ARS Grape and Wine Industry Workshop
Physiology, Cultural Practices, and Sustainability Presentation
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Purpose

The purpose of this presentation was to introduce our university and industry colleagues to the research programs being conducted by ARS scientists within the broad topic area of "physiology, cultural practices, and sustainability" in grapevines or vineyards. Six scientists were introduced; all work primarily or exclusively with grapes. Loosely translated, this disciplinary area could be considered one that addresses three lines of inquiry: 1) how the vine or vineyard works; 2) how we can make the vine or vineyard work better for the grower; and 3) how this better functioning can be sustained for the lifetime of the grower and beyond. Because the presenter is an ARS scientist working directly and exclusively with grapes, the material presented was from a bottom-up perspective.

Organizational Background

Many of our university and industry partners refer to their ARS colleagues sweepingly as "USDA," making it important to draw our partners' attention to the organizational complexity of the Department of Agriculture so that they may work and communicate more effectively with various agencies. Particularly important is knowledge that ARS and CSREES, while related, have different missions and objectives. Thus the audience was made aware that ARS is a single agency within the family of agencies under the USDA umbrella. Other USDA agencies that our stakeholder partners may have already been familiar with include CSREES (Cooperative State Research and Extension Service), APHIS (Animal, Plant Health and Inspection Service), NRCS (Natural Resources Conservation Service), and RMA (Risk Management Agency).

Within ARS, scientists are grouped into "Units" each of which is directed by a scientist with the title of "Research Leader." Units may have as few as four or as many as 16 scientists. Some units work in relatively congruous disciplinary areas or a small number of crops; others are more diverse. Some units are housed in large federal facilities; others are housed in university facilities on campuses; and others work in smaller federal facilities nearby or associated with university campuses. Within a Unit, one to several scientists are grouped into projects termed CRIS projects. The CRIS project system provides a mechanism of accountability to Congress. Awareness of the frontline organizational structure is critical for ARS' stakeholders to build effective communication with the agency and with individual units across the country.

Our industry and university partners may have observed that ARS scientists whose research programs are commodity-related, as are the grape-oriented scientists in this group, tend to build strong, visible working relationships with our industry partners. Such relationships are valuable for the scientists to focus their research on questions that are relevant to growers. However, such visibility and productive relationships should not be interpreted as ARS scientists having roles as Extension Specialists, Farm Advisors, or industry programmers. This is not the case. The audience was made aware of the specific mandate of an ARS scientist to conduct research of relevance to agriculture that ultimately will create a favorable impact on agriculture. ARS scientists are researchers first and foremost.

People and Places (Scientists and Worksites)
Paul Schreiner, Julie Tarara, Krista Shellie, and *Jungmin Lee* are part of the Horticultural Crops Research Unit, a team of 16 scientists working on various aspects of small fruit and nursery crop production, physiology, and diseases. Paul, Julie, Krista, and Jungmin work predominantly or exclusively on grapes. Three other HCRL scientists spend up to half of their time on grapes, studying insect pests, nematodes, and fungal diseases. Thirteen of the 16 HCRL scientists, including Paul, work in Corvallis, OR, in an ARS building on the campus of Oregon State University. Julie's worksite is at the Irrigated Agriculture Research and Extension Center, a facility of Washington State University, in Prosser, WA. Krista and Jungmin's worksite is in an ARS facility at the Parma Research and Extension Center of the University of Idaho in Parma, ID.

Kendra Baumgartner and *Kerri Steenwerth* are part of the Crops Pathology and Genetics Research Unit, a team of seven scientists working on a variety of crops. The CPGRU is located in university facilities on the campus of the University of California at Davis. Kendra's program is housed within the Plant Pathology Department and Kerri's program calls home the Viticulture and Enology Department.

Grape-related scientist positions have come to ARS in a number of ways. For example, Paul Schreiner filled a vacancy left by a retirement. Although the discipline of the position remained the same (root physiology), Paul's research leader directed him to focus specifically on grapes. By contrast, Julie, Kendra, Krista, Kerri, and Jungmin's positions were added to ARS by "Congressional Directive" as a result of targeted lobbying of members of Congress by various stakeholder groups. The Congressional directives established the disciplinary area of research, the crop to be studied, the size of the research budget, and the worksite of the scientist.

In the long term, ARS subscribes to a philosophy of defining the specifics of a position by the "scientist in the job." The scientist in the job develops an area of expertise and carves out a niche within the broad scope of the original directive such that during his or her career, he or she builds a national and international reputation within the discipline. Finally, it was mentioned that the ARS scientists in the "physiology, cultural practices, sustainability" group maintain active collaborations with university colleagues from the University of California, Oregon State University, Washington State University, and the University of Idaho, among others.

Physiology/Cultural Practices/Sustainability Research Programs
In response to the Food Quality Protection Act (1996), the California Association of Winegrape Growers (CAWG) recognized a potential for devastating restrictions on indispensable chemicals, not the least of which could be sulfur dust—a cheap, effective, organic, and non-resistance-inducing mainstay for control of powdery mildew in grapes. Hence the proposal to Congress to establish ARS scientists to evaluate pesticide use plus alternative cultural practices for general pest and disease control in viticulture, with an ultimate goal of limiting or reducing the industry's dependence on pesticides, i.e., "sustainability." Kendra Baumgartner, a plant pathologist, emphasizes sustainable control of grapevine diseases of fungal or bacterial origin. Her goal is that by understanding pathogen spread and diagnosis, she will be able to develop control

practices that are cost-effective and physically practical enough that most growers will be able to make them part of their overall IPM strategy. Her current projects involve control of *Armillaria* root disease by cultural practices and biological agents; and Pierce's disease by management of the disease vectors and alternate hosts in riparian areas near vineyards. Additionally, Kendra is pursuing applied and basic studies of mycorrhizal fungi in terms of the effects of vineyard floor management practices on indigenous fungal populations, and their contributions to nutrient uptake from cover crops. Mycorrhizal fungi are not pathogens; they are beneficial root fungi that help plants absorb higher concentrations of soil-derived nutrients than they could on their own. Early studies on phosphorus deficiencies in vineyards planted in fumigated soils demonstrated that grapevines rely heavily on these fungi for nutrient uptake.

Also pursuing sustainability issues is Kerri Steenwerth, Soil Scientist, who joined ARS in 2004. Thus Kerri's program is in its development phase. In the initial discussions of what constituted "sustainable viticulture" and how Kendra Baumgartner's program might evolve, a key herbicide concern was brought up: Simazine and its relatives. Ultimately CAWG proposed that Congress establish an ARS position for a weed ecologist to address non-chemical and reduced-chemical alternatives to vineyard floor management. Kerri's research emphasis will include weed ecology, but she also will be expanding that mandate with a holistic perspective to understand soil microbial ecology in vineyards and soil-root interactions within the grand scheme of vineyard floor management. She expects to address specific questions about tillage and mowing; the management of cover crop residues; and the cycling of carbon in vineyard soils. There currently is discussion in the Crops Genetics and Pathology Research Unit of how to define a newly-appropriated scientist position (2005) within this emerging sustainable viticulture group, potentially to address water management or vine physiology with respect to water management.

Farther north in Corvallis, OR, Paul Schreiner also is in pursuit of a holistic understanding of the below-ground environment, working from the perspective of root physiology and the interactions between grapevine roots and mycorrhizal fungi. Pursuit of the mysteries of the subterranean world may not be glamorous or fast, but it is a foundation of vineyard sustainability. Mycorrhizal fungi are one of very few soil organisms that have been demonstrated both in the greenhouse and in the field to have direct, measurable effects on grapevine nutrition, particularly with phosphorus. Paul has conducted controlled experiments on mycorrhizal colonization in young vines, important for our understanding of vineyard establishment. However, mycorrhizal colonization is equally important in mature vineyards because it is the fine roots of mature vines that are responsible for water and nutrient uptake. Fine roots turn over, or replace themselves one or more times per growing season depending on the climate. Knowledge at this level of biology will have application to vineyard management in terms of irrigation scheduling and fertilizing. In fact, excess fertility suppresses mycorrhizal populations. Healthier root systems, vines that are more efficient miners of soil phosphorus and soil water, less money spent on fertilizer, and more rapid vine establishment all are valuable contributors to the economic viability of the vineyard.

Vineyard production practices and their ultimate effect on fruit and wine quality are mandates of the viticulture program that extends to the remote worksites of the Horticultural Crops Research Unit (Prosser, WA and Parma, ID). Krista Shellie is building a program to investigate the impact of irrigation management on berry quality and vine health. She is also evaluating geographic and

site-specific adaptations of grape varieties, and irrigation management in challenging climates. She will assess the effects of various cultural practices on fruit quality with an emphasis on production in an arid climate that has risk of winter cold injury. In the wine market, it is evident that varietals are commanding more market share and at higher margins. The successful varietal mix will change over time in response to the global wine market, thus requiring guidelines for location-appropriate varietal selection, particularly in some of the more marginal climates. Krista's approach will produce a logical contribution to medium- and long-term economic viability of the vineyard enterprise in a highly competitive marketplace. In cooperation with the University of Idaho, Krista oversees a wine grape varietal vineyard and has been consulting with commercial winemakers to vinify as many varieties and clones as possible for future chemical analyses of quality attributes.

Also at the Parma site is Jungmin Lee, a Food Technologist who joined ARS in late 2004. Thus Jungmin's first order of business has been to establish her analytical laboratory and its standard protocols for wine chemistry analysis. Jungmin expects to study analytically the chemical components of commercial wines that may be associated with wine quality; to investigate and potentially identify appellation-specific attributes of wines; and to connect some of the cultural practices identified by viticulturists with the attributes we associate with fruit and wine quality. Jungmin already has been collaborating with an industry partner to examine the effects of seed removal during fermentation on the phenolic compounds in red wine.

Unlike the rest of the physiology, cultural practices, sustainability group who focus on the biotic environment, or living organisms (Jungmin excepted), Julie Tarara addresses the vine and vineyard microclimate, or the abiotic environment. Microclimate modification is one of the cornerstones of horticulture. The crop microclimate is something we can manipulate with reasonable effort, and have been doing so for millennia, even if farmers did not recognize their practices as such. Julie's program is designed to work in concert with plant physiologists to understand how the physical environment affects both small-scale vine biology and the entire vineyard. Better knowledge of these interactions will allow growers to make more rational decisions about which agricultural practices they can expect to make a reasonable return on investment via fruit quality or vineyard longevity. The physical environment is integral to the functioning of plants, which, unlike animals, cannot walk away from adverse conditions. Some of Julie's specific projects have included direct measurement of vine water use under well-watered and deficit-irrigated management; measurement of whole-vine photosynthesis and transpiration under deficit irrigation; separation of the effects of temperature from those of light in the 'sunscald' of red-fruited varieties; and devising an apparatus and method to exploit the existing trellis elements for continuous crop monitoring and automated yield estimation.