ASEV 2024 Merit Award

Presented at the 2024 75th ASEV National Conference
Merit Award Presentation Summary

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Genesis of a Viticultural Research and Extension Program in Virginia

What an honor to be on this stage to accept the American Society for Enology and Viticulture's (ASEV) 2024 Merit Award. I thank the nominator and the ASEV awards selection committee for the award. I also thank all of you for coming out early today for this presentation.

This was perhaps the most difficult work-related talk I've had to prepare. Afterall, how do you summarize your career in a 45-min talk? What I've tried to do is explain why I did what I did with my work, and highlight some of my accomplishments that perhaps helped me to exceed my 15 minutes of fame.

To put my career in temporal context, consider the technology that has since developed that makes our lives and work easier: the internet, or Web (around 1991); Global Positioning System for civilian use (1983, but much more commonly used in the 1990s); Google (1998) and other web-browsers; Bluetooth (2004); and of course, smartphones emerging in the mid-nineties. All of these technologies, and others, were instrumental in my success as a research scientist and an extension educator.

Mine was not a solo journey. I relied on and benefited tremendously from many excellent people along my career path. On a personal note, I credit my father, Ken Wolf, who instilled in me an appreciation of nature, a sense of curiosity, and the demonstration that science is paramount to answering questions that we can formulate about biological systems. I also had many academic mentors early in my education. Chief among them, I would mention Robert Pool, or Bob, as he was familiarly known. Bob was my PhD advisor at Cornell. He was an excellent viticulturist and he went out of his way to support me with travel opportunities and computer programming for data-acquisition in my cold-hardiness studies, and he called my attention to the advertised viticulture position at Virginia Tech.

I want to unpack my career into the different areas of interest and responsibility. These were research, extension, teaching, what I'd call "community service", and administration. Before we go there though, a little bit about my academic background. My undergraduate degree was completed at West Virginia University, while my Masters and PhD were completed at Penn State University and Cornell University, respectively. I was hired by Virginia Tech in January 1986 into a new Viticulture Extension Specialist position based at what was then referred to as the Winchester Fruit Research Laboratory, located in the northern Shenandoah Valley.

At the time of my hire, the Virginia wine industry had about 35 wineries, and maybe 1,100 acres of winegrapes. The contemporary Virginia wine industry was a scant 10-years-old. It was challenged by a number of climatic threats; a narrow, and to some extent, incongruent grape variety base; and a deficit of viticultural experience within the industry. It was ripe for a freshly minted viticulturist to hopefully help move the industry forward.

I should describe Virginia's climate in a viticultural context, as it sets the stage for the research that I pursued. Virginia has a humid, sub-tropical climate, very similar to portions of Uruguay and the Hunter Valley region of New South Wales, Australia. We have a continental climate with rainfall typically measured in all months, ranging from about 890 to

1400 mm of rain per year, depending on location within the state. Hurricanes and other tropical storms can bring heavy rains during the harvest season. Many of the principal grapegrowing areas of Virginia experience 3,500 to over 4,000 growing degree days (base 50°F) of heat accumulation between April and October. We can also express heat as the mean temperature of July, which is around 25 to 27°C for the northern Piedmont region.

Our warm-to-hot growing season is combined with winters that are relatively mild, but can be punctuated by cold episodes of -23°C or lower. However, such winter minima were more common in the 1980s and much of the 1990s; this has rarely occurred since 1996 in major grapegrowing areas of the state. Despite a warming climate, winter injury is still an issue for grapegrowers, and not just in Virginia.

We have a tremendous diversity of soil characteristics, ranging from relatively young coastal soils high in sand content, to much older soils in the piedmont and mountain/valley complex comprised of weathered granite and greenstone, as well as limestone and sandstone.

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What are the consequences of these growing conditions for vine management and fruit quality potential? We can list increased disease pressure, potential for winter cold injury, and our continental climate increases spring frost potential. We have the potential for hurricanes and other tropical storms impacting Virginia and, despite “average” rainfall amounts, moderate-to-extreme droughts can also occur, as witnessed in 2023 and 2024. Some of these threats can be mitigated by good vineyard site-by-variety selection, but some are random, and our climate is definitely changing, such as we’ve seen with the advance of vine development starting with budbreak in spring.

The combination of generally fertile soils and the warm-to-hot climate supports the growth of large, vigorous grapevines in many of our vineyards. “Canopy management” was ill-defined when I started with the viticulture position. The handbook Sunlight into Wine (Smart and Robinson 1991) was not published until 1991, and there was a lag-time in adoption of some of the practices advocated in the book. Shoot positioning and fruit-zone leaf thinning were often not practiced. Lacking shoot positioning, shoot hedging was often either excessive or insufficient. Vines often exhibited shaded canopy interiors that promoted botrytis, sour rot, and non-specific fruit rots.

I like the expression “heroic viticultural efforts” to describe what our growers continue to confront in terms of viticultural challenges. Growers face increased canopy management costs, additional pest management (particularly of fungal pathogens), and use of steeper vineyard sites to reduce plant available water and the threat of spring frost damage.

To digress, while I might have painted a grim picture of the climate for grapegrowing in Virginia, I cannot overstate how receptive and welcoming the Virginia – and eastern United States – wine industry was to have someone interested in their enterprise that was willing to conduct research and extension programs on their behalf. That reception did not change over 35 years of effort and gave me a great deal of gratification.

Research

I worked in several different areas over my career, including various aspects of pest management, use of growth regulators, and studies of physiological disorders such as bud necrosis. However, the four core areas of my research were vine management impacts on cold hardiness, novel (to Virginia) variety evaluations, demonstrating effective training and canopy management practices under Virginia’s growing conditions, and management of vine vigor and vine size to optimize wine quality potential in proactive rather than simply remedial means.

It’s important to acknowledge here that I had opportunities through competitive grant proposals to fund the research, including graduate students and post-docs. The Virginia Wine Board derived funding from a wine promotion tax on Virginia wines and was authorized to spend a third of this funding on research and extension projects. Regional sources of funding such as the Viticulture Consortium (USDA), and national sources such as the USDA’s Specialty Crop Research Initiative, also provided generous funding over the years.

Cold hardiness studies

I was in a good position starting with Virginia Tech in 1986 to explore some of the factors that impacted grapevine cold hardiness. My dissertation work included a refined methodology for the thermal assessment of grape dormant bud cold hardiness – sometimes referred to as differential thermal analysis, or DTA (Wolf and Pool 1987). With Bob Pool’s help, we also developed a programmable data acquisition system to accurately detect freezing events in grape buds. Dormant grape buds resist freezing by supercooling, but when the temperature decreases beyond the ability to supercool, the bud freezes, which kills the bud.

If we froze enough buds, we could generate data that could be statistically analyzed. What is also relevant is that the average temperature of these freezing events in the lab closely approximated the predicted temperature of bud kill in the field. Serendipitously, we had been monitoring the lab-based freezing temperature of a number of varieties in our first variety trial when we had a cold episode in January 1994 that caused a range of bud kill from 0 to 100% among the vari-

eties. The correspondence between the predicted hardiness from the lab assays and the actual field survival of buds was excellent (Wolf and Cook 1994).

The controlled freezing studies in the lab allowed us to predict the cold tolerance of varieties without having to wait for "test winters" to sort it out.

Our variety evaluations, our crop level studies (Wolf 2004), and our vineyard floor management work all included evaluations of the impact on dormant bud cold hardiness. While we occasionally saw treatment effects on bud cold hardiness, the differences were modest, and more often observed in early fall or shortly before budbreak in Spring, likely reflecting differences in phenological development (Wolf and Cook 1992). For a given variety, optimizing vine health and performance for high wine quality potential almost always went hand-in-hand with optimized vine cold hardiness.

Novel variety studies

At the time of my hire in the mid-1980s, the "modern" Virginia winegrape variety portfolio had been shaped by both winery owner interests and consultation with extension specialists in other states such as New York and Pennsylvania. Some varieties such as Chardonnay did well, and some presented chronic issues. For example, Riesling was among our top three varieties grown in 1986. Again, when you consider the climate that we grow grapes under, rot-prone and heat-sensitive varieties such as Riesling and Pinot noir should have been recognized as poor candidates for building a state reputation.

I established three variety evaluation plantings over the course of my career, two at Winchester and one at another research center in what we call the southern Piedmont, a much warmer area of the state. Soon after my hire, I established a variety evaluation planting at our research station in Winchester. That first planting comprised 20 novel varieties plus a handful of benchmark varieties such as Chardonnay and Vidal blanc. Yield components, primary fruit chemistry, dormant bud cold hardiness, and vine performance data were collected from each.

Variety performance was shared with industry at meetings and in written media in a way that highlighted the pros and cons of the variety. An example of a variety which I introduced to the Virginia industry was Petit Manseng, of which the center of production was limited to the Jurançon region of southwest France. I was intrigued by Jancis Robinson's description of Petit Manseng, and fortuitously found that Cornell's Geneva Experiment Station had mature vines in a test planting, from which I was able to collect budwood.

The variety testing continues at Winchester: one of my last vineyard plantings before retirement was a collection of so-called "disease resistant" varieties, including some of the Vivai Cooperativi Rauscedo varieties and San Marco, of which New Jersey and the Outer Coastal Plain Vineyard Association has staked a claim.

Virginia was, and still is to an extent, in a unique position to explore novel varieties such as Tannat or Petit Manseng, as well as elite germplasm from breeding programs that offer enhanced wine quality potential, disease resistance, or unique phenology – such as the late-budbreaking Mourvedre -- that is better adapted to our continental climate. I recognize the consumer interest in classical varieties, but is this the best we can do?

Canopy management and vine training studies

I'll now speak about the canopy management and vine training work that we performed. The Virginia wine industry used an assortment of training systems in the 1980s and some of this was owed to recommendations from other states and from some of our Old World ex-pats' familiarity with the training systems. Unfortunately, fruit rots and generally poor fruit chemistry were prevalent problems, as I earlier mentioned. "Canopy management" was rudimentary at best at this time. But the late-1980s and early-1990s saw a renaissance of vine training, canopy management, and vine planting design that began to be reflected in better vineyard management and better wine quality potential.

My enologist colleague, Bruce Zoecklein, and I conducted numerous field studies to explore the impact of different training, canopy management, and cropping levels on several varieties important to the Virginia industry. These studies were done at cooperating vineyards and also at our research center in Winchester.

The training system comparison done at Winchester involved three varieties and three training systems. Varieties were Viognier, Cabernet franc, and Traminette. We used two divided canopy training systems, Smart-Dyson (SD) and Geneva Double Curtain (GDC), and a "standard" system that was beginning to be used more commonly in the industry, vertical shoot positioning (VSP).

There were specific reasons for choosing the three varieties in this project. Viognier, for example, was a rising star in our industry, but it had a propensity for low crop yields due to bud necrosis. Canopy division was a potential means of compensating for the low yield potential of Viognier. Both SD and GDC training had the potential to increase crop per vine, and per acre, possibly without negatively impacting crop quality. So, yield, fruit chemistry, and vine vegetative responses were of primary importance. We also lacked sufficient information on how fruit exposure affected volatile components of aromatic varieties such as Viognier and Traminette. As with most of our field experiments, the training system comparison was conducted for six cropping years, and major findings can be summarized for Viognier, for example, as follows (Zoecklein et al. 2008):

- GDC training increased cluster number, crop pervine, and fruit sunlight interception, and decreased cane pruning weight per meter of cordon, compared to SD and VSP.

- Crop yields were modestly adjusted in each of six seasons to result in average yields of 10 kg/vine (GDC), 10 kg/vine (SD), and 6 kg/vine (VSP).
- Fruit was harvested at comparable total soluble solids (Brix) values among training systems, with other primary components of fruit chemistry generally unaffected by training.
- Dr. Zoecklein's lab found that SD training resulted in the highest concentration of most free volatiles quantified in juice and wines, while GDC wines frequently had the highest concentration of phenol-free glycosides.
- Triangle difference sensory testing revealed that GDC wines generally had higher fruity and floral aromas compared to SD- or VSP-trained vines.

My interest in comparing training systems extended into a sabbatic leave in South Australia during 1999 to 2000, where I participated in and published (Wolf et al. 2003) a training system comparison study of Shiraz in the Barossa Valley. I owe a debt of gratitude to my sponsor and friend at the University of Adelaide, Dr. Peter Dry. As an aside, I encourage any academic colleague to take advantage of research study leaves, if available. The upshot of the Barossa field trial was that in the hot, arid climate of South Australia, the simplest system of our comparison often resulted in superior fruit yields and quality.

I started a large field experiment with Cabernet Sauvignon in the early 2000s. The goal was to evaluate several practical methods of suppressing vine vigor, with a working hypothesis that we could simultaneously improve wine quality potential through increased exposure of fruit on smaller vines with more light-porous canopies. The novel aspects of this work compared the use of under-trellis cover crop with conventional herbicide strips (Hickey et al. 2016). The rationale was that the competitive effects of a cover crop under the trellis could be used to throttle back vine vigor through water and nutrient limitation. The experiment also compared three rootstocks and another novel treatment – the use of root-restriction bags that are used in the nursery industry to suppress growth of the plant. While rootstock had an effect on scion growth in some years, the effects were not significant when averaged over the seven years of data collection. Under-trellis cover crop reduced cane pruning weights by 26% and increased fruit exposure by 35%. Under-trellis cover crops have become more common in our environment, as vineyards are increasingly sited on steeper terrain that can be subject to soil erosion.

Extension

Extension and outreach were the more public aspects of my work and my activities would likely be familiar to those with an extension appointment. What is important to point out here is that Extension delivery of information and knowledge was intimately tied to the research. Written communications, one-on-one interactions, service on industry associations and boards, and planning and conduct of industry-wide meetings were all tools of the trade. My extension outputs were typical of those used by peers at the time. Dr. Zoecklein and I started a bi-monthly newsletter the year we were hired. I continued "Viticulture Notes" for over 35 years and adapted some of the newsletter topics to Extension bulletins.

One of the outputs of my extension work was the assistance provided in developing a Geographical Information System (GIS) to help evaluate potential vineyard sites. To my knowledge, this was the first GIS tool for vineyard site evaluation in the US. My role in this work was to define important vineyard parameters such as elevation, slope, aspect, and soil characteristics, and to assign numeric values to these variables. This work started with MSc student John Boyer at Virginia Tech and resulted in two-dimensional maps of land suitability for vineyards on a 0 to 100-point scale. Advances were subsequently made by moving the GIS to a web-based platform, which potential growers could access at any time. The web-based version, developed by the Center for Geospatial Information Technology at Virginia Tech, allowed users to zoom to their areas of interest and generate a report on the vineyard suitability of the land parcel.

I feel that one of the principal legacies of my extension role was publishing the Wine Grape Production Guide for Eastern North America in 2008. This book was published by the Natural Resource, Agriculture, and Engineering Service (NRAES), affiliated with Cornell University. Several thousand copies were sold before NRAES was discontinued, but the book is now freely available as a PDF document through Cornell's eCommons collection.

Teaching

Until 2012, my teaching had been focused on graduate student advising, with the exception of guest lectures on campus. With a longing to try something different in my annual activities, and based on student interest in the grape and wine industry, I decided to develop and teach an upper-level viticulture course. This is not something I'd recommend to pre-tenure faculty without teaching appointments, but at this stage of my career, I felt comfortable taking the time to do this. Developing the content for the course was time-consuming, but I already had the Wine Grape Production Guide from which I could draw. Although time-consuming, I really enjoyed teaching – especially interacting with the students and reaching the end of the semester, when we all took a breather. For more than eight years, I taught more than 200 students, and applied changes to some of the modules every year.

Community service

I cite the example of a $3.8M USDA Specialty Crop Research Initiative grant that I directed from 2011 to 2015 to reinforce the notion that progress occurs in a team environment. The "community service" on something like this starts by stepping up and taking on the job. I also felt that as a member of a

professional organization such as the ASEV, it's important to contribute to the governance and policy-making of the society. I enjoyed and benefited from my service as an Associate Editor for the American Journal of Enology and Viticulture, and I was happy to serve as officer, including Chair, of the ASEV's Eastern Section. Yes, it takes time, but it's an important means of supporting the Society.

Administration

I won't dwell on this role, but 25 to 50% of my work time was devoted to serving as director of Virginia Tech's Alson H. Smith Jr. Agricultural Research and Extension Center from 2004 until my retirement in 2022. In essence, I was responsible for fiscal, physical, and personnel resources at the research center. This meant frequent meetings with college administrators and our faculty and staff, as well as outreach activities with the public and elected officials. There was no greater reward in the directorship role than to be able to hire motivated staff and faculty, make substantive improvements to our infrastructure, and promote and reward exceptionalism among our unit's staff, students, and faculty.

Conclusion

To close, I will reiterate the comment I made at the beginning of this talk that I had a lot of help along my career path. Some of this help came from technicians and post-docs; some from colleagues, including graduate students; and some from wage employees who wanted to learn more about viticulture. This assistance cannot be overstated.

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