Trellis Systems vs. Varieties vs. Management:
Pros & Cons & Ideas from Michigan

Dr. Duke Elsner
MSU Extension
Traverse City, Michigan

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My Experience

- Southwest Michigan – American juice grapes, 1970’s
- Northwest Pennsylvania – American juice & hybrid wine grapes, 1982-1986
- Northwest Michigan – **vinifera** & hybrid wine grapes, 1990 to present
• Mid 1970's
• Both students at MSU
• Department of Entomology
• With Larry Olson, too
Purposes & Attributes of Training Systems

• Sustainability of the growth form
• Consideration of the pruning process
• Establish a sunlight-efficient canopy
• Compatibility with canopy management practices
• Position fruit to promote maturity
• Facilitate harvest efficiency
• Establish a fruitful renewal zone
• Cost effective Management
Additional Considerations

- Grafted vines or own-rooted?
- Recumbent or upright growth habit?
- Yield & quality requirements?
- Acreage to be maintained
Setting Priorities

- Risks of severe winter injury
- Fruit/wine quality needs
- Availability & cost of labor
- Cost of trellis materials & maintenance
Risk of Extreme Cold?

• Use more long canes

• Avoid cordons

• Keep fruiting zone and renewal zone low
Snow Cover Helps
Risk of Spring Frosts?

- Avoid very low fruiting zones
High Fruit Quality

- Fruit-leaf area ratio
- Fruit sun exposure
- Discourage fruit rots & fungi
Disease Susceptible Cultivars?

- Avoid dense, shady canopies
- Disperse fruit clusters
- Shoot positioning
Training systems affect spray coverage
Setting Priorities

- Availability & cost of labor
- Cost of trellis materials & maintenance
Training System Terms

• Trunk
  – Upright older growth from base of vine

• Head
  – Centralized region of older wood used for generation of renewal canes and spurs

• Cordon
  – 2 year and older woody “arms” which continue to bear buds or spurs
Training System Terms

• Cane
  – 1 year old woody shoot bearing numerous nodes

• Spur
  – Cane shortened to just a few nodes kept in the fruiting zone

• Renewal Spur
  – Spur kept in a position to facilitate replacement of canes, cordons or trunks
Training System Terms

• Bull Cane
  – 1 year old cane from a shoot with excessive vigor; large diameter, long internodes; typically poor buds

• Persistent Lateral
  – 1 year old side canes arising from a bull cane; buds typically of higher quality
Training System Terms

• Suckering
  – Removal of unwanted shoots from base and trunks of vine

• De-fruiteding
  – Removal of fruit from shoots in non-fruiting zones
Head Systems

- Head – Centralized region of older wood used for generation of renewal canes and spurs
- Cordon – 2 year and older woody “arms” which continue to bear buds or spurs
Head Systems
Cordon Systems
Importance of Perennial Wood

- When possible, use cordon systems
- Old wood serves as a carbohydrate storage organ
- But must maintain renewal options
Importance of Perennial Wood

• But must maintain renewal options
Provide “Spare Parts”

- Renewal zone
- Renewal spurs
- Trunk renewal canes
- Multiple trunks
Provide "Spare Parts"
• Trunk renewal canes

• Multiple trunks
Recumbent Cultivars

• High Head systems
  – Umbrella Kniffin
  – Four-Arm Kniffin
  – Keuka High Renewal

• High Cordon systems
  – Hudson River Umbrella
  – Single Curtain

• Divided Canopy systems
  – Geneva Double Curtain
Umbrella Kniffin

Fig. 5. The Umbrella Kniffin training system on a standard 3-wire trellis.
Umbrella Kniffin

• Advantages
  – easily learned by hand pruners
  – fruit high, distributed and well exposed
  – simple trellis construction
  – utilizes long canes for fruitful nodes

• Disadvantages
  – plenty of annual tying
  – not adaptable to mechanical pruning
  – less adaptable to shoot positioning
Fig. 3. Four-Arm Kniffin training system on a standard two wire trellis.
Four-Arm Kniffin

• **Advantages**
  – ease of pruning to long canes
  – vertical distribution of fruit
  – more compatible with tolerating winter injury than cordon systems

• **Disadvantages**
  – plenty of annual tying of canes
  – not adaptable to mechanized pruning
  – difficult to maintain quality of lower nodes
  – not compatible with systematic leaf removal & shoot positioning
Fig. 4. A Modified Keuka High Renewal training system which utilizes long canes which originate from a central head region of the wire.
Keuka High Renewal

• Advantages
  – very compatible with frequent replacement of vine parts in response to frequent winter injury

• Disadvantages
  – plenty of annual tying
  – difficult for inexperienced pruners
  – not adaptable to mechanized pruning
  – not adaptable to systematic leaf removal & shoot positioning
Figure 2. High Cordon. Syn. Sylvoz, Hudson River Umbrella, Single Curtain, No-tie. Dimensions: Post height - 72"; Fruit bearing top wire - 72"; Optional pair of mobile wires - 48". Figure and dimensions after Jackson, 1997.
Fig. 1. The Top-Wire Cordon training system. This variation utilizes long canes tied to a lower wire for better vertical distribution of fruit and canopy.
High Cordon
High Cordon
High Cordon

• Advantages
  – adaptable to mechanical pruning, unskilled manual pruning, and mechanical shoot positioning
  – fruit high for good sun exposure
  – little or no annual tying

• Disadvantages
  – tends to reduce vine vigor, especially if shoots are positioned
  – difficult to establish cordons where there is frequent winter injury
  – old cordons hard to remove from wires
  – old cordons may become a reservoir for diseases
Hybrids on High Cordon

- Hybrids vary in tendencies for recumbent vs. upright shoot growth
- Some are quite “bushy”
- Fruit shading and differential cluster ripening is a big problem
Hybrids on High Cordon
Hybrids on High Cordon
Geneva Double Curtain
Upright Growth Cultivars

• Head systems
  – Guyot
  – Pendlebogen
  – Fan
• Cordon systems
  – Mid-Wire Cordon
  – Low Cordon

All Need Vertical Shoot Positioning !!!
Figure 1. Guyot training. Syn. Vertical Shoot Position
Dimensions: Post height - 78"; Fruit bearing wire - 32"; 1\textsuperscript{st} set double wires - 40"; 2\textsuperscript{nd} set double wires - 52"; Top wire - 78". Figure and dimensions after Jackson, 1997.
Guyot

• Advantages
  – fruit can be situated relatively low to ground where it may benefit from radiant heat
  – minimal vine structure makes it east to cope with winter injury to vines
  – long canes retain more fruitful nodes

• Disadvantages
  – difficulty in pruning & harvesting if low to ground
  – not adaptable to mechanical pruning (?)
  – possible congested fruit zone
  – greater risk of spring freeze injury (depends….)
Guyot
Guyot
Guyot
Fig. 8. A variation of the Pendlebogan training system which utilizes long fruiting canes close to the ground.
Pendlebogen

• Advantages
  – all the benefits of Guyot, plus….
  – arching of canes creates better vertical distribution of fruit on the trellis
  – relatively few ties per vine
  – can be spur pruned for next 1-2 years

• Disadvantages
  – more challenging if fruiting wires are low to the ground
  – not adaptable to mechanical pruning?
Pendlebogen

- We typically place our Pendlebogen higher in the trellis
- Widely used in NW Michigan for most vinifera cultivars
Pendlebogen
Spur-Pruned Pendlebogen
Fan

Fig. 6. The Fan training system which provides maximum flexibility in response to frequent winter injury.
Fan

• Advantages
  – maximum flexibility to adjust to frequent winter injury due to the retention of minimal permanent vine parts
  – easily learned by manual pruners

• Disadvantages
  – plenty of annual tying
  – not adaptable to mechanical pruning
  – not adaptable to systematic shoot positioning or leaf removal
  – Fruit is hard to find and harvest
Mid-Wire Cordon
Mid-Wire Cordon

• Advantages
  – ease of establishment (2\textsuperscript{nd} year Guyot!)
  – adaptable to mechanical pruning or unskilled manual pruning
  – little tying required

• Disadvantages
  – fruiting zone may become crowded and shaded on large vines
  – nodes on fruiting spurs may be of lower quality
  – bud counts may be low during renewal years
Mid-Wire Cordon

Fig. 2. The Mid-Wire Cordon training system on an 8 foot trellis.
Fig. 13. A Low-Cordon training system.
Low Cordon

• Advantages
  – fruiting zone close to ground utilizes radiant heat to promote ripening
  – adaptable to mechanical pruning
  – low fruiting and renewal zone utilizes snow cover or artificial covers to avoid winter injury

• Disadvantages
  – difficult labor low to ground
  – requires excellent weed management
  – soil residues on fruit
  – spring freeze susceptible
Scott Henry
Scott Henry

- Advantages
  - promotes a systematic display of a large canopy and good exposure of fruit to sunlight
  - if cordons are used in upper fruiting zone partial mechanization of pruning is possible
  - well organized fruiting zones are easy to hand harvest

- Disadvantages
Scott Henry

• Disadvantages
  – Fruit maturation in lower fruiting zone is often behind the upper
  – canes and buds developing in lower portion of trellis are of inferior quality
  – complicated shoot positioning is required
  – tall trellis is required
  – no advantage to weak vines
Scott Henry Variations
Scott Henry – worst version
Scott Henry – high vigor vines
Scott Henry – medium vigor vines
Fig. 11. The Smart-Dyson training system which has a vertically divided canopy and shoot positioned.
Smart-Dyson

• **Advantages**
  – adaptable to mechanical pruning
  – uses shoot positioning to expose fruit for ripening
  – less likely to develop differences in fruit maturity and bud quality than with Scott Henry system

• **Disadvantages**
  – lack of experience with this system
  – many uncertainties!
Lyre
Lyre

• Advantages
  – excellent distribution of the grapevine canopy
  – desirable upward growth of all shoots
  – good exposure of fruit for ripening
  – adaptable to mechanical pruning

• Disadvantages
  – complexity and expense
  – extensive shoot positioning required
  – difficult to mechanically harvest
Alright, Which One?

- You and your winemaker must judge
- Don’t discount employee opinion
- Avoid decisions based on neatness
- Learn how to judge deficiencies
Recognizing Deficiencies

- Difficulty in maintaining the vine form
- Poor fruit quality from shading
- Pest & disease problems
- Poor fruiting capacity over time
Recognizing Deficiencies

- Dense canopies with deteriorating interior leaves
- Confusion at pruning & training time
- Inability to efficiently employ canopy management practices
- Wine quality problems
My Mentors

• Dr Tom Zabadal
  – SW Michigan Research & Extension Center
My Mentors

- Dr Stan Howell
  - MSU Dept. of Horticulture (retired)