A FARMER'S GUIDE TO FOOD SAFETY AND CONSERVATION:

FACTS, TIPS & FREQUENTLY ASKED QUESTIONS

Second Edition - October 2017

Background

It seems too often 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. With data collection intensifying since 2006, some research now shows that removing habitat does not reduce food safety risk and can actually do the opposite - increase risk.

In 2011 the Food Safety Modernization Act (FSMA) was passed by Congress, and in 2016, the Food and Drug Administration's (FDA) produce safety regulations became effective. Part of FSMA directed FDA to write regulations that do not conflict with or duplicate the National Organic Program's (NOP) regulations. NOP requires farms to conserve biodiversity and maintain or improve wildlife and its habitat. FDA allows produce to be grown in diverse landscapes with native species without using fences to exclude animals or destroying animal habitat or otherwise clearing farm borders around crops or drainages. So whether organic or not, farmers can take steps to ensure that they are reducing food safety risks while still maintaining the conservation areas important to their operations.

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.


USDA NRCS

Animal feces can contain pathogens that make humans sick.

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/

Washing boots after working with animals, properly composting manure, and ensuring livestock doesn't contaminate produce fields can help reduce the risk of spreading patogens.

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.

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.

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

Sunlight helps kill pathogens through its destructive UV radiation.

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.

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.


USDA NRCS

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


USDA NRCS

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

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.

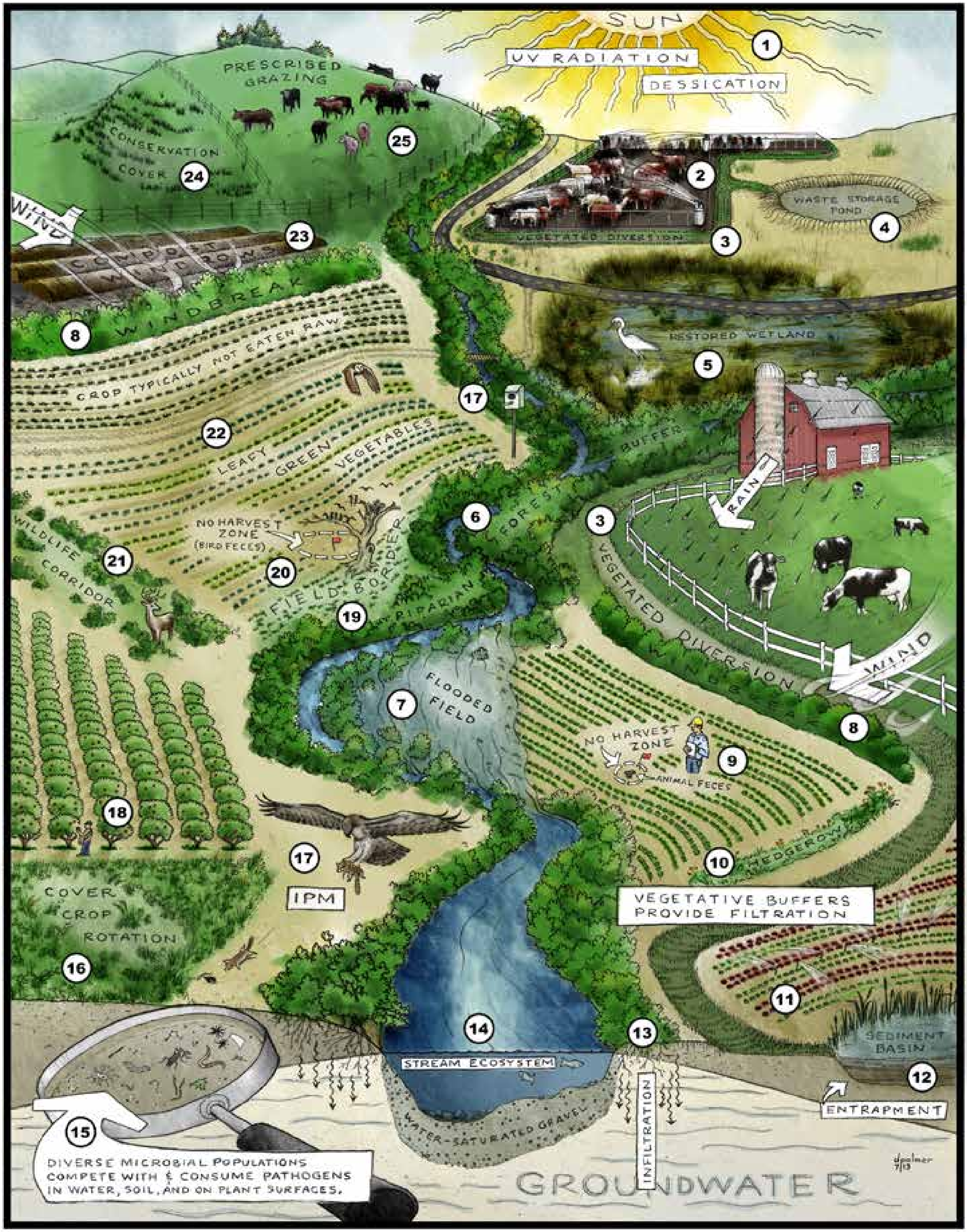
Vegetation

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.

Healthy Diverse Ecosystems Help to Keep Pathogens in Check



Not to Scale

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 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. FDA produce regulations require that the effluent from the ponds not be used on crops. 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: 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. FDA considers flooded crops to be "adulterated" if the edible portion of the crops touch the flood water.

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. FDA produce regulations require that farmers monitor crops for significant contamination during the growing season and immediately prior to and during harvest of crops. If significant numbers of animals, feces or crop destruction are 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: FDA produce regulations require using sources of irrigation water that are adequately free of contamination, although FDA has stated as of this printing that they may make revisions. 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 being 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 only from the tree, not the ground, is required by FDA produce regulations. 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: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/technical/cp/ncps/*

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, FDA produce regulations and a mix of requirements from third party auditors.

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.

USDA NRCS

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

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*, *Campylobacte*r, *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 *Campylobacte*r. 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

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 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. FDA states that the presence of wildlife in a crop is, in and of itself, not a significant food safety risk, though action needs to be taken if significant evidence of feeding, trampling 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 significant numbers of wildlife or significant evidence of feces, feeding or trampling in the production fields?

FDA requires monitoring of crops for significant contamination during the growing season and immediately prior to and during harvest of crops. If significant contamination is 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. Feces and the contaminated product can be disposed of away from the crop, sanitize the shovel or other equipment, and wash hands afterwards. Keep records of all actions taken. Continuing crop assessments will help 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.

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. FDA's produce regulations do not expect farmers to destroy habitat or clear farm borders around crops or drainages.

Sam Earnshaw

FDA and many food safety audits allow habitat 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 to some degree.

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 temporally 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. FDA's produce regulations state that they do not expect farmers to fence or exclude animals from production fields.

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 windbreak 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 published guidance's on leafy greens, tomatoes and melons to help growers reduce risk. Depending on the method by which

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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.

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.

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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.

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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?

FDA produce regulations do not require irrigation water to be tested if: (a) it is not intended to or is unlikely to be used on the crop during its growth, such as using drip irrigation on tree fruit crops, or (b) it is treated or is from a municipal water system. FDA requires that your irrigation water be tested for an acceptable level of generic *E. coli* if it is intended or will likely be used on the edible portion of the crop during the growing season, such as overhead irrigation on tomatoes, and buried drip on carrots because in both cases the water will touch the crop.

B2. Can I still use raw manure?

Pathogens that pose a serious food safety risk may be contained in raw manure. FDA's produce regulations at this point recommend that growers follow the USDA National Organic Program (NOP) regulations which 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. FDA may change its stance on the waiting period once more research in the next five to ten years helps them make an informed decision. Some marketing agreements, such as the one for leafy greens, requires a one-year waiting period between application of soil amendments with raw manure and production of the next crop. Records of applications of raw manure must be kept. 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. FDA's produce regulations do not require a time period between compost application and harvest of crop. If not completely composted, it should be treated like raw manure.

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. FDA produce regulations allow either of these composting methods: (a) Static composting that maintains aerobic (i.e., oxygenated) conditions at a minimum of 131 °F (55 °C) for 3 consecutive days and is followed by adequate curing; and (b) turned composting that maintains aerobic conditions at a minimum of 131 °F (55 °C) for 15 days (which do not have to be consecutive), with a minimum of five turnings, and is followed by adequate curing. You must maintain records that document that you conformed with one or the other treatment processes. Care must be taken to ensure composts aren't re-contaminated with pathogens on the farm.

While FDA does not require a waiting period between grazing livestock in crops and the harvest of the subsequent crop, it can help reduce the risk of manure contaminating produce.

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.

When using compost from a supplier, FDA produce regulations require that you obtain annual records (such as Certificate of Conformance or Certificate of Analysis) showing that: (a) the treatment process used is scientifically valid and carried out with appropriate process monitoring, and (b) compost has been handled, conveyed, and stored in a manner and location to minimize the risk of contamination by untreated biological soil amendment of animal origin.

E2. Is aged manure okay to use?

FDA treats aged manure as raw manure, recommending that the same 90/120-day waiting periods be used as what the NOP requires (see B2), until such time in the future that research refines FDA's understanding and they publish requirements.

F2. Are there other ways to treat raw manure?
FDA produce regulations allow valid thermally or chemically processed manure. For instance, steam, ammonia or stabilized lime may be used if the process to reduce specifically identified pathogens has been validated with laboratory analyses. 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 FDA produce regulations only require adequate control of animal feces in order to prevent contamination of the crop, some standards suggest a waiting period of 120 days to take 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).

Make sure U-Pick customers know where bathrooms and hand washing facilities are located.

H2. Can Community Supported Agriculture (CSA) members and U-Pick customers be on the farm?
Yes. Before walking the fields, FDA's produce regulations require that all visitors are made aware of the farm's food safety policy and procedures and that they are told how they can access the bathroom and hand washing facilities. You may want to provide a food safety fact sheet and have customers sign an agreement form stating that they will comply with farm hygiene practices.

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?
FDA allows cats and dogs on the farm provided that systematic implementation adequately controls their feces and litter.

K2. Do I need a food safety plan?
FDA's produce regulation recommends an operational assessment and 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 by attending a training to learn more about the topic and then modifying one of the existing templates available for free online. CAFF provides free word templates available for download on our website along with other resources listed at the end of this document.

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Food Safety Plans

Most often, a farmer's buyer triggers the need for a food safety plan (FDA doesn't require one). 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.

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

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. Organic farmers should remind inspectors/auditors that FSMA clearly states there should be no conflicts between food safety and organic regulations. All farmers should also remind them that FDA produce regulations permit crops to be grown in diverse landscapes with wildlife and native habitat. Additionally, FDA allows the presence of wild animals in crop fields, stating that they in and of themselves are not a significant food safety risk.

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. 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 That Will Cause an Automatic "Fail" During a 3rd Party Audit

• An immediate food safety risk that has or would reasonably cause the produce to become contaminated.
• The presence or evidence of general unsanitary conditions, rodents, or excessive pests in the produce.

- Personal hygiene that has jeopardized the safety of the produce.
- Falsification of records.
- Not having a written and established food safety plan.

Possible Consequences for a Farm that has an Egregious Condition Discovered During a FSMA Inspection

Farms must comply with these regulations; they are mandatory, not voluntary. FDA or the FSMA Inspectors at the State Department of Agriculture responds to a egregious condition found at the farm during a FSMA Inspection by:

- Notifying the State Department of Public Health so that they can arbitrate the next best course of action.
- In an extreme case where people die, you could be charged with a crime such as the Jensen brothers in the cantaloupe foodborne illness outbreak in Colorado.

What is an Egregious Condition?
A practice, condition, or situation on a farm or in a packing house that is reasonably likely to lead to two conclusions. The first being serious adverse health consequences or death from the consumption of or exposure to covered produce and/or second an imminent public health hazard is posed if corrective action is not taken immediately (example: edible portions of produce contacting potential source of contamination).

• 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

• Co-managing Farm Stewardship with Food Safety GAPs and Conservation Practices: A Grower's and Conservationist's Handbook. Wild Farm Alliance. 2016. (http://wildfarmalliance.org/food_safety_and_conservation_resources)

• 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.

• 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)

• National Sustainable Agriculture Coalition (http://sustainableagriculture.net/category/food-safety/)

• UC Davis Small Farm Website (http://sfp.ucdavis.edu/)

• Oregon State University Small Farms Website (http://smallfarms.oregonstate.edu/)

Good Agricultural Practices (GAPs) Websites

• US Food and Drug Administration (FDA)'s Standards for the Growing, Harvesting, Packing, and Holding of Produce for Human Consumption became effective January 2016. http://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm334114.htm

• 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 currently offers the only FDA approved Grower training program (https://producesafetyalliance.cornell.edu/).

• Global GAP certifies safe, sustainable production of food, flowers, and ornamentals. They work with over140 independent and accredited certification bodies to carry out certification worldwide (http://www.globalgap.org/).

• Produce GAPs Harmonized Food Safety Standard Field Operation and Harvesting offered by USDA is independent audit that was created by United Fresh with input from the produce industry (https://www.ams.usda.gov/services/auditing/gap-ghp)

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Jo Ann Baumgartner of Wild Farm Alliance (WFA) wrote this guide in 2013 with review and substantial technical input from Trevor Suslow at UC Davis, and editing from Community Alliance with Family Farmers (CAFF). WFA and CAFF, with Trevor's assistance and that of Lauren Gwin of Oregon State University, updated this document in October 2017.

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

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