Gardening After a Flood

Best Gardening Practices After Flooding

1. Discard any produce that was touched by flood waters (above or below ground).
2. Treat any produce that was present during flood but not actually touched (see chart below for specific actions).
3. Wait at least 60 days before replanting (see diagram below for details).
4. Wear gloves and closed shoes, wash hands thoroughly, and mulch garden and paths to keep dust down.

Flooding of streams and creeks not only causes property damage, but can also damage gardens by affecting your soil quality and the safety of crops being grown. Working in the garden and consuming garden produce after a flood can be unsafe because of health risks posed by flood waters, which can carry unknown and hard-to-identify microbes and contaminants. The purpose of this fact sheet is to teach you some simple practices to reduce risk when growing your own food after a flood.

What is the risk from flooding?

Flood water can deposit biological and chemical contaminants on any garden/ farm produce that has been in contact with it. Ingesting these contaminants can cause illnesses and health problems that are hard to diagnose.

In most cases, chemicals in flood waters are likely to be diluted and at low levels. Highly contaminated soil can sometimes be recognized by signs such as staining, sheens, or beading of water on the soil surface; water taking longer to soak in; vegetation that doesn't look well; or chemical odors. However, some contaminants may not be noticeable by sight or smell at all.

Flood water can be contaminated by oil and gasoline from cars. Source: U.S. Geological Survey.

Flood water can contain pathogenic microorganisms like bacteria (e.g. *Escherichia coli, Salmonella* spp.), viruses (e.g. hepatitis A, norovirus), and parasites (*Giardia lamblia*, *Cryptosporidium* spp.) from overflow of sewers, septic tanks, or from livestock facilities. Depending on the other nearby areas that have been flooded (e.g. industrial, residential, or rural), flood water may also contain chemicals such as:

- Hydrocarbons, for example, petroleum products from roads, garages, or auto service industries;
- Heavy metals like lead, cadmium, and arsenic used in metal or electronics industries;

- Pesticides and fertilizers from agricultural runoff; and
- Hazardous chemicals and other substances used or stored on industrial sites in the flooded area.

Disease-causing microorganisms and chemical contaminants can remain in the soil even after the water visibly dries up. Some microorganisms will die within a few weeks, whereas other microorganisms and chemical contaminants may remain in the soil for months to years. Even in soil with elevated levels of chemical contaminants such as heavy metals, plants absorb relatively little of the contaminants at levels that would be harmful to humans, although the extent of contamination depends on the type of plant and soil characteristics. Gardeners and children are most likely to be directly exposed to these contaminants by ingesting, inhaling, or through skin contact with garden soil and soil dust rather than eating contaminated produce.

Can I eat produce from my garden after it has been flooded?

It depends on the type and level of contaminating substances and disease-causing microbes (pathogens) the flood water contains, which is usually difficult to know for sure without laboratory testing. Therefore, the best and most cautious approach is to **discard all produce that has been in contact with flood water**, either submerged or splashed by water or mud. This includes surface vegetables such as leafy greens, tomatoes, string beans, berries, and corn; underground crops, such as potatoes, carrots, and garlic; and even produce with a hard outer skin or shell, such as watermelon and winter squash.

Pumpkins and melons exposed to flood water. Source: Food Safety News, 2016.

Table 1. Treatments of produce from farms or gardens after a flood [2]

	Wash, Rinse, Sanitize[1]	Peel	Cook Thoroughly	Discard
Produce touched by flood water				
Fruit or veggies where edible part has been touched by flood water				x
Produce NOT touched by flood water				
Soft, cracked, or bruised fruit or veggie				x
Plants where fruits have set (tomatoes) or flowers are evident (cauliflowers, broccoli)	x	x	x	
Crops above flood water, harvested within a few weeks after flood	x	x	x	
Crops from growth formed after flooding subsides (e.g. tomatoes, peppers, eggplant, squash, etc)	x	x	x	

[1] Wash with tap water (no soap), soak for 2 minutes in a solution of 2 tablespoons bleach in one gallon of water, and rinse again with tap water [2].

These actions can minimize food-borne illnesses, but do not completely reduce risks. Washing produce only removes some of the pathogens present, thus this step may not reduce microbes to a safe level if high numbers are present following the flood event. Additionally, peeling can transfer pathogens and chemical contaminants from the skin to the edible flesh of the produce. Adequate cooking temperatures and times can inactivate pathogens, however if the initial level of these microorganisms on the produce is high, cooking may not adequately reduce illness risks. Cooking is not effective in reducing chemical contamination and so cannot be used as a method to make produce safe for consumption if chemical contamination is suspected. If chemical contamination of flood water or soil is suspected, it is best to discard produce that has been in contact with it to minimize risk to the consumers.

DO NOT attempt to can, dehydrate or otherwise preserve any produce not fit for eating based on the chart above [2].

Is my soil safe to garden in? What should I do to reduce risks from contaminated soil?

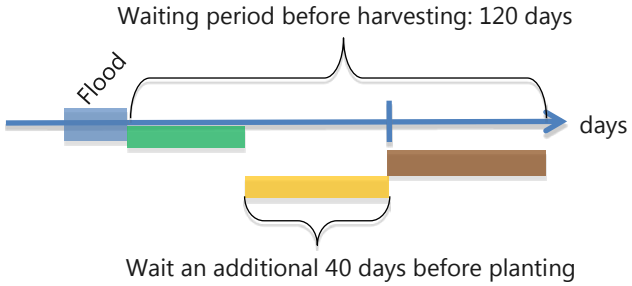
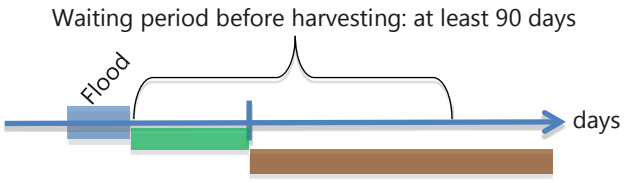
The survival of pathogenic microorganisms in the environment generally decreases with time. Soil drying and exposure to the elements (sunlight, heat) can inactivate pathogenic microbes. The amount of time you should wait before replanting your garden depends on the pathogenic microorganism and conditions such as temperature and type of soil. At this time, researchers do not have a clear determination of the exact amount of time to wait before safely replanting after a flood [1]. However, recommendations made by the US Food and Drug Administration (FDA) and the US Department of Agriculture (USDA) National Organic Program (NOP) standards for application of untreated manure to fields can be used as guidelines. The FDA recommends waiting 30 to 60 days before replanting in fields impacted by flood [1]. The NOP requires a 90-day waiting period before harvesting edible materials that had no direct contact with the soil after an untreated manure application and a 120-day waiting period before harvesting edible material that had direct contact with the soil after an untreated manure application (e.g. lettuce, radish) [5].

Considering these two recommendations, to safely grow food in a garden impacted by flood, **wait at least 60 days after the flood recedes before replanting and 90 to 120 days after the flood recedes before harvesting**, depending on whether the edible part of the crop will be in contact with the soil or not. Depending on the type of crop and time to maturity, you may need to wait more than 60 days before replanting in order to allow the proper amount of time before harvesting. Check the seed packet to determine days until maturity.

For example, the diagram below illustrates the waiting period needed after flood waters recede before replanting and harvesting two sample crops, radishes and cherry tomatoes.

Figure 1: Sample waiting periods before replanting and harvesting after a flood

If you want to plant or garden in soil affected by flooding…

Edible part of produce in direct contact with flooded soil (Roots, bulbs, flowers, leaves)	Edible part of produce has no contact with flooded soil (Fruits)
Example: radish [6]	Example: cherry tomatoes [7]
Time to maturity = 20-35 days Waiting period before harvesting = at least 120 days Waiting period before planting = 60 + 40 days	Time to maturity = 60-70 days Waiting period before harvesting = at least 90 days Waiting period before planting = 60 days
	
In this case, you would have to wait an additional amount of time in order to satisfy both safety recommendations from the FDA and NOP.	In this case, after waiting 60 days to plant, by the time your tomatoes are ripe, you will likely have met the necessary 90-day waiting period to harvest for fruits not touched by the soil.

Required minimum days before safely replanting (60 days)
Time to maturity (depends on crop)
Additional waiting time before planting

If flooding occurred from an upstream industrial area and flood water is likely to contain chemical contaminants, soils should be tested by a certified lab after the flood waters have receded for the substances that are most likely to be present in the water, such as hydrocarbons, heavy metals and any known substances used or stored by the industries in the area that were impacted by the flood. If test results or visible signs indicate heavy contamination, more extreme forms of remediation, such as raised beds, should be considered before continuing to grow food [3, 4].

Soil testing labs:

A list of certified soil testing labs in Northern and Central California is available here: http://cesonoma.ucanr.edu/files/27431.pdf

Hydrocarbons and heavy metals are often included in the category of analyses called *Hazardous Waste* on this list. However, it is better to contact the lab before sending any sample to inquire about their analysis. Moreover, laboratories can usually assist with the sampling.

If flooding occurred in a residential area or green space and there is no suspicion that the water contains chemical contaminants, it is possible to work with existing soils by following good management practices [4]:

1. **Turn over the soil deeply and thoroughly** to allow potential contaminants present at low levels to be diluted. Soil should be turned over 18-24 inches in depth.
2. **Maintain soil pH at or close to neutral** (6.5-7.0). Lead and some other heavy metals are less available to plants within this range.

3. **Incorporate organic matter** such as compost to the soil before each planting season and in small amounts during planting. Additional organic matter will further dilute pollutants and will bind to heavy metals, reducing their chance of being taken up by plants and potential risks to human health.

In addition, following some simple steps can limit your exposure to any potential soil contaminants while working in the garden [4]:

- Mulch paths and walkways between planting beds to control dust that may contain contaminants;
- Wear gloves and closed-toe shoes when working in the garden and remove gloves and shoes before reentering the house to avoid introducing contaminated soil into the home; and
- Wash hands well after working in the garden. This is especially important for small children, who tend to put their fingers in their mouths.

For more information:

Soil testing and remediation: http://anrcatalog.ucanr.edu/pdf/8552.pdf

Food safety and flooding: http://ucfoodsafety.ucdavis.edu/Backyard_Farming/

UC Cooperative Extension Master Gardener Program in your area: http://mg.ucanr.edu/FindUs/

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References

[1] U.S. Food and Drug Administration. October 2011. Guidance for Industry: Evaluating the Safety of Flood-affected Food Crops for Human Consumption. https://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/EmergencyResponse/ucm287808.htm

[2] B. INGHAM, S. INGHAM, UW-Food Science. July 2016. Safely Using Produce from Flooded Gardens. Publication XHT1187.

[3] T.L. PROVIN, S.E. FEAGLEY, J.L. PITT, M.L. MCFARLAND. Texas A&M Agrilife Extension. Soil testing following flooding, overland flow of wastewater and other freshwater disaster. Publication E-522, 5-09

[4] R. SURLS, V. BOREL, A. BISCARO, UC ANR. 2016. Soils in Urban Agriculture: Testing, Remediation, and Best Management Practices. Publication 8552.

[5] United States Department of Agriculture. July 2011. Guidance Processed Animal Manures in Organic Crop Production. Publication NOP 5006

[6] V.A. FRITZ, University of Minnesota Extension. Growing carrots and other root vegetables in the garden. http://www.extension.umn.edu/garden/yard-garden/vegetables/growing-carrots-and-root-vegetables/

[7] D.R. PITTENGER, N.F. GARRISON. P.M. GEISEL, C.L. UNRUH, UC Cooperative Extension. 2005. Growing tomatoes in the home garden. Publication 8159

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