REDUCING FOOD SAFETY RISKS FROM MANURES

Manure – friend or foe?

Manures have been used to improve agricultural soil fertility for over 7,000 years. Manures add nutrients and organic matter, increase soil bulk density, enhance structure and water holding capacity and increase biodiversity.

Unfortunately, manures can contain pathogenic bacteria such as *Escherichia coli* (*E. coli*), *Salmonella* spp., *Listeria monocytogenes*, *Campylobacter* spp., *Yersinia enterocolitica* and others. Even a small dose of some of these human pathogens – particularly some species of *Salmonella* and types of *E. coli* – can cause severe illness and even death.

Untreated manures used to grow vegetables can contaminate food with these bacteria. Contamination may occur directly through contact between vegetables and manure-amended soil, or indirectly if manures contaminate water used for irrigation or crop sprays.

Reducing risk – composting

The best option for reducing risk is to use only manures that have been thoroughly composted. Heat generated during composting kills human pathogens present in the manure, along with weed seeds and plant diseases.

Food safety programs do not restrict use of manures if they have been treated. That is, composted in accordance with Australian Standard 4454. A key requirement is that the materials must heat to >55°C for at least three days, with five turnings to ensure all of the materials are thoroughly composted. If materials are not certified, they are considered the same as untreated manure.

Reducing risk – withholding periods

Most human pathogens do not survive for extended periods in soil. Many food safety standards mandate withholding periods between application of untreated (or semi-treated) manures and harvest. These time intervals are intended to allow human pathogens in soil or on plant surfaces to return to normal environmental levels.

However, die off rates are hard to predict, being affected by temperature, soil type, soil moisture and many other environmental factors. For this reason, withholding periods between application of manure and harvest are both variable and conservative, assuming a 'worst case' scenario.

The **Guidelines for Fresh Produce Food Safety** and **Freshcare** both stipulate a **90-day** withholding period for products that are grown in or close to the soil and may be eaten uncooked, and **45 days** for other (low risk) products. However, other schemes mandate longer periods:

- **GLOBALG.A.P.** – 60 days between application and harvest for tree crops, but 60 days between application and planting for vegetable crops
- **USDA** – 120 days / 90 days for high and low risk products respectively
- **HARPS** – 365 days if the harvestable part of the crop is grown in or within 1m of the ground or is harvested from the ground, and may be eaten uncooked
- The **Fresh Salad Producers group** – 365 days withholding period
- The **California Leafy Greens Marketing Agreement** prohibits all use of manures

Why 90 / 45 days?

Withholding periods are based on an overview of die off rates published in the scientific literature. However, most studies have focussed on Europe and North America, with results varying widely by environment and agricultural practices.

The project "Pathogen persistence from paddock to plate" (VG16042) has examined how quickly populations of human pathogens (*E. coli*, *Salmonella* spp. and *Listeria* spp.) return to environmental levels when added to sandy or clay loam soil. Cattle manure and fresh poultry litter with added human pathogens (*E. coli*, *Salmonella* hofit and *Listeria innocua*) were incorporated into the soil at a high rate (20t/ha) at the start of spring (trial A), summer (trial B) and autumn (trial C) crops of cos lettuce.

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Populations of *E. coli* in soil amended with poultry litter fell below the level of detection (10 CFU/g) within 50 days in all three trials, indicating a mortality of over 99.9%. Although die off was extremely rapid in soil amended with cattle manure in trials A and B, the bacteria survived longer when it was added to soil in trial C. Modelling the data indicated that, after 50 days, *E. coli* would be at or below the level of detection in all seasons.

Salmonella spp. populations also declined rapidly after addition to soil, with the bacteria undetectable after 50 days in summer and autumn trials. However, the bacteria survived significantly longer during trial A; although the population was too low to count, there was still a 50% probability of detection in 25g of soil after 50 days.

Listeria spp. proved the most persistent. Species of *Listeria*, including the *L. innocua* used in this trial, can survive in soil for extended periods. In trials A and C, approximately 50% of plots were still positive for this bacteria 50 days after it was added to the soil.

While soil contamination affects risk, it is the presence of human pathogens on harvested product that matters most. To simulate a "worst case" scenario, mature lettuce were tested with the dirty outer leaves still attached. *E. coli* was rarely detected (0.25% of samples) on lettuce grown with manure, and *Salmonella* spp. was not detected. However, *Listeria* spp. was detected on three lettuce in the trial C.

Conclusions

In these three trials, high initial populations of E. coli and Salmonella spp. in soil fell below or close to detectable levels within 50 days of application.

However, the results must be considered cautiously. The trials were conducted in a single location over a relatively short time period. Moreover, *Listeria innocua* persisted in the soil during two out of three cropping cycles. This does not necessarily mean that the human pathogen *L. monocytogenes* would also survive under these conditions, but does demonstrate the variability in microbial populations.

While human pathogens in soil are potential contaminants, it is their presence on the harvested product that is most important. Even though lettuce were tested with soil attached, *E. coli* and *Salmonella* spp. were rarely found.

Despite this, detections of *Listeria* spp. on a number of lettuce does raise concerns. There is zero tolerance for *L. monocytogenes* on harvested produce, so any detection will trigger a product withdrawal. Moreover, if this lettuce was processed then stored, initially small populations of bacteria could potentially multiply, creating a significant food safety risk.

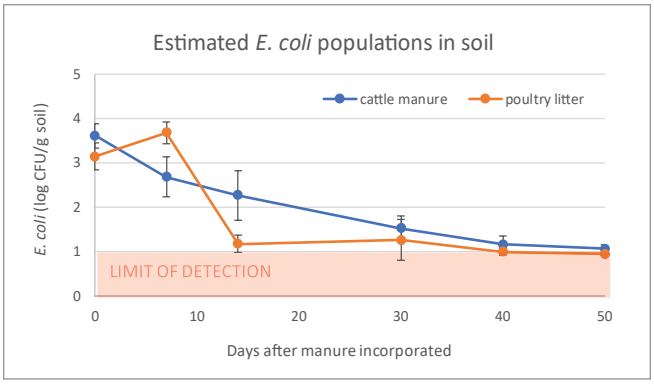

Figure 1. Average populations of *E. coli* in soil amended with cattle manure or poultry litter. Data combined from sandy and clay loam soil. Values modelled from three separate crops. Bars indicate 95% confidence intervals.

Recommendations

- The best way to reduce risk from manures is to only apply products that have been treated (e.g. composted in accordance with AS4454) to kill any human pathogens present
- High temperatures, dry conditions and other environmental factors reduce survival of human pathogens in soil, but effects are variable
- Withholding periods between application of manure and harvest provide an alternative method to reduce risk:
    - In these trials, populations of *E. coli* and *Salmonella* spp. consistently fell to barely detectable levels within 50 days after addition to soil
    - Populations of *Listeria* spp. can potentially survive longer than 50 days
- The length of withholding periods used will therefore depend on:
    - Whether the product is grown in or close to the soil and may be eaten uncooked (i.e. high risk)
    - On-farm risk assessments
    - Customer mandated requirements