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Precision Agriculture in Grape Production

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As the new Director of the Center for Precision Agricultural Systems at Washington State University, I was asked to speak at the Annual Meeting of the Washington State Grape Society about what precision agriculture is and what it might have to offer to the grape industry in Washington. I eagerly accepted the Society's invitation to speak, in part because I am excited about precision agriculture and wanted to share my thoughts with you, and in part because I have a lot to learn about grapes and your meeting was a great place to start.

First, let me introduce myself. I am a soil scientist with M.S. and Ph.D. degrees in Soil Science from the University of Minnesota. I came to Washington from Michigan State University where I was a professor of Soil Science in the Department of Crop and Soil Sciences, having been on the faculty there for 16 years. My research interests have been in soil management, working in the area of conservation tillage and soil and water quality as it related to the production of the major grain crops, as well as potatoes, sugar beets, dry beans, and tomatoes. While I haven't worked with grapes, I have fond memories of growing up in Upstate New York and visiting the wine vineyards in the Finger Lakes Region, particularly those around Naples, NY. Since 1991, I have been actively involved in the development and evaluation of precision agriculture. On September 1, 2000, I became the Director of the Center for Precision Agricultural Systems at WSU.

The Center for Precision Agricultural Systems (CPAS) was funded by the Washington State Legislature as part of the WSU Advanced Technology Initiative in 1999. The legislation provides base funding for the Center for years to come. The vision for CPAs is to be the internationally recognized leader in the development of precision agricultural systems for products and environments characteristic of Washington State. The goal of CPAs is to foster collaborative research, education, and outreach programs that create practical technologies and management systems for precision agriculture that support competitive production of Washington's agricultural commodities, stimulate the state's economic development, and protect the region's environment and natural resources.

The message to the grape industry is that the role of CPAs is to advance the science and practice of grape production and utilization through innovations in technology. A major pathway for technological innovation in the grape and wine industry is to enhance current research efforts through the creation, adoption, and/or adaptation of the technologies and principles of precision agriculture or instigate new research to meet industry needs. My message here is simple: Tell me about grapes and how the Center

for Precision Agricultural Systems can help!

What is Precision Agriculture

Over the years, I have defined precision agriculture in a number of ways. At a speech in Iowa in 1994, I defined it as "Doing the right thing, in the right place, at the right time, and in the right way" (Pierce, 1994). This definition reflected the intuitive appeal of what was then called "site-specific management" in which inputs were applied to areas within fields based on location specific needs of crops and soils rather than on a whole field management strategy as has been the traditional approach. Based on limited information I have already heard since my arrival this fall, this definition fits grape production in Washington very well. After all, vineyard management is all about achieving grape quality through a well-managed growing environment.

In a recent review of precision agriculture, we defined it as "the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for the purpose of improving crop performance and environmental quality" (Pierce and Nowak, 1999). While complex, this definition brings some important aspects of precision agriculture to the forefront. The first is that precision agriculture is about managing spatial and temporal variability in crop production. What this means is that attention to detail at every step of crop phenology is essential to optimizing crop productivity and minimizing environmental impacts of crop production. The second is that precision agriculture is TID - Technology enabled, Information Based, and Decision Focused. The technologies underlying precision agriculture - computers, Global Positioning Systems (GPS), Geographic Information Systems (GIS), sensors, both ground based and remote, and control systems - make attention to detail possible at levels never before achievable. This "attention to detail" creates considerable information management requiring the full spectrum Information Technology advancements available on the farm. The notion here is that "you cannot manage what you do not know". Ultimately, value from precision agriculture comes not from just knowing the details but rather from decisions made from that detailed knowledge base. In other words, no decision - no value. It is easily demonstrated that a yield monitoring system, one of the flagship technologies of precision agriculture in the 1990s, produces yield maps that are very informative albeit data intensive, yet in themselves produce no value until they lead to a management decision on the farm. Thus, the value of precision agriculture is found in decisions made.

More recently, this fall, my colleague and I defined precision agriculture to the Information Technology sector as "the digital face of agriculture" (Pierce and VanAcht, 2000). We made the case that the next agricultural revolution would be based on a model of agricultural productivity based on "brainpower", quite different from the "horsepower" model responsible for the agricultural revolution of the 20th century. The "horsepower" model was based on major advances in machinery, chemicals, irrigation, and seed technology that improved crop yield and quality but also put pressure on our natural resources. The dilemma facing US agriculture today is that markets are global, inputs are local. The result is and will be continue to be economic pressure on farm families to get more efficient and be more market focused in order to stay viable. Add to that growing concerns over agriculture's impact on air, water, and soil quality, farmers must also actively engage in new farming practices that enhance the environmental performance of their farming operations. The "brainpower" model for agricultural productivity in the 21st Century will be based on improved genetics, integrated pest, water, and fertility management, and automation of field tasks. The "brain-power" model of agricultural productivity requires information technology (IT) that is the essence of precision agriculture.

Extracting Value from Precision Agriculture

In my view, precision agriculture is much more than variable rate technology (VRT) and yield mapping, as is often portrayed in the popular press. I believe that precision agriculture impacts the complete spectrum from plant genetics to the table. For example, applying the technologies and principles of precision agriculture to crop selection should hasten the commercial release of new varieties. In other applications, precision agriculture could facilitate identity preservation of food products for the consumer or provide for new methods of early detection of crop, soil, and pest problems for growers. The broad

view of precision agriculture as advancing technology from genetics to the table will lead to value. The key for CPAs will be finding pathways to extracting value from precision agriculture. I offer four potential pathways for precision agriculture to provide value to agriculture.

The first pathway to extracting value from precision agriculture is to improve current practices and technologies in part by increasing the efficiency and/or efficacy of agricultural inputs. Variable rate technology for soil fertility management is the most common example. The concept was to take existing fertilizer management practices and apply them to smaller areas within fields. The concept is viable in principle but in practice, this did not produce large economic returns in many areas. This pathway of doing what we already do better has been a main focus of precision agriculture to date. There are opportunities here for grapes particularly where optimization of inputs is required to ensure grape quality.

A second pathway for extracting value from precision agriculture is to facilitate problem solving on-the-farm. In many ways, precision agriculture is a problem solving tool kit. The attention to detail in space and time have provided insights into problems not possible in other ways. As for value, the value of a solved problem is often underestimated in part because there are long-term benefits from problems solved. One example of a problem that precision agriculture could address in grapes is crop estimation.

A third important pathway for extracting value from precision agriculture is found in the area of basic research. There is great value in the detailed information and knowledge obtainable via precision agriculture about the processes and properties regulate crop productivity and environmental impacts from crop production. For example, detailed information in space and time about a pest would provide a basic understanding about the its life cycle and may lead to more integrated approaches to its management in crop production.

A fourth pathway for extracting value from precision agriculture is found in the development of products, services, and management practices specifically designed to take advantage of its inherent features. The notion here is that the value in new technology is found not so much in the ability to do what you already could do better, but rather in doing things that could not be done currently. Consider, for example, the conversion from DOS operating systems to Windows. The value in converting to the Windows operating system was in what you could do with it that you could not do with DOS. The reason Windows was successful was largely do to the fact that others built applications that used the inherent features of Windows. Windows got better and evolved into Windows95 because of demand for more and better applications. So, the value of precision agriculture will be found in its applications. I believe this is the major value pathway for precision agriculture. Unfortunately, little has been done in this regard to date.

The focus of CPAs will be to explore all value pathways from precision agriculture. I have exciting ideas of how we can do this in grapes. I look forward to working with you in these ways.

Precision Agriculture: Is it for Grapes?

I sense that precision agriculture is made for grapes and that it is already in practice in its early stages. I heard that in statements made at the first day of this Grape Society meeting. I saw it nearly 10 years ago during my visit to wine growing regions in California where vineyard managers were irrigating and fertigating grape plants by vineyard location and site-specifically harvesting grapes for wine processing. At the first day of these meetings, Ray Folwell stated in his speech that "Agriculture in the US has to change . . . Growers must adopt advanced technology to survive" (Dr. Raymond Folwell, Nov. 16, 2000). A grower spoke here about the use of precision agriculture in establishing new vineyards, including the use of grid soil sampling and the establishment of precision irrigation management zones. There were at least four trade show exhibitors currently offering products and services related to precision agriculture at these meetings, including those used by this grower. Another grower spoke of stopping irrigation sooner in low areas in order to harden grape plants against frost damage. Clearly a space and time management consideration relevant to precision agriculture. The American Viticulture &

Enology Research Network (AVERN) states that "In this world wine economy, only those who progress survive"

(wineserver.ucdavis.edu/AVERN/avernnat.HTML). Many of the research priorities presented by AVERN for grapes and grape products have dimensions of space and time that are conducive to precision agricultural management. So, my answer to whether precision agriculture is for grapes is a resounding YES!. It is my intention to work through CPAs to assist the grape industry in extracting value from precision agriculture.

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