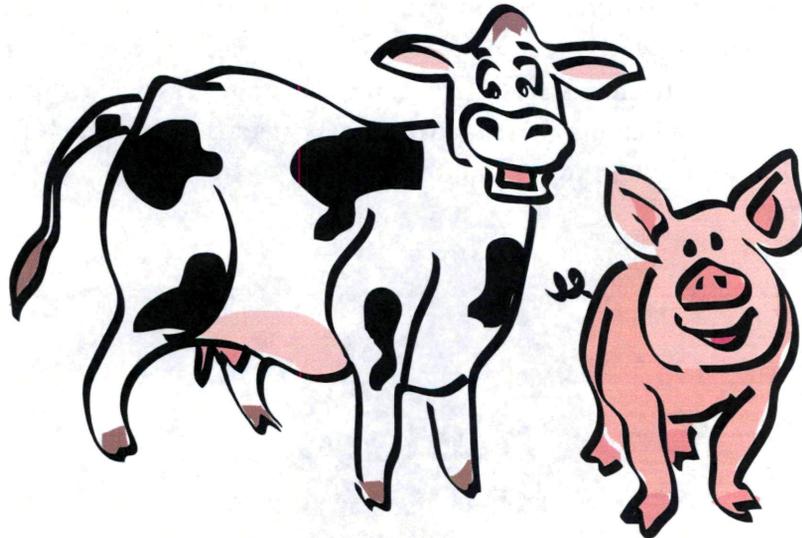


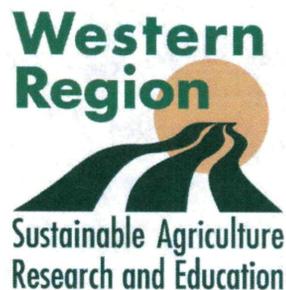
Manure Management for Livestock 4-H Projects

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Colorado
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Each animal that is adopted through a 4-H project has to be fed, housed, cared for and cleaned up after. In order to keep your animal, community, water, and air clean and healthy there are a few facts about manure management that this workbook will introduce to you. Through the reading and activities we hope that you develop a plan for how you will manage the manure from your animal(s). Hopefully you will even become a small-business person and make a few dollars from the manure. Stranger things have happened! Have fun with the activities and remember that manure management is as important for your animal as it is for you and your community.



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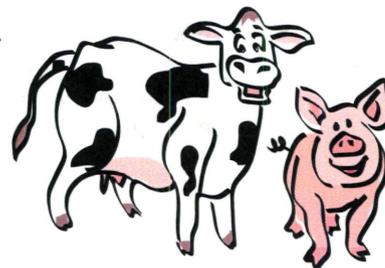
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Healthy Animals, Healthy People / Chapter 2

One of the most important goals in animal care is to keep them healthy. Keeping animals healthy can be a lot of work. They need the right kind of food at the right times and a clean and safe place to live. They also need human care to stay happy and healthy. Animals, like you, are more likely to stay healthy when all their needs are met.

Animals get sick for different reasons. They can be injured and need special care, get sick from a bad diet, or get a disease. Diseases are illnesses that are passed between animals. Diseases have symptoms that are physical changes in your animal that act as clues that can tell you your animal's health is changing. When you get a cold, you usually sneeze and blow your nose. These symptoms are easy to see these. If you take care of animals, you need to be able to recognize the symptoms that are telling you your animal might have a disease.



Some diseases can make your animals very sick and they can die or lose their usefulness. Therefore, it is important to quickly recognize symptoms in your animals. Diseases can spread quickly from one animal to another through touching, sharing the same drinking water, and contact with manure from a diseased animal. Before long, you can have many diseased animals instead of one.

One early symptom of a disease in an animal is a change in its manure. The manure may be wetter than usual, a different color, or may smell different from usual. It is important for you to know what normal manure from your healthy animal looks and smells like. If you notice changes in your animal's manure, it could have a disease.

How to Manage a Sick Animal!

Quickly separate a diseased from other animals to prevent the disease from spreading. Have a 'sick pen' or isolation area ready at all times, in case you need it. In addition to separating a diseased animal from other animals, carefully clean up and remove its manure from areas where other animals can come in contact with it. The pathogens that cause disease can be present in manure. It is important to always wash your hands after coming in contact with manure, but it is especially important if you think an animal has a disease. You can spread the disease to other animals through dirty hands.





The Plan I Hope to Never Need!

Do you know what manure from a healthy animal of the species you take care of looks like?

Do you know where you would isolate an animal that you think has a disease?

Pathogens that cause animal disease can cause diseases in humans as well. We call these zoonotic diseases. An example of a zoonotic disease is rabies, which a human can get if it is bitten by a dog or other animal with rabies.

Many other diseases can pass between animals and humans. Visit the web sites at the end of this section and the vocabulary list to read more about these diseases and how they are passed to other animals.



Keeping Records!

1. In your journal, describe all areas of your 4-H animal project where you handle manure.
2. Describe how you are dressed, when you wash your hands, or how you clean your boots, or change and wash clothes.
3. What are you doing to reduce the chance of spreading disease between animals or people?

The More You Know, The Safer You Are!

If possible, visit a veterinarian who can talk to you or a group about diseases that are common to your area, your species of animal, and whether the disease can spread through manure.

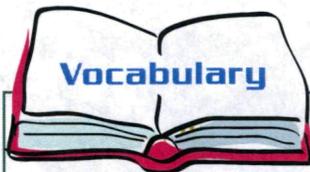
“Scoop on Poop”

- Pathogens can be present in animal manure, even if the animal does not appear to be sick. These pathogens can cause illness in other animals or humans.
- Sick animals can transmit diseases in their manure.
- It is important to know what normal manure looks like. If you see any changes in the appearance of your animal’s manure, it may be a signal that your animal is sick.
- Isolate animals with abnormal manure from other animals. Carefully clean up their manure so that other animals do not come in contact with it.
- It is a good habit to wear washable boots when in contact with animal manure. Wash boots after use.
- Wear clean, washed boots when you visit another place with animals. To prevent the spread of diseases, clean these boots before leaving so that manure is not carried from one location to another.
- Wearing washable coveralls when you expect to come in contact with animal manure. Wash coveralls in hot water.
- Don’t wear clothes in the house or a vehicle that may have come in contact with manure.
- Always wash your hands well with warm water and soap after coming in contact with animal manure.
- Avoid touching your face when your hands or gloves have come in contact with manure.
- Pathogens, as well as nutrients, can enter water supplies along with manure. Keep manure away from water supplies.
- Composting manure destroys most pathogens, as well as parasite eggs.



More Information:

- <http://www.californiastatehorsemen.com/enviro/index.htm>
- <http://www.ext.vt.edu/news/periodicals/dairy/2000-05/manure.html>
- http://www.cdc.gov/healthypets/animals/farm_animals.htm
- <http://www.bt.cdc.gov/recentincidents.asp>



Microorganisms are organisms too small to be seen without a microscope, such as bacteria and fungi.

A *pathogen* is a microorganism that can cause disease in an animal or human.

A *disease* is an illness that can be passed from one animal or human to another.

Escheri coli, sometimes called fecal coliform bacteria, is a type of bacteria found in manure from warm-blooded animals. Fecal coliform is found in the human digestive tract to aid in digestion. Fecal coliform bacteria can enter water sources when the runoff from a storm and sewage is discharged into water. Fecal coliform levels are watched because of the connection between fecal coliform counts and the chance of getting a disease from the water. These diseases are the result of the pathogenic organisms that appear with *E. coli* colonies.

A *zoonotic* disease naturally occurs in animals. It can sometimes be transferred to humans, such as rabies, Lyme disease, or West Nile Fever.

Where Does Our Water Come From? / Chapter 3



Planet Earth has a certain amount of fresh water. Most of the water on our planet is in the ocean and is not good for growing plants or drinking by humans or animals. Some of it evaporates and comes back into our fresh water supplies as rain. The freshwater (not salt water) exists as surface water in lakes, reservoirs, streams, or rivers and as groundwater. Groundwater is water found in the spaces between soil particles, in underground aquifers, and in underground water tables.



Local Water is My Water

1. Find out where the water you and your family drink comes from.
2. Do the same for your nearest neighbor.
3. Draw the surface and ground water locations on your property map. Be sure to include any irrigation ditches, creeks, wetlands, and wells that might be on your property. If you don't have any of these features, find out the address and location of the utility company that provides your water. Call and ask them how many gallons of water they deliver per day, week, and year as drinking water to their customers.

Clean Water for Everyone!

Every plant, animal and human needs clean water to live. Water pollution comes in many different forms and is toxic at different concentrations. Pollution can reach both surface and ground water through point source and non-point source avenues. Point source pollution sources are fixed in time and space. For example, the wastewater treatment plant that treats a city's wastewater has a constant supply of treated water that is released or discharged into a river or surface water system. Although the effluent water (water flowing out of a place) is treated, it still is considered a point source discharge because it has been removed



from the initial surface water body, used, treated and returned. Point source dischargers are required to have a discharge permit issued through the state so the quantity and quality of the effluent can be assessed and monitored. Non-point source discharge is variable in time or space. For example, outside of a horse corral, manure may be piled during the winter months. In the spring, a rainstorm may trigger runoff (water from precipitation or irrigation that flows over the ground and into bodies of water) from the pile that can discharge into local surface water or penetrate the soil and move pollutants into the groundwater.

Types of Water Pollutants Related to Manure Management:

Type	Source	Effect on Water Quality	Effect on Humans/Animals
Microorganisms	Manure and urine	Nothing visual. Quality is unsuitable for drinking without proper treatment.	Can cause illness in both if water is consumed prior to treatment. Ex: Giardia in mountain streams.
Excess nutrients: nitrogen and phosphorus	Manure and urine have high concentrations of nutrients in them from undigested food.	Water may turn green. Excess nitrogen can leach through the soil and pollute groundwater. Phosphorus can lead to algae growth and eutrophication of surface water.	Nitrogen polluted groundwater is toxic to humans and animals and may kill at high enough concentrations. As algae decompose in the water, the dissolved oxygen decreases. Fish need dissolved oxygen to breath underwater. Severe algal growth may kill fish.
Pharmaceuticals: antibiotics and hormones	Manure and urine contain undigested pharmaceuticals.	Nothing visual. May cause antibiotic resistance genes in aquatic animals and affect reproductive development of aquatic species.	Certain antibiotics may become ineffective in treating illnesses when microorganisms become resistant to the medicine.

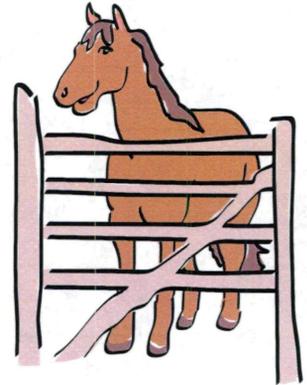


1. If you have a well, do you have it tested? How often? If you are on city water, the supplying company is required to send a water quality report each year to your mailbox. Have you looked at this report?
2. Determine how good your water quality is using the Water Quality Tool located at www.csuwater.info. Write down any water quality concerns that you need to be aware of for your drinking water.

Protecting Your Water

Best management practices (BMPs) are suggested ways to reduce the amount of soil and pollution that enters our water. A few BMPs to protect surface and ground water pollution are listed below:

- Fence animals out of all surface water (rivers, streams, dry creek beds, and lakes). This will keep them from contaminating the water with manure and urine.
- Plant grass and other vegetation along banks of water on your property. Vegetation filters out nutrients from runoff and reduces the amount of nitrogen and phosphorus that get into surface water.
- Install a cement pad in any area that you store or compost manure where the groundwater is less than 20 feet below ground, so nitrogen does not leach into the ground water
- Only give animals antibiotics and hormones when necessary.



Go With the Flow!

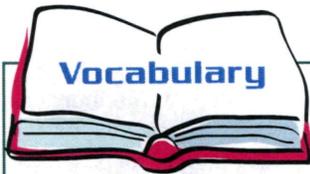
Imagine you are a raindrop falling in the middle of a corral on your property or place where you keep livestock, animals or manure. On your property map trace where the drop of water will go. If possible, do this during a rainstorm!

The Big Picture

Does the manure on your property affect water quality?

How can you change your manure management to decrease the impact on water quality?





Water Pollution – Anything that makes water unsuitable for its planned use. The alteration of the physical, chemical, or biological properties of water by the introduction of anything that makes the water harmful to use.

Surface Water – Water on the surface of the land, including lakes, rivers, streams, ponds, flood-water, and runoff.

Ground Water – All water under the surface of the land. Water that is unable to be seen by our eyes. All water in between soil particles, in aquifers and water tables.

Point Source Pollution – Any pollution that can be traced to the place it came from.

Non-Point Source Pollution – Pollution variable in time or space. For example, pollution that occurs as runoff after a big rain storm.

Waste Water Treatment Plant – Facility that cleans pollution from household water waste (toilet water, bath water, dishwasher water, or washing machines, too!) before returning the water to a stream, river or other surface water body.

Discharge – An outflow of water from a stream, pipe, ground water system, piece of property, or watershed. Discharge is often polluted.

Effluent – Same as discharge.

Runoff – Precipitation that flows over land to surface streams, rivers, and lakes.

Algae – An aquatic plant that requires sunlight, oxygen, nitrogen and phosphorus to grow.

Eutrophication – A condition in a lake, reservoir, or pond where high phosphorus concentrations provide food for an algal bloom. As the algae decompose, the dissolved oxygen in the water is consumed, decreasing the dissolved oxygen concentration. The water may not supply enough oxygen to keep the fish alive. The water in eutrophied water bodies often looks green and smells bad. Fish living there can die.

Dissolved Oxygen – Oxygen in water that is necessary for a healthy aquatic system to function. Fish and algae need specific concentrations of dissolved oxygen in order to breathe in water.

Leaching – The movement of water downward through the soil toward or into the groundwater.

Protecting Air Quality / Chapter 4

In addition to food and water, clean air to breathe is necessary for human life. Can you think of a time when you had trouble breathing? Maybe you were swimming and swallowed too much water, gagged on some food while eating, or exercised too hard. Have you ever had trouble breathing because of bad air quality? People with asthma or other breathing difficulties, elderly people, or infants may be more sensitive to air quality effects than you are. Do you know someone who is especially sensitive to air quality? This section is for them, your family members and neighbors (including your animal and plant neighbors), who may be sensitive to poor air quality.

Animals Affect Air

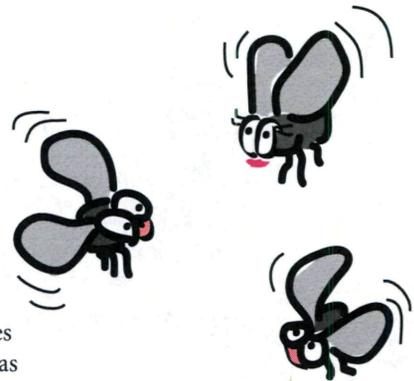
So what are some of the ways that your 4-H livestock can affect air quality? The first thing you probably thought of was odor, the smell of animal manure and urine. Did you know that manure has over 600 chemical compounds in it that contribute to odor? Yes, that's right! And, of course, the perception of what stinks varies among people, depending on their life experiences and the sensitivity of their noses.

What other air quality problems can you think of? Dust is another one that animals can contribute to. If the place where they are kept does not have plants growing, when conditions are dry and animals are active, dust may be a problem. Dust can reduce visibility, creep into a clean house and make it dirty, make it hard to breathe, and carry odors or disease-causing organisms.

What about flies and mosquitoes? Sometimes having animals or manure piles will give insects a place to breed. They can then move around and can be irritating to people and livestock and or can even spread disease.

Greenhouse gases are another air quality problem that you can't smell or see, but have serious impacts on global warming. Cattle belch methane (an important greenhouse gas), and manure piles can give off carbon dioxide or nitrous oxide (other greenhouse gases) as well as methane, depending on how they are managed.

One more important air quality consideration is ammonia. You have probably smelled ammonia in household cleansers or from manure, but ammonia has some special impacts that make it more than just something smelly.



Ammonia can form something called particulate matter, or dust, that causes coughing, bronchitis and asthma attacks. It also can be re-deposited to Earth's surface and cause environmental problems. If the ammonia lands on a neighbor's field or garden, it's sort of like free fertilizer. If it lands on a mountain meadow, it can encourage weeds to grow and reduce wildflower populations. If ammonia lands on water, it can increase algae and turn a formerly beautiful place into a scummy and smelly pond. Ammonia can cause air quality problems in barns by hurting the lungs of the animals who live there and the people who work in them.

List some of the possible negative impacts of animals on air quality:

- 1.
- 2.
- 3.
- 4.
- 5.

Odor from Animals

Scientists can quantify odor in four different categories. You can remember the categories by thinking of a common name for a pet dog, FIDO.

F=Frequency. This is a measure of how often an odor occurs: once a year, once a month, once a week, or everyday. Sometimes frequency depends on weather conditions, like rain or wind. Sometimes it depends on human activity, like cleaning out the chicken coop or spreading manure.

I=Intensity. This is a measure of how strong the odor is and can actually be measured by how much clean air it takes to dilute the stinky air before you can't smell it anymore.

D=Duration. Duration means how long it is stinky. It's possible to have a high frequency, low duration odor (for example, it's stinky every week but only for 5 minutes) or a low frequency, high duration odor (a situation where it stinks only once a year, but it lasts for a whole month) or other combinations, too.

O=Offensiveness. This is a measure of how bad an odor is, and is determined by comparison with some other odor. All odors are not created equal, and this is a way to quantify that.

Think about an odor you've experienced. How would you describe its FIDO characteristics?

F
I
D
O



Follow Your Nose!

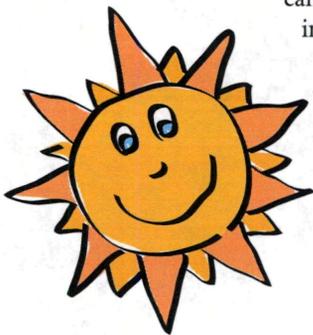
For this activity you will need a partner. Your partner will lead you on a walking tour of the place where you keep your 4-H animal(s), and you will be wearing a blindfold! As your partner leads you around, describe to him or her what you smell. After taking off the blindfold, make notes onto your map (developed back in section 1) about where you think the odors are coming from.

Bringing It Home

Think about your family. Does any member of your family have allergies, asthma or some other health condition that affects their ability to breathe? If so, when are these problems most troublesome? Is there anything you can do to reduce the problem?

Greenhouse Gases

Why are they called greenhouse gases? Well, if you've ever been in a greenhouse, you know that they tend to be warm places, much warmer than the area outside of the greenhouse. This is because the glass walls hold heat inside of the building instead of letting it escape back outside. You can think of the greenhouse gases as the glass walls of the greenhouse with the Earth inside. The greenhouse gases increase the temperature of the Earth by holding heat in the Earth's atmosphere. The sun's rays shine down and bounce off the Earth's surface, and then greenhouse gases prevent that radiation from escaping the Earth's atmosphere and going back out to space. This leads to rising temperatures at Earth's surface!



There are three main greenhouse gases. Can you name them?

- 1.
- 2.
- 3.



The greenhouse gases are carbon dioxide, methane and nitrous oxide.

Protect Your Air

So what can you do to protect the air from your animal's impacts? One important principle to know is that, "Wet manure stinks and dry manure is dust!" So it may seem you are in a bad situation, where you can't help but cause a problem. That's not true! Your goal is to keep manure wet enough not to blow away and dry enough not to stink too much. Here are some things you can do:

- Keep your outdoor pen as smooth as possible so that you don't get puddles of water when it rains.
- Collect the manure frequently and remove it from the pen.
- If it's dusty, consider sprinkling the pen area with just enough water to hold the dust down.
- Don't feed your animals a diet that is too high in protein. Meet the animal's needs without going over. This will help reduce ammonia production from your pen.
- Don't let water collect around your manure pile. This may lead to odor and runoff problems and greenhouse gases.
- Consider composting the manure to control insects and odor (see composting chapter).
- Turn manure into the soil as soon as possible, after you apply it to land.



Air Quality Action Plan

Read the box titled 'Protect Your Air' and decide what you will do to keep the air clean around your 4-H project animal. Make a list of your plans. You don't have to choose from the list below. Feel free to add your own ideas! Jot three of your ideas down here:

1.

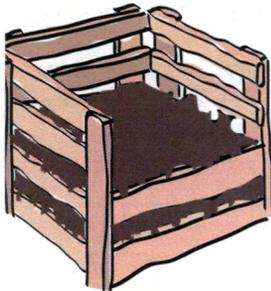
2.

3.

Don't forget to come back and check your list when you finish the Manure Management Book and see how well you are doing. Are you doing what you said you would do?

The Art and Science of Composting / Chapter 5

About 40 percent to 50 percent of the material that the United States puts in the landfill is organic and able to be composted. Just think of all of the recycling we could do if this much waste was turned into a fertilizer and soil builder.



Composting is the process where microorganisms, both bacteria and fungi, break down organic material into a humus-like substance called compost. A compost pile must be managed to encourage microbial growth. The composting microorganisms, which you can think of as tiny bugs that are too small to be seen without a microscope, do not need to be added because they are found everywhere in the environment, especially in dust, finished compost, and soil with organic matter.

Four Essentials for Composting

To make the best compost, focus on four details:

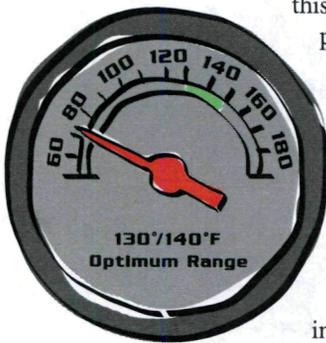
1. *Carbon and Nitrogen:* All microorganisms (found in the composting process) thrive in a feedstock mix when they are combined with the right amounts of carbon and nitrogen, which is 30 carbons to one nitrogen, or 30:1. We call this the carbon to nitrogen ratio. Carbon is one of the basic chemical elements found in a periodic chart. You can think of it as the “brown material” around your property, including dead leaves, bedding and aged manure. Nitrogen is also a chemical element found on the periodic chart. But in the world of composting, it is the green material and includes vegetable waste from your kitchen, spoiled alfalfa and grains, and fresh manure. The smell you think of from fresh manure is often nitrogen converting into a gas form that your nose can detect called ammonia.

When you compost manure, the microorganisms in the manure turn half of it into carbon dioxide, which has no color or odor. This carbon dioxide is lost to the air. We write the chemical formula for this as CO_2 . This same thing happens when we breathe in air. We take in oxygen to our bodies, and breathe out carbon dioxide. We call this change, from a solid form to a gas, ‘volatilization.’ Nitrogen can also be changed from a solid form in the “green materials” to gas and escape as a gas with a strong smell, which is called ammonia.



2. *Moisture:* The composting microorganisms live best in material that is 40 percent water. To better understand how wet this is, think of how a sponge feels when you squeeze out water. That is about 30 percent moisture! If these conditions are not present, the microorganisms stop growing, divide and enter a resting phase. The composting process slows almost to a stop. We act the same way if we can't drink when we are thirsty. After conditions improve, the resting phase becomes active again, which means the microorganisms begin to grow and divide again, and the composting process starts up again.

3. *Oxygen:* The composting microorganisms need oxygen to do their job. Think of this as air that contains 20 percent oxygen. Air is what we breathe too, but the oxygen part of it is also what our bodies need to breathe. The compost pile should have between 5 percent and 20 percent oxygen. The best way to provide oxygen to the pile is to turn it. Each time a scoop of compost is fluffed by a shovel or manure fork, or front end loader, air gets into the little pockets between composting material. Microorganisms use the oxygen in these pockets.

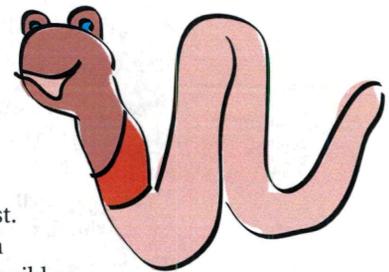


4. *Temperature:* The composting microorganisms that are present early in the process are thermophilic, which means they like to live at high temperatures that we would find uncomfortable. As the organisms eat the carbon and nitrogen in the pile, they produce a lot of heat, which causes the compost pile to heat to 130 to 140°F. When the compost pile begins to cool after reaching these high temperatures, the microorganisms run out of carbon, nitrogen, oxygen, or water. Usually, the first thing they use up is oxygen. Gravity makes the pile settle and the particles settle and shrink as they decompose.

At this point, it's important to turn or water the pile. Turning it also redistributes the microorganisms so they are close to fresh carbon and nitrogen.

Squiggly Worm Compost

Worms called 'red wigglers' also carry out the composting process. When compost is made using worms, the process is called 'vermicomposting' and the finished product is vermicompost. "Vermi" means worm in Latin. Worms eat the microorganisms that live on the carbon and nitrogen. The digested material the worms poop out is compost. As the worms move through the pile in search of more food they turn the pile and create tunnels where oxygen and water can move through the compost. However, composting worms live best at the same temperatures that people do. Compost worms cannot live in thermophilic or hot compost. They also can't live in cold winters without some protection from changes in temperature. To provide the perfect habitat for composting worms you can build a long row of compost and feed new carbon and nitrogen at one end. This way the thermophilic microorganisms can heat the pile and the worms can move into the parts of the pile that have already cooled off.



Check out the Colorado State University Extension fact sheet, *Vermicomposting Horse Manure*, at:
<http://www.ext.colostate.edu/PUBS/LIVESTK/01224.html>.

Are you interested in composting your animal's manure? If so, there are more resources on the web to read. Search for the following:

1. The Worm Digest at www.wormdigest.org
2. New Mexico State University publication at http://cahe.nmsu.edu/pubs/_h/h-164.pdf
3. Happy D Ranch at www.happydranch.com
4. Compost thermometers (at least 20 inches long) at www.reotemp.com or www.gemplers.com, or contact your local extension agent.

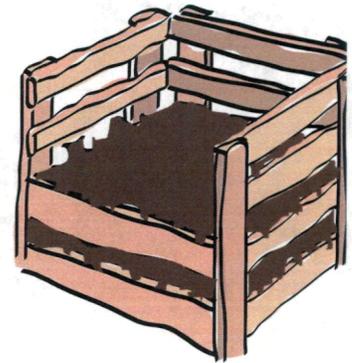
The Finished Product!

The compost process takes anywhere from three months to over a year to complete, depending mostly on how the compost process is managed. After the active process (3 months to 1 year) is complete, it is important to cure your compost. Curing lets microorganisms finish their jobs and adjust small parts of the chemistry. To cure compost, turn it one more time and water it. Then let it sit for one month. Think of this as letting your fresh-baked cake to cool before you frost it.

Finished compost has an earthy odor and particles that are about the same size. It improves plant growth because it is a good source of essential nutrients for plants and releases these nutrients into the soil slowly. There are laboratories that can analyze your compost to determine what is in it, which is important if you plan to apply your compost to a garden.

The composting process inactivates many pathogens or microorganisms that naturally occur in animal manures. Properly composted manure is free of microorganisms that can make you sick if it got on your vegetables. A laboratory test will show whether or not your compost has microorganisms in it, so you can be confident about your management process.

The composting process kills most weed seeds due to the high temperatures it generates in the compost and to the high moisture levels. This is a plus so you don't spread weed seeds into your garden or lawn.



Let's Make Compost!

Making compost is a hands-on thing. You can read about it in books and know a lot, but still not know how to make it. Read this section through all the way before you get started. Also, read through the Troubleshooting section before you begin this project!

As you make your first compost in a bin, you will learn from the microorganisms how compost is really made.

Materials needed:

- Feedstocks, both “green” and “brown,” about 125 cubic feet in volume. Hint: to figure how many wheelbarrows you’ll need for this amount, measure your wheelbarrow’s length, width and height, and calculate its volume.
- Source of water, like a garden hose
- Wheelbarrow
- Manure or hay fork
- Rake and shovel
- Compost thermometer
- Nice, but probably not essential is good quality topsoil, about 1/2 of a 5- gallon bucket or compost that is already made to “make sure” the right microorganisms are bountiful in your feed-stock mix. Note: all buckets we call 5-gallon buckets are not the same size!



There are many ways to compost. A simple way to make a small batch of compost is in a bin that is about the size of four pallets tied together at the corners. This compost pile will have enough size to work properly but won't overwhelm you while you learn how it works. Another material that works to enclose a small bin is a roll of fairly stiff woven wire fencing. Cut enough to enclose a circle about 4 feet across (diameter). Small straw or old hay bales can be used to make a simple enclosure. Cement blocks will also work.

Using the table provided, determine the amount of nitrogen and carbon in your materials. While this isn't possible to do exactly without submitting samples to a lab for analysis, you can estimate, which means take an educated guess!

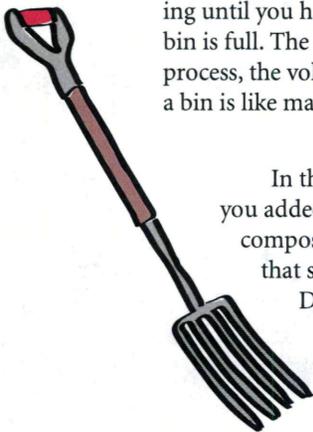


Some Common Feedstocks and Their C:N ratio (from On-Farm Composting*)	
Feedstock	C:N
Horse manure	30
Dairy Manure	13
Laying hens	6
Sheep manure	16
Alfalfa hay	16
Wheat straw	127
Wood shavings bedding (softwood)	600
Dried fallen leaves	54
Fresh grass clippings	17
Household vegetable food wastes	11-13
Coffee grounds	20
Grass hay	32

First, build the bin you will make the compost in. With a hay or manure fork, loosely layer in one of your coarsest feedstocks. A layer can be 3 or 4 inches deep. Feel this material, using the squeeze test. If you think it is less than 50 percent moisture, sprinkle some water on this layer right now. It will be harder for the water to soak through to wet the bottom after you have added many layers.

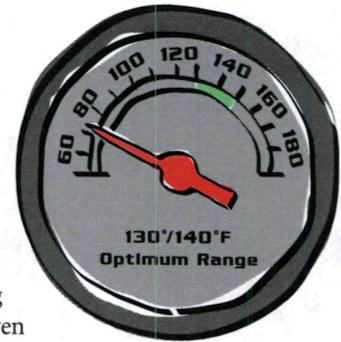


Next, layer a different feedstock, again about 4 inches deep. You can slightly mix the two layers with your fork at this point to help the microorganisms have access to lots of different food sources. Again check moisture. Sprinkle a little if needed. Keep repeating this layering until you have used all the types of feedstocks that you choose. Repeat these layers until your bin is full. The finished height should be 4 to 5 feet high. Remember that during the composting process, the volume of the original materials will decrease by about half. Building a compost pile in a bin is like making lasagna, with different layers of noodles, sauce, meat and cheese that repeat.



In the compost log provided, write down what your original feedstocks were, whether you added water, and how full the bin was. If possible, take a photograph of the newly built compost bin!!! Try to get a close-up showing what the mixture looks like. Also get a picture that shows how high the top of your pile is in relationship to the top of the bin. This is Day 1 of your compost pile. In anywhere from three months to over a year, these “heterogeneous” feedstocks will have become compost, with good management on your part.

What is good management? Think of it as being the best microorganism farmer that you can be. As soon as your pile is built, on Day 1, measure the temperature of the center of the compost pile. Insert your compost thermometer into the center of the pile and watch the hand on the dial move. When it stops moving, that is the temperature to write down. This may take a few minutes, so be patient. Write down the temperature in your compost log under "Day 1 temperature." Measure the temperature each day for the first seven days. Record the temperature each day. After the first week, you can measure the temperature every other day. While you are learning about how composting works, measure the temperature daily.



Also, notice the smell each day. Smells are strongest at the surface in the center of your pile. Write down in your compost log what you smell each day that you record temperature.

Note any physical changes you see. If your pile was at the top of your bin on Day 1, where is it in the bin on Day 7 when the pile is one week old? At least one time per week, write down what you observe in your compost log.

Note when the temperature in your pile gets hotter than the air temperature. This part of the composting process is called the 'thermophilic stage' because of the heat (thermo) that the microorganisms produce. The microorganisms that like living in hot conditions (what are they called?) are now thriving. You don't have to do anything except measure the temperature, because the microorganisms are doing all the work. Notice when the temperature of your pile starts to cool off. After several days of temperatures getting cooler and cooler, the microorganisms in your pile are not able to work as hard. Something is interfering with their work! That is probably oxygen. Now, as the "microorganism farmer" you need to step in and help.

To get air into the pile, take the sides apart and break the pile apart with your hay or manure fork. This is also a good time to check moisture. Use the squeeze test to see if you need to add water. If so, sprinkle everything on the ground lightly with your hose. Fluff everything up with your hay or manure fork, then put your bin together again next to the fluffed up material. Now, fork everything back into the bin. You don't have to layer anything now, because all the feedstocks you started with should be well mixed by now.

Write down in your log when you turn the pile. Also write down if you added any water, what you observe, and what you smell.

After the first turning, check the temperature again daily and write it down. Also write down what you smell and what you observe. After about a week, you can measure the temperature less often. Again, when the temperatures start decreasing for several days in a row, it is a sign that your microorganisms need some help. Repeat the steps you followed the first time you "turned" the compost.

Continue monitoring and turning your compost until the temperatures no longer rise. At this point, microorganisms are still working in your pile, but the thermophiles have been replaced by microorganisms that thrive at lower temperatures. In your log, write down the approximate time when temperatures stopped rising. This is the beginning of the curing phase, or mesophilic phase, which is also very important in the composting process. The microorganisms in this phase are mostly fungi. You may even see small mushrooms popping up in your compost bin after it rains. From now on, you will have to rely on appearance and smell to determine how your compost is doing.

Remember how the feedstocks looked on Day 1? If you took photographs that day, take a look at how the feedstocks looked on Day 1. How do they look now? On Day 1, where was the top of your pile? Where is it at this point? Write these things down in the “observation” part of the log.

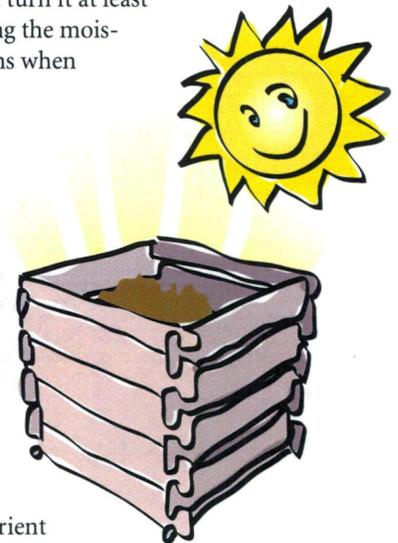
Curing compost needs less management. It will help the process if you turn it at least one more time. It still needs water, but may not need it as often. Keep checking the moisture with the squeeze test. Add water if necessary. If your curing stage happens when winter begins, you can let it continue curing over the winter.

When is my compost done? This is a very good question. If this is the first time you have made compost, this may be a difficult question to answer. Compost is done after it cures, when you can no longer see any of the original feedstocks. The compost is dark, crumbles easily in your hand, and it smells “earthy.” If you have visited a place where compost is made, ask if they will look at your compost and give you their opinion. Or, if you know an experienced composter, ask them to take a look at your compost, smell it, and give you their opinion. If it looks like compost and smells like compost, it usually is finished!

Compost, like soil, can be tested at special laboratories. Tests can be done that show whether the composting process has finished, what is the nutrient level in your compost, and other things. Large composting operations often send their compost to labs for testing. If you want to learn more about this, visit this web site: <http://www.compostingcouncil.org/section.cfm?id=38>

*From On-Farm Composting Handbook:

http://www.css.cornell.edu/compost/OnFarmHandbook/onfarm_TOC.html



Designing Your Own Composting System

After you make this learning compost pile in a bin, think about what kind of composting system would work best for managing your manure supply. Ask yourself these questions:

1. After learning how to make compost, did I enjoy doing it?
2. Can I use my manure better if I made it into compost?
3. Could I sell compost if I made it? To sell compost, you have to have willing buyers!
4. Do I have an area where I can compost?
5. Do I have the time and materials to compost?
6. Do I know the local regulations for making compost?



There are many ways to make compost. Making compost in a bin is a good way for you to learn what happens, but this might not be the most efficient way for you to make compost with the manure generated by your 4-H project animals and other available feedstocks. Check out the following website where you can learn more about designing a composting system that works for you: www.manuremanagement.info. Click on presentations and look under the compost heading.

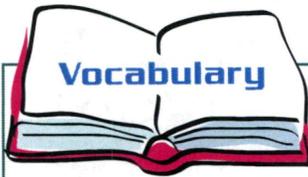
Compost Improves the Soil!

- It increases the water held by the soil.
- It improves aggregation, which means there are more pores and roots can grow more easily.
- It improves the infiltration rate (speed that water moves into and through the soil) of water in soils. This is important for soil holding the water until the plant needs it and the movement of nutrients into the soil where they will get used by plants.
- It improves the ability of soil to hold onto nutrients until the plant needs them.

Troubleshooting Problems in Your Compost Pile

1. After a few days, you smell ammonia coming from the pile.
 - a. You have probably added too much nitrogen. Break the pile apart and mix in some feedstocks whose C: N is higher than 40:1. This will bring your C: N into a favorable range so that excess nitrogen does not convert to ammonia.
2. After a few days, the temperature in your pile has not risen above the temperature of the air.
 - a. Check the moisture content by feeling the compost in five spots in the pile. If it is too low, add water. This may be easiest if you poke a deep hole into the pile and put the hose in the hole so that the water gets into the middle of the pile.
 - b. If the moisture is ok, review your feedstocks. If your C: N is a lot above 40:1, it is possible that the microorganisms do not have enough nitrogen to get going. Break pile apart and use a feedstock with a low C: N, one that is high in nitrogen, like fresh manure, or fresh grass clippings.
 - c. Did you make your pile large enough? Large enough is about the volume contained in four average size pallets. If your pile is too small, the heat generated by the microorganisms will all be lost, poor heating will occur, and microorganism growth will be limited.
3. You smell sulphur smells, something like rotten eggs.
 - a. Your pile is anaerobic. Break it apart, allow the feedstocks to air dry, or add some dry materials to this mix to absorb some of the excess water. Use the squeeze method to check the moisture in several places. It is possible that only part of the pile was too wet and it just needs to be well mixed.





Aerobic means in the presence of oxygen, or air, which contains oxygen. Between 5 percent and 20 percent oxygen is considered adequate for active composting to occur.

Ammonia is a chemical compound that contains nitrogen. It has a strong odor and indicates that nitrogen is escaping from a compost pile in a gaseous form.

Anaerobic is the opposite of aerobic. It means in the absence of oxygen, or air. Compost piles that contain too little oxygen are anaerobic. Many microorganisms can live without air. However, they produce gases that can smell very bad. In addition to the unpleasant odors these microorganisms produce, they are not very good at making compost. Avoid anaerobic conditions when making compost.

Bacteria are a type of microorganism too small to be seen by the human eye. They can, however, form colonies that can be seen. Often when food spoils in the refrigerator, bacterial colonies are visible. They can be white, black, pink, or even green.

Carbon is a chemical element and present in all living things. Carbon is very important in the composting process. Microorganisms need plenty of carbon to eat while making compost. Humans also need to eat carbon to live, but we get our carbon mostly from carbohydrates, like oatmeal, bread, and potatoes.

Compost is a mixture that consists largely of decayed organic matter and is used for fertilizing and conditioning land.

Curing is the period at the end of the composting process, when temperatures cool down to air temperature. Microorganisms are still at work in the compost pile, but they are different ones than the ones that are first present that give off lots of heat. These microorganisms are mostly fungi. Often white threads can be seen in the compost which is hyphae, the chain-like structures formed by fungi. You might also see some small mushrooms sprouting up from the compost in summer after a rain. These microorganisms help break down the last of the carbon present in the original feedstocks. Letting compost cure for six weeks to two months or longer is an important step in making good quality compost.

Feedstock is a material that can be composted, such as animal manures, garden waste, yard waste, spoiled hay and grain, which contains carbon and nitrogen. High carbon feedstocks have a C: N above 40, low C: N feedstocks have a C: N of 40 or below. High carbon feedstocks are sometimes called "brown" feedstocks. High nitrogen feedstocks are sometimes called "green" feedstocks.

Fungi are a type of microorganism that is too small to be seen by the human eye. They form long chains, called hyphae, which can be seen by the human eye. When you see white fuzzy growth on spoiled bread, you are seeing fungal hyphae. Details of hyphae can often be seen with a simple magnifying glass.

Mesophilic means living at temperatures of about 70°F. Most fungi are mesophilic microorganisms because they live best between 50 and 90°F.

Nitrogen is a chemical element. It is present in all living things and very important in the composting process. Microorganisms need about 1 part nitrogen for every 30 parts carbons that they eat (you can translate 'part' to bucket, spoonful, wheelbarrow, or any other measurable container), which is why compost piles are built with that C: N in the beginning. Humans also need to eat nitrogen to live, but we get our nitrogen mostly from protein, like those found in meat, milk and beans.

A *microorganism* is a small life form that can grow and reproduce itself but is too small to be seen by the human eye. They were discovered after microscopes were developed that could magnify them enough to be visible to the human eye.

The *periodic table* is an arrangement of the chemical elements by atomic number, starting with hydrogen in the upper left-hand corner and continuing in ascending order from left to right, arranged in columns according to similar chemical properties.

Thermophilic means to live at high temperatures, from about 100°F to 150°F. Some microorganisms thrive at these high temperatures and are called thermophilic microorganisms.

A compost *thermometer* is a special thermometer with a slender metal shaft that is designed to be inserted into the center of a compost pile to measure temperature. It should be at least 20 inches long.

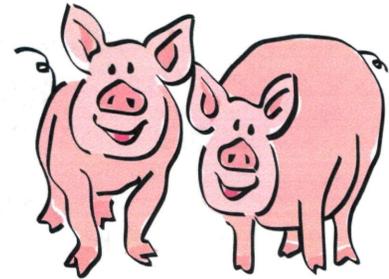
Volatilization is a term used to describe a change in form from solid to a gas. Nitrogen can volatilize from a compost pile as ammonia. Carbon also volatilizes from a compost pile as carbon dioxide.



What Is Economics? / Chapter 6

Economics is the science that deals with the production, distribution and use of goods (for example: baseball bat, hamburger, computer) and services (for example: ambulance service, cell phone service/connection, internet service). It is important to think about how resources can best be distributed to meet the needs of the greatest number of people. A resource is defined in economics as an available supply of anything that can be used.

Hopefully by now you are convinced that the manure produced by your animal is a resource. This resource has many uses if managed correctly and may be a source of income for you and your project. The manure can be sold as a soil additive to increase the organic matter and nutrient content in a local field or composted and sold to neighbors as fertilizer for their vegetable gardens. Another option for your animal manure is to collect it and take it to the landfill where you will pay a fee for dumping it. Depending on the choices you make to manage your animal's manure, the economics of the process might be good or bad for your pocket.



Weigh Your Options!

1. How much manure does your project animal generate per week? Measure the volume of manure produced in 5-gallon buckets. Now calculate the volume of your 5-gallon bucket by using the following formula: $V = \pi r^2 h$ where V is volume in cubic inches, π is 3.14, r is the radius of your bucket (measure the diameter of the top of your bucket in inches and divide that by 2 to get the r , and h is the height of your bucket in inches. Your answer will be in cubic inches. To convert the volume of manure that you have into cubic feet (a volume that a trash hauler can relate to) multiply the total manure volume in inches by 0.000579. Now you have the total volume of manure that your animal produces per week in cubic feet (ft^3).
2. If you had to hire a trash hauler to remove this volume of material and dispose of it at the landfill, what would it cost? Call a local trash hauler and determine the cost.
3. What costs do you need to be aware of if your family delivered manure to a farm or house across town (for example, gas)?





Supply and Demand Rules!

You may wonder why the prices of goods go up and down so often. One of the reasons is the law of supply and demand. Supply refers to how many of a certain good or service are available for people to purchase. Demand means how many people wish to buy that good or service.

How does this work? Let's say that a brand-new, super awesome video game is about to come out. The game makers have to decide how many of the games to make so they are not stuck with too many. Then they have to decide how much to charge for the game - its price. They would need to charge enough for the game to cover the costs of creating the game, advertising the game, and shipping the game to stores. Since they also wish to make a profit on the game, they will also want to figure that into the cost as well. If the price of the game is too high, people may not be able to afford it or decide it is not worth the price and there will be too many or an oversupply. If the price is too low, costs will not be covered and little profit will be made even though the game may sell very well. The company would lose money and may even have to close. The people who invest money in the company would not want to give the company money anymore to make more products because they would not get a good share of the profits.

Usually as prices rise, the supply or amount of a product increases because less people can afford to buy the product and as prices fall, the supply decreases as more people can afford the product.

Value-Added Manure!

1. Determine the value of your animal's manure if it is all composted by calling a local compost dealer and asking what price compost sells for per cubic yard.
2. Knowing that manure shrinks in size by $\frac{1}{2}$ of its volume, calculate how much you can make if you composted all of your animal's manure.



If the product is a truly excellent one, there will probably be high demand. Also, if it is well advertised, more people will know about the product and be apt to want it. If the product is not well advertised or is not a good product, consumers will not want it and the demand will be low and the supply greater.

In the case of the video game, if a better game came on the market later with superior technology, the demand for the current game would probably drop and thus the price would have to drop to sell it.

Other factors that affect sales of an item are if the product is available, how good the customer service is, the appearance of the store, how the items are displayed – even what the parking is like for a store or the colors of the boxes the product is in.

Economic Costs!

What costs are associated with making the two different kinds of compost?
Don't forget the cost of your labor!

Now think about how this concept applies to managing your animal's manure. If you are planning to sell the manure or compost you must apply these economic principles.

Dollar and Cents!

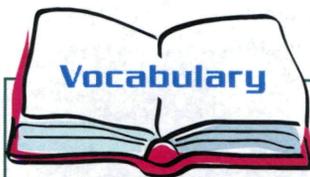
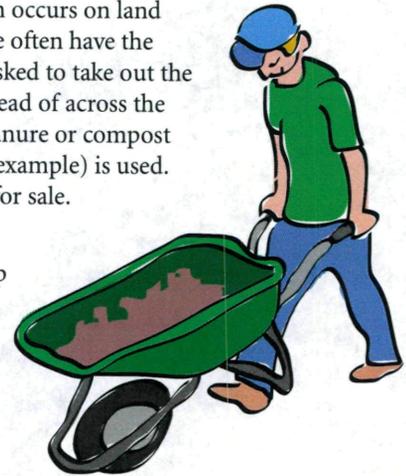
1. If you sold all of your animal's manure to a nursery/landscaping business/grower, what is its value? Take into account the costs you thought of above.
2. If you sold it as compost or vermicompost, what is the value?
3. What opportunities (places) do you have in your community to sell these resources?



Active Manure Management

Have you ever seen a bull's eye on a dart board? Often this pattern occurs on land where manure or compost is applied. Fields closest to the manure source often have the most manure or compost applied to them. For example, when you are asked to take out the trash, wouldn't you rather walk it to the curb in front of your house instead of across the street or down the road to a dumpster? The same concept applies for manure or compost hauling. The fewer miles the material is moved, the less energy (gas, for example) is used. This is an important concept to remember when pricing your compost for sale.

The nutrients added to the soil from manure products will add up quickly if the manure or compost is applied too close to the center of the bull's eye (place of distribution). To make sure there are not excess nutrients in the soils around your house, remember to take soil samples regularly!



- *Consumer* – A person who buys economic goods and services.
- *Demand* – How many consumers desire the goods that are in supply at a certain time.
- *Distribution* – Supplying goods and services to people and retailers so that people's needs are met.
- *Economics* – The study of choice and decision-making in a world with limited resources.
- *Good* – A thing that someone wants.
- *Service* – The performance of any work or duties for another person.
- *Supply* – The amount of goods available at a certain price at any time.

Putting Your Manure to Work / Chapter 7

Manure can be used for lots of things! It can be used for construction, to strengthen and insulate walls. It can be burned to heat or cook with, or it can even be converted to electricity. But the most common use of manure (or composted manure) is to fertilize plants and improve soils. What will you do to put your manure to work?



Manure Is Magnificent!

Is manure just another word for fertilizer? Well, not exactly! Manure is a lot bulkier than fertilizer. In other words, if you need a certain amount of nitrogen or phosphorus, you'll need a lot more manure than fertilizer to meet that need. And, manure and compost release nutrients slowly compared to most fertilizers that dissolve as soon as they get wet, releasing nutrients immediately.



Manure and compost also have benefits as a soil amendment or something that when added, will improve the soil. Fertilizer can't do that! How does manure improve soil? Manure and compost have organic matter in them that, when added to soil, becomes soil humus. Humus is very important in helping soils hold water and nutrients so they don't leach out. And, humus also holds soils together, so they form clods (scientists call them aggregates). Clods are important because they improve soil drainage and the availability of air for plant roots. Humus is also food for worms and other bugs and microbes in soil, and that's important, because those soil organisms have important jobs to do that help plants to grow.

List benefits of how manure and compost can improve soil quality.

- 1.
- 2.
- 3.

Manure Is Messy

You already know that manure can make a mess, but manure can also be challenging to use in a garden or field. There are some special challenges that manure can have, and it's important to be aware of them. Fresh manure can burn plants - it's sometimes called "hot" because the nitrogen is too rich for plants to tolerate. Manure can also make land "salty" or "saline." If that happens, you'll notice a white crust on the soil surface and plants struggling to survive. Manure can be a home for disease-causing organisms called pathogens, and it's important to take care not to spread disease when you spread manure. Weed seeds may also be present in manure depending on what the animal was fed, and manure is often blamed for spreading weed problems around. Composting can kill pathogens and weed seeds, and those are good reasons to consider composting. Other things you can do to prevent these problems are listed in the box called, Getting the Most Out of Your Manure.

Getting Down and Dirty

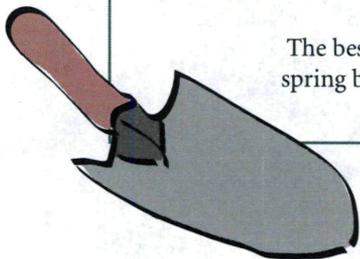
In order to figure out how much manure to apply to your garden or field, it is important to know what's already in the soil and what levels of nutrients are in the manure itself. That way you can match up the manure to the soil! If you apply too much manure, you can reduce plant growth or cause water pollution. This is why soil sampling is so important. A soil doesn't stay the same. It's changing all the time in response to the weather, the plants growing in it, and the things humans do to it. Soil sampling is an important first step before making plans to apply manure.

What do you need to soil sample?

- 1) a plastic bucket
- 2) a shovel, trowel, or soil probe
- 3) a paper bag

When should you soil sample?

The best times to sample are either in the fall after harvest is over or in the spring before you plant.



Getting Down and Dirty (continued)



How do you soil sample?

Dig down about 8 inches deep for vegetables or grains and about 4 inches deep for lawn, hay, or pasture. Be sure to get at least five small samples (about a handful per sample) from a garden or lawn and at least 10 to 15 samples from a field. Walk all around the area where you plan to spread manure while you are sampling so the sample will represent the area well. Mix those samples together in your bucket, and then take one or two handfuls out and put it in the paper bag. Let it air dry for a day or two (don't put it in the oven or microwave!), and then send it to a local soil testing lab. See the list in the back for lab information. Be sure to tell the lab what you plan to grow and ask them to give you a fertilizer recommendation for your soil.

Now go do it! Record the date you sampled and the place it came from below. Make notes if you noticed anything special about the soil.

Location: _____

Date: _____

Notes: _____

While you're in the sampling mood, get a manure sample, too! Five or six samples mixed together ought to do it. Or, you can use the table on the next page to estimate your manure's nutrient contents. All manures are not the same, so using the table is just an estimate. If you do sample the manure, put it in a plastic bag instead of a paper one, and don't dry it before sending it in. Ask the lab in advance if they'd like you to do something special with the sample before you send it in (for example, some labs might suggest freezing the manure).

If Some Manure Is Good, Is More Better?

While it's true that manure is a wonderful soil amendment, too much manure can damage plants and cause water pollution. So, it's important to apply manure at the agronomic rate. The agronomic rate is the amount of manure (or compost) to apply over a certain area that meets the needs of the plants, but doesn't go over that. To figure out what the agronomic rate is, you will need:

- soil sample test results,
- manure sample test results or the table value for your manure type shown below, and
- your long division thinking cap (or a calculator).

First, look on your soil test results for the Nitrogen Fertilizer Recommendation. If it's in pounds per acre, and you are going to apply manure to a lawn or garden, then divide the number by 44 to get pounds per 1,000 square feet. Then divide that number by the amount of available Nitrogen (not total nitrogen!) in the manure (usually reported in pounds per ton). That will give you your agronomic rate in tons per acre or tons per 1,000 square feet. If you are working with square feet, you'll probably want to convert tons to pounds by dividing by 2,000 (since that's how many pounds are in a ton).

Are All Plants Alike?

You don't feed a chicken the same thing you feed a cow, do you? Well, plants have different needs, too! So, they need to be manured differently. Think about the different plants in your yard, farm or a nearby park. Do you think all the plants you see have the same nutrient needs? Kids going through a growth spurt need more food than kids that aren't. Kids who exercise need more food than couch potatoes! The same is true for plants. What characteristics do you think a plant would have that needs a lot of nutrients? Make a list.



- 1.
- 2.
- 3.

Plants with high nutrient needs also need higher manure or compost application rates.

Manure Utilization Action Plan

Read the box titled, 'Getting the Most Out of Your Manure', and decide what you will do to put the manure from your 4-H project animal to good use. Make a list of your plans.

Where will you apply it? _____

When will you apply it? _____

How much will you apply? _____

Which of the recommendations from the 'Getting the Most Out of Your Manure' box will you use?

- 1.
- 2.
- 3.

Don't forget to come back and check your list when you finish the Manure Management Book and see how well you are doing. Are you doing what you said you would do?





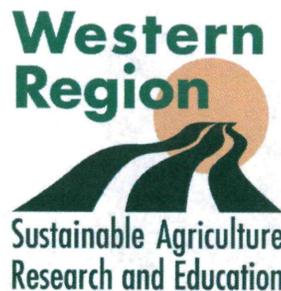
Getting the Most Out of Your Manure (...or Compost!)

How you manage manure will affect your results. Your goal should be to protect human and animal health, improve the soil, grow beautiful plants, and protect water and air quality all at once! Here are some things you can do to protect the environment while putting your animal's manure to good use.

- If possible, till manure into soil to improve soil quality and protect air quality. On lawns, aeration prior to compost application helps work the composted manure into the soil.
- If you are applying manure to a vegetable garden, apply manure at least 120 days before you expect to harvest a crop to prevent disease. Or, compost the manure first to be even safer! Never apply fresh manure to a growing vegetable garden.
- Soil sample, and have your soil tested.
- Be sure to apply manure at the agronomic rate.



- Don't apply manure within 150 feet of a well, pond, creek, lake, or river.
- Don't apply manure on a holiday when your neighbors are having a barbecue.
- Always wash your hands after handling manure!



This project was funded by a grant from the Western Sustainable Agriculture Research and Education Program.