 14.2 a | 6.3 a | 7.4 a | 100 b |
| East side | 22.1 a | 3.53 a | 13.6 a | 6.2 a | 6.8 a | 121 a |
| Both sides | 22.1 a | 3.48 b | 12.5 b | 6.0 a | 6.5 a | 125 a |
| **1999** | | | | | | |
| None | 22.9 a | 3.83 a | 10.1 a | 8.0 a | 5.8 a | 124 b |
| East side | 23.1 a | 3.84 a | 10.4 a | 8.2 a | 5.4 a | 157 a |
| Both sides | 22.4 a | 3.84 a | 10.3 a | 8.0 a | 5.3 a | 169 a |
| **2000** | | | | | | |
| None | 21.2 b | 3.85 a | 11.2 a | 7.0 a | 6.2 a | 18 b |
| East side | 21.8 a | 3.82 a | 10.3 b | 6.9 a | 5.2 b | 25 a |
| Both sides | 22.1 a | 3.79 a | 10.3 b | 6.8 a | 4.5 b | 24 a |

Main and Morris, 2004. Amer. J. Enol. Vitic. 55:147-152.

# Leaf removal and methoxypyrazines

- No removal; removal of leaves 1,3,5; removal of leaves 1-5 at 10, 40, 60 DAA
- Cabernet Franc
  - Early (10, 40 DAA) leaf removal reduced IBMP by up to 88% (2007) and 60% (2008)
  - 10 DAA increased Brix in 2007
  - Almost all treatments reduced TA in both years
  - pH was not affected by leaf removal treatments
- Merlot
  - All leaf removal treatments significantly reduced IBMP 37-52%
  - Leaf removal treatments had no effect on Brix, pH or TA

Scheiner, et al, 2010. Amer. J. Enol. Vitic. 61:358-364.

# Crop load management

- Removal of shoots and clusters to achieve yield that is in balance with the vegetative growth of the vine

# Effects of Overcropping (Excessive Crop Load)

- Delayed maturity
- Decreased growth
- Loss of vine size
- Increased risk for winter injury
- Reduced subsequent yields
- Reduced fruit quality
- Reduced profitability

Winkler. 1954. AJEV 5:4-12

# The 3 steps of crop load management

- Balanced pruning
- Shoot thinning
- Cluster thinning

# Shoot thinning - hybrids

- Effects from research have been variable and cultivar specific
- Morris, et al. 2004. Arkansas

| Cultivar | Yield (t/a) | Ravaz Index |
|---|---|---|
| Aurore | 8 to 5.5 | 13.6 to 8 |
| Chancellor | 11.8 to 6.9 | 15.8 to 9 |
| Villard Noir | 10.7 to 7.1 | 16.5 to 11.2 |

- No appreciable effect on Brix, pH or TA

# Shoot thinning - vinifera

- More effective on vinifera fruit and wine composition
- Reynolds, et al. 2005. Ontario
- Minor reduction in yield
- Pinot Noir
  - Increased TA and Brix in berries and must
- Cabernet Franc
  - Increased Brix and color intensity in berries
  - Reduced TA in musts
  - Higher color intensity, phenolics and anthocyanins in wine

# Effects of canopy management practices on yield and fruit composition of Chambourcin grapevines trained to a high-wire single curtain trellis.

| Treatment | Yield Per Acre (tons) | Average Cluster Number | Average Cluster Wt (g) | Average Berry Wt (g) | Average Berries/ Cluster | Soluble Solids (%) | pH | Titratable Acidity (g/L) |
|---|---|---|---|---|---|---|---|---|
| **SP+LR** | 9.7 a | 85.79 a | 150.16 efgh | 2.03 ab | 74.92 cdefg | 21.1 fg | 3.41 g | 7.29 a |
| **CONTROL** | 9.3 a | 91.25 a | 135.73 h | 1.99 b | 68.51 g | 20.8 g | 3.41 g | 7.26 a |
| **LR** | 9.1 a | 81.92 a | 147.42 efgh | 2.07 ab | 71.40 efg | 21.4 efg | 3.38 g | 7.20 abc |
| **SP** | 8.6 ab | 84.00 a | 137.58 gh | 2.02 ab | 67.98 g | 21.1 fg | 3.43 fg | 7.19 abc |
| **ST** | 8.3 abc | 64.84 b | 174.30 abc | 2.08 ab | 83.92 abc | 22.1 def | 3.53 cde | 6.98 abcd |
| **ST+LR** | 7.1 bcd | 56.58 bcd | 168.38 bcd | 2.17 a | 77.85 bcdef | 23.1 bcd | 3.50 def | 6.80 def |
| **ST+SP+LR** | 7.0 cd | 56.67 bcd | 164.08 bcde | 2.18 a | 75.18 cdefg | 23.0 cd | 3.53 cde | 6.87 cdef |
| **ST+SP** | 6.4 de | 59.25 bc | 145.89 fgh | 2.10 ab | 69.46 fg | 22.6 de | 3.46 efg | 6.86 bcdef |
| **SP+CT** | 6.1 def | 51.50 cde | 159.42 cdef | 2.10 ab | 75.92 cdefg | 24.3 ab | 3.54 bcde | 7.08 abcd |
| **CT** | 5.7 defg | 46.42 de | 163.00 bcde | 2.07 ab | 79.04 abcde | 24.0 abc | 3.56 bcd | 7.25 ab |
| **CT+LR** | 5.0 efgh | 41.79 ef | 160.28 cdef | 2.04 ab | 78.75 abcde | 24.9 a | 3.58 abcd | 6.95 abcde |
| **SP+CT+LR** | 4.8 fgh | 41.42 ef | 154.11 defg | 2.12 ab | 72.92 defg | 24.5 a | 3.57 abcd | 6.88 bcdef |
| **ST+CT+LR** | 4.62 fgh | 32.92 f | 188.55 a | 2.16 a | 87.19 a | 25.0 a | 3.65 a | 6.60 ef |
| **ST+CT** | 4.3 gh | 32.25 f | 178.06 ab | 2.09 ab | 85.56 ab | 24.5 a | 3.59 abc | 7.11 abcd |
| **ST+SP+CT+LR** | 4.0 h | 31.67 f | 167.21 bcd | 2.05 ab | 81.54 abcd | 24.7 a | 3.63 abc | 6.52 f |
| **ST+SP+CT** | 3.7 h | 29.04 f | 169.02 bcd | 1.97 b | 86.02 ab | 24.8 a | 3.63 abc | 6.74 def |

# Vine nutrition

- Many nutrients are required by vines for healthy vine growth and proper function
- Imbalances of certain nutrients can have serious consequences for wine quality
- Nutrient status and requirement should be established by regular monitoring
  - Observation
  - Soil testing
  - Petiole testing

# Nitrogen (N)

- Required by grapevines in largest amount of all nutrients
- Taken up or utilized as either nitrate ($NO_3^-$) or ammonium ($NH_4^+$)
- Used in amino acids, proteins, nucleic acids, chlorophyll, enzymes
- Mobile in plants
- Vine nitrogen status
  - Excess levels can cause excess vigor, delay ripening, decrease berry quality
  - Deficiencies can reduce growth, crop, berry quality and aroma precursors

# Nitrogen fertilization of Riesling

- 3-yr study in WA State on site with low-fertility
- Fertilization rates of 0, 50, 100, 200 lbs/ac
- As N rate increased:
  - Pruning wt increased up to 100 lb rate
  - Yield increased with 50 lb, no significant difference from 50 to 200 lbs
  - Ripening and harvest was delayed from 6-16 days with increasing rate of N
  - Total N, amino acids increased as N did
  - Increasing N reduced free monoterpenes, increased many bound monoterpenes
  - Decreased some higher alcohols
  - Increased concentrations of most esters

# Potassium (K)

- Used in large quantities; in grapevines is $2^{nd}$ most required element
- Used as regulator of biochemical processes in plants including: CHO production, protein synthesis, solute and sugar transport, stomatal regulation
- Taken up as K+ ion
- Vine potassium status
  - Deficiencies can result in lower sugar levels
  - Excesses can potential lead to high juice/wine pH levels

# Excess potassium

- Morris, et al. 1987
  - 3 year study
  - 5 winegrape varieties (Ge, Se, CS, deC, Cyn)
  - Fertilized with 6 lbs $K_2SO_4$ per vine
  - Significantly higher must pH (3.6 – 3.8) in all except Gewürztraminer
- Morris, et al. 1983
  - 3 high rates of $K^+$ to applied weekly to Concord vines
  - Juice processed and analyzed either fresh or after 3-day cold storage
  - In both cases juice pH was significantly increased
  - High pH led to juices of less desirable color

# Conclusions: Vineyard management and grape quality

- Wine grape quality development is improved by practices that improve:
  - Vine health and nutrition
  - Leaf area:fruit ratio
  - Leaf and fruit exposure to light
- Research results on many aspects of vineyard management vary, especially according to region and grape variety, indicating need for regional and varietal specific investigations