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Food Safety on the Farm: Good Agricultural Practices and Good Handling Practices—Manure and Municipal Biosolids[1]

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As part of the Food Safety on the Farm series, a collection that reviews the generally recognized principles of GAPs as they relate to produce, primarily at the farm level and with particular focus on fresh Florida crops and practices, this publication focuses on GAPs relating specifically to manure and municipal biosolids. The publications in this series can be found online at the EDIS site at http://edis.ifas.ufl.edu/topic_series_food_safety_on_the_farm.

Introduction

The principles of Good Agricultural Practices (GAPs) were introduced by the US Food and Drug Administration (FDA) in the 1998 Guidance for Industry *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables* (FDA 1998). This guidance document for the fresh fruit and vegetable industry provided general guidelines for reducing the risk of contamination of fresh produce by microbial organisms. In response to this guidance, the United States Department of Agriculture (USDA) formally implemented the Good Agricultural Practices & Good Handling Practices (GAPs and GHPs) audit verification program.

The USDA incorporated the Produce GAPs Harmonized Food Safety Standard into its GAP & GHP audit program in 2011. The USDA further combined these two into a harmonized GAPs (H-GAPs) program in May 2018. To make the oversight of food safety stronger and more efficient, the FDA and the USDA announced the alignment of the USDA H-GAP with the requirements of the FSMA's Produce Safety Rule (PSR) in June 2018. Since H-GAP is not equivalent to the Global Food Safety Initiative (GFSI) the USDA augmented the H-GAP audit to meet GFSI equivalence standards. The new USDA Harmonized GAP Plus+ audit is the only USDA GAP audit recognized as being GFSI technically equivalent. Regardless, all these programs adhere to the same basic principles of GAPs.

Under the new Food Safety Modernization Act (FSMA), GAPs are the foundation of the PSR. Up until the PSR, GAPs programs have been voluntary, imposed by the industry or buyers. Exceptions are the Florida Tomato Good Agricultural Practices (T-GAP) and Tomato Best Management Practices (T-BMP) regulations, which are state laws regulating the safe production of tomatoes. The current PSR mandates all non-exempt operations to follow the new FSMA federal guidelines (FDA 2017), except for exempt commodities (as outlined in the regulation) and for those producers exporting to foreign countries. In those

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circumstances, voluntary GAPs programs may still be required by buyers or trade organizations.

The aim of both the mandatory PSR and the voluntary GAPs program is to reduce the foodborne illness burden associated with produce (FDA 2018a; FDA 2019). The FDA has compiled information from the Centers for Disease Control and Prevention (CDC) data regarding produce-associated outbreaks that occurred between 1996 and 2010 where contamination was likely to have happened early in the production chain, during growing, harvesting, manufacturing, processing, packing, holding, or transportation (CDC 2018; FDA 2018a). An updated report from the CDC estimates that produce accounted for 51.6 percent (21,280 of 41,269) of all foodborne outbreaks in the United States from 1998 to 2016 (CDC 2018).

The use of manure and municipal biosolids as crop fertilizer can be both safe and effective when properly administered. However, pathogens (microorganisms that cause harm) may be introduced into the food supply when contaminated forms of manure or biosolids—whether due to lack of treatment, improper treatment, or recontamination—contact produce. Produce that is grown under or near the soil surface is most susceptible to pathogenic contamination, while crops where the edible portion is kept away from the ground yield a lesser risk for contamination. Regardless of the commodity, growers using manure or biosolids should follow GAPs to minimize risk and identify possible sources of fecal contamination in their specific growing environment. The FDA is conducting and encouraging risk assessment and extensive research on the waiting period between the application of raw manure as a soil amendment (any material, including manure, that is intentionally added to soil to improve its chemical or physical condition for growing plants or soil's water holding capacity) and harvest. Presently, the FDA does not object to farmers complying with the USDA's National Organic Program (NOP) standards, which set a 120- and 90-day waiting period between the application of raw manure and harvest for crops in contact with the soil and for crops not in contact with the soil, respectively (FDA 2019).

This fact sheet will focus on those activities and facilities that will be operational under GAPs as outlined in the *Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables* (FDA 1998; FDA 2019). This fact sheet will specifically address those GAPs that pertain to use of manure and municipal biosolids as crop fertilizer. Additional UF/IFAS Extension fact sheets in this series focus on other specific aspects of the GAPs program and how they relate to Florida crops and practices.

Hazards and Routes of Contamination

Both animal manure and human fecal matter provide a substantial source for pathogenic bacteria, namely the *Escherichia coli* O157:H7. *E. coli* O157:H7 is known to originate from cattle, sheep, and deer, which shed it through their feces. *Salmonella* and *Cryptosporidium* may also originate from ruminant and human fecal matter, creating a need for close management of all types of biosolids and manures to prevent contamination. However, unexpected contamination may arise from the following possible sources: nearby manure processing or storage areas; unsanitary transportation or equipment; livestock or poultry operations; a dense wildlife area adjacent to the growing and harvesting environment; and nearby municipal wastewater or manure storage, treatment, or disposal areas (FDA 1998).

In addition to microbial risk factors, other possible hazards, such as organic compounds and potentially toxic heavy metals, should be considered. Other resources for growers concerning the use of biosolids include the USDA's Natural Resources Conservation Service (NRCS) and the Cooperative State Research, Education, and Extension Service (CSREES).

How to Control Potential Hazards

GAPs play an integral role in the reduction of potential hazards and are imperative to the production of safe produce. Regarding the use of animal manure and biosolids as soil amendments, GAPs generally aim to reduce pathogens. For example, the time between application of these amendments and harvest of the crops should be maximized. The FDA identified and outlined the following areas to monitor: municipal biosolids, manure management (including active and passive treatments to reduce pathogen levels as well as handling procedures for both treated and untreated manure), and animal feces (FDA 1998).

Manure Management

Good Agricultural Practices have been set forth concerning proper handling of manure. These GAPs include processes designed for pathogen reduction. Furthermore, methods to minimize both direct and indirect contact between manure and produce have also been outlined (FDA 1998).

Municipal Biosolids

Several sources are available that outline requirements for the use of municipal biosolids as soil amendments. The Environmental Protection Agency (EPA) published a note

(56 FR 33186) in the Federal Register on July 18, 1991, that describes US interagency policy on beneficial use of municipal sewage sludges on federal land (EPA 1991). Furthermore, Title 40 of the Code of Federal Regulations, part 503, states the specific requirements for the use of biosolids, including surface disposal and incineration (EPA 2018). This portion of the CFR outlines pathogen reduction or elimination for various types of biosolids, such as minimum times between application and harvest. These specifications may be accessed online at https://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/Title40/40cfr503_main_02.tpl. Additional state requirements may also be applicable. Consider that, while the application may be allowed under these requirements, buyer restrictions may not accept the application of biosolids.

For tomato growers in Florida, the Florida Department of Agriculture and Consumer Services (FDACS) authorized Tomato Good Agricultural Practices (T-GAPs) that took effect from July 1, 2008 (FDACS 2007). The T-GAPs regulations are in place for preventing or minimizing contamination of tomatoes in all steps of production. While biosolids may be allowed for most operations in compliance with 40 CRF part 503, T-GAPs prohibits their use. The T-GAPs regarding manure and land use can be found in the Tomato Best Practices Manual (FDACS 2007).

Pathogen Reduction

Various treatment methods may be utilized to achieve pathogen reduction in both manure and other organic materials. Individual growers and suppliers should choose proper treatments to accommodate their personal resources. Generally, treatments are divided into two groups: passive and active treatments.

Passive treatments usually depend on the passage of time coupled with environmental conditions to minimize microbial hazards. Examples include moisture fluctuations, natural ultraviolet radiation, and temperature shifts. It is important for the manure to be well-aged and decomposed before application to field crops. Furthermore, these passive aging treatments should not be confused with active treatments like composting. Holding time for passive treatments will vary by regional and seasonal climatic factors as well as with the type and source of manure.

Active treatments are much more labor- and resource-intensive and involve processes such as pasteurization, heat drying, anaerobic digestion, alkali stabilization, and/or aerobic digestion. Composting is a common active treatment and involves the digestion of organic materials through either aerobic or anaerobic microbial action. Under careful conditions, pathogen reduction may be achieved from the generated heat in days. Much research is still being conducted to determine specific durations and temperatures needed to eliminate or reduce various pathogens under different conditions. Seasonal and regional climactic factors, such as ambient temperature and rainfall, also affect these requirements. Specific management of the process operations should consider ongoing research efforts (FDA 1998).

Handling and Application

The handling and application of both untreated and treated manure should be evaluated to identify possible sources of contamination. The following practices should be recognized.

Separation of manure storage and treatment sites from fresh produce areas: The risk of microbial contamination increases when manure storage and treatment sites are situated close to packinghouses or fresh-produce fields. The minimum distance between the two will depend on many factors such as slope of the land (for runoff), climate, and the quantity and containment of the manure. Manure storage and treatment sites should be situated as far as practicable from fresh-produce production and handling areas (3).

Physical containment of manure in high-risk areas: Storage areas in which heavy winds, runoff, and/or leaching are probable should be properly secured with either barriers or physical containment. These may include concrete blocks, soil berms, pits, or lagoons. Storage on concrete slabs or clay-lined lagoons is recommended to minimize the possibility of leachate, or undesirable liquid runoff, entering groundwater systems (FDA 1998).

Minimization of leachate contamination: Good Agricultural Practices should be used to minimize the risk of leachate contaminating fresh produce. Leachate may pose a microbial hazard similar to the manure from which it originates. Since leachate forms from rainfall upon manure piles, growers may consider covering or sheltering these manure storage areas. Alternatively, growers may collect leachate for either controlled disposal or usage in moisture control (applicable during composting) (FDA 1998).

Minimization of recontamination possibility: Since treated manure may be recontaminated by birds and rodents, manure should be stored away from harborage and/or covered to prevent microbial contamination. Moreover, equipment

should be cleaned and sanitized properly to prevent cross-contamination from partially-processed manure to produce fields. High pressure washes or steam sprays are appropriate before equipment enters produce fields. Well-designed farm layout and traffic flow are vital in preventing tractors from spreading contaminated manure (FDA 1998).

Untreated Manure

Untreated manure poses a greater risk for microbial contamination than treated manure. The FDA is currently conducting a risk assessment and extensive research on the number of days needed between the applications of raw manure as a soil amendment and harvesting to minimize the risk of contamination. Currently to minimize the risk of contamination the following GAPs should be considered (FDA 1998):

• Incorporate untreated manure into soil prior to planting (to induce microbial competition).

• Do not apply untreated manure or leachate from manure to produce fields during the growing season prior to harvest.

• Maximize the time between application of manure and harvest of produce.

• Do not use untreated manure where the above GAPs are not possible, such as for fresh produce harvested throughout most of the year.

• The Produce Safety Rule (PSR) requires that untreated biological soil amendments of animal origin must be applied in a manner that does not contact covered produce during application and minimizes the potential for contact with covered produce after application (FDA 2019).

Treated Manure

Composted manure and other natural fertilizers should be used in manners that follow GAPs. Since the amount of processing needed to reduce or eliminate pathogens in manure has not yet been determined for specific pathogens, recommendations similar to those for untreated manure are often implemented, especially the maximization of time between application and harvest. In the PSR, microbial standards that set limits on detectable amounts of bacteria have been established for processes used to treat biological soil amendments, including manure (FDA 1998). The PSR outlines two examples of scientifically valid composting methods (static and turned composting) that meet provided microbial standards (FDA 2018b). Additional GAPs for treated manure include the following:

• Avoid contamination of fresh produce by manure that is only partially processed.

• Apply GAPs that ensure all materials receive adequate treatment, such as thorough mixing to avoid cold spots.

• When purchasing manure, obtain a specification sheet from the supplier for each shipment. This sheet or certificate should outline treatment procedures.

• Contact state or local manure-handling experts for advice explicit to growers' individual operations and climatic regions.

Animal Feces

Animal waste/fecal matter is a known source of foodborne pathogens. Although all animal contact cannot be excluded from outdoor farming and processing areas, farmers should implement GAPs to minimize the risk of animal feces contaminating fresh produce. GAPs for minimizing hazards from livestock are as follows (FDA 1998):

• Do not allow domestic animals in fresh-produce fields, vineyards, or orchards during the growing season. The FDA encourages farmers to voluntarily consider waiting periods between grazing and harvest.

• Take measures to prevent animal waste from adjacent fields or waste storage facilities from contaminating fresh produce. Fences, ditches, mounds, grass/sod waterways, diversion berms, and vegetative buffer areas may be used.

• Implement GAPs to deter or redirect wildlife from fresh-produce crops.

• Monitor fields on a regular basis for wildlife intrusion.

• All covered farms must visually examine the growing area and all covered produce to be harvested in order to make sure that the produce is not contaminated by domesticated or wild animals.

• Farms are not required to exclude animals from outdoor growing areas, destroy animal habitat, or clear borders around growing or drainage areas. Nothing in the PSR should be interpreted as requiring such actions.

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