Canadian Organic Growers

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Canadian Organic Growers Inc is Canada's national membership-based education and networking organization representing farmers, gardeners and consumers in all provinces.

COG Reference Series

#15,Organic Agriculture, Manure and E. Coli

Reference Series 15 has been slightly adapted from a chapter in COG's Organic Field Crop Handbook, writer/editor Janet Wallace, COG, 2001. Please see also the valuable tables on Troubleshooting and The N, P K Content of Manure, Urine and Bedding in the Handbook. @ Canadian Organic Growers, 2001.

Manure is a valuable resource on an organic farm. Livestock are inefficient in extracting nutrients from feedstuffs; typically, 75-90% of major nutrients that are fed to livestock pass directly through the animal into the manure. The extent to which these nutrients can be returned to the soil and made available to subsequent crops depends on the way the manure is stored and handled. The use of compost to maintain and increase soil fertility and humus content of the soil is recommended by the Canadian Standard for Organic Agriculture.
The compost must meet provincial and/or federal standards for compost quality, specifically in terms of its age and levels of pathogens, trace elements and foreign matter. Rather than using raw manure, organic farmers usually apply composted manure to their fields. There are many concerns over the use of raw manure on agricultural land, including threats to both human health and to the environment. Raw manure may contain pathogens (such as E. coli 0157) that can contaminate drinking water. Also, raw manure contains high levels of nitrate, a water-soluble form of nitrogen. As well, certain crops accumulate excess nitrate in the plant tissue.

There are various health risks associated with both drinking water or eating plant tissue containing high levels of nitrate-nitrogen. Runoff or leaching of nitrates can cause water pollution in either groundwater or surface water bodies. To reduce the potential for nitrate pollution, organic certification standards prohibit the application of raw manure to frozen or waterlogged soil and strongly discourage the application of raw manure to bare soil. Although the use of raw manure is discouraged, raw manure can be used on certified organic farms with the following restrictions, according to the Canadian Standard for Organic Agriculture (CGSB, 1999: 6.4.2.2):

- If raw manure is to be applied to crops for human consumption, there must be at least four months between application of the raw manure (including liquid manure and slurries) and harvest;
- If crops that accumulate nitrates are to be grown, the raw manure must be applied at least four months before these crops are planted. Nitrate-accumulators include brassicas, leafy greens, beets and chard;
- raw manure must be applied in moderate amounts
- the soil must be warm; and moist.

Composting is the controlled decomposition of organic matter by micro-organisms in the presence of oxygen. The organic matter can be manure, crop residue or other organic material. The organic matter is decomposed by the successive action of bacteria, fungi and actinomycetes. Microbial activity causes the temperature of the composting material to rise to 55°-60°C (130°-140°F) where it remains for several weeks.
Redworms (manure worms) are active in the final stages of decomposition, helping to transform the compost into humus. Young compost, which has not reached the stable humus stage, is high in active organic matter and available nutrients, but low in stable humus. Mature compost has a higher proportion of stable humus, and is considerably reduced in bulk. Compost at various stages, from young to fully-aged, may be used according to the needs of the soil and the crop. However, immature compost is similar to raw manure in terms of nutrient availability and the same guidelines should be followed to avoid water pollution and health risks. Both contain a higher proportion of soluble nutrients than composted manure.

Compost is defined as: a stabilized product of controlled decomposition of an appropriate mixture of nitrogen and carbon-bearing materials that have been piled, periodically mixed, subjected to heating above 55°C (131°F), then cured for an extended period of time (in a process designed to mitigate environmental damage) to produce humus as a soil amendment or fertilizer" Canadian Standard for Organic Agriculture (CGSB, 1999: 3.2).

The nutrient content and other benefits of the compost depend on
5. the source materials,
6. the conditions under which the compost was made, and
7. the maturity of the compost when it is applied.

Immature compost stimulates biological activity in the soil in the short-term, whereas mature compost contributes more to soil organic matter levels and soil structure. Applications of compost contribute more to long-term fertility than applications of manure.

To illustrate this point, consider three manure piles each containing 30 tonnes of fresh manure and bedding (see table below). One pile is applied as raw manure, another pile is partially composted before being applied and the last pile is fully composted. During the composting process, the volume is reduced. The fully composted pile is only half the size of the initial pile. This means half as many trips with the manure spreader, compared to spreading raw manure.

During the composting process, the organic matter changes, from active organic matter containing highly soluble nutrients to the more stable nutrient states. Four to five years after the manure or compost is applied, the material has transformed into humus. A fully composted pile adds more humus to the soil than the raw or partially composted manure. Humus both increases the soil fertility and improves soil structure.
So, in the long-term, composted manure actually provides more humus than raw manure. Better yet, the composted manure has a reduced volume, so it takes fewer trips with the spreader, compared to raw manure.

State of manure	Initial weight	Weight when applied	Humus	Notes
Raw	30 tonnes	30 tonnes	3 tonnes	The volume of material removed from the barn
Partially composted	30 tonnes	22 tonnes	4 tonnes	The volume of material when it was applied to the soil as either raw, partially composted or fully composted manure
Fully composted	30 tonnes	15 tonnes	5 tonnes	Amount of humus produced by the manure 4-5 years after it was applied to the soil

Advantages of composting
The storage and handling requirements involved in the production of compost are offset by the benefits of the finished compost to the organic farmer.
The advantages of composting include the following:

- Composting recycles nutrients on the farm. The nutrients in manure, crop residue and livestock mortalities can be returned to the soil as compost. Amounts vary, but well-prepared mature compost may contain 7.5-15 kg/tonne (15-30 lb/ton) nitrogen, 2.5-5 kg/tonne (5-10 lb/ton) phosphate and 15 kg/tonne (30 lb/ton) potash.
- Composting improves the biological, physical and chemical properties of the soil by stimulating soil life and adding organic matter. In comparison, raw manure can temporarily disturb soil life by creating an imbalance of nutrients.
- Compost is less acidic than raw manure. Composting increases the pH of the raw materials which can help make the soil a better environment for plant growth.
- The nutrients from mature compost are released to the plants slowly and steadily. The benefits will last for more than one season. As well, nutrient losses are reduced as nutrients are transformed into more stable states.
- Compost binds soil particles into crumbs, greatly increasing soil's resistance to wind and water erosion. (Compost has a lower density (400-600 kg/m3) than raw manure (400-1000 kg/m3). The volume of material is reduced by 50-60% during composting. Handling is easier and fewer trips are made to the field.
- Weed seeds are reduced by a combination of factors including the heat of the compost pile, rotting and premature germination.
- Any weeds found growing on the pile should be destroyed before they go to seed.)
- Fly eggs are killed and plant and animal pathogens are reduced if the temperature of the pile reaches 60°C (140°F).
- Crops fertilized with mature compost tend to have lower pest and disease problems than crops fertilized with raw or partially composted manure. Bacteria in mature compost reduce the incidence of soil-borne diseases. As well, the slow release of nutrients from mature compost tends to reduce pest and weed problems.

- Raw manure is one of the primary culprits for pollution of the waterways, and odor from farms is considered an increasing problem in the rural areas. Composting raw manure reduces these problems.

General Methods Making good compost depends on having the proper sources of nutrients with a balance of carbon and nitrogen, keeping the pile of compost moist and making sure that there is adequate aeration. The compost pile can heat up to 60°-70°C (140°-158°F) due to the heat generated by microbial activity. However, high temperatures will result in substantial losses of nitrogen in the form of ammonia gas.
The Canadian Standards for Organic Agriculture definition of compost stipulates that the compost must be held at temperatures greater than 55°C (130°F).

Materials to compost
The most commonly used materials for the compost pile are manure mixed with livestock bedding. To achieve the balance of carbon to nitrogen (25-35:1) needed to begin the composting process, mix bedding (which is predominantly carbon) with the raw manure (which is an excellent source of nitrogen). Bedding materials vary in their carbon : nitrogen (C:N) ratio from about 80:1 in straw to 200:1 or more in sawdust or shavings. Bedding with a high content of wasted hay, typical for sheep pens, will have a lower C:N ratio. If the bedding to manure ratio is high, and the manure is very dry as with horse operations, it might be beneficial to water the material with a high nitrogen slurry. In practice, this is difficult to do.
Provided that it contains no hazardous substances and the correct C:N and moisture balance can be maintained, virtually any organic material can be composted. However, organic certification bodies may not accept the use of certain off-farm sources of material, particularly if there are concerns about heavy metals, pesticides, pathogens or antibiotic residue in the material.

Possible materials for composting include: sawdust, nursery wastes, fruit and vegetable residue from processing plants, feathers, grass and lawn clippings, vegetable market wastes, garden wastes, leaves, wood shavings, fish wastes and seaweed.
Municipal sewage sludge is not permitted according to the Canadian Organic Standards (CGSB, 1999:6.4.2.3).
Carbon : nitrogen ratio (C:N) of compost materials:
Dairy manure 20:1 , Sheep manure 14:1, Poultry manure 10:1, Humus 10:1, Vegetable wastes 12:1, Seaweed 19:1, Straw 80:1, Corn stalks 60:1, Leaves 45:1, Alfalfa 13:1, Legume/grass hay 25:1, Grass hay 80:1, Rotted sawdust 200:1, Fresh sawdust 500:1, Newspaper 800:1

Storage of solid manure
As composted manure is the primary source of fertilizer for an organic farm, care should be taken that nutrients are not lost from the raw manure. Losses of nitrogen can occur as soon as the urine hits the bedding. To reduce losses, use generous amounts of bedding to soak up liquid wastes and to provide a carbon source for composting the manure. Considerable losses, especially of potassium, can result from leaching and runoff during storage. This is not only a serious pollution problem, but also a waste of valuable nutrients.
Plans and information regarding manure storage and handling are available from your provincial department of agriculture.

The following was extracted from the Ontario Ministry of Agriculture and Food's fact sheet #85-052.

Solid manure storage systems should contain three parts:
1. an enclosed area, on a sloped cement pad, preferably under a cover;
2. a perimeter curb to contain and direct the liquids to the low end; and
3. a pit to contain the liquid runoff until it can be pumped and spread on the land.

When dealing with the runoff, follow the same precautions as if dealing with raw manure. Locate the manure storage in such a way as to allow for future expansion of the livestock operation. Also, do not block livestock or vehicle flow. Don't locate the storage within 30 meters (100 feet) of a well or excavate into ground with a high water table. Adjacent existing tile drains should be blocked off.
Check your local zoning bylaw to ensure that you comply with any municipal requirements.

Approaches
There are several approaches to on-farm composting, including:
- Passive (open pile) composting,
- Aerated passive composting,
- Contained, in-vessel composting, and
- Windrow composting.

1) Passive composting
Passive composting is simple system appropriate for small farms. It consists simply of making piles of materials with an appropriate C:N ratio and moisture content and letting the pile sit and heat. This method requires little labor or equipment, and nutrient loss is minimal. However, the process is slow and fly problems can arise. The success of this method relies on the initial mix of materials. It is essential to have an appropriate mix of materials with the ideal carbon to nitrogen ratio, moisture level and porosity. To allow air to circulate through the pile, the pile must be small, less than 2 meters (6 ft) high and 3.5 m (12 ft) wide. Although not required, occasional turning will speed up the process. Passive composting of manure and bedding usually takes one year.

2) Aerated passive composting
Aerated passive piles are windrows that are not turned. Air circulates through the piles through perforated pipes. Compared to windrow composting, this approach requires a greater initial setup time but less labor afterwards. As with other passive systems, it is essential to have a proper mix of materials in terms of C:N, moisture and porosity. The process is fairly rapid, with an average of 10-12 weeks required to compost manure and bedding, followed by a curing period of 1-2 months. A windrow is constructed with open-ended perforated pipes (10 cm diameter with 1 cm wide holes). The pipes are laid in a bed of peat moss, wood chips or chopped straw at the base of the pile. The windrows can be 1.2 m (4 ft) high, 3 m (10 ft) wide and as long as desired. The pipes are laid across the windrow, one pipe every foot, for the entire length. Or, an aerated static pile can be constructed with one pipe running the length of the windrow (less than 21 meters), with a blower attached to the pipe.

3) In-vessel composting
In-vessel composting are systems in which the composting takes place inside a building or a container with forced aeration and mechanical turning. These systems have high capital costs and require skilled labor to maintain. There are however, many advantages to in-vessel composting. Compared to other methods, in-vessel composting is faster, requires less labor and is less likely to have problems with flies or odors. In-vessel systems can fully compost manure in just a few weeks, although the curing time is usually another two months.

4) Windrow composting

Windrow composting is the most common form of on-farm composting. The compost materials are mixed or layered, and spread in a windrow (a long, narrow, flat row). The windrow is turned periodically to aerate the pile and maintain the desired temperature. With frequent turning, manure and bedding can be composted within a few months, followed by a curing period of 1-2 months. Building a windrow: The site chosen for building the compost piles or windrows should not be near water bodies or in areas with high water tables. Ideally, there should be a way to retain the liquids that will leach out of the pile and seep into the soil if the pile becomes too wet during heavy rainfall. This can be done if the site is on a slight slope (1-3°), with a receptor pit to catch the runoff. Otherwise, use level land and do not use the same place each year.

Heavy clay soil is ideal, because it prevents leachate (liquid that leaches from the compost) from reaching the water table. A front end loader is usually used to remove the solid manure from storage and to load the manure spreader. The manure spreader should be a 'power-take-off' type so that it can discharge its load while parked. The tractor pulls the spreader, parks and unloads the manure through the beaters, which shred the manure and add air as the pile is being built. The spreader is then pulled ahead about 1 meter (3 feet) and the procedure is repeated.

This method is used to form the windrow and for the turning of the pile. Windrows created from cattle manure should be made about 1.25 meters (4 feet) high and 2-2.5 meters (6-8 feet) wide. Horse manure can overheat, so windrows should only be 0.5 meter (1.5 feet) high for efficient cooling.

However, because of the large surface area, shallow windrows can dry out quickly in drought conditions or suffer from leaching in heavy rainfall. It is more practical to add layers of horse manure every few days. Hog manure is very dense and large quantities of straw need to be added to facilitate air circulation. Any liquid manure that seeps out of the windrow should be pumped back onto the drier materials and allowed to percolate through. Manure from loose-housing bedding may overheat, due to the large straw to manure ratio. Limiting the amount of air in the pile will prevent this and can be accomplished by using a dump trailer to create windrows instead of a manure spreader. Air can also be expelled by tramping down on the pile.

To reduce loss of nitrogen to the air, cover windrows with a 5 cm (2 in) layer of finished compost. A thicker layer of compost 15 cm (6 in) will insulate the pile and allow composting to continue during cold winter weather. Plastic tarps are sometimes used to cover windrows; they reduce waterlogging but they may cause problems with reduced aeration. Temperature Microbial activity generates heat and the pile can warm to about 60-70°C (140-158°F) within one week; then decrease over the next few weeks. The compost should be kept at a temperature above 55°C (130°F) for a period of at least 15 days. The optimal temperature for composting reflects a compromise between minimizing nutrient loss and maximizing the destruction of pathogens, weed seeds and fly larvae. At temperatures above 50°C (122°F), nitrogen is converted to ammonia and lost to the air.

Overheating stops microbial action and causes excessive nutrient loss, hence temperatures above 60°C (140°F) should be avoided. However, to destroy pathogens, temperatures should be held at 55°C (131°F) for at least fifteen days. To destroy weed seeds, the temperature should reach 63°C (145°F).

The temperature in the pile can be monitored with a temperature probe 0.5-1 meter (2-3 feet) long. Overheating may indicate deficient moisture levels, too much nitrogen or too large a pile. Adding soil helps to reduce temperature. In cold weather, warmer conditions can be maintained by covering the pile with black plastic. This will also prevent nutrient loss by leaching.

Turning is also used to control the temperature. Turning the pile Turning the pile is not needed if optimal conditions are met. Turning may be required to aerate the pile. Turning is recommended when the temperature of the pile falls below 50°C (120°F) or exceeds 60°C (140°F). As well, turning during fly season will reduce fly problems.

Some people advocate turning the pile to speed the decomposition process and obtain mature compost in about ten weeks. This however, will also likely cause high nutrient losses. The simplest turning method is to use a front-end loader to push the piles over and reform them. Using the manure spreader will do a better job of remixing the compost. Commercial-brand compost turners are available but are not essential.

Moisture and aeration

The moisture content of the pile often determines if turning is necessary. Ideally, the moisture content should be 50%. If a moisture meter is not available, test by squeezing the material in your hand -- if it glistens and small moisture droplets appear, the moisture content is sufficient. Beginners at composting tend to have piles that are either too dry or too wet. For dairy, hog and other types of wet manure, a dry bulking agent, such as chopped straw, is added at a rate of 1-2 parts bulking agent to manure. Consider the carbon to nitrogen ratio of the bulking agent and aim for the 30:1 ratio. If the pile is too moist, water replaces the air in the pile, leading to a lack of oxygen in the pile (i.e. anaerobic conditions). Turning the pile adds air, and changes the pile from anaerobic to aerobic. The smell of the compost should be your guide. Sweet-smelling compost indicates ideal, aerobic conditions whereas an unpleasant smell indicates that anaerobic decomposition is taking place.

In wet regions, either build a roof over the pile or cover the pile with straw or black plastic to avoid leaching of potash, nitrates and trace elements. A thin layer of finished compost covering the pile will help reduce nutrient losses to the air. On the other hand, if the pile is too dry, biological activity will cease. In this case, water will have to be added. This is best done when the compost is being turned. Mineral additions Mineral additions to the compost, in the form of powdered rock, can be useful. Rock phosphate is often added to the gutter in the barn to reduce an immediate nitrogen loss and manure odor. It has the added benefit of increasing phosphorus reserves and encouraging nitrogen fixation by blue-green algae. Clay minerals such as bentonite and montmorillonite are added at any time. They trap liberated ammonia and increase the cation-exchange capacity of the compost. In this way the clay makes nutrients more available to the crops and hastens the formation of the clay-humus complex. Small amounts of kelp can be added to the compost directly to provide nutrients and trace elements.

Curing

The final stage of composting is the curing phase. Immature compost is converted into mature compost during the curing phase. During the curing phase, the microbial community within the compost changes. The resulting mature compost is low in phytotoxins, and contains slowly releasing nutrients. The mature compost can be used safely on all stages of plant growth, and can even be used in potting mixes. In contrast, immature compost contains more readily available nutrients, but can harm plants, particularly seedlings, by releasing toxins or tying up available oxygen or nitrogen. The ability of compost to reduce the incidence of plant diseases is due to the bacteria which proliferate during the curing phase. Compost is ready for curing when it no longer reheats after being turned.

To see if the compost is ready, moisten a sample of compost and store it in a sealed plastic bag at room temperature. One week later, open the bag and smell the compost. If there is a foul odor, the compost will need to be turned again and is not yet ready for curing. The compost is ready for curing if there is no odor after one week. To cure the compost, turn the pile. If the compost is dry, add additional moisture. The compost can be stacked higher than an actively composting pile. The pile can be covered with fleece or a breathable cover. The pile is then left to sit, for several weeks or months. A minimum of one month of curing is recommended.

Application of compost

Compost piles or windrows take about three months to mature and should be black-brown in

appearance with a crumbly texture. The temperature of the pile should be close to ambient temperature. Ideally, compost should be spread as soon as it is ready. The longer it sits, the more it mineralizes and loses available nutrients. The presence of weeds on the pile indicates that mineralization is occurring and that the compost should have already been applied to the land. Application rates vary depending on the crops, the needs of the soil and the age of the compost but for row crops. In general, applications of 5-10 wet tons per acre (10-20 cubic yards) is recommended. Mature compost contains 50% water, so one ton of wet compost is equivalent to a half ton dry matter. By dry weight, mature compost contains 1.5% nitrogen, 0.5% phosphorous and 1.0% potassium.
Applying compost to cropland before spring planting may encourage the growth of weeds. If composting is started just after seeding it should be ready to apply to stubble fields after harvest. Incorporate the compost lightly into the top 10 cm of the soil; if any deeper, much of the nutrient gains and soil conditioning value will be wasted. Cover crops can be seeded immediately after applying the compost. Compost should, however, be applied to growing plants whenever possible; it will not burn them and the nutrients are readily utilized. As mentioned, young compost is high in soluble nutrients, whereas mature humus has a higher proportion of stable humus. This will determine where you should apply your compost.
Crops that are nutrient-demanding, such as winter wheat and corn, should receive applications of young compost. Mature compost applied to these crops will have little immediate benefit. On depleted soils, compost should be applied to all the fields to stimulate microbial activity.

Liquid manure systems
Many pig, poultry and dairy operations have slurry or liquid manure systems. Raw slurry can lead to serious pollution problems, by fouling waterways and disrupting the flora and fauna in the soil. A form of composting can be done with liquid slurry by microaerating the slurry in the tanks. This reduces nutrient loss from volatilization which occurs when nitrogen changes into gaseous ammonia. Also, the microaeration process cuts down on odors from anaerobic conditions.

Microaeration significantly reduces weed seed and pathogens and also reduces nitrogen loss because the nitrogen is converted from ammonia to bacterial protein -- a stable form of nitrogen. Application of liquid manure is most beneficial if applied onto green manure crops in late summer or fall. This is when the ground is dry and the green manure crop can efficiently tie up the nutrients.

Example of a liquid manure system
Lawrence Andres has developed a highly effective liquid manure system on his dairy farm in Ontario. Liquid runoff from the manure storage area and yard scrapings go into three tanks, 25 m (82 ft), 15 m (50 ft) and 7.5 m (25 ft) in diameter. All tanks are 3 m (10 ft) high. Aeration is achieved with a small submersible diffusion pump. The pump is placed at the bottom of the slurry tank where it creates a vacuum, sucks air down a hose and distributes the air in the form of fine air bubbles throughout the slurry. The unit is operated on a timer, running a few minutes every hour depending on the volume and consistency of the slurry. To begin the composting process, a water-soluble carbon source, such as liquid molasses, can be added to the slurry. Particles which tend to float and form a cover are periodically stirred back in with an extra agitator to increase the carbon supply for the microbes. The liquid manure is applied to the stubble of fall cereal crops before seeding oilradish, to plowdown crops of red clover and to permanent hay fields and pastures.
For more details, see *Lawrence Andres* article entitled **'Managing liquid manure through microaeration' in Sustainable Farming** (Vol. 2., No. 2, Summer 1991, pp. 24-25).
Note that since the original article was written, some modifications have been made to the

system. For example, the straw cover is no longer necessary.

Reducing Risks from E.coli 0157

This section is based on an article by *David Patriquin* in the Spring 2000 issue of Eco-Farm & Garden. The entire article and a detailed list of references can be found at .

The occurrence of human pathogens in livestock and livestock manure concerns both farmers and consumers. A virulent bug known as Escherichia coli 0157:H7, called 0157 for short, seems to be appearing more frequently.

What is E.coli 0157?

E. coli is a normal inhabitant in the intestines of humans and animals. The number of E. coli in a sample of water is a commonly-used indicator of fecal contamination. Most strains of E. coli are harmless, but a minority of the strains cause human disease, including the strain E. coli 0157 (although 0157 does not harm other host animals). In humans, 0157 produces a toxin that breaks down the lining of our intestines and can damage kidneys. Some people with E. coli 0157 have bloody diarrhea and abdominal cramps whereas other people may have non-bloody diarrhea or no symptoms at all. Usually little or no fever is present, and the illness dissipates in five to ten days. A more serious complication called hemolytic-uremic syndrome (HUS) can lead to kidney failure and death; it occurs mostly in young children and the elderly.

In Canada, 75-90 episodes of HUS occur in Canada each year, most of them between April and September. In May 2000, drinking water contaminated with E. coli 0157 caused several deaths in the town of Walkerton, Ontario.

Most 0157 infections have been associated with eating undercooked ground beef which was contaminated through contact with feces in slaughterhouses. However, infections have also resulted from ingesting 0157 in water and other foods, including drinking water, prepared foods, raw milk, sprouts and vegetables from manure-fertilized gardens. Meat contamination commonly occurs in the slaughterhouse. Dairy products can become contaminated in the dairy, or in later stages of food preparation. Contamination of prepared food is usually attributed to contact with ruminant manure at some stage. E coli 0157 is very acid tolerant and can grow in low pH juices. As well, 0157 can survive and grow on lettuce and other vegetables. An exceptionally low dose of E. coli 0157 can cause infections. Only 2 to 2000 cells can cause an infection; in contrast, 10,000 to millions of salmonella cells are required to cause salmonella food poisoning. This makes handling of contaminated materials particularly hazardous. Once introduced into a family or a closed group, the bacteria can be spread by person-to-person transmission, especially by children who are not toilet trained. Young children shed 0157 in their feces for 1-2 weeks after their illness resolves; older children rarely carry 0157 without symptoms.

E.coli 0157 on the Farm Industrialized farming practices are considered to be a factor contributing to increased levels of food-borne illness associated with zoonotics. However, it is safest to assume that most of these organisms, including 0157, are everywhere, including organic farms. E. coli 0157 is sporadically found in the gastrointestinal tract of humans, livestock and wild animals.

The specific routes by which 0157 arrives on a farm are not known although birds, deer, other wild animals and livestock brought in from other farms are suspected. Ruminants appear to be the primary hosts. For example, a study in the UK found 0157 in 15.7% of cattle (dairy and beef), 2.2% of sheep, 0.4% of pigs and none in chickens. Other studies have also revealed low incidences in pigs and poultry. Improved detection methods indicate a very high incidence of 0157 in cattle. For example, a 1999 study in the mid-west US revealed 0157 in 27% of fecal samples from cattle brought to slaughterhouses during the summer; 72% of the 29 lots (individual farms or feedlots) represented in samples included at least one animal positive for

0157. After the meat was processed, 2% of the carcasses were still contaminated with 0157. Although the prevalence of 0157 may seem alarming, food-borne pathogens are something we have always lived with and different cultures have evolved a wide variety of practices to reduce the chances of food poisoning.
If there is a single factor underlying what seems to be increasing incidents of food-related bacterial diseases, it is a kind of globalization of impatience with the procurement and preparation of food - we want everything there is from everywhere, and we want it now and we want it cheap. Cutting corners is the inevitable outcome of this attitude.

Reducing occurrence and risks of 0157 on the organic farm
Research into the life history and prevention of E. coli on the farm is just beginning, and for now, mostly what can be offered are guidelines about livestock-borne pathogens generally. What we do know about E. coli 0157 – notably its high toxicity for children and the elderly, its low infection dose, and its common association with healthy ruminants – indicate that a highly precautionary approach is needed. Handling and processing manure Fresh manure, particularly during summer months, has a high probability of carrying 0157 and other pathogens. Thus special precautions should be followed in handling fresh manure, such as wearing protective clothing, avoiding hand contact with the mouth, eyes and nose, and washing after handling livestock and manure. Activities of small children in the vicinity of livestock and manure should be carefully monitored and directed, if allowed at all. Farm families need to be aware that farm pets can transmit 0157 to humans. Hides are readily contaminated by fecal materials, and can be a source of E coli 0157 in slaughterhouses, thus livestock should be as clean as possible before being sent to the abattoir.

Composting, a key component of organic farming, reduces the pathogen content of manure. Most bacterial pathogens are killed by exposure to temperatures of 55°-60°C (130°-140°F) for a few hours or less. Such temperatures are maintained for days to weeks in the hot stage of composting. Canadian commercial compost standards require that a temperature of 55°C (130°F) or greater is maintained for at least 15 days during windrow composting and that during this period, the compost is turned at least five times.
With on-farm composting, it can be difficult to ensure uniform exposure to high temperatures without overheating the compost. During the composting process, pathogens can be killed by high temperatures, by competition or suppression of other microbes or by the various changes in the pH pile (such as an increase in pH). Frequent turning also helps to destroy pathogens. In time, pathogens are destroyed. Long composting and curing times will greatly reduce or eliminate pathogens from the compost. Thus, the organic standard that untreated manure must be aged before application to food crops is consistent with this principle, and should be strictly adhered to. Allowing time for proper maturation (curing) of compost is also important. Aeration, independent of heating, appears to suppress 0157 in manure.
It is very important not to reintroduce pathogens into matured compost by mixing it with uncomposted or immature compost. It appears that some of the increase in food-borne pathogens is due to the increased density of animals on farms. As well, pathogens are more common as a result of quick methods for disposal of manure, notably use of slurries versus traditional methods employing bedding and composting. Liquid manure should be contained and aerated for at least 1-3 months before being applied. Raw liquid manure can spread disease as well as creating other problems.
Composting and curing of manure is obviously important for use on food crops, but may also be important for forage crops in order to reduce levels of 0157 in livestock. E. coli 0157 survives much longer in manure products than in the live animals, and thus manure-contaminated materials can potentially re-infect livestock. Feed and Water E. coli 0517 can spread between animals through drinking water. Frequent cleaning and appropriate sanitation of water troughs

can help prevent the spread and persistence of 0157. Frequently refilling small water reservoirs is recommended, over the use of large reservoirs. E. coli 0157 may also be spread through wet feed. Also, there is evidence that frequent use of antibiotics increases the likelihood of occurrence of E. coli 0157 in dairy cattle. The significance of a feeding regime to control 0157 is currently quite controversial. Some scientists dispute the highly publicized study suggesting that feeding hay to cattle before slaughter could reduce incidents of E. coli in slaughterhouses. Thus for now, it appears that more reliance should be put on sanitation, rather than on feed as a primary line of defense.
Regardless of the E. coli issue, organic farmers use forage-based diets for ruminants, with less reliance on grain inputs.

Probiotics
Probiotics are infusions of beneficial bacteria that become established in the intestine. They are frequently used to establish desirable organisms in young animals (we are all born without bacteria in the guts), and used after antibiotic treatments have eliminated desirable as well as undesirable organisms. Commercial strains of Lactobacillus acidophillus specifically antagonistic to E coli 0157 are being developed.

Survival in soil
Several factors affect the survival of pathogens in the soil. Pathogens are less likely to survive in biologically active soils than in sterilized soils.
Earthworms in particular can help eliminate Salmonella and other pathogens in soil. Treating liquid effluents Manure slurries and other liquid effluents containing fecal materials can contaminate downstream surface waters, posing hazards to the public or other farms. If the liquid effluent is recycled on the farm for irrigation, washing, flushing or as a water source for livestock, it may maintain high levels of 0157 and other pathogens. Lagoon treatment systems combined with constructed wetlands are highly effective in removal of pathogens. Lagoons with vegetation are more efficient at eliminating pathogens, compared to non-vegetated lagoons. The greater the diversity of vegetation, the greater the removal of pathogens. It appears that wastewater stored in lagoons and/or treated in the wetlands for a combined period of 20 days is safe for irrigation and cleaning purposes. Conclusion Several of the core practices and principles of organic farming reduce the levels of 0157 on organic farms. The incidence of E. coli 0157 in organic livestock is likely reduced by the maintenance of relatively closed systems, by the promotion of healthy intestinal flora and the lack of reliance on antibiotics.

On organic farms, manure is almost always composted and applied to soils with healthy microbial populations. However, certain routes by which 0157 moves into farms apply almost equally to organic farms (e.g. via birds that have been feeding on neighboring farms). Thus, there is no basis for complacency and special precautions are still very necessary. What worked in the past may not work today. Excellent sanitation practices for livestock, harvest containers and contact surfaces, and postharvest washing are very important. Farmers and their certifying organizations should encourage improvements in composting systems to achieve uniform exposure to high temperatures. Curing of compost for four months, and aging of uncomposted manure for a year should be encouraged; it also produces better amendments.
Manure slurries should be aged and aerated. More specific and stringent regulations than currently specified in certification codes may be appropriate, at least until we have a much better understanding of 0157, and how it is affected by organic practices.

Ways to reduce the risk of E. coli 0157 contamination on the organic farm
- Ensure that farm residents, workers and visitors are aware of the potential risk of E.coli 0157 and learn measures they should take to reduce risk of exposure

- Prohibit or carefully supervise activities of small children in areas where they might be exposed to fresh manure
- Follow good sanitation practices for livestock, harvest containers and contact surfaces, and wash vegetable produce free of soil
- Flush water troughs with fresh water frequently, and clean them regularly
- Consider whether imported manure is highly likely to contain E.coli 0157 (e.g. fresh ruminant manure from a feedlot)
- Take care to prevent cross-contamination of old or composted manure with fresh manure.
- Make improvements to the composting system to ensure thorough mixing of compost during the high temperature phase. (Allow compost to cure for 2-4 months (or longer) after the heating phase
- Aerate liquid manures for 1-3 months.
- Age uncomposted manure for one year before use.
- Clean hides of livestock being taking them to the abattoir.
- Process liquid effluents from the farm in holding ponds/wetlands for 20 days or more.

Further reading

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