

Can clean get cleaner? Evaluation of cleaning and sanitation process improvements for harvest equipment of leafy greens

Summary

A baseline assessment conducted in 2023/24 to define “What is clean” funded by the Center for Produce Safety provided near real-time data on Cleaning & Sanitation (C&S) practices in states under the FDA Leafy Greens Harvester Sampling Assignment (CA, AZ, FL). Key findings included: (1) Cleaning tools and detergents impact microbial reductions more than sanitizers alone; (2) Chlorinated detergents significantly reduced ATP, Total Coliforms, and *E. coli*; (3) The cleaning step itself has the most significant bacterial reduction effect; (4) Cross-contamination risks exist in current SOPs; (5) ATP monitoring effectively evaluates C&S effectiveness in real time. Simple changes, such as better tools, dedicated cleaning time, proper chemical application, and improved crew training, enhanced C&S performance. However, initial study conditions likely represented a best-case scenario, as equipment was cleaned immediately after harvest. Real world conditions, including prolonged equipment sitting, may increase biofilm formation, requiring adjustments like low-pressure or foamer applications to improve efficacy. This project will build on previous efforts to assess the impact of harvester sitting time, continuous sanitizer use, the use of two new chemistries not evaluated previously PAA and CLO₂, and improved tool usage to refine industry practices and enhance harvest equipment sanitation efficacy.

Objectives

1. Objective 1: Enhance our understanding of the impact of time/temperature (prolonged equipment sitting), through aggressive sample collection and assessment in three produce growing regions of the US (AZ, CA, and FL)
2. Objective 2. Evaluate specified tool and continuous sanitizer use on the effectiveness of cleaning and sanitation of harvest machines to inform industry practice

Methods

The research and extension team will assess a total of 9 harvest machines, aiming to visit each machine a total of three times each during the beginning, middle, and end of each regional harvest season. This will allow the assessment of diversity of regions, conditions, equipment types, and harvest conditions. We will assess three-point belt type harvesters and will also include a minimum of 3 tender leaf harvesters (one in each state). Swabs will be used to assess surface prevalence (presence/absence) and concentration for a variety of indicator measurements including bacteria. Swabs will be submitted to Eurofins Labs (<https://www.eurofins.com/environment-testing/>) in each state where the study is being conducted to follow AOAC Standard Methods used by commercial labs for better comparability across states. Swabbing will commence at project initiation, per harvester unit, and will consist of the following swabbing frequency: 25-point swab pre-cleaning (post-harvest), 25-point swab post-cleaning (wash down, detergent application, and rinse), and 25-point swab post- sanitizing (wash down, detergent application, rinse, and sanitizer). For each event, we will assess the following parameters: ATP (Charm Field Format **and** Hygiena), Aerobic Plate Count (APC), generic *E. coli*, Total Coliform bacteria, and Enterobacteriaceae, Glucose and/or Lactose, and Protein (GFSI accepted). Metadata related to conditions surrounding each swabbing event will also be collected to assess commonalities and variability in cleaning and sanitation practices.

Results to Date

To date, our team has acquired new equipment, supplies, and has trained students and staff on methods/procedures we aim to deploy for harvest machine swabbing during the upcoming leafy greens 2026 spring/summer season in California and 2026/2027 fall/winter seasons in AZ and FL. This includes expanding our previous assessment to include both the Charm and Hygiena ATP meters, new Protein swabs, and new Sugar swabs. These new tests will be conducted in addition to the analytes previously evaluated. Working with Factor IV, the research and extension team has also acquired the necessary asset tracking equipment for machine deployment. We have recruited harvest companies (new companies and those from the previous sanitation project) for inclusion in swabbing evaluation under Objective one. Additionally, swab sample analysis contracts have been established for Eurofins in each of the three participating states, AZ, CA, and FL in preparation for sample collection. We are also currently preparing calendar and timelines for sample collection including who is responsible and how many samples should be collected for each analysis and the appropriate universal coding within in state. Sample collection has been initiated in May of 2026.

Benefits to the Industry

Success of the project will include an increased understanding of the impact time, temperature, and complete coverage of sanitizer may play on cleaning and sanitation efficacy. Our previous work greatly increase industry understanding on the impact of detergent and sanitizer type on the reduction of microbiological indicators assesses as well as grower guidance to overcome potential hurdles. By investigating shifts in cleaning and sanitation practices to increase contact time and coverage of sanitizers on food contact surfaces, this project will provide real world data to inform and improve industry practice leading to reduced risk.

Analyte (Bacterial or other target)	Method
ATP	Charm Field Format
	Hygiena SuperSnap -ATP swab with increased buffering and sensitivity
Aerobic Plate Count (APC)	AOAC 990.12
generic <i>E.coli</i>	AOAC 991.14
Total Coliform Bacteria	AOAC 991.14
Enterobacteriaceae	AOAC 2003.01-2006
Glucose/Lactose	Hygiena SpotChek Plus – Rapid Glucose & Lactose Test
Protein	Hygiena PROClean – Protein Hygiene Tester

Figure 1:
Analytical Targets

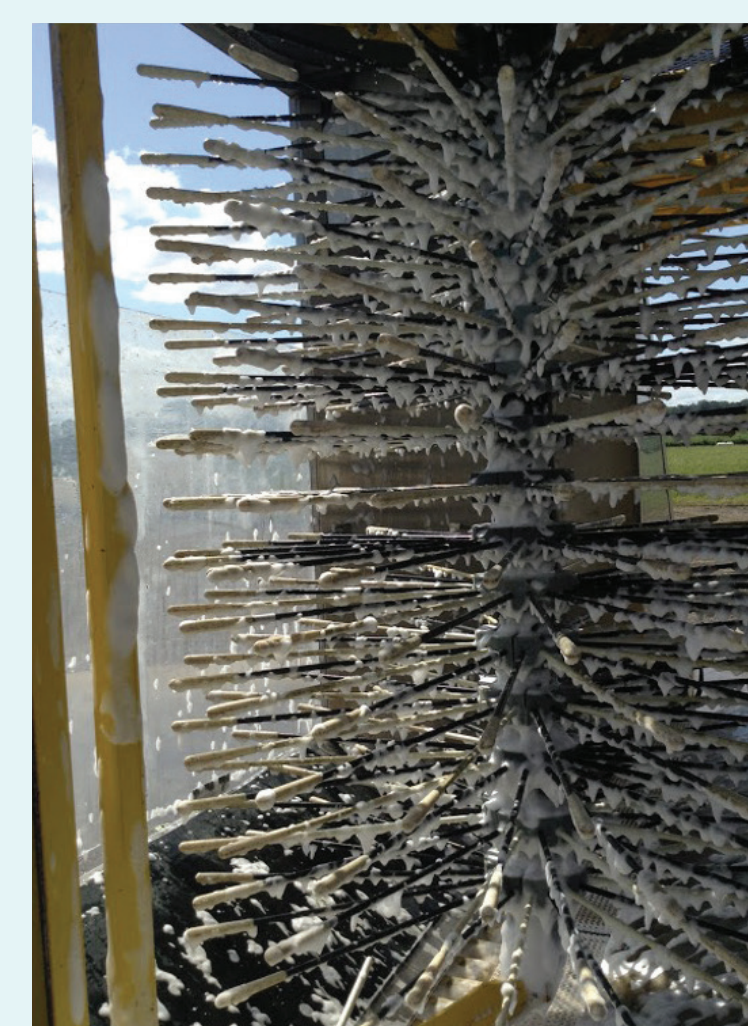
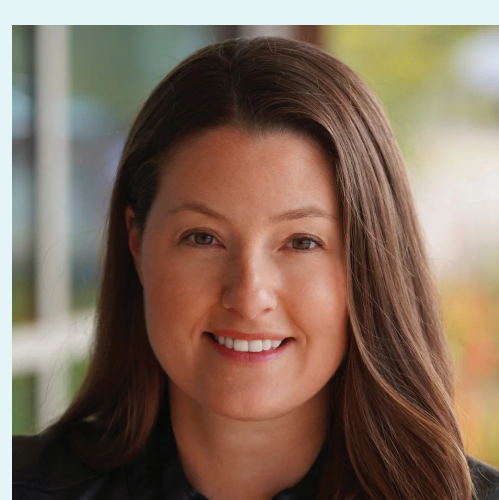


Figure 2:
Foaming Detergents



Figure 3:
Bright belt to flood detergent or sanitizer on belt surface



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