

# WTFRC Technology Roadmap

# Case Study: SmartOrchard





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The Smart Orchard project in Grandview, WA is headed by Steve Mantel and the team at Innov8.ag, and aims to optimize resource utilization, reduce waste, and increase yields by "sensorizing" the orchard. The specific focus of the project is on irrigation, nutrients, soil health, and plant health, with the overall objective of creating a more sustainable and efficient orchard. The annual report for the project will be released in Q4 2023.

# **Project Goals and Technologies**

2023 was the third year of the Smart Orchard project, and the first year the project has been carried out in its new location, where the orchard is more highly variable in terms of terrain, topography, and plant and soil health. A focus in the past three seasons was to bring in a variety of commercially available sensors, from simplistic to highly complex, to experiment with what is currently possible in terms of data collection, processing, relatability, and return on investment. Specific goals for the 2023 season were to isolate irrigation and chemical thinning task maps to inform variable rate applications. Engaging with both University and commercial researchers was also a target outcome.

Tools and technologies in use:

- Lidar
- Green Atlas Cartographer
- Smart Apply Intelligent Spray Control System
- Swan Systems
- Burrow Tractors

#### **Shifting Orchard Locations**

Correlating input data to yield was an early goal, but the project met with limitations when annual yield data was not widely accurate or readily available after the first season. This lack of information led to a heavier focus on crop load management tools in the second season, to allow researchers to be able to understand yield and quality impacts more immediately throughout the growing season. Green Atlas was the main partner that could provide crop load management data in-season in 2022. However, though crop load management data was collected in 2022, it was largely not actionable because of highly uniform conditions within the orchard which meant that the goal of separating the orchard into different management zones was not achieved. This uniformity prompted the move to the new location in 2023– an older, more variable Honey Crisp orchard– and led to the closure of the previous location.

#### 2023 Focus Areas and Early Results

Extensive crop load management data was available from the test orchard throughout the 2023 season, from cluster numbers to leaf area to fruit color index, and total apple counts per acre.



# Blossom Density



Lidar imagery of actual tree on right, selected from map on left





#### Map to tree image



Computer vision zoom identifying blossoms



Additional focuses in 2023 were mapping, irrigation optimization, fertility optimization, and spray optimization, with a particular goal of creating zones to adopt more precise prescriptions. Five applications of a chemical thinner were done with greater precision, with the test area of the orchard isolated into three zones targeted with three different application levels ("high," "medium," and "low" application rates). To accomplish this, the grower did have to make three different passes through the field to apply at three different rates due to the immaturity of



precision spray tools for orchards. The team did witness a noticeable increase in uniformity among cluster size across the three zones as compared to the control sections.

### Laying the groundwork for automation

Bringing together different layers of data to make them all more relevant to growers is another key goal of this project. The team has been able to visualize inter-seasonal data around bi-annual bearing characteristics for Honey Crisps (see image below). This information can be translated into labor maps to advise with precision on intensity of pruning (which has led to consideration of other possible solutions, like marking the ground with green paint in front of "light prune" trees and with red paint for "heavy prune"). In a larger sense, however, this data makes a strong argument for developing and adopting tools and tech that can facilitate precision pruning. In other words, this kind of data is ready to be automated.

Top left shows yield density in 2023, top right yield density in 2022, and bottom shows yield density in 2021



# **Irrigation Experiments**

On the irrigation side, the Innov8.ag team worked with SWAN Systems to pull in irrigation data, which was then overlaid with soil type data and the crop coefficient for the specific variety in the specific location, tied in with satellite imagery and weather forecasts to create additional advice for irrigation sets in a coming week.





### Soil map data for the SmartOrchard site for integration with irrigation data

#### **Takeaways and Areas for Improvement**

The work of Innov8.ag provides a powerful, third-party perspective on the usability and usefulness of some of the commercially available tools, especially in the irrigation and crop load management spaces. It is valuable for the commission to have access to the findings of the SmartOrchard. Additionally, the project has served as a valuable convening tool, bringing together farmers and other stakeholders, and those in need of training, to share ideas and envision the future of technology in the industry. Growers too have gained some insight on soil type and prospective layout of future plantings, especially at the current Washington site, where the orchard will be replaced after the current season.

However, a few key improvements should be made to the project going forward.

- Representative site(s). The SmartOrchard in 2023 operated in a very mature orchard. Going forward, finding a more representative orchard where the project can remain for a period of years or decades will be key to developing and verifying the results of inter-season data. Maintaining one or a few representative sites in the long term will increase the usability of the results for growers, and likely increase the intangible benefits of the orchard as a convening space.
- 2) **Focus.** Determining extremely clear and limited in-season goals with this project, and perhaps even curbing the number of questions under exploration at a given time, will likely result in more actionable results for growers. For example, though advanced irrigation tools and sensors have been in place in SmartOrchards at their various locations since the first season, many variables were being manipulated simultaneously, muddling



the actionability of insights and replicability of results. Identifying a season in which the only variable to be experimented with is water (as manipulated and tracked through various tools), for example, could yield more usable information than proceeding with a broad slate of variables and goals each season.

- 3) **Identifying areas for future work and collaboration.** The usability and applicability of SmartOrchard findings seem to be limited by two main factors: 1) the digital nativity of farm managers and agronomists; and 2) the availability of tools that facilitate precision activities.
  - a) **Digital nativity.** In the first case, the Innov8.ag team has developed the ability to convert massive amounts of data into visualizations that could allow growers to isolate problem areas of the orchard, develop fine-tuned management plans, and understand in-orchard nuances at a granular level. To take full advantage of this, however, decisions-makers need to have advanced digital data processing and analysis skills.
  - b) **Equipment to action recommendations.** In the second case, though Innov8.ag has made interesting advances in linking and overlaying data and being able to convert that data into shape files and tasks that could be carried out by precision equipment, there is an absence of precision equipment in the orchard space that can utilize those files to carry out those tasks. This is true in irrigation, nutrient and chemical application, and crop load management.

These limitations suggest that there must also be focus on closing gaps that exist beyond the scope of this project before the full benefits of SmartOrchard work can be realized by Washington growers.