Food safety in the greenhouse

Implementation of the Food Safety Modernization Act will impact fresh produce-growing greenhouse operations in a variety of ways

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The greenhouse produce industry continues to grow. Over one-half of tomatoes and one-third of peppers sold on the fresh market are greenhouse grown (Brauther, 2010).

While greenhouse production can be a significant driver of local economies due to high profit margin and opportunities for value-added products, it is not without economic risks.

The mainstream publicity of national foodborne disease outbreaks linked to fresh produce consumption has shaken consumers' confidence. An outbreak associated with a single greenhouse could have catastrophic consequences for owners and employees, including bankruptcy and jail time.

Greenhouse production centers on controlling environmental conditions. However, practices are not designed to reduce microbial contamination.

In fact, the very conditions that allow intensive, year-round greenhouse production are unfortunately conducive to the survival, growth and spread of foodborne pathogens.

In 2013, greenhouse cucumbers contaminated with *Salmonella* Saintpaul infected 84 individuals nationwide (CDC, 2013). The food safety concerns related to greenhouse-grown produce are real.

Food Safety Modernization Act and the *Produce Rule*

The Food Safety Modernization Act (FSMA) authorizes the U.S. Food and Drug Administration (FDA) to regulate food safety at the farm level, and specifically establishes new standards for produce production via the *Produce Rule*.

If your business grows, harvests, packs or stores fresh fruits and vegetables that may be consumed raw, it is likely that you are subject to compliance with the *Produce Rule*.

There are small-scale producer exemptions (on average, less than $25,000 in produce sales per year; personal or on-farm consumption). The deadline for publication of the final *Produce Rule* is October 31, 2015, with staggered compliance beginning in 2017.

Researchers evaluate recycled water treatment during an observational visit of food safety practices at a large tomato greenhouse.

Based on 2007 estimates, 1,128 commercial greenhouses will be covered by the new regulations. Of these, 956 are considered small or very small. Large, small and very small greenhouse operations have diverse production flow and management practices.

Most large, high-tech, high-volume greenhouses have food safety management programs that include intensive sanitation. However, small operations are more likely to have limited knowledge of microbial food safety risks, which contributes to a lack of effective management strategies.

Fortunately, FDA, state agencies and universities are ▶

proposing regional training centers and increased extension efforts to assist small producers and processors in compliance.

The *Produce Rule* establishes standards in four key areas:

- Health and hygiene;
- Irrigation water quality and management;
- Animals and waste; and
- Sanitation of equipment, tools and greenhouse surfaces.

Health and hygiene

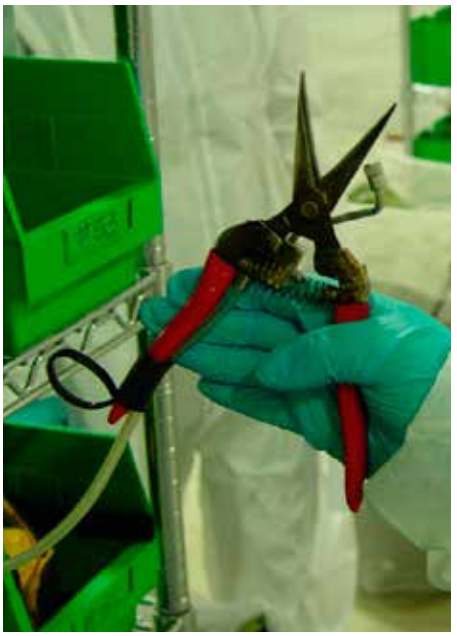
One significant focus of the *Produce Rule* is hygienic practices for personnel associated with production of fresh produce. Mandated criteria relate to personal cleanliness, handwashing and appropriate glove use.

Handwashing ranks as the most effective food safety strategy in greenhouses during propagation and vegetable growing, followed by an effective health policy.

Handwashing is a simple, cost-effective method for preventing contamination of fresh produce with pathogens; however, it is rarely implemented and enforced in greenhouses. A recent survey indicates that only 22 percent of greenhouses practiced handwashing prior to harvesting tomatoes.

Personnel will be required to thoroughly wash and dry hands before starting work, before wearing gloves, after toilet use, and after breaks or absences from workstations.

For handwashing to be an effective food safety strategy, it is critical to have easily accessible and convenient stations. The importance of handwashing must be emphasized through employee training, and a handwashing culture must be encouraged to promote and



Harvest clippers with a hose connected to a sanitizer bottle designed to deliver sanitizer to the clipper after each use.

maintain good habits.

The use of gloves is not mandated. However, if gloves are used, they must be maintained in an intact and sanitary condition and replaced when necessary.

Most greenhouse workers wear gloves to protect their hands and not for improving food safety. It is important to maintain gloves so that they do not contribute to contamination. Depending on material and durability, gloves should be washed regularly or disposable gloves should be available.

The proposed rule does not discuss risks associated with contaminated footwear, despite the fact foodborne pathogens have been isolated from greenhouse workers' shoes (Ilic et al., 2014).

Footbaths are a useful intervention to reduce spread of contamination associated with foot traffic patterns between greenhouses. If used, footbaths should be installed at entrances of greenhouses and should be maintained with appropriate disinfectant management.

Irrigation water quality and management

Agricultural water quality used for irrigation of "covered produce" has been the most contentious issue in the *Produce Rule*.

The rule mandates establishment of the water quality baseline profile, annual inspections, and continuous maintenance of the entire water system. Final criteria will be published in the final rule or in later guidance documents.

Contaminated irrigation water has been implicated in several multistate produce outbreaks, including the 2006 *E. coli* O157:H7 spinach outbreak (Gelting et al., 2011).

Greenhouses draw water from a variety of sources, including city supply, wells, surface ponds and reservoirs. Understanding the quality of different water sources is an important step in reducing the risk of contamination.

The nature of each water source and its recommended use will determine microbiological testing frequency and criteria required by the regulation. ▶

DIGGER Marketplace

The proposed rule provides a tiered approach to classify water sources based on the likelihood of contamination, and mandates testing frequencies for generic *E. coli*. Potable water sources are considered to be very low risk and do not require testing; however, documentation is still required.

Untreated groundwater is considered moderate risk and requires at least annual testing for generic *E. coli*. Untreated surface water has the highest risk and will require the most frequent testing after the baseline is established.

Greenhouse operations often recycle water to reduce water expenditure and increase sustainability. Best practices for recycled water include treatments to remove pathogens before application on the next crop. Recycled water could be effectively treated with a variety of methods, such as UV light or chlorine-based disinfectants.

Water treatment should occur prior to mixing with additional source water, or fertilizer or pesticide dosing.

Animals and waste

Domestic and wild animals are hosts to foodborne pathogens. Their presence in produce fields has been linked to outbreaks, including Oregon's 2011 *E. coli* O157:H7 strawberry outbreak (Laidler et al., 2013).

The *Produce Rule* primarily focuses on minimizing risk of domestic and wild animal intrusion on growing activities that occur outside or in partially enclosed buildings.

Despite being fully enclosed, greenhouses are not designed to prevent animal intrusion. Rodents, birds and raccoons are common greenhouse pests.

Greenhouse management strategies can indirectly discourage animal intrusion. For example, rapid removal of plant debris will minimize shelter for rodents.

Many small and very small greenhouse operations have domestic cats to assist with pest control; however, felines can also be a source of contamination. Domesticated animals must be excluded from fully enclosed buildings that contain exposed transplants, produce, food-contact surfaces or food-packing materials.

Sanitation of equipment, tools and greenhouse surfaces

Foodborne pathogens are commonly found throughout the greenhouse environment. Recently, 37.5 percent of environmental samples tested positive for *Listeria monocytogenes*, including harvest bins and boxes, scales, tarp floor covers and doorknobs in tomato greenhouses (Ilic et al., 2014).

The *Produce Rule* mandates that all equipment and tools likely to contact produce should be easy to clean and maintain. Food-contact surfaces, including tools and equipment, must be inspected, maintained, cleaned and sanitized to prevent contamination. The rule requires non-food contact surfaces to be maintained and cleaned to minimize contamination.

Sanitation of equipment, tools and surfaces during propagation, growing and post-harvest handling significantly impacts produce safety. Currently, the majority (60 percent) of U.S. tomato greenhouses do not have a sanitation program, and an additional 25 percent sanitize only selected surfaces (clippers and propagation tools).

The greenhouse industry will need to make significant improvements in their sanitation practices for compliance.

A sanitation schedule and written sanitation standard operating procedures (SSOPs) should be developed for pre-growing cleanup and periodically during growing. Tools should be cleaned and sanitized after each use. Multiple sanitizers with different properties are currently used in greenhouses, including quaternary ammonium compounds, hydrogen peroxide, peroxyacetic acid and chlorine bleach.

Propagation

Greenhouse operations that exclusively propagate plants, but do not grow vegetables, are not subject to the *Produce Rule*. Contamination of plants during propagation poses a food safety risk for greenhouse produce. Following similar hygiene, water quality, pest control and equipment sanitation practices can reduce contamination of transplants.

Conclusion

Significant changes in production and management of produce are necessary to reduce the probability of foodborne infections linked to fresh produce consumption. Implementation of FSMA seeks to improve food safety by focusing on production areas known to contribute to contamination.

This article highlights areas pertinent to greenhouse operations; however, this is not an exhaustive review of the implications of FSMA on the greenhouse industry. Local extension agents, experiment stations and the state