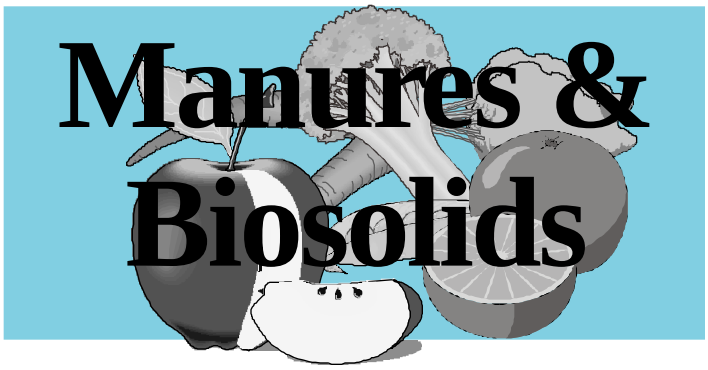


Karen L.B. Gast, Horticulturist, Postharvest and Marketing;
Rhonda Janke, Specialist, Sustainable Cropping Systems; and Kim Holt

When treated properly, animal manure and municipal biosolids can be effective and safe fertilizers and soil conditioners. But food safety concerns arise if manure or biosolids are untreated, improperly treated or recontaminated. If used as fertilizer, there is a possibility the materials may contain pathogens that can contaminate produce.

Crops that are at a greater risk from contamination include those that grow in or near the soil or are low-growing and may be splashed with soil during irrigation or heavy rainfall. Produce with physical characteristics that foster entrapment or attachment of soil are also threatened by contamination.

Microbial Hazards

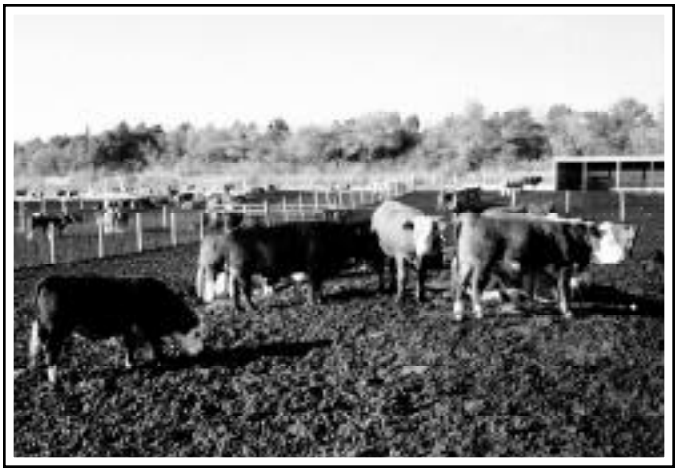
Animal manure and human fecal matter are significant sources for human pathogens. *Escherichia coli* O157:H7 is known to be transmitted from ruminants such as cattle, sheep and deer. Animal and fecal matter are known to harbor *Salmonella*, *Cryptosporidium* and other pathogens. So solid manure, manure slurries and manure teas need to be closely managed to minimize pathogen contamination. Potential sources of contamination that can introduce the presence of human or animal fecal matter into produce growing and handling environments include:

- Use of untreated or improperly treated manure.
- Nearby composting or manure storage areas, livestock or poultry operations.
- Nearby municipal wastewater or biosolids storage, treatment or disposal areas.
- High concentrations of wildlife in the areas of growing, harvesting and handling.

Control of Potential Hazards

Municipal Biosolids

On July 18, 1991, the Environmental Protection Agency (EPA) published a notice in the Federal Register outlining U.S. policy statements on the beneficial use of biosolids on federal land, including its use on food crops (56 FR 33186). Requirements for the use of biosolids are set out in Title 40 of the Code of Federal Regulations, Part 503 (40 CFR part 503). Part 503 requires either elimination of pathogens or significant reduction of pathogens along with certain restrictions, such as minimum times between the application of biosolids and the harvest of different food or feed crops. Some states



Feedlots are a potential source of contamination.

Risk Level	Type of Crop	Organic Fertilizers	Equipment Use	Livestock/Wildlife
LOW	Grain	No manure	Different equipment for manure handling and crop production	No livestock or wildlife on site
		Heat treated manure above 170 F		Few wildlife
		Well composted manure, frequently turned, uniformly heated to above 150 F	Equipment used for both manure application and harvest but cleaned and sanitized	History of livestock Greater than a year
MEDIUM	Above ground vegetables and fruits	Passively composted manures	Equipment used for both manure application and harvest, and cleaned	Livestock in area less than a year ago
		Aged manure, exposed to sunlight		Livestock and pets in close proximity to fields
HIGH	Below ground vegetables and root crops, ones consumed fresh	Raw manure applied to soil	Equipment used for both manure application and harvest and not cleaned	Livestock present during cropping season or heavy wildlife pressure
		Manure and compost tea— foliar application		
		Municipal (human) biosolids		

Figure 1. Risks Associated with Various Agricultural Practices.

also have requirements for the use of biosolids. Growers using biosolids must first meet the requirements of Part 503, and then comply with any additional state requirements. Since animal manure may contain equal or higher levels of certain pathogens, some of which are infectious to humans, growers may want to consider some of the principles behind the Part 503 requirements and consider the appropriateness of adapting these practices to the land application of manure.

Growers need to be aware that the use of municipal biosolids on fields used to produce food crops can contain additional hazards, such as toxic heavy metals and organic compounds. The Part 503 regulation discusses these.

GAPs for Manure Management

Good Agricultural Practices (GAPs) can reduce the risk of introducing microbial hazards to produce. These include composting and minimizing direct and indirect manure-to-produce contact, especially close to harvest. Among the most important to prevent cross-contamination is washing hands and boots when going between areas.

Food products that are marketed directly, such as livestock, fruits and vegetables, could be subjected to microbiological contamination at one or more points in the production system. The chart on the opposite page illustrates several points of likely contamination that can be controlled through grower education and adoption of good agricultural practices.

Pathogen treatments

Treatments to reduce pathogen levels in manure and other organic materials can be performed by growers or suppliers. Treatments can be divided into two groups, passive and active.

Passive treatments rely primarily on the passage of time. They are dependent on regional and seasonal temperatures and the type and source of manure. Passive treatments such as aging should not be confused with actively managed treatments such as composting.

Active treatments generally involve a greater level of intentional management and input of resources compared to passive treatments. Active treatments include pasteurization, heat drying, anaerobic digestion, alkali stabilization, aerobic digestion or combinations of these. Pathogens are destroyed by the high temperatures associated with composting, an active treatment where organic materials are digested aerobically or anaerobically by microbial action. However, little research has been done to make recommendations on the specific time and temperature that would apply to all composting or other manure treatment operations.

Handling and Application

Growers are encouraged to review their operation's current practices and conditions to identify potential sources of contamination.

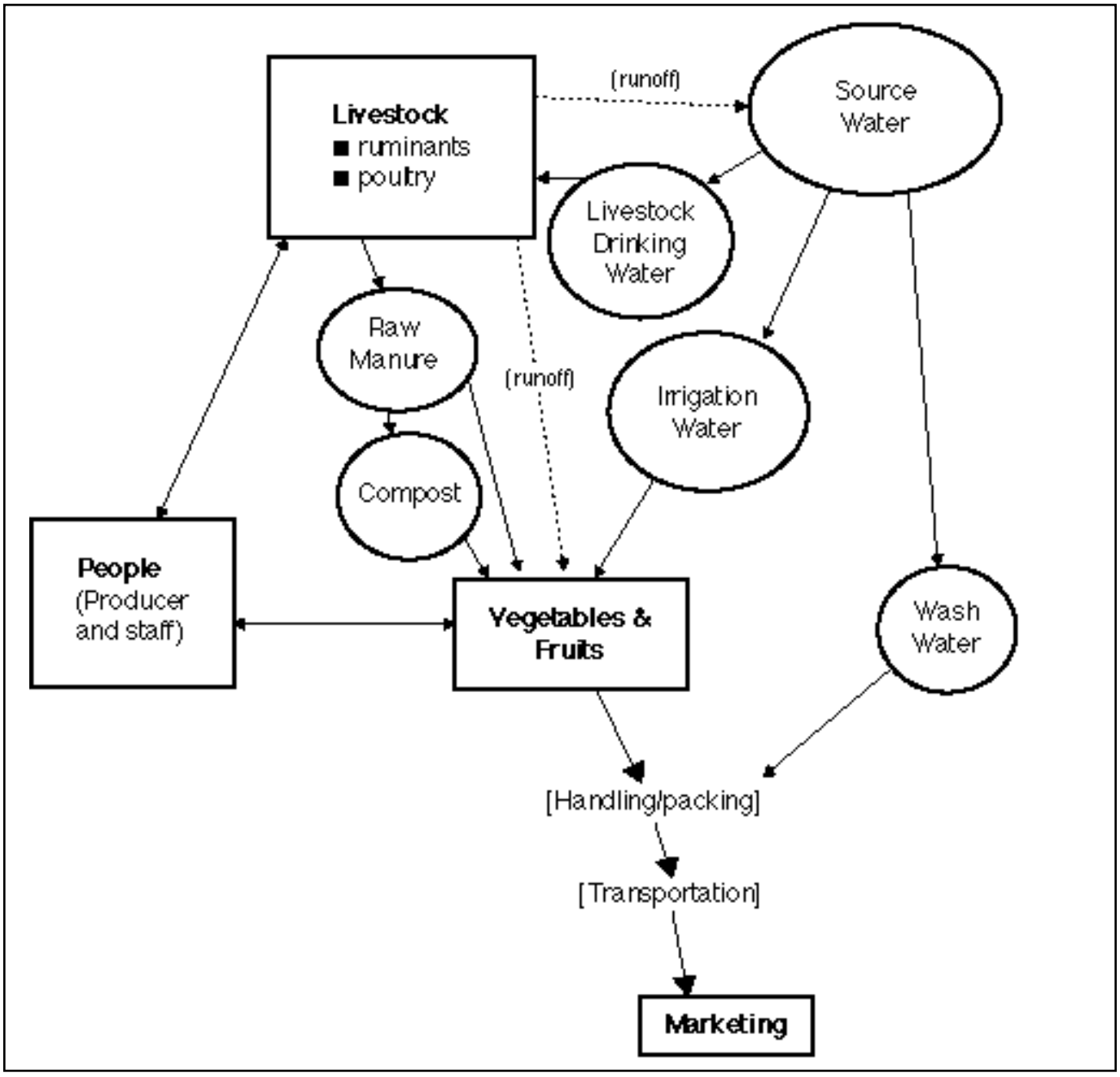


Figure 2. Fruits and vegetables can come in contact with manure sources in many ways.

Treated Manure

Composting, aging and other treatments may reduce, but might not eliminate the number of pathogens present in treated manure. Limited research has been conducted to know how well pathogens survive and regrow in treated manure. Growers using treated manure may want to consider some of the recommendations made for using untreated manure, in addition to the good agricultural practices outlined here:

- Avoid contaminating fresh produce with manure that is in the process of being composted or treated.
- Apply GAPs to ensure adequate treatment of manure. Consider all factors when designing manure treatment protocols. These include organic material type, pH, moisture content, process management, the carbon / nitrogen balance of organic materials, and climatic factors such as rainfall and temperature.
- Thoroughly mix and turn outside edges into the center of a compost pile during processing to maintain a uniform temperature.
- When purchasing treated manure, growers should obtain a specification sheet for each shipment, so that they know how the manure was treated.
- Growers are encouraged to contact state or local manure handling experts when seeking advice specific to their operations and regions.

Physical barriers like this ditch keep animal waste from contaminating production areas.

Animal Feces

Animal feces is a known source of pathogens that can cause foodborne illnesses. Here are some good agricultural practices for minimizing hazards from livestock:

- Don't allow domestic animals into fresh produce fields, vineyards and orchards during the growing season; fence off from these areas or confine animals in pens or yards.
- Take measures to ensure animal waste from adjacent or nearby fields and storage facilities does not contaminate the produce production areas, especially during heavy rains. These might include physical barriers such as ditches, mounds, grass or sod waterways, diversion berms and vegetative buffer areas.
- Work with local officials to control wildlife access to production areas.
- Restrict free-range chickens, weeder geese, turkeys and guinea hens used for insect control from fields.
- Don't pick up "windfall" or dropped fruit in areas with livestock or wildlife.

Reference

Guide to Minimize Microbial Food Safety for Fresh Fruits and Vegetables, U.S. Food and Drug Administration. Available on the World Wide Web (WWW) at *http://vm.cfsan.fda.gov/-dms/prodguid.html.*

Helpful Information

U.S. EPA. *A Plain English Guide to the EPA Part 503 Biosolids Rule*, EPA 1832-R-93-003, Washington DC, 1994.

Obtain by contacting the U.S. EPA / NCEPI, P.O. Box 42419, Cincinnati, OH 45242-2419. Telephone: 1-800-490-9198; FAX (513) 489-8695. You must give the EPA catalog number for the publication.

Electronic versions of additional EPA documents, such as criteria and supporting documents, are available at: *http://www.epa.gov*.

Containment barriers such as this lagoon can help control runoff.

Equipment used in manure handling should be dedicated to that use.

Manure storage and treatment sites should be situated as far as practical from fresh produce production and handling sites. The minimum distance for sites depends on numerous factors, some of which include farm layout, slope of land, runoff controls in place, potential for wind spread or heavy rainfall, quantity of manure, and how manure is contained.

Containment structures and barriers can help control runoff, leaching, and wind spread from manure storage or treatment areas. Examples of physical containments include concrete block, soil berms, pits or clay-lined lagoons.

Use GAPs that minimize leachate from manure storage and treatment areas.

- Cover manure piles.
- Collect leachate and dispose of it properly. If manure leachate or manure tea is used in fresh produce production areas, maximize the time between application and harvest. Leachate may pose a microbial hazard similar to the manure from which it originates.
- Implement practices to minimize the potential of recontaminating treated manure.
- Keep out birds and rodents by covering manure and by reducing nearby pest habitats, such as tall grass, weeds and debris.
- Clean equipment that has been used to move untreated or partially treated manure before it makes contact with fresh produce or treated manure.
- Look at farm layout and traffic flow, and redesign to minimize the potential for contamination. For instance, be sure a tractor isn't driven through manure before entering a produce field.

Untreated manure

There is a greater risk of contamination when untreated (raw) manure is used on food crops, compared to manure that has been treated to reduce pathogens. Consider these good agricultural practices when using untreated manure:

- Incorporate manure into the soil before planting.
- Do not apply raw manure or leachate from raw manure to produce fields during the growing season prior to harvest.
- Maximize the time between application of manure to produce production areas and harvest.
- In general, the shorter the time between applications, the greater the risk of pathogens. Risks are reduced if a crop is to be cooked or heat-processed before it is delivered to the consumer. You should also carefully consider the timing when applying untreated manure to adjacent fields.
- Raw manure should not be used on crops that are harvested throughout the season.

Helpful Resources

The NRCS Conservation Practice Standard 317, *Composting Facility,* sets out standards for on-farm composting (USDA, SCS, December 1990) (202) 720-5157; or at: *www.ncg.nrcs.usda.gov/nhcp_2.html.*

NRCS AWMFH 651.1004(F), Rynk et al., *On-Farm Composting Handbook,* NRAES-54 Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701 (607) 255-7654.

R.T. Haug, 1993, *The Practical Handbook of Compost Engineering,* Tachnomics Publishing.

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