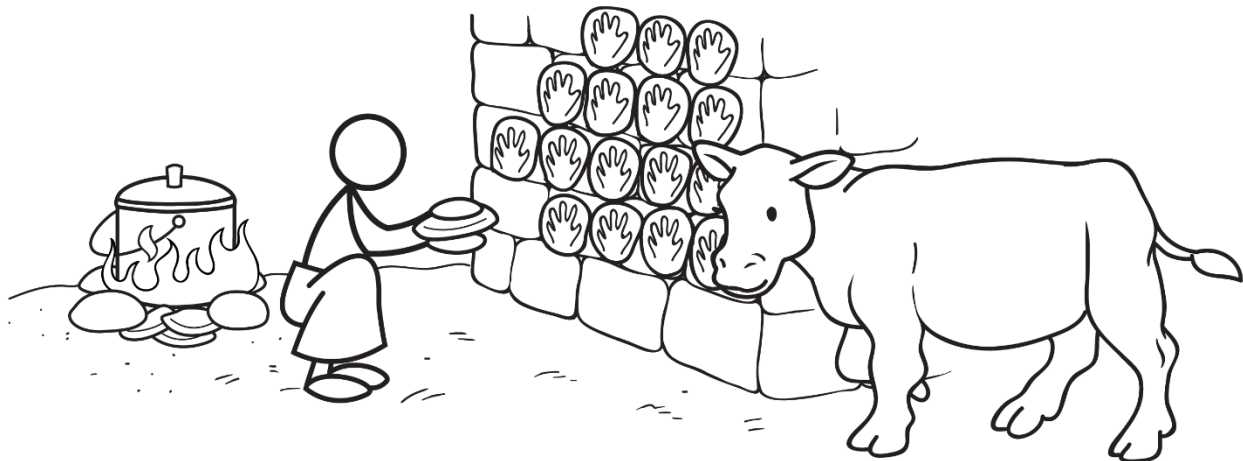


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1 Introduction

Just as human excreta presents health hazards, so does animal excreta. There are many pathogens – microorganisms such as bacteria, viruses, protozoa and helminths that cause disease – that can be found in animal feces and urine. Zoonoses are diseases and infections that are naturally transmitted between animals and people (WHO, 2006a). Many zoonotic diseases are transmitted by pathogens found in animal excreta. Not only can animal excreta transmit pathogens directly, it can also provide a breeding site for other disease vectors, like sandflies.

Low income people are more at risk of contracting zoonoses. There is a strong association between poverty and living in close contact with animals. Zoonoses typically affect isolated rural communities who keep livestock and those living in urban slums. The number of poor livestock-keepers worldwide is estimated to be between 500 and 900 million (WHO, 2006a). For these people, livestock are an important part of their survival and can help to break the poverty cycle. Basic sanitation, proper hygiene and safe drinking water can also help break the cycle of poverty.

As well, in communities where people are suffering from zoonoses, the animals are sure to be affected as well. When an animal does fall ill, it is difficult for many livestock keepers to afford treatment or to have good access to veterinary services and healthcare information (WHO, 2006a).

Effectively managing animal excreta will help to prevent and control several zoonotic diseases, resulting in decreased disease burden, reduced poverty and increased food supply for large numbers of the rural poor worldwide (WHO, 2006a)

2 Diseases Related to Animal Excreta

Human health can be compromised when pathogens are transmitted due to poor animal excreta management. This is shown in the following table. Many animals infected with pathogens do not show symptoms of disease or illness, so you do not know that they are able to transmit pathogens to people.

The following diseases related to animal excreta are considered by the World Health Organization (2013a) to be neglected tropical diseases, and are discussed in more detail in the next sections. The term “neglected” highlights that these diseases affect mainly poor and marginalized populations in low-resource settings.

- Cystic echinococcosis
- Cysticercosis
- Leishmaniasis
- Soil-transmitted helminths infections

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Some Diseases Associated with Animal Excreta

No.	Possible Diseases	How We Get Sick	How to Stop Getting Sick
1	Diarrhea, salmonellosis, giardiasis, cryptosporidiosis, toxoplasmosis	Fecal pathogens in water and food are ingested, or passed through direct contact with infected animal feces	<ul style="list-style-type: none"> • Use sanitation to prevent human and animal feces from contaminating water and food • Treat water to make it safe to drink • Wash hands after handling animal feces and before touching food
2	Ascariasis roundworm infection, hookworm infection	Helminths (fecal pathogens) in dried animal feces or contaminated soil are ingested (roundworm) or go through the skin (hookworm)	<ul style="list-style-type: none"> • Use sanitation to prevent human and animal feces from contaminating soil • Wash food with safe water before eating • Wash hands after contact with contaminated soil (especially for children playing outside) or dried animal feces (e.g., using dried dung for fuel) • Wear protective footwear
3	Cystic echinococcosis	<i>Echinococcus granulosus</i> tapeworm eggs (pathogen in human, sheep and dog feces) in water or food are ingested, or passed through direct contact with infected dogs	<ul style="list-style-type: none"> • Use sanitation to prevent human, sheep and dog feces from contaminating food and water • Deworm dogs and prevent dogs from eating undercooked sheep meat • Control stray dogs • Proper hygiene when slaughtering sheep • Wash hands after contact with infected dogs and sheep
4	Cysticercosis	<i>Taenia solium</i> tapeworm larvae (pathogen in human and pig feces) in water, food and raw or undercooked pork meat are ingested	<ul style="list-style-type: none"> • Use sanitation to prevent human and pig feces from contaminating food and water • Cook pork meat thoroughly to kill larvae • Treat water to make it safe to drink • Wash hands after contact with human or pig feces
5	Leishmaniasis	<i>Leishmania</i> protozoa are passed on by bites from <i>phlebotomine sandflies</i> that breed or live in animal feces, rodent nests, garbage, mud-plastered houses and bushes	<ul style="list-style-type: none"> • Reduce sandfly breeding and resting sites through rodent control, animal excreta management, solid waste management, domestic wastewater management, and stormwater management • Use pesticides to control sandfly populations • Prevent sandflies from biting by using bed nets and wearing long clothes
6	Leptospirosis, hantavirus	<ul style="list-style-type: none"> • Leptospirosis – Passed on by water, soil or food contaminated with infected rodent urine, or direct contact with infected rodent urine • Hantavirus – Passed on by contact with rodent excreta 	<ul style="list-style-type: none"> • Manage solid waste to reduce food supplies that attract rodents • Use rodent-proof food storage containers • Design rodent-proof buildings • Deter rodents with cats and dogs • Use rodenticides and traps to reduce rodent populations • Do not work, bathe or swim in water that is known to be contaminated with animal urine

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2.1 Diarrheal Disease

Diarrhea is one of the leading causes of death and illness. Globally, an estimated 2,000 children under the age of five die every day from diarrheal diseases. Of these deaths 1,800 are linked to water, sanitation and hygiene (UNICEF Canada, 2013). For every child that dies from diarrhea, countless others suffer from poor health and lost educational opportunities leading to poverty in adulthood. The reduction in diarrhea by meeting the sanitation Millennium Development Goal (MDG) target would add almost 200 million days of school attendance per year (UN-Water, 2008).



Measures to prevent the transmission of diarrhea include the following:

- Using sanitation to prevent human and animal feces from contaminating food and water
- Treating water to make it safe to drink
- Washing hands after handling human and animal feces and before touching food

2.2 Cystic echinococcosis

Cystic echinococcosis (also known as hydatid disease) is caused by the tapeworm *Echinococcus granulosus*. Its natural cycle is as a cyst in sheep and as a tapeworm in dogs. Dogs feed on infected sheep meat and in turn shed eggs in their feces which are ingested by sheep. People become infected by ingesting food or water contaminated with animal feces containing tapeworm eggs, or when they have direct contact with infected dogs. Cysts, often in the stomach, grow slowly over time and can become very large. The cure is usually surgery.

Cystic echinococcosis is found throughout the world in communities where sheep are raised together with dogs. It is highly prevalent in many developing countries, especially in poor communities. It causes serious human suffering and considerable losses in agricultural and human productivity.

Measures to prevent the transmission of cystic echinococcosis include the following:

- Using sanitation to prevent sheep and dog feces from contaminating food and water
- Deworming dogs and preventing dogs from eating undercooked sheep meat
- Controlling stray dogs
- Using proper hygiene when slaughtering sheep
- Washing hands after contact with infected dogs and sheep

(WHO, 2006a)

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2.3 Cysticercosis

Cysticercosis is caused by the *Taenia solium* tapeworm and is emerging as a serious public health and agricultural problem in many poorer countries of Africa, Asia and Latin America. People become infected when eating raw or undercooked pork meat contaminated with cysticerci, the larval form of the tapeworm. The larvae develop in the intestine of humans where they become adult tapeworms which can grow to more than three metres long. These adult worms shed eggs in human feces. These can infect other people as well as pigs by direct contact or by ingesting contaminated water or food.

Ingested eggs result in larval worms that migrate to different parts of the human and pig body and form cysts (cysticercosis). Pigs can harbour thousands of these cysts, making the pork from these animals unsafe to eat. A principle site of migration in humans is the central nervous system. Human neurocysticercosis occurs when the cysts develop in the brain. It is considered to be the most common parasitic infection of the human nervous system and the most frequent preventable cause of epilepsy in the developing world. Cysticercosis affects about 50 million people worldwide and, in endemic areas, causes some 50,000 deaths.

Measures to prevent the transmission of cystic echinococcosis include the following:

- Using sanitation to prevent human and pig feces from contaminating food and water
- Cooking pork meat thoroughly to kill larvae
- Treating water to make it safe to drink

(WHO, 2006a)

2.4 Leishmaniasis

There are three main types of leishmaniasis:

- Visceral leishmaniasis (also known as kala-azar) is the most serious form of the disease and fatal if left untreated. It is characterized by irregular bouts of fever, weight loss, enlargement of the spleen and liver, and anaemia. It is highly endemic in the Indian subcontinent and in East Africa. An estimated 200,000 to 400,000 new cases occur worldwide each year. Over 90% of new cases occur in six countries: Bangladesh, Brazil, Ethiopia, India, South Sudan and Sudan.
- Cutaneous leishmaniasis is the most common form of the disease and causes ulcers on exposed parts of the body, leaving life-long scars and serious disability. About one-third of cases occur in the Americas, the Mediterranean basin, the Middle East and Central Asia. An estimated 0.7 to 1.3 million new cases occur worldwide annually.
- Mucocutaneous leishmaniasis leads to partial or total destruction of mucous membranes of the nose, mouth and throat. Most cases are reported in Bolivia, Brazil and Peru.

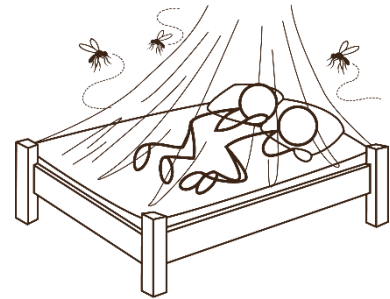
People can become infected with leishmaniasis if bitten by female *phlebotomine sandflies* carrying the *leishmania* protozoa. The sandflies can breed or live in animal feces, dung and mud-plastered houses, rodent nests, garbage and bushes.

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Poverty increases the risk for leishmaniasis. Poor and crowded housing and a lack of environmental sanitation (e.g., lack of waste management, open sewerage) can increase sandfly breeding and resting sites, as well as their access to people.

Measures to prevent the transmission of leishmaniasis include the following:

- Reducing sandfly breeding and resting sites through sanitation to properly manage animal excreta, and solid waste management to remove garbage
- Controlling sandflies by using insecticide spray, insecticide-treated bed nets and personal protection (see CAWST's Technical Brief: Vector Control)



(WHO, 2013b)

2.5 Leptospirosis

Leptospirosis (also known as Weil's syndrome, canicola fever, canefield fever, nanukayami fever, seven-day fever) is a bacterial disease that is transmitted to people through contact with:

- Urine (or other body fluids, except saliva) from infected animals
- Water, soil or food contaminated with the urine of infected animals

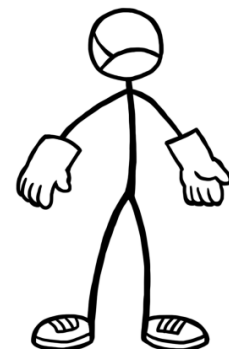
The bacteria can enter the body through skin or mucous membranes (eyes, nose, or mouth), especially if the skin is broken from a cut or scratch. Drinking contaminated water can also cause infection.

Rodents were the first recognized carriers of leptospirosis and are considered the primary source of infection to people. Cattle, buffalos, horses, sheep, goats, pigs and dogs are also considered common reservoirs of the bacteria that cause leptospirosis.

Leptospirosis occurs worldwide, but is most prevalent in tropical and subtropical regions. Outbreaks of leptospirosis have been reported following natural disasters, such as flooding. Some people have a high risk of exposure because of their occupation or the environment they live in. Occupations at risk include farmers, slaughterhouse workers, sewer maintenance workers and waste disposal facility workers. In some countries, most of the population is at risk as a result of high exposure to contaminated water in their daily activities; for example, working in rice paddies and sugarcane plantations. Although leptospirosis is often considered to be a rural disease, people living in cities may also be at risk from exposure to infected rats.

Measures to prevent transmission of leptospirosis include the following:

- Wearing protective clothing, especially for at risk occupations (e.g., boots, gloves, safety glasses, aprons, masks)
- Covering broken skin with waterproof dressings



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- Preventing access to, or giving adequate warning about, bodies of water known or suspected to be contaminated (e.g., pools, ponds, rivers)
- Avoiding bathing or swimming in potentially contaminated water
- Washing or showering after exposure to urine splashes or contaminated soil or water
- Washing and cleaning wounds after potential exposure to urine or contaminated soil or water
- Avoiding or preventing urine splashes and aerosols, avoiding touching ill or dead animals or assisting animals in giving birth
- Using hygienic measures during care or handling all animals
- Where feasible, disinfecting contaminated areas (e.g., scrubbing floors in stables, butcheries, abattoirs)
- Drinking safe water

(CDC, 2013 and WHO, 2012)

2.6 Soil-Transmitted Helminth Infections

The main helminth species that infect people are roundworms (*Ascaris lumbricoides*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*). Helminth infections are transmitted by eggs present in human and animal feces, which in turn contaminate soil in areas where sanitation is poor. This can happen in several ways:

- Eggs attached to vegetables are ingested when the vegetables are not carefully cooked, washed or peeled
- Eggs are ingested from contaminated water sources
- Eggs are ingested by children who play in soil and then put their hands in their mouths without washing them

In addition, hookworm eggs hatch in the soil, releasing larvae that mature into a form that can actively penetrate the skin. People become infected with hookworm primarily by walking barefoot on the contaminated soil.

There is no infection from fresh feces, because eggs passed in feces need about three weeks to mature in the soil before they become infective. As well, roundworm eggs can remain viable for years, creating long-term contamination of soil wherever infected feces are allowed to disintegrate.

Soil-transmitted helminth infections are among the most common infections worldwide and affect the poorest communities. More than 1.5 billion people, or 24% of the world's population, have soil-transmitted helminth infections. Infections are widely distributed in tropical and subtropical areas, with the greatest numbers occurring in sub-Saharan Africa, the Americas, China and East Asia. Children have the highest risk of infection and it impairs their physical, nutritional and cognitive development.

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Measures to prevent the transmission of helminths infections include the following:

- Using sanitation to prevent human and animal feces from contaminating soil
- Washing food with safe water before eating
- Washing hands after contact with contaminated soil (especially for children playing outside)
- Wearing protective footwear

(WHO, 2013c)

3 How Long Pathogens Survive and Remain Infectious

Many people mistakenly believe that only fresh animal feces present a health risk. In fact, many pathogens found in animal feces can survive and be infectious for days, weeks or even years after an animal has defecated.

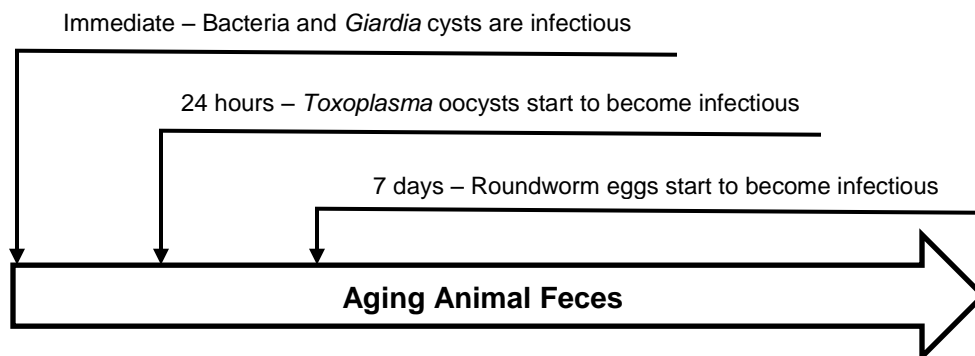
How Long Pathogens Survive in the Environment

Pathogen	Animal Feces	Soil	Water
<i>Escherichia coli</i> O157 bacteria	2 months-1 year	2 days-10 months	2 weeks-6 months
<i>Salmonella</i> bacteria	3-5 weeks	8 months	6 months
<i>Cryptosporidium</i> protozoa	2 months-1 year	1 year	1 month
<i>Giardia</i> protozoa	1 week-1 year	2 months	3 months
<i>Ascaris lumbricoides</i> roundworm	Years	Years	Years

(Adapted from Sobsey *et al.*, 2006 and University of Wisconsin, no date)

Some pathogens, like bacteria and *giardia* protozoa, are immediately infectious after an animal has defecated, while other pathogens require some time before they are infectious to people. For example, *toxoplasma* oocysts in cat feces take one to five days after defecation to become infective to people and other animals. *Ascaris* roundworms eggs in animal feces do not begin to become infectious until the feces have aged for a week or longer (Beeler and May, 2011).

Duration from Defecation to Infectivity of Common Pathogens in Animal Feces



(Credit: Beeler and May, 2011)

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4 Treatment, Use and Disposal

Over time, the number of pathogens will naturally decrease in untreated excreta due to sunlight (UV radiation), drying, high temperatures and high or low pH. However, pathogen reduction may not be extensive and it depends on factors such as the type of pathogen, characteristics of the animal excreta and the environmental conditions. Compared to human excreta management, there is relatively little research on the effectiveness of different technologies to reduce pathogens and disease transmission from animal excreta (Sobsey *et al.*, 2006).

The rate that pathogens are inactivated or removed from animal excreta can be improved through different treatment technologies, many of which also generate a beneficial product that can be used, including the following methods:

- Composting to produce a material that can be used to improve soil structure and provide nutrients for plant growth
- Exposing feces to sunlight (UV radiation) and drying
- Using lagoons or constructed wetlands
- Using anaerobic digestion to produce methane gas as a fuel source (e.g., biogas digester)

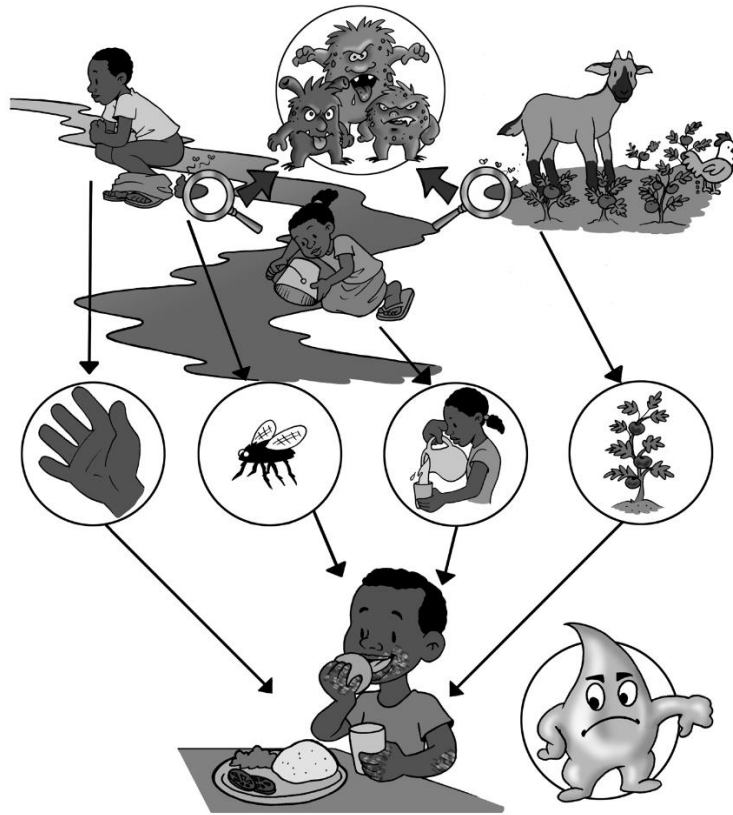
Animal dung has other beneficial uses in some countries. For example in Sudan, cow dung is mixed with clay to make bricks and donkey dung is used as a protective coating for mud walls and roofs (Majzoub, 1999). It is also a common practice in many developing countries to make cakes or patties out of cow and buffalo dung, dry them in sunlight and then use them as a fuel source (e.g., cooking and heating by fire).

For final disposal, animal feces are often applied to agricultural crops as a fertilizer. Depending on the type and extent of treatment, if treatment is used at all, pathogens may still be present at concentrations of concern to both human and animal health (Sobsey *et al.*, 2006).

As shown in the following illustration, there are many different routes that animal fecal pathogens can be transmitted from animal or human excreta to people, for example:

- Pathogens can be ingested directly from contaminated crop food
- Pathogens can enter surface and ground water supplies that are used as drinking water sources
- Flies can transfer pathogens to food
- Farmers that handle animal excreta can transfer the pathogens directly from their unwashed hands to their mouths.
- If human or animal excreta is not properly treated before being used as a fertilizer it will remain high in pathogens and be a potential contamination hazard.

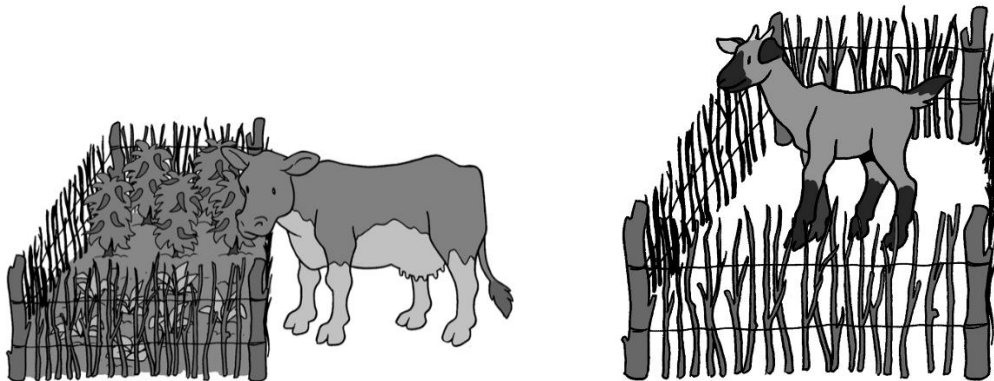
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Transmission of pathogens from human and animal excreta to people

4.1 Preventing Contamination

As a minimum, animal excreta around households should be collected on a daily basis and moved to a location that is away from water, food and people, especially children. As well, livestock animals (e.g., cattle, goats) should be kept away from homes and gardens by using fences to keep the animals in or out.



Using fences to keep animal feces away from homes and gardens

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4.2 Composting

Composting can be an effective method for reducing pathogen concentrations in animal excreta and is a traditional practice in many rural communities. This process accelerates the decomposition of excreta with the help of bacteria and other organisms (e.g., yeast, fungi, worms). The result is a compost material that can be used to improve soil structure and provide nutrients for plant growth.

Composting as a traditional waste management practice



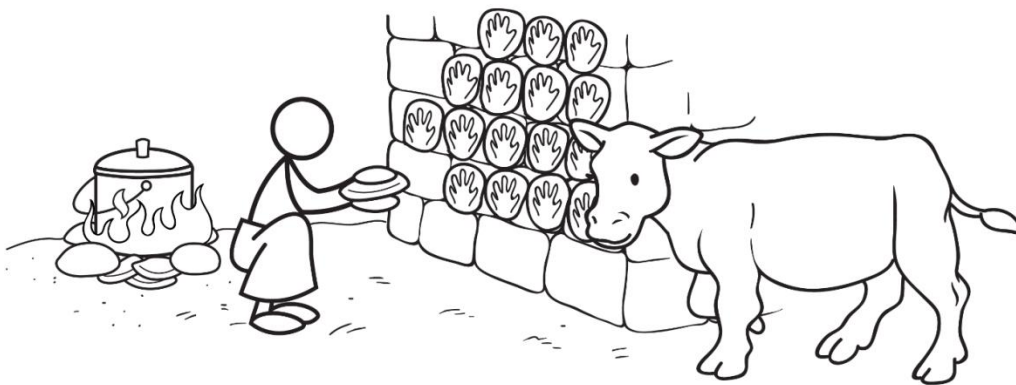
There are three main techniques for composting animal excreta:

1. Pile – Excreta is mixed with a bulking agent (e.g., another organic material like leaves or wood chips) that encourages aeration. Air is blown into the mixture for approximately 21 days followed by a 30-day curing period.
2. Windrow – Excreta is mixed with a bulking agent and then piled into rows 1-2 metres high. The rows are turned every few days for 30-60 days.
3. In-vessel – Excreta is mixed in a composting vessel while air is forced through the materials.

It is important to optimize the composting conditions (e.g., air, water, heat) to ensure that pathogens are reduced and the final compost product is safe to use afterwards. The temperature of the composting process is critical since heat is needed to kill or inactivate the pathogens. In a static pile process, a temperature of 55°C or higher must be maintained for three days or longer to achieve effective pathogen reduction (Bitton, 1999 cited in Sobsey *et al.*, 2006).

4.3 Drying and Burning

Drying animal feces and burning it as a fuel source is another widely practiced approach in many rural communities in developing countries. Cow and buffalo feces are shaped by hand into dung cakes or pats, placed in sunlight to dry out, and then burned as fuel for cooking, boiling water and heating.



Using animal feces to make dung pats for fuel

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Bacteria are highly susceptible to sunlight (i.e., UV light) and drying; however, viruses, protozoa and helminths are more resistant and can survive for weeks or months. Little is known about the extent to which pathogens are reduced because there have been few studies to document the effectiveness of UV light and drying (Sobsey *et al.*, 2006). One study found the effect of sunlight and rainfall on animal dung pats to be complex. For the initial one to three weeks after defecation, sunlight actually helped bacteria to grow by warming the pats to optimum temperatures and creating a crust on the pat that retains water. After this time, sunlight then helped to reduce the number of bacteria through dehydration (Sinton *et al.*, 2007).

While drying and burning animal dung may reduce the amount of waste that requires final disposal, it is also a serious public health problem. Pathogens from animal dung pats can be transmitted to people through different routes. The main route is directly from unwashed hands to mouths. It is very important that people wash their hands with soap and water after making animal dung pats and before touching food (e.g., preparing food, eating). Although it is rarely practiced, people can also reduce transmission of pathogens by wearing protective clothing, such as gloves, when handling animal dung.

Another potential transmission route is from insects that breed or live in the animal dung pats as they are drying. For example, *leishmania* protozoa are passed on by the bite from *phlebotomine* sandflies that breed or live in animal feces, dung and mud-plastered houses, rodent nests, garbage and bushes.

As well, the inefficient burning of animal dung in an open fire or traditional stove indoors creates hundreds of air pollutants - primarily carbon monoxide and small particles. The resulting indoor air pollution is responsible for more than 1.5 million deaths a year – mostly young children and their mothers. Millions more suffer every day with difficulty in breathing, stinging eyes and chronic respiratory disease (WHO, 2006b).

7 Additional Resources

CAWST (2013). Technical Brief: Composting. CAWST, Calgary, Canada. Available at: www.cawst.org/resources

- This technical brief discusses how to safely and properly compost organic waste in developing countries.

CAWST (2013). Technical Brief: Handwashing. CAWST, Calgary, Canada. Available at: www.cawst.org/resources

- This technical brief discusses when and how to properly wash hands with soap, as well as the hardware and software needed to change behaviour and promote handwashing.

CAWST (2013). Technical Brief: Vector Control. CAWST, Calgary, Canada. Available at: www.cawst.org/resources

- This technical brief discusses passive and active methods to control mosquitos, flies and rodents.

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- This report reviews the pathogens potentially present in farm animal excreta, and discusses the effectiveness of different treatment and management technologies.

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CAWST (Centre for Affordable Water and Sanitation Technology)
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