



A FARMER'S GUIDE TO FOOD SAFETY AND CONSERVATION: FACTS, TIPS & FREQUENTLY ASKED QUESTIONS



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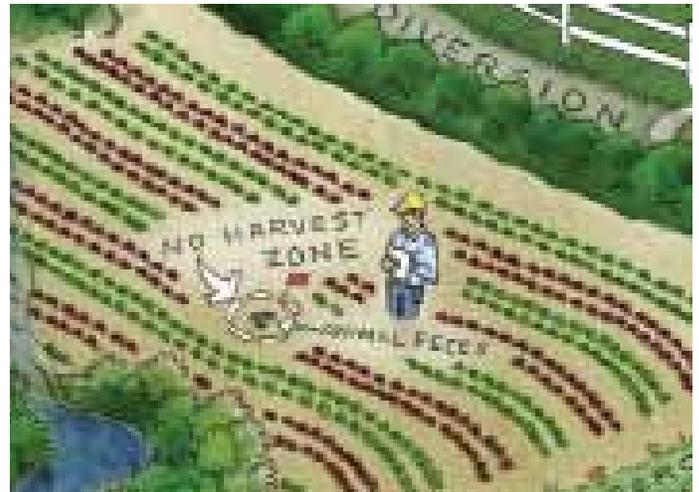
Background

It seems every few months headlines like these make breaking news: “*E. coli* Fears Prompt Romaine Lettuce Recall,” “Spinach Recalled in 39 States,” “Cantaloupe *Listeria* Outbreak Deadliest in a Decade.” These dramatic headlines reflect the attention given to food-borne illness outbreaks associated with contaminated fruits and vegetables. Taking sound, science-based steps to reduce the risk of contaminating produce with pathogens makes sense, but some misguided food-safety standards and interpretation of audit checklists have encouraged or required the removal of on-farm conservation plantings such as hedgerows, windbreaks and grassed-waterways, and the destruction of riparian areas and wetlands. Conservation-minded farmers know that conserving these areas on the farm helps protect water and air quality, supports pollinators, and reduces erosion and greenhouse gases. In a climate of food-safety angst, knowing the basics of managing crops and conservation practices to address food safety can go a long way in maintaining on-farm conservation plantings while reducing the risk of pathogen contamination.

It is highly unlikely that farmers would ever intentionally sell contaminated produce. In the past, it was long held that common sense approaches were sufficient to ensure produce did not have food-borne pathogens. Animals were discouraged from production areas because they damaged crops. The potential for animal manures applied as fertilizers and soil amendments to result in water and crop contamination with human pathogens was well recognized. However, in 2006, everything changed when an outbreak of *E. coli* O157:H7 was traced back to a farm on California's Central coast, the center of the state's fresh-cut salad industry. While it was never unequivocally determined how the spinach became contaminated, non-native feral pigs, contaminated irrigation water, and adjacent cattle operations were all considered as possible sources. All wildlife and the habitat they occupied became scrutinized by public health, academia, and especially the leafy greens industry.



Beneficial natural processes, such as Integrated Pest Management (IPM), help to control rodents.



Periodically monitoring for animal damage or feces in the production field ensures a safe harvest.

Ironically, research conducted in response to this and related leafy greens recall incidents has, so far, indicated that native wildlife in the U.S. have a low relative prevalence of carrying human pathogens. The broad risk appears low; however, the combination of low localized prevalence of wildlife pathogen shedding and changing seasonal conditions remain a concern. Non-native feral pigs were first introduced to California during colonization by Spain and later in the 1920s as a game animal. Particularly where their range intermingles and overlaps with cattle, feral pigs do have a higher prevalence of shedding and now pose a risk to leafy crops. Industry buyers purchasing fresh-cut leafy greens from growers often refuse to buy lettuce or spinach that comes within a certain distance of wildlife habitat because large mechanized harvesters do not exclude picking up hidden fecal matter or even small animals with the crop, as manual harvesting does. To avoid losing production area, many growers are pressured into removing conservation plantings and other non-crop vegetation, such as riparian vegetation, immediately adjacent to their land. In effect, these buyers require ‘sterile’ or ‘scorched-earth’ environments; no grass in the drainage ditches, no bushes next to fields—just dirt and lettuce. This aversion to wildlife and its habitat, driven by the uncertainties of risk, has unfortunately transferred to other crops even though their harvests don’t accidentally take small animals.

Government agencies are becoming more involved in the produce safety area as well. In 2011 the Food Safety Modernization Act (FSMA) was passed by Congress. When it goes into effect, it will require the implementation of certain on-farm food safety measures. While the legislation has yet to be fully enacted, things are moving forward. In January 2013 the Food and Drug Administration (FDA) published the first draft of the rules that translate the act into on-the-ground regulation. Before the rules officially go into effect, they must be reviewed and commented on by the public and then revised and published in their final form by the FDA. Forward thinking farmers will be learning about the food-safety and conservation issue before FSMA becomes implemented, taking steps to ensure that they are reducing food safety risks while still maintaining the conservation areas important to their operations. Understanding how pathogens move onto crops and having management tools to reduce the risk of this movement are essential knowledge for every produce grower.

How Pathogens Get on the Farm

To put it bluntly, poop contains pathogens. That said, not all poop contains pathogens that make humans sick, but caution should be used to reduce the risk of contaminating crops with feces and the pathogens it may contain. Understanding the pathways in which feces/pathogens come to contaminate crops can aid farmers in preventing contamination from happening, and in identifying potentially contaminated produce before it goes to market.

Livestock, Wildlife and Human Pathways

Animals intruding onto fields may contaminate a water source or the crops with their feces. Such intruders include wildlife, free-range animals (such as chickens), escaped livestock and companion animals (e.g. dogs, cats). Farmers who use animal traction may also run the risk of having their work animals defecate on crops in the field.

Improper management of raw manure from livestock may increase the risk of pathogen contamination. When used as a soil amendment, raw manure may contaminate crops with pathogens if an appropriate waiting period is not practiced between the application of the raw manure and the harvesting of the crop. Similarly, livestock grazing (and defecating) in harvested fields may potentially contaminate future crops, if an appropriate waiting period is not allowed between grazing and planting/



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Animal feces can contain pathogens that make humans sick.



Washing boots after working with animals, properly composting manure, and keeping livestock out of produce fields can help reduce the risk of contaminating produce with pathogens.

harvesting of crops. Composting or heat-treating manure greatly reduces the number of pathogens in the manure, thus reducing the risk of crop contamination when it is applied as a soil amendment.

Humans may contaminate produce if appropriate sanitary measures such as properly washing hands after using the restroom, changing or washing boots after working with animals, or cleaning farm equipment between non-crop and crop uses, are not taken before harvesting or handling produce. All produce handling surfaces and equipment, including pickup truck beds for local transport, should be managed to prevent cross-contamination from prior uses of the same equipment.

Airborne Pathways

Pathogens that cause human illness can be transported in the air attached to soil and organic particulates and to water droplets. Manure-laden dust blowing off of small or large livestock operations may contaminate surface water sources or produce growing down wind. The pathogen prevalence in the livestock, and the presence of vegetation or the use of other measures that reduce the spread of the dust, determine the extent of the risk.

Waterborne Pathways

Water can become contaminated with pathogens in a number of ways. When water runs off feedlots, pastures, animal loafing areas, manure stockpiles or composting yards, it may pick up feces and pathogens along the way, eventually contaminating the streams, rivers, ponds, and canals to which it flows. Animals may also contaminate water bodies by defecating into the water directly or on banks and levees, leading to pathogen increases during rain events. Poorly managed sewers, septic systems, or portable toilets can contaminate surface water with human feces. Ground water may be contaminated by improperly managed septic systems or by poorly sealed well-heads that allow contaminated surface water to flow into the well. In times of heavy rainfall, very porous sandy soil, soil with macropores from former root penetration, or soil with cracks in its profile may direct pathogens into shallow groundwater and eventually back to surface water.



As water runs off areas where livestock congregate, it may pick up feces and pathogens along the way.

If contaminated surface or groundwater is used for irrigation, it may lead to persistent crop contamination. Pathogen-laden water during a storm or flood event can also contaminate crops.



Factors that Affect Survival of Human Pathogens

Temperature, Moisture and Diversity

Pathogen survival in soil, water and on plants depends on the temperature, moisture, the nature of the plant surface characteristics, and diversity of the microbial populations present. The sun and desiccation help to kill pathogens. In the summer, when the days are warm and long, direct sunlight, with its destructive UV radiation and its ability to dehydrate pathogens, can help to decrease the survival of pathogens on plant and soil surfaces.

Sunlight helps kill pathogens through its destructive UV radiation.

Pathogens tend to persist longest in cooler times of the year when cloud cover and moist conditions are more constant and pathogens, such as *E. coli* and *Salmonella*, are less active. Another bacterial pathogen of concern in minimally processed foods, *Listeria monocytogenes*, actually does better under cool moist conditions but the primary control point is not on the farm. Freezing by itself does not completely kill pathogens. A caveat to that is when rapid freeze-thaw cycles of weather occur, they can cause rapid death of pathogens in soil.

Microbial diversity helps to reduce pathogen survival. Non-pathogenic beneficial microbes usually prevail if diverse populations are present, by outcompeting the pathogens for food, water, and space; by killing and consuming the pathogens; and/or by generally making conditions unfavorable to the pathogens by tying up critical growth nutrients such as soluble iron.

Fumigation studies reinforce that microbial diversity is important. Soil fumigation can foster human pathogens because conditions become more favorable for the survival and growth of the few pathogens that weren't killed or that are re-introduced. Most fumigation is done on conventional farms. Glucosinolate compounds, found in high concentrations in some of the seeds of the *Brassica* plant family, are being applied as mustard meal to decrease organic strawberry plant pathogens, and separate lab studies show that it kills *E. coli* and *Salmonella*. Whether mustard meal will be useful in the field for human pathogens is yet to be determined — the same principle probably applies that if diversity is eliminated, pathogens can persist.

While some microbes may kill pathogens, others may help them survive. In nature, nothing is absolute, and this is the case with biological control of pathogens. While many types of microbes — bacteria, viruses and protozoa — cause harm to human pathogens, not all do. Some protozoa harbor pathogens by consuming but not killing them. Bacterial communities can also surround themselves with a matrix of complex carbohydrates called biofilms. These biofilms sometimes shield pathogens from predators and harsh environmental conditions, while at other times make them more susceptible. Biofilms can form on soil particles and plant roots, in water on aquatic plants and irrigation systems, and on plant leaves.

Soil

Pathogens, like most plants, prefer soils in the range of a neutral pH, with low salts, and with available nutrients, especially carbon and nitrates. Concentrated nutrients exuded by growing root tips, and by diseased plant parts, are especially attractive to microbes. Unlike most plants that can live in many types of soil, pathogens prefer heavier clay soils that can hold water better than sandy soils.

Manure and Antimicrobial Resistance

Pathogenic *E. coli* populations tend to be lower in cattle when the animals graze on forage, than compared

to a grain diet. Similarly, when manure comes from a barnyard it tends to have fewer nutrients readily available for pathogens than when it comes from a slurry. Many confined animal feeding operations administer antibiotics and similar drugs, together called antimicrobial agents. When manure from these confined animal feeding operations is spread on a production field, some of the pathogens, as well as other microbes, typically have genetic traits for antimicrobial resistance. This resistance can be transferred among many types of soil microbes, and can increase the risk of non-pathogenic *E. coli*, *Salmonella*, and other bacteria becoming a health hazard, especially for people with compromised immune systems. Microbes that do not infect healthy people can sicken people with weak immune systems, and the antimicrobial resistance makes it more difficult to treat. Pathogens with antimicrobial resistance are not only found in those carried by livestock and in soils with manure, but have also spread to wildlife.

Sediments and Algae in Water

Sediments have been shown to be a key site for pathogen persistence in water bodies. When sediments are stirred up in water, pathogens are brought back into the water column or flow. The reasons for increased pathogens in sediments are not well understood, but the lack of UV radiation and presence of biofilms may be responsible. UV is not able to penetrate sediments at the bottom of creeks, streams, ponds and lakes. Biofilms may provide protection from environmental stress and from predation by other microbes.

Nutrient pollution in surface water can cause algae blooms or mats. Some kinds of pathogenic bacteria survive longer when attached to algae. UV penetration in water, important in reducing pathogens, is diminished with the presence of algae. Therefore, reducing nutrient runoff from fields and blending tailwater with ground water in ponds may aid in reducing both algae and pathogens in irrigation surface water.

Vegetation

Vegetation can help reduce the movement of pathogens across the farm by filtering pathogens, increasing infiltration of water into the soil, and serving as a structure for biological competition to take place. Grasses and other types of vegetative buffers filter pathogens in runoff before they reach a pond or stream. The vegetation also slows surface water flow which allows for increase infiltration rates.

Wetlands decrease pathogen levels due to increased oxygen levels in the water, antagonistic root exudates, and the fostering of antagonism in biofilms. These processes that act to reduce pathogens in water work best when the water has a long residence time—it moves slowly through the vegetation—a proper hydraulic loading rate—the volume of water flowing through is suited to the size of the planted vegetation, and appropriate settling rates of suspended sediments.

Windbreaks can intercept dust that may be carrying pathogens. When dust trapped on the leaves of a windbreak is exposed to sunlight and other desiccation effects, pathogens can be destroyed.



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Algae blooms, like the one in this lake, may increase pathogens in the water.



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Vegetative buffers, like this grassed waterway, help filter out pathogens in runoff water before they reach a pond or stream.

Illustration Key

Note: The Healthy, Diverse Ecosystems Help Keep Pathogens in Check illustration is not drawn to scale; it serves as a visual summary of the conservation practices and food safety actions used to address food safety referenced in this document. These practices and actions do not provide complete and conclusive protection against food-borne pathogens on a given farm/ranch, and some vegetative conservation practices may attract wildlife that can vector pathogens. When implementing in-field practices to address food safety, one should take into account the conditions present on the farm/ranch and use this information to assess the effectiveness of a given practice in reducing the risk of food-borne pathogen contamination of crops.

- 1. Sun:** UV radiation from the sun may inactivate recently deposited pathogens on the surfaces of soil and leaves, as well as in clear water. The sun also facilitates the desiccation of pathogens, which leads to pathogen reduction.
- 2. Dust from animal activity** is reduced with the application of water by sprinklers and with manure harvesting. Reducing emissions and removing manure proactively are cost-effective means of mitigating pathogen transfer.
- 3. Diversions** redirect water running off of confined animal feeding operations to waste treatment and sedimentation lagoons, preventing the movement of waterborne pathogens to nearby farm traffic areas, fields and waterways. Vegetated diversions also intercept organic matter and soil carrying pathogens running off pasture, and divert potentially contaminated water away from specialty crop fields. The diversions slow pathogen dispersal and provide a matrix for beneficial bacteria and protozoa that compete with and consume pathogens. Plants should be selected for low-flow filtering capacity and the ability for high flows to flow through the vegetation. Selection criteria should also consider how well air and sunlight are able to penetrate into the vegetation, as the cool, moist, shaded interior vegetation may provide favorable habitat for pathogen survival. Otherwise additional maintenance will be required that regularly harvests and removes excess vegetation.
- 4. Waste storage pond** temporarily stores waste, such as manure runoff from confined animal feeding operations, thereby reducing pollution potential in the landscape. The waste storage pond should be properly designed and maintained so that it does not overflow. Food safety Good Agricultural Practices (GAPs) recommend that the effluent from the ponds not be used on crops typically eaten raw. Monitoring of animal movement around the pond and between waste handling areas and crop fields should be a scheduled activity.
- 5. Restored wetlands** can considerably reduce pathogen transport by slowing the water, which increases the interaction time, and providing a matrix for beneficial microbes. The diverse plant and microbial community establishes desirable interactions that serve to limit pathogen persistence. Use of vegetation and designs that facilitate slow moving water over long periods in the wetland allow the best chance for pathogen reduction in water draining from the wetland. The vegetation in the wetland may decrease the ability of UV light to reach the pathogens, which may increase survival. However, pathogens may be retained on vegetation. As water recedes, the pathogens that are retained on the vegetation may be exposed to sunlight and desiccation.
- 6. Riparian forest buffers** are vegetated areas along bodies of surface water, including streams, wetlands and lakes. They may trap wind-borne pathogens on their vegetation and filter waterborne pathogens attached to suspended organic-soil particulates and other solids. The diverse plant and microbial community in the buffers encourages interactions limiting pathogen persistence.
- 7. Flooded field:** Food safety GAPs recommend that crops typically eaten raw are not planted on lands that often flood. If and when a flood occurs, it may take time for pathogens present in the soil to die off. Depending on the frequency of floods, the field could be fallowed for a period, replanted to a cover crop, or possibly, permanently taken out of production with the restoration of riparian habitat.
- 8. Windbreaks** can trap dust containing pathogens and prevent it from entering specialty crop fields. Plants should be selected with foliar and structural characteristics to optimize dust/pathogen interception. If interior vegetation is too dense, it may provide a cooler, moister and shadier environment, which may create a favorable conditions for temporary pathogen survival.
- 9. Evidence of animal intrusion in a crop field should be monitored.** Food safety GAPs recommend that farmers monitor for animal feces and signs of feeding, and when found, a no-harvest buffer is placed around the contaminated source, or other measures are taken to reduce risk of harvesting the contaminated crop. The following considerations all factor into determining the appropriate risk reduction actions taken: the type and number of animals; whether they are present intermittently or continually; if they are there because of food, a movement corridor, or live next to the crop; and if they are seen initially before planting or right before harvesting.
- 10. Hedgerows** may trap waterborne pathogens in their root systems, and wind-borne pathogens on their vegetation. Shaded interior of the vegetation may provide favorable conditions for temporary survival of pathogen if too dense.
- 11. Irrigation:** Food safety GAPs recommend using sources of irrigation water that are adequately free of contamination. Management techniques that promote infiltration of the water into the soil can reduce runoff and may aid in reducing the movement of pathogens already present in the field. Techniques that aid in infiltration include soil quality management that increases porosity and improves structure, and irrigation management that keeps soil from becoming saturated.

12. Sediment basins capture and detain sediment-laden runoff that may contain pathogens. Correctly designed, basins allow sufficient time for the sediment to settle out of the water. With moist, cool conditions, the basin may support the survival of pathogens. Having a sediment basin that dries down as rapidly as possible helps to alleviate these moist conditions and helps reduce pathogen survival. Moist sediment that is removed from the basin and put on cropland should be treated as contaminated and a time period similar to non-composted soil amendments between its application and the next crop's harvest should be established.

13. Riparian forest root zone: The roots of the riparian forest promote water infiltration and provide biological activity. This helps divert pathogens from surface water, and encourages interactions with other soil microorganisms that can limit pathogen persistence.

14. Stream ecosystem: In a stream ecosystem where diverse microbial communities exist, they are thought to reduce pathogens by competition, parasitism, and predation. Clear water allows light to reach pathogens, which can lead to their reduction. Flowing water dilutes pathogen populations. Some algae and protozoa may serve as an alternate host for pathogens, allowing pathogens to survive even when environmental conditions are unfavorable.

15. Diverse microbial populations compete with and consume pathogens in water, soil and on plant surfaces. When diverse microbial populations are present, beneficial microbes compete with pathogens for carbon and nitrogen, while others kill and consume them. Diverse microbial communities in water and on plants also compete for resources and/or consume pathogens. In some instances, biofilms—a matrix of bacteria and carbohydrates—can harbor pathogens.

16. Cover crops: Rotating with cover crops increases soil organic matter and supports soil microbial communities that may aid in suppressing pathogens. Cover crops may also reduce the movement of pathogens in water run-off by trapping pathogens in their roots and leaves. They can be used as part of a 'waiting-period' between events that might pose contamination risk (e.g. grazing, flooding) and the planting of a crop typically eaten raw. Cover crops also reduce open soil, which helps reduce dust transmission problems.

17. Integrated pest management (IPM) of vertebrates such as mice and squirrels can be used as a means of control for pest animals that enter crop fields. Having a few predatory animals, such as hawks or owls, on the farm is less of a risk than numerous prey species. A crop should not be planted directly under a raptor nest box or a roost, so that it is not contaminated with raptor feces. Farm traffic should not carry fecal droppings into the cropped area or equipment and storage yard.

18. Harvesting orchard fruit from the tree, not the ground, is recommended by Food Safety GAPs when it will be consumed fresh. Fallen fruit may have come in contact with animal feces.

19. Field borders can intercept and reduce waterborne pathogens moving in overland flow from the field. This planting encourages infiltration and serves as a buffer between the field and the riparian vegetation.

20. Tree bird roost: Food safety GAPs recommend that a no-harvest zone is established under branches that hang over the field to ensure bird feces will not touch the crop.

21. Wildlife corridors allow wildlife to access resources (water, food and cover) without having to walk across crop fields or leave their preferred habitat.

22. Crop placement: Food safety GAPs recommend that leafy green vegetables or other crops typically eaten raw not be planted near manure stockpiles or composting facilities and windrows, or other areas of contamination, as pathogens may transfer to the field via water or wind.

23. Compost: Properly managed compost windrows heat up to a temperature that results in significant pathogen reduction. Compost itself supports beneficial organisms that compete with, inactivate, and consume pathogens. Compost that has been allowed to be re-contaminated, or compost that is unfinished could be a source of pathogens; thus, measures should be taken to prevent these below par composts from moving onto adjacent fields through wind or water. For information on proper compost management practices refer to 'Chapter 2: Composting' in Part 637 of the USDA, NRCS National Engineering Handbook.

24. Conservation cover is used to establish and maintain perennial vegetative cover to protect soil and water resources on land retired from agricultural production or on other lands needing permanent protective cover that will not be used for forage production. Perennial plants may trap wind borne pathogens on the vegetation and waterborne pathogens in the root system.

25. Prescribed grazing uses animals to manage vegetation. It also helps to increase water infiltration, reduce runoff and prevent erosion. This aids in stopping the movement of pathogens in water runoff. Grazing animals are a reasonably foreseeable source of pathogens; thus, measures should be taken to prevent pathogens from the animals' feces from moving onto adjacent fields through wind or water.

Note to User: Details on the design, dimensions, spacing and maintenance specifications of many of the conservation practices represented here can be found on the NRCS website: http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/?cid=nrcs143_026849.

Frequently Asked Questions

Questions related to the co-management of food safety and conservation are listed first and followed with general questions that small and mid-sized farmers may have. Answers to these questions are based on common sense, science, and a mix of requirements from third party auditors. While FDA's produce rules are in process, you can visit the WFA website to learn what is being proposed (see www.wildfarmalliance.org).

Co-management Questions

A1. Are there natural processes a farmer can encourage that reduce pathogens on the farm?

Sunlight

Allowing time for sunlight to hit feces left by grazing animals in row crop fields before tilling it in, and managing orchard canopies to let sunlight in on feces will help desiccate and reduce survival of pathogens. The degree of effectiveness depends on how well the pathogens are directly exposed to UV light and how well they dry out. For larger animals, such as cattle grazing un-harvested crops, a light disking to break up partially dried pats may accelerate pathogen die-off. It is important to minimize the potential for manures left on the surface to be carried to surface water during a significant rain or irrigation event, prior to incorporation.

Clear Water

When UV radiation is allowed to penetrate clear water, pathogens won't survive long. If there is sediment in the water or nutrients causing algal blooms, UV radiation isn't as effective. Proactively protect water quality by ensuring irrigation water infiltrates the soil well, and excess fertilizers and eroded soils are not causing pollution and murky water. UV penetration can then effectively foster pathogen reduction.

Vegetation Intercepts Pathogens

Using nature's vegetative filtering systems by planting or conserving non-crop vegetation in appropriate areas on the farm can help intercept airborne and waterborne pathogens and other pollutants, and keep the water clean (see #s 3, 5, 6, 8, 10, 16, 19, 21, and 24 in illustration).

Proper Composting

Pathogens are reduced by high temperatures and antibacterial compounds found in compost processes that purposely generate alternate cycles of high heat through the correct mix of carbon and nitrogen, moisture, and aeration by turning. Then the curing process at cooler temperatures can allow the growth of suppressant microorganisms that tie-up nutrients and can limit or outcompete pathogen re-growth or growth following accidental re-contamination.

Encouraging Soil Microbe Diversity

Farming practices that increase the native soil microbial community, such as high organic matter inputs of compost, cover crop rotations (see #s 16 and 23 in illustration), and reduced tillage, promote competition, predation and antagonism of pathogens.

B1. Do some animals pose a higher risk of contaminating produce with food borne pathogens than others?

Humans and Livestock Have Pathogens in Common

Livestock and companion animals can carry human pathogens, such as *E. coli*, *Salmonella*, *Campylobacter*, *Listeria* and *Cryptosporidium*. Some pathogens are more common in some animals than in others. Cattle often host *E. coli* pathogens, while poultry and pigs are common carriers of *Salmonella*. Poultry may also carry *Campylobacter*. Small ruminants, such as sheep and goats, are infected with *Listeria* more than other animals.

Animals can be carriers of human pathogens, such as *E. coli* O157:H7, that do not make them ill but can cause very severe human diseases. The age of the animal and season of the year may influence the level of pathogens an animal



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Clear water allows UV radiation from the sun to enter the water, which helps kill off pathogens.



Young livestock are likely to carry higher levels of pathogens than adults.



Wildlife living near areas with high levels of pathogens, such as these landfill-dwelling seagulls, may pose a greater risk of transferring pathogens than wildlife not associated with such areas.



Vern Wilkins, Indiana University, Bugwood

Seeing rodent-eating raptors, like this Short-Eared Owl, in habitat near a produce field is good for food safety.

carries. Young animals tend to carry higher levels of pathogens than adults. Seasonal stress may also result in higher pathogen levels. Cattle, for example, shed more *E. coli* in their manure during the summer than during the winter. Individual animals can be ‘super-shedders’ in a herd that has an overall low prevalence of shedding.

Since livestock can be contained, the risk of contaminating crops with livestock manure depends on whether the manure is inadvertently being transported into the produce fields via wind, water, wildlife or people; or whether it has been applied directly on the field as a soil amendment without adequate composting, aging, or time period before planting and harvest.

Native Wildlife Pose a Low Risk of Carrying Human Pathogens
Thus far, studies have shown that native wildlife have a low prevalence of carrying pathogens that cause human illness. The risk of extensive crop contamination from wildlife is small; however, it will never be zero. Within a given population, the number of individual wildlife carrying pathogens, such as *E. coli* O157:H7 or *Salmonella*, is generally less than three percent, based on the fairly limited snapshots of research around the country and the world.

Where wildlife live and what they feed on may influence the level of pathogens they carry. Birds, rodents and feral pigs that live near areas with high levels of pathogens, such as landfills, feedlots, dairies, cattle ranches, or pig farms, may pose a greater risk of transferring pathogens, than wildlife not associated with such areas. Some research shows that non-native feral pigs, which frequently share rangeland with cattle and eat cattle feces, carry food-borne pathogens at a higher rate than native wildlife does.

Unlike livestock, wildlife cannot be contained or completely excluded from produce growing areas, so depending on the circumstances they may pose a risk when in the production field. In writing the ‘first draft’ of the proposed rules for the Food Safety Modernization Act (FSMA), FDA suggests that the presence of wildlife in a production field is, in and of itself, not a significant food safety risk, though action needs to be taken if evidence of feeding or feces are found in a crop field.

C1. What should I do if I see wildlife in habitat near my produce field?

Seeing wildlife in habitat is usually good, since the habitat is often planted or conserved to support pollinators, migrating predators that eat rodents and other types of wildlife. There is only a potential for a problem when and if wildlife enter a field and damage the crop, and/or leave feces behind that can contaminate the crop. Monitoring the production field next to

the habitat for damage and feces can help determine if the wildlife are coming in, thereby increasing the risk (see #9 in illustration). By monitoring at a scheduled time, preferably in conjunction with other tasks such as during insect pest scouting or before an irrigation, and keeping records of the monitoring, the farmer can both reduce risk and have simple documents that support their farm safety program.

D1. What steps do I take if I see wildlife or their evidence in the production fields?

Assess the production field for crop damage or animal feces that can contaminate the crop. If found, cordon off a specified area—the damaged/contaminated area plus a small percentage—so the risk of cross contamination is removed from the growing area (see #9 in illustration). The size of the cordoned-off area depends on the amount of feces, splash that could occur from irrigation or rain, and how close the crop is growing to the soil. A five-foot radius for overhead-irrigated crops is typically felt to be sufficient; for drip-irrigated crops in a dry season the contaminated plant and its nearest two neighbors are often cited as sufficient buffering. Dispose of feces and the contaminated product away from the crop, sanitize the shovel or other equipment, and wash hands afterwards. Keep records of all actions taken. Further crop assessments may be required to determine if there are repeat visits by individuals or many wildlife, and if they were feeding or just passing through. The number of wildlife in the crop is important to notice—more intrusion equals higher contamination risk. In writing the ‘first draft’ of the proposed FSMA rules, FDA’s perspective about crop contamination is that if the crop does not come in contact with manure, or in this case with wildlife feces, then it would not be covered in the rule. Hence, deer droppings in an apple orchard would not be covered. Of course, the apples should not be picked up from the ground.



Jason Wade

Predators like bobcats help keep rodent populations down in produce fields.

E1. Are predators of rodents okay to have on the farm?

It is better to have a few predators, such as hawks or bobcats, on the farm that help keep the rodent population in check, than numerous rodents that could cause much more contamination (see #17 in illustration). Hawks and owls can be attracted to the farm with hawk perches and owl boxes, but do not plant directly under them. If four-footed predators are present near the production field, monitoring for feces should be conducted periodically.

F1. Can I plant a conservation practice such as a hedgerow, or leave wildlife habitat next to a crop and still be able to pass a food safety audit?

The OnFarmFoodSafety.org self audit, the USDA food safety audit, and several other audit programs allow for non-crop vegetation on the farm without losing certification or audit points. Global GAPs encourages habitat restoration. In writing the ‘first draft’ of the proposed FSMA rules, FDA’s perspective about wildlife habitat is that they do not expect farmers to destroy habitat or otherwise clear farm borders around outdoor growing areas or drainages.



Sam Earnshaw

Many food safety audits allow non-crop vegetation on the farm. Some even encourage habitat restoration.



Jo Ann Baumgartner

As a last resort, fences around fields can discourage wildlife from entering production areas.

G1. What are some ways I can discourage unwanted wildlife?

In some situations, conserving habitat in wildlife corridors along waterways or other established routes may keep wildlife from crossing through the crop (see #21 in illustration). If wildlife, their crop damage or feces are continually found in the produce field, corrective actions are warranted. Removal of animal attractants such as feed (culls or spilled grain) and standing water may reduce intrusion; or use of hazing techniques such as loud noises, raptor or distressed bird sounds, and visual deterrents may also work.

Fencing may be necessary as a last, expensive resort. The type of fencing used depends on the animals that need to be excluded. Short silt fencing can be effective for smaller animals, such as ground squirrels that tend not to climb something they cannot see over. Rabbit fencing is a bit more involved but functions on the same visual barrier principle tied to their natural avoidance behavior. Silt fencing is inconsistent in discouraging movement of frogs into fields and tends to be less effective in irrigated fields when immediately adjacent natural waterways dry up. Short, moveable electric fencing can temporarily keep less determined feral pigs out of a field, whereas more permanent short hog wire fencing keeps those more persistent out. Tall permanent fencing, especially when electrified, can keep out deer. By fencing just the production fields, instead of the whole property, room is left for wildlife to move through the farm for food and cover in neighboring lands. In writing the 'first draft' of proposed FSMA rules, FDA's perspective about fencing out wildlife is that they do not expect farmers to fence or otherwise exclude animals from outdoor growing areas.

H1. Is it okay to grow produce next to a compost pile?

When compost includes raw manure as a feedstock, extra steps should be taken to ensure crop contamination does not occur. Taking into account wind direction and speed, locate the compost pile a safe distance away from the production field so that unfinished compost cannot blow onto the crop and contaminate it. Consider planting a wind-break to reduce the distance needed between the compost pile and the production field (see #23 in illustration). The location of the compost should also be chosen so that water running off the site is both contained and diverted away from traffic routes to the crop. When wildlife are attracted to compost feedstock such as produce culls, they may explore or inadvertently step in raw manure and then move through the production field, so keeping culls out of their reach can reduce contamination risk. Ensure that any heavy equipment and hand implements used for making or handling the compost are cleaned and sanitized before being used in the crop. Personnel involved in both compost and crop management should be trained in proper prevention and cross-contamination measures.

I1. Are some fields more suited than others to grow certain types of produce?

Since wind, water, wildlife and people may transport pathogens from contaminated areas such as dairy, livestock, or fowl production facilities, dumps, and compost piles to the crop, it is better to plant low risk crops near these areas, and to install a barrier between them (see #23 in illustration). The Center for Disease Control reports that leafy vegetables, tomatoes, and melons are associated with a high number of food-borne illness outbreaks. FDA has



Produce contaminated by flood water is considered 'adulterated' by the FDA. Converting sections of fields that flood often into permanent field borders reduces the movement of pathogens by intercepting overland water flow.

published guidance's on leafy greens, tomatoes and melon to help growers reduce risk. Depending on the method by which these crops are grown and harvested, they may or may not be higher risk. However, almost every year new commodities not previously recognized as vehicles for food borne outbreaks are identified. Therefore, the prudent approach is to consider all crops as potentially vulnerable to risk although many have naturally risk-minimizing traits of growth habit and cropping practices.

FDA considers the edible portion of produce that has been flooded “adulterated,” so fields subject to frequent flooding are better planted to crops not consumed by humans (see #7 in illustration). The best management for areas that often flood may be to covert them to conservation plantings, such as permanent field borders (see # 19 in illustration) or riparian forest buffers (see # 6 in illustration) that intercept pathogens in overland flow and encourage infiltration. The forest root zone along a river, stream, wetland or water body helps reduce the movement of pathogens by slowing subsurface flow of contaminated water and providing for biological activity that can reduce pathogens (see # 13 in illustration). For fields that don't often flood, a waiting period should be instituted to allow pathogen reduction to occur before planting another cash crop. Cover crops can be a temporary solution.



USDA NRCS

Funding and technical assistance for on-farm conservation projects can be found through the USDA Natural Resources Conservation Service.

J1. What are the safety precautions I should take when growing produce and raising livestock on the same farm?

In order to reduce the risk of livestock manure unintentionally contaminating the crop, the livestock should be located downhill from the production fields, or runoff should be diverted away from the livestock yards with the use of a berm or diversion ditch (see # 3 in illustration). Depending on the contamination of the diverted water, it may need to be contained in a waste storage pond or sediment basin (see #s 4 and 12 in illustration). Windbreaks and tall hedgerows can be used to reduce dust blowing from livestock areas (see #s 8 and 10 in illustration). If wild birds are eating extra grain, placing the grain in a covered area where the birds don't feel safe entering it can discourage them.

K1. Does prescribed grazing help to reduce pathogens in the environment?

Prescribed grazing helps to disperse animal feces on the grazing lands where healthy stands of grass can help to filter pathogens (see # 25 in illustration). While cattle both in confined operations (fed grain) and out on pasture (eating forage) can test positive for *E. coli* pathogens, a USDA comprehensive review indicates that populations of these pathogens are higher in cattle fed grain diets. Additionally, confined operations concentrate feces and often increase animal vector occurrence, thereby increasing risk.



USDA NRCS

Testing your irrigation water for pathogens is a good food safety practice.

L1. Where can I get assistance with installing conservation practices?

The USDA Natural Resources Conservation Service offers technical assistance and Farm Bill cost-share funds for farmers interested in implementing conservation practices. It is important to note that they are not a regulatory body of government. Please visit www.nrcs.usda.gov for further information.

Small- and Mid- Size Farm Questions

A2. Do I need to test my irrigation water?

The Produce GAPs Harmonized Food Safety Standards offered by USDA suggests that testing may not be warranted if past testing showed no high levels of fecal indicators, the crop will not be eaten fresh, the harvest will not occur soon, and the water will not touch the crop. On the other hand, if any of these conditions do occur, initial baseline testing is recommended, along with the establishment of a routine testing regime. Others recommend testing the water source at the beginning of the growing season for generic *E. coli*. If the water source is found to have high bacterial counts (eg. > 500 *E. coli* /100 ml), advice should be sought from local university extension personnel or farm consultants since recommendations can vary depending on the situation. The quality of the water should conform to prevailing regulations.

B2. Can I still use raw manure?

Pathogens that pose a serious food safety risk may be contained in raw manure. Some standards, such as those in the USDA National Organic Program (NOP), require that raw manure be incorporated into the soil not less than 120 days prior to the harvest of a product whose edible portion has direct contact with the soil, or not less than 90 days prior to the harvest of a product whose edible portion does not have direct contact with the soil. An intermediate recommendation from the USDA GAPs states that when raw manure is applied, it is incorporated at least two weeks prior to planting, and a minimum of 120 days prior to harvest. Some marketing agreements, such as the one for leafy greens, suggest a one-year waiting period between application of soil amendments with raw manure and production of the next crop. It is best to keep records of the composition of the manure and the time and method of application, and to conform with prevailing regulations. If the suggested waiting periods are not feasible, use only properly composted manure.

C2. Is manure-based compost okay to use?

Composting is a treatment process that reduces the microbial hazards of raw manure. When done correctly, the composting process can kill most pathogens in manure. Some standards do not suggest a time period between application and other farming practices, while others recommend it be used only before planting, or only applied at least 45 days before harvest. In all cases, it is a good idea to record the dates that the compost is applied to the field. If not completely composted, it should be treated like raw manure.



Using a waiting period between grazing livestock in orchards or produce fields and the harvest of the subsequent crop helps reduce the risk of pathogens in the livestock manure contaminating produce.

D2. Is it still okay to make my own compost, or should I purchase it?

Manure-based compost can be made safely on the farm when methodical management of the decomposing process is done. *Farming with Food Safety and Conservation in Mind* (see www.wildfarmalliance.org) lists details to be considered when making compost. USDA National Organic Program requires a specified carbon to nitrogen ratio of the compost feedstock, a temperature be reached for a set number of days depending on if it is a static pile or in a windrow, and a specified number of times of turning when in a windrow. Besides recording the compost's composition and the dates and methods of the compost treatment, some standards also recommend that farmers obtain residual fecal indicator and pathogen analyses of the compost. In all cases, care must be taken to ensure composts aren't re-contaminated with pathogens, and the composting process should conform to applicable federal, state, and local regulations.

Compost made solely with vegetative feedstock (i.e. no animal products) has fewer restrictions. The source of the feedstock should not come from situations where hazards such as glass or heavy metals are introduced.

Accepting off-site or purchasing commercial compost should be done only when a letter of guarantee or certificate of pathogen analysis from the compost maker can be obtained. It is also beneficial to find out what the compost was made from (e.g., cattle or horse manure; spent mushroom compost; vegetable culls) and that it was produced under conditions that are not a hazard.

E2. Is aged manure okay to use?

Using aged manure that relies primarily on the passage of time can reduce pathogens. During this aging period, natural temperature and moisture fluctuations and UV radiation from sunlight will decrease the number of pathogens. The time needed to reduce the pathogens will vary depending on the weather and on the type and source of manure. Growers who rely on the passage of time should ensure manure is well aged and decomposed before applying to fields, in order to minimize microbial hazards. Most food safety standards treat aged manure the same as raw manure.

F2. Are there other ways to treat raw manure?

Some standards approve of thermally or chemically processed manure. For instance, steam, ammonia, stabilized lime, and more recently biochars (a by-product of biomass conversion) are used to reduce pathogens in the manure. Care must be taken not to accidentally re-contaminate sterilized manure with pathogens since beneficial microorganisms that are antagonistic to pathogens will be absent.

G2. Can I allow my livestock to graze under a fruit orchard, and in produce fields after the crops have been harvested?

Yes. Grazing should be scheduled so that there is time for pathogens in the feces to be significantly reduced by sunlight and other environmental factors. When ladders are used, harvesters may inadvertently walk in feces or contaminated soil or vegetated cover and then climb up and down their ladders contaminating their gloves, or they may accidentally place harvest containers on contaminated areas of the ground. While some standards do not address this issue, others suggest that a waiting period of 120 days takes place between grazing and harvest. An assessment to determine if any feces are seen should be done between five and seven days before harvest. It is a good policy to never pick fruit up off the ground since the fruit may have come in contact with animal feces (see #18 in illustration).



USDA NRCS

Ask U-Pick customers to sign-in at the entrance of the farm and agree to farm hygiene practices.

H2. Can Community Supported Agriculture (CSA) members and U-Pick customers be on the farm?

Yes. Before walking the fields, have members and customers review a food safety Fact Sheet and sign-in on an agreement form to comply with farm hygiene practices that are addressed in the farm's food safety plan.

I2. Can school children visit the farm and pick produce?

Because children don't always follow directions, it is best to have a distinct learning area or garden just for them that is separate from the production fields. Instructing kids about food safety, and requiring them to wash their hands before picking and eating produce are good policies.

J2. How can I have cats and dogs on the farm and still grow food safely?

USDA GAP standards suggest that dogs can be in production fields when the harvest is more than 120 days away or the planting is more than two weeks away. As the time becomes closer, the dogs are leashed and any feces are picked up and disposed of properly. Since cats cannot be controlled like dogs, their presence in the production fields is not recommended. In writing the 'first draft' of the proposed FSMA rules, FDA's perspective about crop contamination is that if the crop does not come in contact with manure, or in this case with pet feces, then it would not be covered in the rule. Hence, dog or cat feces in a fruit orchard would not be covered. Again, the fruit should not be picked up from the ground.

K2. Do I need a food safety plan?

There are currently no federal regulations requiring a food safety plan. Several states may create their own food safety requirements. To get ahead of the curve, and to make your customers happy, consider creating your own food safety plan using the step-by-step process on the onfarmfoodsafety.org website, or contact CAFF for individual assistance.

Tips on How to Have a Successful Food Safety Audit or Inspection While Advocating for Farm Conservation Practices



USDA NRCS

Food Safety Plans

Most often, a farmer's buyer triggers the need for a food safety plan. This is especially true for anyone looking to sell to government institutional food programs, such as the USDA National School Lunch Program or correctional facilities. That plan typically covers personal hygiene of people on the farm, water testing, use of soil amendments, land use history, neighboring issues, wild and domestic animals, and harvesting. For assistance with creating a food safety plan, contact CAFF.

Food Safety Auditors

Sometimes the buyer requires a third party audit of the farm. If that is the case, they will either request a specific food safety auditor(s) be used, or will let the farmer choose the auditor. A third party audit can be mandatory if the farmer opts to sell to a handler who is part of a USDA recognized commodity group such as the Leafy Green Marketing Agreement. The USDA Agricultural Marketing Service offers food safety audits, as do some states, and there are many private auditing companies. They usually have a very specific checklist and make general observations. The purpose of the auditor's visit is to verify that your written food safety plan "says what you do – and you do what you say."

Food Safety Inspection

The FDA or State health enforcement officer may appear on your farm, but the chances of this occurring are small, unless you are growing a crop considered by them to be risky, or your produce is linked to a food borne illness.

When a food safety visitor comes to inspect a farm operation—be it a third party auditor, the local or state health department, or the Food and Drug Administration (FDA)—it may be helpful to follow the 'Co-management Principles', 'General Rules of Thumb', 'Do's and Don'ts,' and 'Follow-Up' outlined below. The farmer will have a more successful food safety audit or inspection and the food safety visitor will benefit from the farmer being prepared. If at the end of the visit, a recommendation is made to which the farmer does not agree, having a conversation with the inspector's/auditor's supervisor may be helpful in correcting the issue.

Addressing Co-management Principles

Farmers can address food safety without sacrificing responsible on-farm conservation measures. According to the Produce Safety Alliance (run by Cornell University, FDA and USDA), farmers can more effectively advocate for their farming practices with food safety auditors by using risk assessment strategies that help identify risks, and by explaining their rationale for management decisions that address those risks. This risk-assessment approach can be used for conservation measures included in a farming operation, such as maintaining streamside habitat or other non-crop vegetation.

Determine risk reduction protocols that address risk identified for your farm's situation. Assess risk such as pathogens coming from a livestock area; conduct necessary corrective actions that address the problem such as installing a diversion as shown in #3 of the illustration; monitor periodically and write down changes in risk; and implement any other corrective actions if necessary, such as using a cover crop as part of a waiting period between a flooding event and planting the next crop, as shown in #16.

Explain rationale for management decisions. Use descriptions of practices in the key to the illustration above to help craft co-management rationale for decisions made.

General Rules of Thumb

Have a written policy for inspections by food safety auditors and government enforcement officers visiting the farm.

- There should be a clear and concise written policy (program) following the farm's food safety plan while auditors and enforcement officers are on the farm. Everyone in the organization should review this policy in its entirety.
- Official food safety auditors and enforcement officers should be "guided" through your farm operation, but you should not impede them in going where they need to go.

What To Do During the Audit or Inspection

Treat food safety auditors and enforcement officers professionally:

- Consider every visit from them as official.
- Always be courteous to them, such as asking if they would like water, coffee or use of the restroom, but keep a professional distance.
- Recognize that they are not paid to be consultants or to assist you with your food safety management.

Require identification and ask for the reason of the visit:

- Have the auditor or enforcement officer sign in on the visitor's sheet.
- Ask that the auditor or enforcement officer provide appropriate credentials and identification, including their business card.
- Ask for their supervisor's name and contact information.
- Ask the auditor or enforcement officer if the inspection is routine or if there is a specific reason for the inspection.
- Require the auditor or enforcement officer to state his/her specific intentions, and in the case of a FDA inspection, to provide Form FD 482-Notice of Inspection.
- Ask the auditor or enforcement officer what s/he wants to see or do, how long it might take, and what resources s/he might need to assist with the inspection.

Take charge of the visit:

- Provide the auditor or enforcement officer with an overview of your farm, including risk assessment strategies for co-managing food safety with conservation and other issues. These practices can be described in detail as part of your food safety plan.
- Escort the auditor or enforcement officer at all times and proactively explain rationale for co-management and other food safety decisions. If possible have two people from your farm present during the inspection.
- Have all policy, management contacts, and standard information records in organized and clearly labeled binders to facilitate and set a positive tone for the inspection.
- If the auditor or enforcement officer asks for records, provide them with a photocopy while you retain the original.
- If the auditor or enforcement officer asks for a produce sample, ask them to make a duplicate one for you and ask what they intend to specifically test for with the sample. Also ask for the expected time to obtain test results so the physical quarantine of the impacted harvested lot may be anticipated. Send the duplicate to a qualified lab of your choice for the same tests.

Strive for clear communication:

- Listen well and ask lots of questions.
- Answer all questions honestly and take time to fully explain each of your answers.
- Stay focused on questions that are asked and only volunteer information when it is related to specific inspection criteria.
- Ask if any minor infractions can be fixed immediately. Don't necessarily accept any advice or recommendations, orders, directions, or instructions without appropriate justification.

Conditions Under Which an Automatic "Unsatisfactory" Will be Assessed in an Audit or Inspection

- An immediate food safety risk that has or would reasonably cause the produce to become contaminated.
- The presence or evidence of general unsanitary conditions, chemical or allergen hazards, rodents, or excessive pests in the produce.
- Personal hygiene has jeopardized the safety of the produce.
- Falsification of records.
- Not having a written and established food safety plan.
- Not having a designated, qualified person on the farm to implement and oversee an established food safety plan.

Training Scenarios for USDA and Third Party Auditors on the Co-management of Food Safety and Conservation as well as Small Farm Concerns

Before a food safety auditor comes to your farm, suggest that they first review training scenarios on co-management and small farm issues posted at www.wildfarmalliance.org. The materials are presented in the accepted food safety industry format of the USDA Harmonized Standards for Field Operations. If the auditor works for, or is accredited by USDA, they can receive continuing education units. By having them learn about co-management and small- and mid-size farm issues, they will be better informed when they arrive at your farm. Farmers may also find value in reviewing these training scenarios, and may want to reference them, if a food safety auditor who has not seen these materials is already on the farm and needs further clarification.

- Ask for references (book, paragraph and line number) to all inspection findings.
- An exit briefing will occur at the end of the audit or inspection, but if one is not done, ask for it, taking good notes. During this debriefing, the auditor or enforcement officer will describe what may be a concern. This will be helpful to know, in case they plan on taking future actions. If the official also asks you to sign a paper with the alleged concern outlined, you may want to defer until you can have your attorney review it.

What Not To Do During the Audit or Inspection (Unless required by proper legal authority)

- Do not admit to any fault or deficiency or sign any forms admitting to fault, without proper legal advice.
- Do not volunteer the following information: recipes, formulas, any item that is strictly proprietary, financial records, research data, customer lists, sales information, pricing information, personnel records, accident data, distribution records, or inventories of products.

Follow-Up Right After the Audit or Inspection

When agreement is not reached:

- If for any reason you do not agree with the auditor or enforcement officer, absolutely have them make complete notes of your objections in their report or provide them (before they leave the farm) with a statement explaining the situation and all facts of the matter.
- At this point it is also recommended that you immediately contact this individual's supervisor and state your concerns. The supervisor wants to talk to you and correct the issues.

Follow-Up Some Time After the Audit or Inspection

Audit results:

- Once the audit is processed, either a final copy of the passing audit, or a letter describing what corrective actions are need to be implemented within a designated period of time will be sent.

Inspection results:

- You should be provided with an inspection report (this can take some months). Respond to any deficiencies noted in the report by making corrective actions in a timely manner (FDA requires 15 days) and telling them you did it. If you do not hear back from the inspecting agency, call them on the phone number they provided to you during the initial visit.
- If you do not agree with the findings, contest them with the advice of an attorney.
- If a warning letter is received, check with your attorney before responding.



Sam Earnshaw



USDA NRCS

By using risk assessment strategies that help identify risk as well as explaining the rationale for management decisions that address that risk, farmers can effectively advocate for their conservation-based farming practices including cover crops and wetlands.

Selected Resources

Co-management Materials

- Farming with Food Safety and Conservation in Mind authored by Jo Ann Baumgartner and Dave Runsten; published by Wild Farm Alliance and Community Alliance with Family Farmers. Updated 2013.
- Co-Management of Food Safety and Sustainability authored by Mary Bianchi and published by UC Davis. 2012.
- Safe and Sustainable: Co-Managing for Food Safety and Ecological Health in California's Central Coast Region authored by Karen Lowell, Jeff Langholz, and Diana Stuart; published by The Nature Conservancy of California and the Georgetown University Produce Safety Project. 2011.

Small and Mid-Size Farm Websites with Food Safety Information

- Community Alliance with Family Farmers (<http://caff.org/programs/foodsafety/>)
- Wild Farm Alliance (www.wildfarmalliance.org)
- Carolina Farm Stewardship Association (<http://www.carolinafarmstewards.org/tag/food-safety/>)
- Northeast Organic Farming Association (<http://www.nofa.org/advocacy.php>)
- National Sustainable Agriculture Coalition (<http://sustainableagriculture.net/category/food-safety/>)
- Maine Organic Farmers and Gardeners Association (<http://www.mofga.org/>)

Good Agricultural Practices (GAPs) Websites

- On Farm Food Safety Project has a free online tool, based on a comprehensive risk-based framework, which generates customized on-farm food safety plans based on user input (<http://onfarmfoodsafety.org/>).
- Produce Safety Alliance is developing a nationwide curriculum to increase understanding of the principles of Good Agricultural Practices (GAPs) and to facilitate the implementation of food safety practices on fresh fruit and vegetable farms and in packinghouses (<http://producesafetyalliance.cornell.edu/psa.html>).
- Global GAP certifies safe, sustainable production of food, flowers, and ornamentals. They work with more than 140 independent and accredited certification bodies to carry out certification worldwide (http://www.globalgap.org/uk_en/for-producers/crops/).
- USDA GAPs is a voluntary program by USDA Agricultural Marketing Service that provides independent audits of produce suppliers throughout the production and supply chain (<http://www.ams.usda.gov/AMSV1.0/HarmonizedGAP>).
- Produce GAPs Harmonized Food Safety Standard Field Operation and Harvesting offered by USDA is another independent audit that was created by United Fresh with input from the produce industry (<http://www.ams.usda.gov/AMSV1.0/getfile?dDocName=STELPRDC5102511>).
- California Leafy Green Marketing Agreement (LGMA) membership requires verification of compliance with the accepted food safety practices through mandatory audits conducted by USDA trained auditors (<http://www.caleafygreens.ca.gov/>).

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Jo Ann Baumgartner of Wild Farm Alliance (WFA) wrote this guide with review and substantial technical input from Trevor Suslow at UC Davis, and editing from Community Alliance with Family Farmers (CAFF). WFA and CAFF co-published the final document in October 2013.

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A FARMER'S GUIDE TO FOOD SAFETY AND CONSERVATION: FACTS, TIPS & FREQUENTLY ASKED QUESTIONS

