Key to Figure 1.3: Healthy, Diverse Ecosystems Help Keep Pathogens in Check

Note: The Healthy, Diverse Ecosystems Help Keep Pathogens in Check *illustration is not drawn to scale; it serves as a visual summary of the practices used to address food safety referenced in this document. Details on the design, dimensions, spacing and maintenance specifications of many of the conservation practices represented here can be found in the NRCS Conservation Practice Standards. In-field practices to address food safety, conservation or otherwise, do not provide ABSOLUTE protection against food-borne pathogens on a given farm/ranch. 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 pathogens on the surfaces of soil and leaves, as well as in clear water. The sun also facilitates the desiccation of pathogens, which may lead to die-off.

2. Vegetated diversions (362) move water running off of confined animal feeding operations to waste treatment lagoons, preventing the movement of waterborne pathogens to near by fields and waterways. The vegetation also intercepts pathogens, slowing their movement, and provides a matrix for beneficial bacteria that compete and predate upon pathogens. Plants should be selected and managed to minimize thatch build up and encourage the penetration of the plant canopy by sunlight, as the cool, moist, shaded interior vegetation may provide favorable habitat for pathogen persistence.

3. Waste storage pond (313) 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 maintained so that it does not overflow. Wild animals should be kept out of the pond.

4. Restored wetlands (657) reduce pathogen movement by enhancing the water's residence time and provide a matrix for beneficial bacteria. The diverse plant and microbial community encourages antagonistic interactions with pathogens. Use of macrophytic vegetation and designs that facilitate low flow rates and long retention times allow the best chance for pathogen reduction in outflows. The vegetation in the wetland may decrease UV penetration, which may provide favorable habitat for pathogen persistence. However, in wetlands with fluctuating water levels, the vegetation may allow for more UV radiation exposure if pathogens are retained on vegetation above the waterline when water levels decrease.

5. Riparian forest buffers (391) trap wind-borne pathogens on their vegetation and waterborne pathogens in their root systems. The diverse plant and microbial community in the buffers encourages antagonistic interactions with pathogens. They also convert extra nutrients into plant materials, thereby reducing nutrient concentration in the water and potentially reducing habitat for detrimental microbes. As described in the practice standard, the minimum width of the riparian forest buffer should be 35 feet, starting at the water line. The width should be increased for buffers located near high animal-waste application areas.

6. Grassed waterways (412) intercept waterborne pathogens running off pasture, and divert potentially contaminated water away from specialty-crop fields. They also reduce soil erosion, which reduces (upon drying) the creation of 'blowable,' dust containing pathogens. Plants should be selected and managed to minimize thatch build up and encourage the penetration of the canopy by sunlight, as the relative moist, shaded interior vegetation may provide favorable habitat for pathogen persistence, that may be released in high flow situations.

7. Flooded field: Avoid planting crops typically eaten raw on lands that often flood. If and when a flood occurs, do not replant with crops typically eaten raw, as it may take time for pathogens present in the soil to die off.

8. Windbreaks (380) trap dust containing pathogens and prevent it from entering specialty crop fields. In accordance with the conservation practice standard, windbreaks used to reduce airborne particulate matter (including dust containing pathogens) should be spaced at an interval less than or equal to ten times the height of the full-grown hedgerow. 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 habitat for temporary pathogen persistence.

9. Evidence of animal intrusion in a crop field should be monitored. Items to monitor include animal feces and signs of feeding. 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, all play into determining the appropriate risk reduction actions taken. When animal feces or signs of feeding are present in the field, place a no-harvest buffer around the contaminated source. The size of the buffer depends on the crop and animal in question.

Key to Figure 1.3: Healthy, Diverse Ecosystems Help Keep Pathogens in Check

10. Pollinator hedgerow: In addition to providing habitat for native pollinators and other beneficial insects, pollinator hedgerows trap waterborne pathogens in their root systems. Tall pollinator hedgerows trap wind-borne pathogens on their vegetation. Refer to the hedgerow (422) conservation practice standard for information on the design and spacing of hedgerows. Shaded interior of the hedgerow may provide favorable habitat for pathogen persistence if too dense.

11. Irrigation: Using clean sources of irrigation water that have not been contaminated by animals will reduce the risk of introducing pathogens into a field. Irrigation techniques that promote infiltration of the water into the soil and reduce runoff may aid in reducing the movement of pathogens already present in the field.

12. Sediment basins (350) capture and detain sediment-laden runoff that may contain pathogens. If 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 cool moist conditions and helps reduce pathogen survival. Sediments, which have not dried out sufficiently, that are removed from the basin and put on cropland should be treated as contaminated and a time period between its application and the next crop's harvest is established.

13. Riparian forest root zone: The roots of the riparian forest promote water infiltration, slow subsurface flow and provide biological activity. This helps divert pathogens from surface water, slows their movement and encourages antagonistic interactions with pathogens.

14. Healthy stream: In a healthy stream ecosystem predation by native microbial communities is thought to increase pathogen die-off rates. Clear water allows for penetration of UV radiation, which can lead to pathogen die-off. Flowing water dilutes, and thereby weakens, pathogen populations. Some aquatic protozoans may serve as an alternate host for some pathogens, allowing pathogens to persist even when environmental conditions are unfavorable.

15. Cover crops: Rotating with cover crops increases soil organic matter and supports soil microbial communities that may aid in suppressing pathogens. Cover crops 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.

16. Integrated pest management (IPM) (595) of vertebrates 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.

17. Harvest orchard fruit from the tree, not the ground. Fallen fruit may have come in contact with animal feces.

18. Field borders (386) intercept waterborne pathogens moving in sheet flow from the field. This planting encourages infiltration and serves as a buffer between the field and the riparian vegetation. According to the conservation practice standard, field borders used to address contaminants suspended in water should have a minimum width of 30 feet. Plants should be selected and managed to minimize thatch build up and encourage the penetration of the plant canopy by sunlight, since the cool, moist, shaded interior vegetation may provide favorable habitat for pathogen persistence.

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

20: Pick up dog poop and discard properly. Dog and other domesticated-animal feces can be a source for pathogens.

21. Crop placement: Avoid planting leafy green vegetables or other crops typically eaten raw near compost windrows, as pathogens from the compost may transfer to the field via water or wind.

22. Compost: Properly managed compost windrows heat up to a temperature that suppresses pathogens. Compost itself supports beneficial organisms that compete with and predate upon pathogens. Unfinished compost might be a source of pathogens, thus measures should be taken to prevent unfinished compost 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.

23. Conservation cover (327) traps wind borne pathogens on its vegetation and waterborne pathogens in its root system. Plants should be selected and managed to minimize thatch build up and encourage the penetration of the plant canopy by sunlight, since the cool, moist, shaded interior vegetation may provide favorable habitat for pathogen persistence.

Key to Figure 1.3: Healthy, Diverse Ecosystems Help Keep Pathogens in Check

24. Prescribed grazing (528) prevents pasture from becoming deteriorated which helps increase water infiltration, reduces runoff and helps prevent erosion. This helps prevent the movement of pathogens in water runoff. Grazing animals can be a source of pathogens, thus measures should be taken to prevent pathogens from the animals' feces from moving onto adjacent fields through wind or water.