ON FARM FOOD SAFETY - REDUCING THE RISK

Human Health Concerns Related to Soil Applications of Manure and Compost

Fruits and vegetables are vital to maintain good health. However, reports of food-borne illness linked to fruits and veggies have become more and more common. One key area of concern is land applications of manure and the relationship of manure management practices to the risk of food contamination by microorganisms harmful to humans. Although scientific literature is limited, it is well accepted that there are several types of microorganisms that can be found in livestock manure which can cause infectious disease in humans. Washing procedures after harvest may not effectively remove or kill harmful organisms, so preventing contamination of the crop in the first place is essential. This document highlights management practices that will help reduce the risk of contamination of produce from manure.

Contamination of fresh produce from pathogens found in manure can pose serious risks to human health. Proper manure management is essential in reducing this risk.

Food-borne illness associated with fresh produce is related predominantly to pathogens of animal origin. More than 150 microbial pathogens have been identified from all animal species that can be transmitted to humans by various routes. The most frequently documented pathogens contained in animal manure include bacterial species such as *Campylobacter spp., Salmonella spp. Listeria monocytogenes, E. coli O157:H7*, as well as protozoa including *Cryptospordium parvum* and *Giardia lamblia*.

POTENTIAL FOR CONTAMINATION

Pathogens can become a public health risk if they are, present and consumed in sufficient quantities. Four main factors affecting pathogen prevalence have been identified: 1) pathogen populations in animal manure; 2) manure treatment, storage and processing; 3) the biological activity and structural stability of the soil where the manure is being applied; as well as 4) the timing and location of manure application during crop production.

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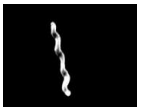
1. **Pathogen populations in animal manure**

Pathogen populations in animal manure may be related to the health and stress level of the animal. E. coli O157:H7 has been shown to have a greater prevalence in young, and stressed animals. Some pathogens may be present in some livestock species but not in others. If you are using an off-farm manure source, it may be useful to know the real source of the manure.

2. **Manure treatment, storage and processing**

Treatment of manure has been shown to significantly reduce (but not always eliminate) the risk of pathogen contamination. Treatment can include facultative lagoons and storage (maintaining a specific temperature followed by storage for a specific period of time); air-drying; composting; anaerobic digestion (treatment in the absence of air for a specific time at a specific temperature); aerobic digestion (agitation with air to maintain aerobic conditions at a specific temperature for a specific time) and lime stabilization.

Manure should be stored separately, away from water sources, buildings and produce. Many outbreaks of foodborne illness associated with manure have occurred through cross-contamination, either as a result of manure run-off from an adjacent field or the manure pile or exposure to manure-contaminated water.

Who are the suspects?	
Bacteria	
	*E. Coli O157* colonizes in cattle and other ruminants but generally not poultry. Populations have shown to be higher in young or stressed animals. In humans , infection leads to hemorrhagic diarrhea , and occasionally to kidney failure, especially in young children and the elderly
	*Salmonella spp. is detected in both cattle and poultry manure and can be highly prevalent in both. In humans causes* intestinal inflammation with diarrhoea that is often muco-purulent and bloody. In infants, dehydration can cause a state of severe toxicosis.
	*Campylobacter jejuni* , according to a USDA survey, had a 37.7% prevalence in individual fecal samples from healthy dairy cattle but it commonly associated with poultry. Infections in humans results in inflammation of the intestine characterised by abdominal pain, diarrhea, and fever.
	*Listeria monocytogenes* is shed in the feces of sheep, cattle, pigs, chicken and many other species of animals. The manifestations of listeriosis include septicemia, meningitis, encephalitis, corneal ulcer, pneumonia, and may result abortion or stillbirth.
	*Mycobacterium paratuberculosis* are shed in feces and can be spread through contaminated foods, water or objects and causes Johne's disease in cattle and other ruminants. It is possibly linked with Crohn's disease (chronic inflammatory bowel) in humans.
	*Yersinia enterocolitica* is a bacterium that has been found in the feces of pigs and cattle and causes fever, abdominal pain, and diarrhea in humans.
Protozoa	
	*Giardia lamblia* is the most common pathogenic intestinal parasite of humans causing moderate-to-severe diarrhea
	*Cryptosporidium parvum* infects cattle, sheep, horses and pigs. Symptoms in humans include watery diarrhea, abdominal cramps, nausea, low-grade fever , dehydration, and weight loss.
Viruses	
Farm animals are known to excrete a number of viruses in their feces and many of these agents are pathogenic to livestock and some are pathogenic to humans.	

Composting has become a popular treatment choice among many producers. In order to reduce the risk of pathogen contamination, composting must be carefully monitored. Ideally, composting temperatures should reach 55-65°C for at least a period of three days. In addition, all materials must be turned to maintain aeration, moisture must be added to maintain the proper moisture level, and the compost needs a curing phase of at least three months. Even with this, composted manure has been reported to act as a favorable environment for recolonization by certain bacterial pathogens. So it should be protected from subsequent exposure to bacterial sources such as fecal material. More complete references on composting procedures are listed at the end of this document.

Serious risks but serious improvements

Some reports are showing the incidence of foodborne illness is dropping. This can be attributed to better production practices on farm, as well as better food handling practices across the food chain, from farm to fork. Nevertheless, the risk of contamination of food from manure sources shouldn't be taken lightly. In Milwaukee, Wisconsin in 1993 an outbreak of *Cryptosporidium parvum* caused 400 000 cases of illness with 87 deaths. One of the suspected sources of contamination was animal manure.

Manure treated as a compost tea should not be considered a treatment to reduce pathogens. Although benefits of applying manure-based compost tea have been documented in a production context, little work has been done to show the effects of tea brewing on pathogen content. In fact, some work has suggested that some teas increase the survival potential of *E. coli O157:H7* and that *C. parvum*, a serious water-borne pathogen, may survive the incubation period for manure teas.

3. **Biological activity and structural stability of the soil**

It is thought that the existing soil microflora can influence the survival of pathogenic bacteria from manure application. Soils with relatively low microbial activity are believed to be a less hostile environment for pathogen survival. Well aggreated soils with good levels of organic matter and high levels of microbial activity create a competitive environment which decreases the persistence of pathogenic bacteria. Pathogens each have unique characteristics and survival time in soil may vary according to species. However, other studies have shown that the persistence of *E.coli* was three-fold greater in organic soil in comparison to a sandy soil, which was attributed to the moisture content of the soil.

4. **Timing and location of manure application**

Raw manure should not be applied to a field or beside a field immediately before harvesting. The absolute window of time separation between the application of manure and crop harvest is difficult to predict. Survival of microorganisms depend upon factors such as temperature, exposure to sunlight, compost amendments, moisture content, redox potential, pH, physical composition and inter microbial competition. However, the Canadian Horticultural Council

(CHC)'s CanadaGAP (On-Farm Food Safety Program) recommends a window of 120 days between manure application and harvest. Again, the duration of survival of livestock fecal pathogens may vary according to species but generalized survival times of pathogens on soil and plants are outlined below.

Pathogen	Soil		Plants	
	Absolute maximum	Common maximum	Absolute maximum	Common maximum
Bacteria	1 yr	2 mo	6 mo	1 mo
Viruses	6 mo	3 mo	2 mo	1 mo
Protozoa	10 day	2 day	5 day	2 day
Parasitic Worms	7 yr	2 yr	5 mo	1 mo

Source: Gerba, C.P. and Smith, J.E. Jr. 2005. Sources of pathogenic microorganisms and their fate during land application of wastes. J. Environ. Qual. 34: 42-48.

For more information on composting and manure application guidelines please reference:

Manure Management Guidelines, Nova Scotia Department of Agriculture
http://www.gov.ns.ca/agri/rs/envman/manureguide_2006lowres.pdf

Dougherty, M. 1999. Field Guide to On-Farm Composting. Natural Resource, Agriculture and Engineering Service (NRAES). Publication 114. Ithaca New York.

Cornell Composting, Cornell Waste Management Institute
http://compost.css.cornell.edu

For courses on composting see:

Compost and Compost Use, Nova Scotia Agriculture College
Gord Price
1-902-896-2461
E-mail:gprice@nsac.ca
http://nsac.ca/cde/courses/DE/Organic/ENVS2002.asp