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Grower Expectations of New Technologies for Applications in Precision Horticulture[1]

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Needs assessment is a primary step in developing any new technology. An 'Orchard-Vineyard Customer Focus Meeting' was held on May 11, 2010, at Ben Hill Griffin, Jr. Citrus Hall, Citrus Research and Education Center, Lake Alfred, Florida. This focus meeting was organized through the Integrated Automation for Sustainable Specialty Crop Farming project sponsored by the U.S. Department of Agriculture-National Institute of Food and Agriculture. The project involves Carnegie Mellon University, the University of Florida, Cornell University, and John Deere & Company. The overall purpose of this meeting was to bring together different stakeholders (growers, processors, and industry representatives) from the apple and citrus industries and discuss issues related to orchard management. This article provides a synopsis of perceived growers' needs, expectations, and concerns related to the new technologies being developed for various precision horticulture applications. Agricultural equipment manufacturers, scientists, and investors that are planning to develop a commercial product for the precision management of fruit crop or other precision horticulture applications can be expected to benefit from the summary of a needs assessment. Needs were assessed based on recorded responses to a series of questions asked during the focus meeting (Appendix 1).

General Expectations

A general summary of grower needs and expectations of any advanced sensing technology are listed below:

- Growers will adopt new technology if it is based on credible science, with a clear acknowledgement from manufacturers indicating possible technological limitations. Evaluations from other growers/stakeholders or credible institutions regarding the performance of the technology was also deemed important. Growers are more likely to make a commitment to purchase the product if they could test the product for as much as one to two weeks to ensure that the technology is useful for their operation.
- The costs (primary, maintenance, and operational) associated with the technology should be low with reasonable financial return (lower production costs, higher productivity,

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and/or higher profitability). For example, citrus growers expect a 10% or higher return of investment on new technology.

- New technology should be robust, reliable, durable, user-friendly, broadly applicable (e.g., can be used for different crops and field operations), require minimal technical skills, and preferably use a multilinguistic guidance system (e.g., English and Spanish). Growers are interested in modular systems for their desired application rather than a larger and more costly product that is designed to do multiple tasks and might need higher investments. A modular system will allow them to add a capability to the system when they need it.
- After the purchase of the new technology, growers need good customer service and technical support from the product-delivering company.

It is anticipated that as younger, more technology savvy growers enter agricultural production, the acceptance of new technologies will accelerate.

Disease Management

Regarding investing in a disease sensing technology, a primary grower interest is to reduce scouting costs—especially after the onset and spread of devastating diseases such as citrus greening disease or Huanglongbing (HLB). Growers predict that scouting will be a major future expense that could reduce the profitability of the entire citrus industry. Some of the growers' expectations for new technologies include:

- A cost-effective, reliable, rugged, fast, disease detection sensor with a high degree of accuracy (expected accuracies ranging higher than 80–90% for HLB detection).
- A sensing technology that can be in the form of an automated sensor or a handheld device for assisting less experienced scouting crew members.
- In apple orchards and other fruit crops, disease prediction is more important than detection—especially for diseases such as apple black spot and fire blight.

Having faced the unexpected devastating effects of HLB, citrus growers are becoming more aware and better equipped to manage other diseases that might become a possible threat in the future (e.g., black spot in citrus).

Yield Estimation

The cost and time associated with yield estimation is another important subject of interest to stakeholders. Some of the growers' needs were identified as:

- A fast, reliable, and cost-effective technique for early yield prediction so that growers and processors can negotiate the cost of fruit based on availability and demand. Specific interest was expressed in characterizing tree size, canopy volume, canopy density, and possibly growth rate (to predict fruit size at harvest) for yield estimation.
- An affordable sensing technology for yield estimation to help evaluate production several times during the growing season.
- The expected accuracy of a sensing technology for yield prediction is 96–97% or greater.
- It was stated by the growers that the traditional method of removing fruits from the trees early in the season and using statistical models to predict yield gives accurate results, provided the models correctly account for the current tree inventory.

Precision Spraying

Some of the growers' expectations for new technology with regard to pesticide application are:

- Precision spraying using any new technology should reduce the need for pesticides (lower costs) while meeting environmental regulations (air, water, noise). For example, apple growers use disease predictive models for pesticide application (e.g., against fire blight) to minimize

the amount of pesticides required for disease control.

- Commonly, pesticide application is prophylactic. It is important to establish or determine the optimum pesticide application in terms of amount per tree, especially for the fresh fruit market where fruit appearance is such an important determinant of price.
- There is a need for sustainable biofuel for sprayer operation to reduce fuel costs.
- Growers expressed a great deal of interest in sensors that can determine the amount of chemicals to be used in addition to monitoring and controlling the spray direction and flow based on the need (area/canopy volume and size).
- Effect of wind on sprayer operation that leads to drift (thus, wastage of chemicals) is a major concern during pesticide application. If this aspect is included in the development of precision spraying equipment, the technology is of much higher value.

Autonomous Vehicles

With regard to autonomous vehicles, the grower's three major concerns are functionality, reliability, and safety. Other concerns are as follows:

- There was some concern with respect to the efficiency of an autonomous agricultural vehicle in comparison to a manually operated one.
- Another concern is the presence of a large number of electronic components (especially in automated spraying operations) that may have a higher potential to fail (and also require expertise to fix).
- Questions were raised related to the potential negative impacts of automated vehicles, such as canopy breakage and technical failures during critical management practices.
- A requested feature was that the autonomous vehicle be manually used in an event when growers need to operate it as a conventional one.
- Growers also prefer simple operation, requiring minimal expertise for the operation of automated vehicles.

Appendix 1. List of questions asked during focus meeting in different sections

Growers' challenges

- Three most common (critical) challenges you face in orchard management.
- Three unique challenges you face.

Growers' views on developed technologies

(after demonstration of the technologies developed as a part of this project on disease detection and yield prediction)

- Which feature did you find most useful?
- Which feature did you find least useful?
- What is your overall first impression?
- Did you have any major concerns?

Technology value

- Will you use the technologies developed in this study? Why?
- What impact do you feel the technology would have in your operation?
- What benefits might the technology have based on your experience?
- What is your anticipated outcome from the developed technology?

Technology commercialization

- How would you go about purchasing the product?
- What are the top three requirements for purchasing the product?

- What is the support you anticipate after the purchase of the technology?

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