Manure Management Planning for Youth Animal Projects

Activities to help youth understand PA Dept. of Environmental Protection Regulations

Designed for 4-H, FFA, and Ag-Ed Classrooms
Here’s the Scoop:
When you see a manure scoop shovel, you’ll find a bit of background for instructor/adult or teen leader in each chapter.

Reflection box:
Each youth is encouraged to share their take aways from each chapter.

Dig Deeper:
The Dig Deeper boxes in this guide provide thought provoking questions and activity ideas to extend a lesson or concept. The ideas in these boxes make great prompts for independent study, Agriscience Fair projects, or 4-H Presentations and Round-Up Exhibits.

Career Connections:
In each chapter, careers will be introduced to cultivate future work experiences linked to agriculture, conservation, and natural resources.

Chapter 7 is focused on writing a manure management plan. Reach out to a plan writer. Assistance is available from certified manure haulers and brokers, Conservation Districts, Natural Resources Conservation Service (NRCS) staff, or Penn State Extension.

ACKNOWLEDGMENTS

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All animals poop. It’s the hope that after learning about the potential for pollution through unmanaged manure you’ll take action to develop a plan to manage the manure of your animal project(s).

### Chapter 1. THE SCIENCE OF MANURE
  a. Get To Know The Life Cycle Of Manure

### Chapter 2. BEST RECIPE FOR MANURE AND SOIL
  a. The Science of Soil

### Chapter 3. PLANTS UTILIZING NUTRIENTS
  a. Engineering Plant Growth
  b. Plant Plumbing
  c. Getting to the Root of It

### Chapter 4. MANURE STACKING
  a. All That Manure is Stacking Up

### Chapter 5. MAPPING THE LAND
  a. Contour Map Your Hand
  b. Slippery Slopes
  c. Technology Tracks Topography

### Chapter 6. BEING WATER WISE WITH MANURE
  a. Manure and Water Don’t Go Well Together

### Chapter 7. MANURE FOR ALL SEASONS
  a. Four Season Best Management Practice Calendar

### Chapter 8. MANURE MANAGEMENT PLAN IMPLEMENTATION
  a. Writing a Manure Management Plan

### Chapter 9. PUTTING YOUR PLAN INTO ACTION
  a. Act and Sign the Pledge

### GLOSSARY

### RESOURCES
Chapter 1:
THE SCIENCE OF MANURE

All animals poop. Manure, the original fertilizer, is alive with varying levels of nitrogen, phosphorus, and potassium along with pathogens and parasites that can cause diseases.

- Animals in a farm operation are enclosed in pastures, meadows, barnyards, and barn areas. This leads to concentrated areas of manure where piles add up.

- Composting manure is recommended prior to using it as a fertilizer. As temperatures in a compost pile rise, pathogens and fly eggs are killed. The process also reduces the volume of manure by 40-70%. Composting the manure prior to spreading lessens the chance of burning plants. Avoid placing raw manure (uncomposted) directly on soil in a field or garden. The nitrogen and ammonia could burn plant roots or stop seed germination.

- Why don’t wildlife face the same manure management concerns as domestic or farm animals? In wild natural areas, nature takes care of manure as it’s not concentrated to one area. Wild animals are able to deposit waste over a varied area differently than a domestic animal in a stall, barnyard, or pasture.

- One animal’s manure is different from another’s based on the animal type, age, feed, how it's composted or stored, and if any animal bedding is mixed in.

- What does one animal produce? For example, a horse produces a large amount of manure that quickly accumulates. Manure includes solids and liquids. About 12 tons of manure and soiled bedding will be removed annually from each horse stall. Horse manure is about 60% solids and 40% urine. Annual stall waste from one horse would fill a 12’x12’ stall about 6 feet deep. Getting the manure out of the stall is only the beginning. A complete manure management system includes: collection, storage, and utilization.

Manure is filled with nutrients for healthy plant nutrition: Nitrogen (N), Phosphorus (P), and Potassium (K).

<table>
<thead>
<tr>
<th>Manure Nutrient Composition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen – N 7 14 0.064 N Nitrogen</td>
<td>• Occurs in the soil in varying forms and can transform into different forms. Nitrogen can follow many paths in and out of the soil in the Nitrogen cycle. &lt;br&gt;• Climate and the type of soil can change the Nitrogen cycle.</td>
</tr>
<tr>
<td>Phosphorus - P 15 3.971 P Phosphorus</td>
<td>• Plants require a large amount of this mineral that helps transfer energy in a living organism. As rocks are weathered or it rains over rocks, phosphate ions are released into the soil and water. &lt;br&gt;• Plants absorb phosphorus. An animal consumes phosphorus from plants.</td>
</tr>
<tr>
<td>Potassium - K 19 39.968 K Potassium</td>
<td>• Found within plant matter. Its role is to move water and nutrients in the plant. &lt;br&gt;• Helps to maintain vigor in the plant so that it doesn’t wilt or lose water too quickly.</td>
</tr>
</tbody>
</table>
Objective:
Students will recognize changes in manure nutrient composition based on animal type.

Vocabulary to Explore and Enhance this Lesson:
nutrient, Concentrated Animal Operation, animal equivalent unit

Materials:
scrap paper, pencil, calculator (optional)

Time Needed:
30 Minutes

1. Circle your project animal(s) in the chart below.

### Average Nutrient Content of Different Types of Manure

<table>
<thead>
<tr>
<th>Manure Type</th>
<th>Dry Matter</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine, with bedding</td>
<td>18</td>
<td>10</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Swine, no bedding</td>
<td>0</td>
<td>23</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Beef/Dairy Beef, no bedding</td>
<td>12</td>
<td>11</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Dairy, with bedding</td>
<td>&lt;5</td>
<td>28</td>
<td>13</td>
<td>25</td>
</tr>
<tr>
<td>Sheep/Goat, with bedding</td>
<td>25</td>
<td>23</td>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>Poultry, with litter - Layer</td>
<td>41</td>
<td>37</td>
<td>55</td>
<td>31</td>
</tr>
<tr>
<td>Turkey, with litter</td>
<td>60</td>
<td>52</td>
<td>76</td>
<td>42</td>
</tr>
<tr>
<td>Horse, with bedding</td>
<td>20</td>
<td>12</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Rabbit</td>
<td>46</td>
<td>5</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Duck</td>
<td>27</td>
<td>21</td>
<td>26</td>
<td>15</td>
</tr>
<tr>
<td>Alpaca</td>
<td>27</td>
<td>3</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>

*a* Total N is made of Inorganic N and Organic N. *Inorganic N is either nitrate or ammonium, but ammonium is most common form.*

*b* P₂O₅ (phosphorus)

*c* K₂O (potassium)

*Sources: Penn State fact Sheet: Pennsylvania Nutrient Management Act (Act 38): Who is Affected? (Agronomy Facts 54)*

*Having your project animal’s manure tested is the ideal way to determine the nutrient content. You may find that it varies greatly from the chart above. Animal manure tests are available through Penn State Agricultural Analytical Service Lab, or contact your local Penn State Extension office.*

The Pennsylvania Nutrient Management Law (Act 38) states that Concentrated Animal Operations (CAOs) and Concentrated Animal Feeding Operations (CAFO) must develop and maintain a nutrient management plan that is written by a certified and trained specialist. A CAO is defined as an agricultural operation where the number of animals of all livestock on the farm exceeds 2 animal equivalent units (AEUs) per acre on an annualized basis. A CAFO is defined as an agricultural operation where the number of animals exceeds the federal threshold requirements, has total of more than 1,000 AEUs when all animal types are combined, or is a CAO with more than 300 AEUs when all animal types are combined.

An AEU is considered to weigh 1,000 pounds. A property with less than 8 AEU is not a CAO. If animals are not present on a farm for the entire year, the animal units are adjusted for the portion of year that animals are present.
2. Animal Calculator

Follow the equation provided to find out the type of farm operation on which your animal(s) live. Reference step one of the activity.

ANIMAL CALCULATOR:

Formula: 
AEUs for each animal type = \[ \text{average # of animals on a typical day} \times \text{average animal weight (lb)} / 1000 \] \times \left[ \frac{\# \text{ of days animals are on farm per year}}{365} \right].

Continue following the animal calculator for each project animal on a separate sheet of paper.

3. If the farm operation is a CAO or CAFO, a Nutrient Management Plan is needed.

CAO’s have more than 2.0 AEUs/acre.
For more information talk with your 4-H Leader, Ag Teacher, or contact your local Penn State Extension office.

<table>
<thead>
<tr>
<th>ANIMAL TYPE</th>
<th>WEIGHT (LB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holstein Cows</td>
<td>1450</td>
</tr>
<tr>
<td>Holstein Heifers (1-2 Yrs)</td>
<td>1000</td>
</tr>
<tr>
<td>Holstein Calves (0-1 Year)</td>
<td>420</td>
</tr>
<tr>
<td>Holstein Bull</td>
<td>1700</td>
</tr>
<tr>
<td>Nursery Pig</td>
<td>35</td>
</tr>
<tr>
<td>Wean to Finish Pig</td>
<td>143</td>
</tr>
<tr>
<td>Grow Finish Pig</td>
<td>165</td>
</tr>
<tr>
<td>Gestating Sow</td>
<td>450</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANIMAL TYPE</th>
<th>WEIGHT (LB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layer – White Egg 18-75 Week</td>
<td>3.13</td>
</tr>
<tr>
<td>Layer – White Egg 18-90 Week</td>
<td>3.14</td>
</tr>
<tr>
<td>Layer – Brown Egg 18-75 Week</td>
<td>3.85</td>
</tr>
<tr>
<td>Layer – Brown Egg 18-90 Week</td>
<td>3.85</td>
</tr>
<tr>
<td>Pullet, White Egg 0-16 Week</td>
<td>1.38</td>
</tr>
<tr>
<td>Broiler – Large 0-53 Days</td>
<td>3.55</td>
</tr>
<tr>
<td>Broiler – Medium 0-35 Days</td>
<td>2.55</td>
</tr>
<tr>
<td>Roaster Male 0-7 Week</td>
<td>4.70</td>
</tr>
<tr>
<td>Roaster Female 0-9 Week</td>
<td>4.95</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of animals</th>
<th>Average animal weight (pounds)</th>
<th>×</th>
<th>1,000</th>
<th>=</th>
<th># of days animals are on farm per year ÷ 365</th>
<th>×</th>
<th>Total AEUs for each animal.</th>
<th>+</th>
<th>Total Acres that can receive manure</th>
<th>=</th>
<th>Total AEU</th>
</tr>
</thead>
<tbody>
<tr>
<td># of animals</td>
<td>Average animal weight (pounds)</td>
<td>×</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total AEUs for each animal.</td>
<td>+</td>
<td>Total Acres that can receive manure</td>
<td>=</td>
<td>Total AEU</td>
</tr>
</tbody>
</table>

Biology
As a livestock producer, why is it important to calculate nutrient rates of your animals?

Physical Science
Explain how N, P, and K combine to affect plant growth?

Chemistry
Use the internet to look for an Agriculture Periodic Table.
In the chart below list animals, crops, and waterways found on your property.

**Lesson 1: The Science of Manure**

**Your Career Connection: Livestock Nutritionist**

**Livestock Nutritionist Career Description:**

**You would** create and balance rations to ensure that all dietary needs are met for the animals under your direction.

**Livestock Nutritionist Tasks and Skills:**

- Formulate balanced rations based on nutritional and caloric requirements
- Assessment of fatness or thinness, known as body condition scoring
- Investigate nutritional disorders and diet related diseases
- Calculate diet formulation and ration size
- Compile ingredient options for specific livestock diets
- Determine economics of feeding systems
- Carry out animal studies and laboratory trials
- Ensure quality control and performance of feeds
- Investigating nutritional disorders

**Livestock Nutritionist Possible Career Pathways:**

- Livestock farm manager
- Feed plant manager
- Pet and livestock feed company research and sales
- Federal and state government offices
- Zoo animal caretaker

*Source: https://www.thebalance.com/animal-nutritionist-125606*
Manure is defined as decaying animal waste. For hundreds of years animal manure has been added to the soil as a way of building and improving the quality and value of soil. The organic matter in manure adds an element to the soil that plants will absorb. It increases the moisture in the soil and can reduce soil loss or erosion and runoff. If you’ve identified any current erosion or runoff issues on your farm, a manure management plant will help you document issues and help address future issues.

There are three types of soil particles or components.

**Clay** particles are the smallest type almost like dust. When rain falls on a clay field the smooth particles tend to stick together. As water evaporates, the clay particles dry as they lay and if stuck together can be very hard to break apart. In comparing the three types to sport balls, clay is like a golf ball in size.

**Silt** particles are larger in size compared to clay. These particles can stick together in rain and then return to their original shape as they dry. Silt particles would compare to a nerf ball with a sponge effect and are larger than a golf ball.

**Sand** particles are the largest in size comparing the three types of soil. Sand particles have edges that make it difficult to stick together when wet and remain in their original state. They dry easily with space around each particle. Sand particles would compare to a basketball when thinking of the three soil particle sizes.

Below are three pictures of soils types. Notice the color changes and particle size.
The Science of Soil

Objective:
Students will investigate 3 soil types to recognize how sand, silt, and clay soil particles absorb water and manure/nutrients.

Vocabulary to Explore and Enhance this Lesson:
percolation, Organic, inorganic, texture

Materials:
Plastic graduated test tubes, soil sample, water, ruler

Time Needed:
30 Minutes

Identifying Your Soil Type

The role of soils in supporting the untold number of organisms that reside both above and below the surface is central to the development and support of ecosystems. Soils are natural resources that influence the quality and availability of many other natural resources, such as ground water, forest resources, and vegetative food for wildlife.

Knowing what kind of soil is on your property can tell you how fast water can soak into the ground known as percolation, and how long it will be stored there. This is important for helping to plan for your lawn, gardens, and for when you are trying to reduce the amount of water that runs off of your property. It is also key to planning how and where you store and use manure on the farm and manage your livestock pasture and barnyard areas.

Soil is made up of three different types of inorganic particles; sand, silt, and clay as well as organic matter (like dead plant material). This is referred to as the textural classifications of soil. Sand, silt, and clay are identified by the size of the particle. Sand is the largest and clay is the smallest (silt falls right in the middle). Sand allows a lot of water to pass through it because there is lots of air in between the pore spaces. Clay is so small that almost no air or water passes through it.

Think of how you can mold clay into a bowl or mug that easily holds water in place and how sand falls apart when squeezed.

Depending on the amount of each type of particle, soil can be classified in lots of different ways. We use a “Soil Triangle” to help us with this.
1. **Get A Top Soil Sample:**
   Dig a small sample of soil - about 1 cup from below the grass line; try not to include any plant material. The best tool to use for this is a soil probe or soil auger, but a hand trowel will work too – just try to collect your soil from the center of the sample on the blade. Ideally you would collect five or more samples from around the entire area you want to test, and you would mix them together to create a composite sample.

2. **Conduct the Texture Test of your soil.**
   Take a small handful of the soil and feel it between your fingers and in the palm of your hand. If the soil is very dry, add a few drops of water so that you can work with it better. The texture of the soil is one way to help identify what type of soil you have.

   **SAND:** Does the soil feel gritty?
   If it does, you have at least some sand particles in your soil. If you have access to some sand from a sandbox, playground, or even an aquarium – you could try exploring what just sand feels like. With 100% sand, you will also notice that you can't form the soil into a ball at all.

   **SILT:** When you squeeze your soil between your fingers, does it feel smooth and slippery?
   Silt is often described as having a slippery or soapy feel when wet. Silt will form a loose ball that doesn't hold together very well. If you run the soil between your fingers and try to form a ribbon, silt type soils will generally break apart before the ribbon reaches two inches in length.

   **CLAY:** When you squeeze the soil together, does it feel sticky. Can you form a ball that doesn't easily fall apart?
   This is a sign that there is clay in your soil. Clay in your soil is very similar to modeling clay you might use for art projects. If you have some modeling clay, try comparing how it feels to the way your soil feels.

3. **JAR TEST : Determining the % of Sand Silt and Clay of Your Soil**
   3. Add soil to a plastic graduated test tube or a tall, narrow jar that you can cover and shake. A canning jar will work too. Fill it until it's about 2/3 full of soil.
   4. Top off the tube or jar with water, leaving just a little air space. Close the cap tightly.
   5. Shake vigorously for several minutes and then allow the tube to settle in the upright position. Sand will settle in the first few minutes. Silt will take several hours. Clay may take overnight to completely clear from the water, so you might have to complete this activity at another time, just leave the tube undisturbed.
   6. Observe the settled tube and look to see if you can identify distinct layers.
   7. The largest particles settle to the bottom, the smallest stay at the top (ignore any organic material that may be floating still or laying on top of the soil layers).
   8. If you have all three layers, **that is the recipe for the ideal mixture of sand, silt and clay** for plant growth. If not you will have to try to determine if you are seeing sand, silt or clay layers. Clay is like a very fine powder, silt particles can be distinguished using a hand lens to magnify them, sand is just how you would think it would look with particles generally easy to see with the naked eye.
   9. Using the measurements on the side of the tube, or a ruler held against the side of your jar, measure the height of each layer of soil, and the total height of all three soil layers together.
   10. Determine the percentage of each type of soil particle by dividing each layer by the total height of all of the soil.

   **Test Results:** Based on your observations, what types of soil particles do you think are found in your soil?
Sand Silt & Clay Jar Test Calculations:

Total Height is 29mL or mm

Total Parts

Clay = 9mL or mm
9 parts clay / 29 total parts = 31% clay

Silt = 9mL or mm
9 parts silt / 29 total parts = 31% silt

Sand = 11mL or mm
11 parts sand / 29 total parts = 38% sand

Your Soil Results:

_________ % Clay

_________ % Silt

_________ % Sand

11. Look back to the soil triangle and find the % of sand in your sample along the bottom axis. Use a ruler to draw a line through the triangle, towards the clay axis, following the same angle as the dotted lines (which are parallel to the silt side of the 29mL triangle).

12. Now find your percent of clay along the left axis. Draw a second line through the triangle towards the silt axis, parallel to the bottom of the triangle. The point where the two lines intersect tells you what type of soil you have. If you were to draw a third line from the silt percentage, it should intersect in the same place. In the example, the result would be Clay Loam

My Soil Type Name Is: ____________________________

What does that mean for my manure management planning?

The table below describes how the different types of soil affect the way nutrients, air, and water move above ground and underground.

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>Nutrient-holding capacity</th>
<th>Water-infiltration capacity</th>
<th>Water-holding capacity</th>
<th>Aeration</th>
<th>Workability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Silt</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Sand</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Loam</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
</tbody>
</table>
Based on your soil type experiments, answer the following questions:

1. How well does your soil allow water to infiltrate into the ground?

2. How well does your soil type hold on to nutrients?

3. How well does your soil hold water?

4. Soils that do not hold water well get saturated much faster. What do you think happens to all of the excess water and nutrients once the soil is saturated?

Information Sources:
The Penn State Agronomy Guide
USDA-NRCS Soil Education Website

Consider the image above, what type of soil is available to your animal(s)? Does plant life make a difference to your soil type?
| **Biology** | If water can’t infiltrate into the ground, where does it go? |
| **Physical Science** | Find a General Soil Map of Pennsylvania using a website or app. Different types of soil are found throughout Pennsylvania and given names. List the soil type at your location. |
| **Chemistry** | If soil can’t hold on to the nutrients, what happens to the nutrients in manure you spread? |

**Lesson 2: Properties of Soil**

**Your Career Connection: Soil Scientist**

**Soil Scientist Career Description:**

**You would** conduct research in production, yield, and management of crops and agricultural plants, their growth in soils, and control of pests. Study the chemical, physical, biological, and mineralogical composition of soils as they relate to plant or crop growth. Classify soils and investigate best management practices for soil conservation and crop productivity.

**Soil Scientist Tasks and Skills:**

- Investigate soil problems to determine sources and effects.
- Consult with engineers or other technical personnel about the effects of soil problems and possible solutions to these problems.
- Conduct experiments investigating how soil forms, changes, or interacts with land-based ecosystems or living organisms.
- Develop methods of conserving or managing soil that can be applied by farmers.
- Investigate responses of soils to specific best management practices to determine the use capabilities of soils and the effects of soil and crop productivity.
- Provide advice regarding the development of regulatory standards for soil conservation.

**Soil Scientist Possible Career Pathways:**

- Wetland and Watershed technician
- Hydrologist
- Environmental technician
- State soil and water quality specialist
- Soil Conservationist
- Land Grant College Agricultural Educator
- Landscaping Architecture, Plant Installer, Turf Technician
- Production Agriculturist
- Soil scientist, mapping and interpretation

Source: https://www.onetonline.org/link/summary/19-1013.00
Plants absorb nutrients from the soil using their root system. Manure is an enhancement to soil composition. Adding the proper amount of manure to the soil increases organic matter, the capacity for the soil to hold water, microbial activity in the soil, and soil aeration. Animal waste as manure is more economical for growing plants than purchasing chemical fertilizers.

Objective:
Youth will examine plant growth while using changing soil nutrients available for plants and see how water travels in a plant.

Vocabulary to Explore and Enhance this Lesson:
Microbial, Economical

Materials:
Magnifying glass, 1 tsp. of radish seeds, clean sponge, saucer of water, 1 celery stalk, ½ cup of water, food coloring, paring knife, clear glass jar

Time Needed:
30 minutes set up, observation over 2 days

Activity
Engineering Plant Growth

1. Set sponge in the saucer of water.
2. Sprinkle 1 teaspoon of radish seeds on top of the sponge.
3. Keep adding water to the saucer as the sponge absorbs water. When the sponge is filled with water stop adding water.
4. In 24 hours you should see fuzzy roots appear.
5. With a magnifying glass, look closely and find the root hairs of each radish.
6. Estimate how many particles of soil can cling to one root hair.

Plant Plumbing

1. In a clear glass vessel add food coloring to ½ cup of water.
2. Cut 1 inch from the bottom of a stalk of celery.
3. Place the cut end of the stalk in water.
4. After 2 hours observe experiment for changes to celery.
5. Cut a diagonal slice of stalk and look closely at the water-carrying tubes.
6. Draw what you see in the celery stalk.
7. Use a crayon or colored pencil to show where the food coloring is found in the celery stalk.
Activity

Getting to the Root of It

Objective:
In this activity, youth will have the opportunity to explore how plant roots interact with the soil as they grow. Roots play an essential role of absorbing water and nutrients from the soil, so understanding how roots grow will increase your ability to understand how plants use nutrients.

Vocabulary to Explore and Enhance this Lesson:
Taproot, Fibrous Roots, Primary Root

Materials:
A clean wide-mouthed glass jar (an old pickle jar works), potting soil, a handful of small rocks, seeds (bean and corn work well – you can try others too), black or dark colored construction paper, tape, a piece of plastic wrap

Time Needed:
30 minutes

Leading Question:
How do roots look when they are growing beneath the surface among the soil particles?

1. Place your small rocks in the bottom of the jar in a single layer. These rocks will help with drainage since our glass jar doesn’t have any holes in the bottom.

2. Fill a clean glass jar about 2/3’s full with potting soil.

3. Gently water the soil so that water makes it all the way to the rocks, but don’t flood the jar.

4. Plant a circle of seeds in your jar near the edge. Depending on the size of your jar and the type of seeds you selected, you may only plant 3-4 seeds or you may plant many. For this experiment the space between the seeds should be about three times the size of the seed. The seeds should be planted to a depth about twice the size of the seed.

5. Using black or dark colored construction paper and a few pieces of tape, create a sleeve that will wrap completely around your jar and cover all of the soil. You want the underground portion of the jar to be in the dark. Cut the paper so that the height of your sleeve doesn’t extend above the top of the jar. Place construction paper around the outside of the jar.

6. Cover the jar with some clear plastic wrap and place in a sunny window.

7. Wait patiently.

8. Your seeds may take up to two weeks to start growing. You may need to add more water during that time, but only if the soil appears to be drying out.

9. Once you see new plants emerging from the seeds, remove the plastic wrap so they can get the air they need. Continue to monitor the soil moisture and water as needed.

10. Slide your black paper sleeve off of the jar and look for the roots. The very first root to emerge is called the Primary Root. Smaller roots will start to appear growing off of the primary root.

11. Cover the jar again with your sleeve (roots grow away from the sunlight, so if you don’t cover the jar, your roots will start to grow in towards the center and you won’t be able to see them anymore.

12. Check in on your roots every few days to see how they are changing.

13. If you have a hand lens, try using it to look closely at the fine roots growing in your jar.
14. What direction are your roots growing? ____________________________________________________________

15. When the roots push through the soil and create channels to grow, what else might be able to travel in those channels? ____________________________________________________________

16. What factors might be stimulating the roots to grow in the direction that they are? ________________________

Create a science experiment to compare how roots grow under different fertilizer conditions. You could grow separate jars for each type of fertilizer from each animal species you care for. You could compare fertilizers with different nutrient content (high nitrogen versus high potassium, etc.). Try comparing it to a jar with no fertilizer at all. Compare compost to chemically produced fertilizer.

<table>
<thead>
<tr>
<th>Biology</th>
<th>How do nutrients impact the growth of roots?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>How do roots benefit soil? How could soil texture effect root compaction?</td>
</tr>
<tr>
<td>Chemistry</td>
<td>What is the reaction in plant growth when fertilizer is applied?</td>
</tr>
</tbody>
</table>
Lesson 3: Plants Utilizing Nutrients

Your Career Connection: Seed Geneticist

**Seed Geneticist Career Description:**

*You would* be responsible for the research of seed characteristics and strive to improve the seed characteristics that are of the best quality for the plant. They work towards finding the best possible trait that is desirable for yield, maturity, quality, size, and can be resistant to drought, frost, and pests in certain plants.

**Seed Geneticist Tasks and Skills:**

Plant breeders have extensive knowledge in:

- molecular technologies
- statistics
- plant growth and physiology
- genetics

**Seed Geneticist Possible Career Pathways:**

- **Crop consultant:** Visit farms to diagnose problems and make recommendations. They work for private companies that give advice to farmers.
- **Crop scout:** Visit farms to collect crop quality and pest data that farmers use to make the best economical and environmental decisions.
- **Plant breeder:** Develop new varieties that will increase yield, require less inputs and tolerate more pests. Breeders normally possess a Ph.D.
- **Sales representative or sales manager:** Work for a company that sells something in the crop science industry like seed, fertilizer, pesticides, equipment, etc. Visit farms, develop relationships with farmers, and attend conferences and field days.
- **Researcher:** A career as a researcher usually requires a PhD. Opportunities to develop the next variety, fertilizer, or pest control product to help feed the world. Most employers are research universities or large agriculture companies.
- **Educator:** Teach the next generation of crop scientists at the high school or college level.


Manure spreading practices that cause runoff can negatively impact streams or a drinking water source. Proper manure management keeps agriculture sustainable to communities and non-agriculture neighbors. A Manure Management Plan will help you apply or store manure in the best way.

Proper field application demands equipment such as a tractor and spreader so the manure is applied in a thin layer over the soil. Weekly spreading in the summer will disrupt fly breeding and egg development cycles. It is important to know how much manure is actually being applied. If using a manure spreader, ensure that the spreader has been calibrated.

Another manure handling option is to contract with a certified hauler who will remove the waste from the stable/barn. A manure hauler can use the manure in a commercial composting operation and if the manure is removed from your property it becomes the responsibility of the hauler.

A less formal “contract” disposal is to interest neighbors in free garden organic material. Empty feed sacks filled with horse manure are a useful package for manure distribution. The neighbor who uses manure from your property needs a Manure Management Plan.

Remember, a Manure Management Plan is needed for anyone with animals generating manure or utilizing manure from animals. This written plan shows what the farm is doing with the manure. Recordkeeping is required, documenting manure utilization.

Putting manure in a pile somewhere, hoping it will just go away is NOT the same as a properly composted manure pile.

Activity

All That Manure is Stacking Up

Objective:
In this activity, youth will identify areas around the farmstead where it would be unwise to stack manure and then design a solution for stacking manure on the demonstration farm. Youth will gain an understanding for how an improperly located or constructed manure stacking area could have an impact on the environment and on their family's health.

Vocabulary to Explore and Enhance this Lesson:
Best Management Practice (BMP), Topography, Runoff, Leaching

Materials:
A laminated copy of the demonstration farm map, dry erase or overhead markers (could also print paper copies of the map and use colored pencils/markers)

Time Needed:
30 minutes

Leading Question:
Where could you stack your manure if this was your family's farm?
1. How far should your manure stack be from your wellhead? (100ft)
   - Draw a 100 foot radius circle around your well, and then draw cross hatches in the circle to indicate that your manure stack cannot go there.

2. Runoff from a manure stack cannot directly reach any environmentally sensitive areas, like waterways. What waterways do you see on this farm? (Spring Creek, pond, drainage swale)
   - Outline the waterways you see on the farm map to highlight them.

3. Manure should be stacked on flat areas at higher elevations and away from steep slopes.
   - Color in any steep slopes you see on the farm map
   - What kind of map could you use to identify steep slopes on your own farm? (older youth may want to explore the topographic map feature on online or printed maps)

4. Be a good neighbor and stack your manure away from your neighbor’s and your property lines.
   - Trace the property boundary’s on your farm map to highlight it

Take a look at your map; do you see any places where you might place a manure stacking pad that would be away from all of the areas you just marked as “bad” places for your manure?
   - Place a star on the map where you would like to build your manure stacking pad.
   - Discuss with your leader/advisor why you chose that location.

- Gully
- Proper Waterway
1. Stored manure on the farmstead must be stacked on an improved surface, like a concrete pad. Is there any place on your farm where you wouldn’t want to construct a concrete pad?

2. Manure can be left on pasture, and not stacked if “you maintain an average vegetation height of at least 3 inches throughout the growing season.” What could you do to keep the pasture forage from being too short or to prevent bare soil/mud spots from forming in your pastures? Older youth might want to explore Best Management Practices (BMPs) for pasture management and other manure management issues.

3. You must remove manure from barnyards and exercise lots throughout the year because they are considered animal concentration areas, not pastures. Why do you think these areas of the farm are more likely to create polluted runoff water than a properly managed pasture?

4. A manure stacking pad that is completely covered and allows no rain or other water to pass through would properly manage all of the potentially polluted runoff. You may be able to better fit your manure storage into your farm when space is limited if it is constructed this way. What are some ways that you could cover your manure storage area? How might you completely limit water from passing through your manure storage area? Investigate a conservation practice to safely divert water away from a manure storage area.

5. When your manure pile starts getting too big, what are some options you have to get rid of or use your manure? There are rules and regulations about how you apply manure, where can you find those? If someone takes your manure away from your farm, what rules and regulations do they have to follow?
Animal manure can get a bad rap. Develop a 3-5 minute impromptu presentation to non-agriculture neighbors explaining the manure storage plan used where your animals live. Include 3-5 facts you’ve learned from this publication.

<table>
<thead>
<tr>
<th>Biology</th>
<th>How can excess manure runoff be avoided?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>What can happen to plants if the manure spread is too concentrated?</td>
</tr>
<tr>
<td>Chemistry</td>
<td>What is the reaction in plant growth when fertilizer is applied?</td>
</tr>
</tbody>
</table>

Lesson 4: Plants Utilize Nutrients

Your Career Connection: Certified Manure Hauler

**Certified Manure Hauler Career Description:**

*You would* transport manure generated by agricultural livestock operations and land apply it in a safe manner with a commercial manure haulers certification. Potentially working as a businessperson, laborer, manager, planner, and financier. Develop Manure Management Plans for client farms.

**Certified Manure Hauler Tasks and Skills:**

- liquid manure pumping
- solid manure spreading
- manure composting and methane digesting
- conducting inventory tracking of manure
- making sure that nutrient plans meet regulatory requirements
- diagnose the nutrients that crops need
- determine the effectiveness of a nutrient
- go into the field to examine soil quality and make recommendations on staying in compliance with environmental regulations and laws.

**Certified Manure Hauler Possible Career Pathways:**

- Certified Manure Hauler
- Equipment Service and Sales
- Equipment Designer

Chapter 5: MAPPING THE LAND

Topography of the land illustrates shapes and features of the earth. Land topography will influence soils, plants, and water infiltration. Knowing the structure of a property can help you recognize environmentally sensitive areas, water flow, and the best locations for planting crops or grazing animals.

Activity

Contour Map Your Hand

For this exercise, you will need a washable (nonpermanent) black or brown marker. Make a fist with your nonwriting hand and place it on a table with your knuckles up (palm side down). Draw a contour line around the top of your knuckles as if they were mountain peaks. These first contour lines will look like circles. Then continue drawing contour lines down your fist until you reach your second (finger) knuckles and your wrist. These contour lines will go all the way around your fist and your knuckle mountain peaks. Next, open your hand up and lay it flat on the table. Now you are looking at a contour map. If you make a fist again, you are looking at the “actual” landforms. Show your contour map to your teacher or group leader and explain what it represents.

1. When you laid your hand flat, were lines were close together at any place? Describe how those parts of your hand looked when your hand was in a fist.

2. Where was the highest point on your hand when it was in a fist?

3. If precipitation fell on the higher elevation parts of your hand, which way would it runoff?
3. What did the contour line drawn there look like?

4. What kind of land formations do you think are similar to the shapes of your hand?

---

**Activity**

Slippery Slopes – Taking Math Outside

**Objective:**
In this activity, youth will have the opportunity to take lessons they have learned in math class about rise over run and apply them to real life. They will learn how to determine the slope of the land using simple tools that they can recreate at home. This is a valuable skill that can be applied to manure management planning on the farm.

**Vocabulary to Explore and Enhance this Lesson:**
Slope, Topography, Erosion, Runoff

**Materials:**
2 yard sticks, a piece of string about fifteen feet long, a line level

**Time Needed:**
30 minutes

**Pre-Activity - Preparing the Materials:**
1. You will be using the string to measure a distance of ten feet, but you will need excess string to tie the ends to the two yardsticks. Measure out about fifteen feet of string. Use a permanent marker or piece of sturdy tape to mark a starting point on the string about two feet from one of the ends. Measure ten feet from that starting point and make a second mark on the string to establish the ten foot measurement.

2. Slide the line-level onto the string.
Leading Question:

How does knowing the slope of the land help us make the best decisions when storing and applying manure?

1. Find a spot outside where you have at least ten feet of open land on a hill. You might want to repeat this activity in several spots with hills of varying steepness.

2. Have one person hold a yardstick straight up and down at a point near the top of the hill.

3. Tie the string around the yard stick so that one of the ten-foot marks is touching the stick.

4. Slide the string all the way to the bottom of the yardstick, so that it is touching the ground.

5. Gently stretch the string out, heading downhill, until the string is taut.

6. Have a second person hold a second yardstick straight up and down at the point where the second ten-foot mark is on the string. Make sure the “zero” mark is the end on the ground.

7. Tie the string around the second yardstick, keeping the second mark as close to the stick as possible.

8. Slide the knot up and down the second yard stick until the string is level. Use the line level to help determine where the knot should go. You may need to slide the level out to the center of the string, make sure the string stays taught.

9. Record the height of the knot on the second yardstick in inches
   - The measurement you just recorded is the “Rise” of the land from the bottom stick to the top stick.

10. In math class, you may have learned that slope is calculated as Rise over Run or Rise/Run. In our case, the “Run” is the length of the string, or ten feet. However, we calculated “Rise” in inches, so we need to convert the “Run” to inches as well.

   How many inches are in 10 feet?

11. Calculate the slope.

   \[
   \text{Rise} \quad \text{inches} \div \text{Run} \quad \text{inches} = \quad x \quad 100 = \quad \%
   \]

Find out what the recommended slopes are for grading various land uses (trails, roads, lawns, playing fields, etc.) Why do each of these land uses have different recommendations for slope? Are any of them related to the movement of water or the control of pollution? Pennsylvania’s manure management guidance refers to percent slopes. Can you find it? What is the reason for restricting activities to certain slopes in that manual?
**Activity**

**Using Google Earth to Map Your Farm**

**Objective:**
In this activity, youth will navigate to their home or farm using Google Earth, identify features related to manure management planning, and understand the basics of using digital geospatial data to map their farm property for their manure plan.

**Vocabulary to Explore and Enhance this Lesson:**
Geographic Information System (GIS), Geospatial Data

**Materials:**
Any computer or device with an Internet connection and Google Earth 4.3 or higher installed.

**Time Needed:**
30 minutes

**Pre-Activity - Preparing the Materials:**
1. You may need to unblock Google Earth on your device(s), if needed talk to your IT personnel.
2. Go to the following website to familiarize yourself with the content - http://www.google.com/earth/learn/

**Leading Question:**
How can we utilize technology to make the best possible map of our farms and how might that improve our manure management planning?

**Classroom Instructions:**
1. When you first open Google Earth on your computer or device, the entire Earth (as a globe) will be shown by default.
2. Close any “Start-Up-Tips” and start to explore and familiarize yourself with the Google Earth. The main menu can be found on the top left on your screen.
3. There are a few settings we want to adjust to make our activity work best.
   - **Borders & Labels – Should be showing (checked)**
     (changing this setting will add country, state, and county borders to the map)
     - To show Borders and Labels, find the ‘Layers’ sidebar on the lower left hand side of the screen and click the box to the left of Borders and Labels to add a check mark (Figure 1).
   - **Terrain – Should be showing (checked)**
     (when you turn on terrain, the hills and valleys will appear on your map)
     - To show Terrain, Click the box to the left of Terrain in the Layers sidebar to add a check mark.
   - **3D View - Terrain – Elevation Exaggeration.** Set to the maximum level of “3” (changing this setting makes the hills and valleys more obvious on your map).
     - You can find this in the Tools menu, under Options on Windows. It is found by selecting Preferences on Mac devices. Be sure to click “Apply.” (Figure 2)

![Figure 1. The ‘Borders and Labels’ option found in the ‘Layers’ sidebar on the lower left side of the screen.](image1)

![Figure 2. Google Earth Options ‘3D View’ tab with ‘Terrain’ Elevation Exaggeration circled in red.](image2)
4. Creating and editing a **Placemark** of your house or farm.
Use the navigation tools on the upper right hand side on the screen to navigate to your house or farm. These tools will allow you to zoom in and out of a location, change your cardinal orientation within a location, and pan across the map.

Two strategies to navigate to your home or farm:
A. Use the **pan tool** to scroll and move on the Earth while zooming in and centering on your home.
B. Enter your address in the **search** bar on the upper left hand side of the screen.

Zoom in by double clicking the image or pulling the zoom slider up until the image becomes fuzzy.

**Hint:** If you notice that features such as new buildings, houses, or roads are missing on Google Earth, then the images are older than the new features. Mapping systems like Google Earth require constant updates. If the images are not updated frequently, the data can become out of date, especially in areas that are experiencing rapid changes in land cover (“development”, in the case of new buildings, houses, and roads).

5. Once you locate your house or farm, click on the **Placemark** icon, the yellow pushpin icon along the top of your screen (Figure 4.)

6. A window called **New Placemark** will open. Drag the yellow pin (placemark) over your house. Now change the name to ‘My House’. Click the **OK** button to close the ‘New Placemark’ box (Figure 5).

**Tip:** You can add a description of your house in the Description box. You can also change the color and type of Placemark, as well as the View and Altitude of the Placemark.

You can also read and edit the information in the Placemark box at any time. To do so, using the mouse, right-click on the Placemark and draw down to ‘Properties’, then left-click. This will open the Placemark box, allowing editing of the Placemark’s attributes.

**Where is my home located?**

One way to answer is this question is to provide an address (for example, 123 Main St. Newtown, USA 54321). Another is to provide the geographic coordinates of your house, or the latitude and longitude.

7. Find and record the Latitude and Longitude of your house by right-clicking on your pin and selecting properties.

Latitude: ____________

Longitude: ____________
What is the topography of your home?

8. Use the navigation tools to change the angle of your perspective from looking straight down, to looking sideways, called an oblique perspective. You’ll find the arrows inside the topo navigation circle helpful for this.

Your home or farm’s topography is the description of the features of the land at that location. What is the most descriptive term that describes the topography of the land at your home? (flat, hilly, rolling, steep, gentle slopes, etc.)

9. You can use your Google Earth map as the basis for your farm map that is required in your manure management plan. Center your farm and zoom in so that it fills the screen image. Print your map using the File menu option. Use black and white ink so that you can use colors to draw on your map later.

10. Your manure management plan requires you to identify certain features on your farm map. We will label a couple of those now for practice, but be sure to follow the plan instructions and identify all the required features when you create your final version.

A. Using colored pens/ pencils and a highlighter, identify the location of the following features on the print copy of your property and your neighbor’s properties if applicable.

a. Manure storage – where do you stack and store manure on your farm
b. Water features -
   i. Wells – where is the wellhead(s) for your family’s drinking water? For your livestock drinking water?
   ii. Streams and Creeks
   iii. Ponds
   iv. Sinkholes
c. Animal Concentration Areas – (barnyard areas and pastures that don’t have year round, healthy vegetation in them)
d. Cropland and other areas available for manure application
e. Steep slopes – where are the biggest hills at your home/farm?

Google Earth has built in tools to allow you to measure distance and changes in elevation between points. Learn how to draw a path on your map and view the Elevation Profile to see these features on your farm. Think about how this might impact the decisions you make about where to store or spread your manure? Is your wellhead (your family’s drinking water) downhill from your manure storage area? Are you spreading manure directly uphill from a pond or stream? Where is that manure going to end up when it rains?

A more advanced option for creating high-quality maps for your manure management plan and other nutrient management plans is PAOneStop. This free tool combines mapping with known soil data to provide more valuable information for your plan. You can access PAOneStop at www.paonestop.org
Lesson 5: Mapping The Land

Your Career Connection: Geographic Information Systems Precision Agriculture

**GIS Precision Ag Technician Career Description:**

*You would* assist scientists, technologists, or related professionals in building, maintaining, modifying, or using geographic information systems (GIS) databases. Design and analyze graphic representations of Geographic Information Systems (GIS) data, using maps, GIS software and hardware applications.

**GIS Precision Ag Technician Tasks and Skills:**

- Enter data into Geographic Information Systems (GIS) databases, using techniques such as coordinate geometry, keyboard entry of tabular data, manual digitizing of maps, or scanning or automatic conversion to vectors.
- Perform geospatial data building, modeling, or analysis, using advanced spatial analysis, data manipulation, or cartography software.
- Interpret aerial photographs.
- Analyze Geographic Information Systems (GIS) data for use in urban planning applications that promote better land use or reduce environmental impacts of development.

**GIS Precision Ag Technician Possible Career Pathways:**

- Agricultural Equipment Sales and Service
- Agriculture Equipment Operator
- Agronomy Sales and Service
- Custom Crop Applicator
- Architects
- Engineering Technicians
- Foresters and Forestry Technicians
- Geographic Specialists
- Meteorologists
- Urban and Regional Planners

Source: https://www.onetonline.org/link/summary/15-1199.05
https://www.onetonline.org/link/summary/19-4099.02
Chapter 6: BEING WATER WISE WITH MANURE

Water and manure don’t mix well together. It’s best to avoid manure contacting drinking water, recreational water, and water that wildlife depends upon.

Most Pennsylvanians use groundwater sources for drinking water. Leachate from excess nitrogen found in manure stacked improperly, or over applied can enter groundwater and lead to human health problems. A neighboring well could be contaminated by leaching nitrates near well casings.

Surface water includes those bodies of water we can see such as lakes, ponds, wetlands, and streams. Manure runoff to these water sources can carry runoff on to other waterbodies. An animal that can direct deposit manure into these water sources makes an even bigger impact. It’s best to utilize streambank fencing and plant a riparian buffer. Both of these conservation practices improve water quality and reduce soil loss and manure runoff.

Activity Manure and Water Don’t Go Well Together

Objective:
In this activity, explore how rain water carries pollutants into our waterways and into our groundwater. See how manure can become a water pollutant, and can even contaminate drinking water, if it’s not managed properly on the farm.

Vocabulary to Explore and Enhance this Lesson:
Runoff, Non-point Source Pollution, Infiltration

Materials:
3 cup Rectangular Plastic Food Storage Container (sometimes called Soup/Salad size), a 6 x 3.5 inch cellulose sponge, a drinking straw, spray bottle full of water, red color powdered drink mix (preferably the premixed with sugar variety, not the concentrated packets), spoon, paper towels

Time Needed:
30 minutes

Pre-Activity - Preparing the Materials:
1. The sponge should fit snug inside the plastic container so that it hovers above the bottom of the container and leaves a 1-2 inch deep air space below it.
2. Remove the sponge from the container and cut one corner off of the sponge to create an open area, exposing the space below the sponge.
3. On the opposite end of the sponge, use scissors to carefully cut a hole big enough for the straw to pass through loosely. This should be done by an adult or responsible older youth.
4. Cut a piece of the straw that is long enough to reach from the bottom of the container, through the sponge, and stick out above the sponge half an inch.
5. If reusing your sponge that was previously prepared, soak the sponge and then wring it out to return it to soft and pliable condition.
6. Return the sponge to the plastic container, fitting it snug hovering above the bottom of the container and place the straw through the hole. (see diagram)
Leading Question: What happens to manure when it rains?

1. In this activity, the red drink mix will represent animal manure. The sponge represents the ground on your farm. The straw represents your well that was drilled to pump your family’s drinking water.

2. Pour water into the container through the cut open corner of the sponge until it fills up to the bottom edge of the sponge. You should see water floating at the surface of the opening. The sponge might soak up a little of your water and you may need to top it off. It’s okay if the sponge gets saturated.

3. The water under the sponge represents ground water. It is actually filling in little tiny spaces between rocks and soil in the ground. The water at the corner opening represents where the ground water joins with surface water. Surface water includes things like lakes, rivers, and streams. For our activity it will be a pond at your farm where you go fishing and swimming.

4. Place a spoonful of “manure” (drink mix) on the sponge next to the pond.

5. Use the spray bottle to make it rain on the farm.
   a. What happens to the manure?
   b. Would you still want to go swimming in the pond?
   c. What do you think might happen to the fish and other wildlife in that pond?

6. Now place a spoonful of manure next to your well and make it rain on the farm again
   a. Where does the manure go when it rains this time?
   b. Do you think your well water is still safe to use?
   c. What types of health risks might your family face if manure contaminates your well?

7. Empty your container at the sink and rinse it out. Rinse out your sponge too. Then reset your farm and refill it with water.

8. Now place a spoonful of manure at the point furthest from your well and the pond – towards the middle of the sponge.

9. Make it rain again on the farm and watch what happens.
   a. Do you see any manure in the pond or in the groundwater?
   b. How does the soil help prevent the manure from reaching the water?
      i. Infiltration is a part of the water cycle that older youth can explore.
   c. Which of the three locations seems like the best place to stack manure on this farm?

Reflection Questions:

1. When it rains on your farm, what direction does the water flow? Is your farm perfectly flat? What is at the bottom of any hills on your farm? Could manure end up washing into those areas? Older youth should explore the term runoff.

2. Do you have a pond on your farm? In the summer time, does it grow a lot of algae that you don’t want there? Manure is used as fertilizer on crop fields and gardens, what do you think that means for the plants and algae in a pond if manure ends up in the water?
3. Soils can act as a natural filter to clean water as it infiltrates into the ground. The water slowly trickles through the tiny spaces and larger particles of pollution get left behind, trapped in those tiny spaces. How do you think the drilled hole down to your well changes that natural filtering process? Why do you think that the law requires most activities on the land to take place 100 feet or more away from well heads?

4. Manure is produced by a lot of farm animals and spread on crop fields by a lot of farmers. How do you think that affects our water quality across the whole state? If water in a river is contaminated by manure, would someone be able to easily identify which farm the manure came from? Older youth might explore the difference between point-source and non-point source pollution.

How would manure application change?
- Frozen sponge
- Saturated sponge
- Completely dry

Using the diagram mark where your neighbor lives in proximity to manure application.
### Biology
- How can wildlife be affected by manure runoff?

### Physical Science
- How does geology underground affect your drinking water?

### Chemistry
- List a benefit to water by using setbacks when applying manure.

---

**Lesson 6: Being Water Wise**

**Your Career Connection:** Water & Waste Treatment

**Water & Waste Treatment Technician Career Description:**

*You would* operate or control an entire process or system of machines, often through the use of control boards, to transfer or treat water or wastewater.

**Water & Waste Treatment Technician Tasks and Skills:**

- Add chemicals, such as ammonia, chlorine, or lime, to disinfect and deodorize water and other liquids.
- Inspect equipment or monitor operating conditions, meters, and gauges to determine load requirements and detect malfunctions.
- Collect and test water and sewage samples, using test equipment and color analysis standards.
- Record operational data, personnel attendance, or meter and gauge readings on specified forms.
- Operate and adjust controls on equipment to purify and clarify water, process or dispose of sewage, and generate power.
- Maintain, repair, and lubricate equipment, using hand tools and power tools.
- Clean and maintain tanks, filter beds, and other work areas, using hand tools and power tools.
- Direct and coordinate plant workers engaged in routine operations and maintenance activities. Maintain quality control of effluent water supply.

**Water & Waste Treatment Technician Possible Career Pathways:**

- Water Treatment Plant Technician
- Wastewater Treatment Plant Technician
- Drinking Water Control Technicians
- Water Pollution Control Technicians

Source: [https://www.onetonline.org/link/summary/51-8031.00](https://www.onetonline.org/link/summary/51-8031.00)
Each season has pros and cons to spreading manure. The best time to spread manure is when it will do the most good for the soil and plants you’re trying to grow. Most animals may be pastured more in summer and fall with less manure stacked. Spring is a time when a lot of manure that was stacked in the winter is applied because risk of pollution is lower than in winter and cover crops will use the manure’s nutrients.

Spring application of manure should be done based on a Manure Management Plan so it is not applied at a rate which washes away in heavy spring rains. Leachate is the brownish liquid that leaches from manure piles. Prevent leachate from contaminating groundwater or nearby waterways by capturing or diverting it.

Winter spreading of manure is discouraged. Spreading manure on frozen or snow-covered ground, especially on land that isn't flat, is prone to runoff from winter rain or melting snow.

**Activity**

Four Season Best Management Practice Calendar

**Objective:**
This activity asks youth to chart a calendar of manure use in coordination with what’s being grown.

**Leading Question:**
What will grow during the year when you apply animal manure in spring, summer, fall, and winter?
Using the chart below, complete each season to create a calendar for application of animal manure and the plants that will benefit.

<table>
<thead>
<tr>
<th>Your Project Animal:</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manure Production Rate/Animal:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What Plant Life is Growing:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where can Manure be Applied on the Property:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Design a flyer or poster to encourage others to follow the 4 R’s when applying manure in the 4 Seasons. The 4 R’s include: The Right Time, The Right Place, The Right Rate, and The Right Source of Nutrients.

<table>
<thead>
<tr>
<th>Biology</th>
<th>What time of year does your property have the highest rate of animal manure production?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Science</td>
<td>What methods do you follow to prevent manure runoff during each season?</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Does your property have enough application areas for the amount of manure produced by your project animal(s)?</td>
</tr>
</tbody>
</table>
Lesson 7: Manure For All Seasons

Your Career Connection: Farm Equipment Sales and Service Specialist

Farm Equipment Sales and Service Specialist Career Description:

You would sell, maintain, repair, and overhaul farm machinery and vehicles, such as tractors, harvesters, and manure land applicators for agronomic practices needing machinery throughout the year.

Possible Career Pathways of a Farm Equipment Sales and Service Specialist

• Recommend products to customers, based on customers' needs and interests.
• Contact regular and prospective customers to demonstrate products, explain product features, and solicit orders.
• Examine and listen to equipment, read inspection reports, and confer with customers to locate and diagnose malfunctions.
• Repair or replace defective parts, using hand tools, milling and woodworking machines, lathes, welding equipment, grinders, or saws.
• Reassemble machines and equipment following repair, testing operation and making adjustments as necessary.
• Use CD license to drive trucks to haul tools and equipment for on-site repair of large machinery.

Farm Equipment Sales and Service Specialist Possible Career Pathways:

• Farm Equipment Service Technician
• Tractor Mechanic
• Sales Representative
• Store Manager/Owner

Source: https://www.onetonline.org/link/details/49-3041.00
This is the most important part of this project book. If you care for animals that produce manure you’re required to have a management plan for that manure. It is time to put the science you’ve learned into practice.

**Chapter 8:**

**MANURE MANAGEMENT PLAN IMPLEMENTATION**

This is the most important part of this project book. If you care for animals that produce manure you’re required to have a management plan for that manure. It is time to put the science you’ve learned into practice.

**Now you’ll need a copy of the Manure Management Plan. Have your project book near by.**


Section 1: General Information.
This section includes general information about the farm. This section is always required in a manure management plan.

Section 2: Mechanical Manure Application Rate and Timing.
This section documents manure application rates and timing for mechanical application of manure. This section is always required in a Manure Management Plan if manure is mechanically applied to crop fields.

Section 3: Farm Map.
This section provides a farm map identifying the location of fields, structures, environmentally sensitive areas and manure application setbacks. This section is always required in a manure management plan.

Section 4: Recordkeeping.
This section provides a description of required recordkeeping and provides forms that can be used for recordkeeping. This section is always required in a manure management plan.

Section 5: Managing Manure Storage in Structures and Stockpiling/Stacking Areas.
This section is only necessary if the farm has a manure storage facility or stockpiles or stacks manure.

Section 6: Pasture Management.
This section is only necessary if the farm has one or more pasture fields.

Section 7: Animal Concentration Areas (ACA).
This section is only necessary if the farm has one or more ACAs (examples: barnyards, feedlots, animal exercise areas).

Questions concerning the Manure Management Plan should be directed to your local county conservation district or the PA Department of Environmental Protection regional office serving the county. Requests for approval of alternative formats should be directed to: DEP, DIVISION OF CONSERVATION DISTRICTS AND NUTRIENT MANAGEMENT
P O BOX 8465, HARRISBURG PA 17105
PHONE: 717-783-7576

Every farm in Pennsylvania that land applies manure is required to have and implement a written Manure Management Plan. This includes manure applied by various types of equipment and/or direct application of manure by animals on pastures and in ACA.

The Manure Management Plan format in the manuals provided by PA DEP must be used for the written manure management plan.

A Manure Management Plan can be prepared by you although you may benefit from obtaining assistance from individuals trained and experienced in developing these plans. Assistance may be available from certified nutrient management specialists.
Lesson 8: Manure Management Plan Guidelines and Implementation

Agricultural Educator Career Description:

You would provide students with educational and hands-on experiences in teaching about agriculture, food, and natural resources. Enhance youth leadership and FFA/4-H as an integral part of the instruction. Instruction may lead students to agricultural career preparation, continued education, and employment. Specific instruction includes educators of agronomy, dairy sciences, fisheries management, horticultural sciences, poultry sciences, range management, and agricultural soil conservation.

Agricultural Educator Tasks and Skills:

- Prepare and deliver lectures/lessons on agriculture topics
- Observe and evaluate students' performance
- Prepare materials and classroom for class activities.
- Evaluate and grade students' class work, laboratory work, assignments, and papers.
- Keep abreast of developments in their agriculture field by reading current literature, talking with colleagues, and participating in professional conferences.

Agricultural Educator Possible Career Pathways:

Agriculture & Environmental Educators:

- Land Grant University Educator and 4-H leader
- Agricultural Education Instructor and FFA Advisor
- Agribusiness Educator

Source: https://www.naae.org/teachag/
I pledge to put into action the Manure Management Plan I have written for the animals in my care.

Youth Signature

4-H Leader or FFA Advisor Signature

Date

DO THE RIGHT THING
Explore, learn, act, and share. You can make a difference.

MANURE MANAGEMENT GLOSSARY

Application: Spreading or adding manure to soil
Aggregates: Groups or clumps of soil particles that form when minerals and organic matter are bound together with the help of organic molecules, plant roots, fungi, and clays
Ammonification: A process performed by bacteria to convert organic nitrogen into ammonia, part of the nitrogen cycle
Animal Concentration Area: Barnyards, loafing areas, exercise lots, or other similar animal confinement areas that will not maintain a growing crop or where manure deposited by animals is in excess of crop nitrogen needs
Aquifer: Permeable rock that can hold and transmit water and serve as a source of groundwater
Available Nutrients: The form of nutrients that a plant is able to readily absorb into their roots and be used help them grow, some nutrients in the soil need to be converted into other forms before they are considered available
Best Management Practices (BMPs): Procedures, measures, or practices to prevent or reduce nonpoint source pollution into waterways, including structural controls, nonstructural controls, and operation and maintenance procedures that help keep soil and nutrients out of the water
Compaction: The compression of pore spaces in the soil by the weight of heavy machinery or overlying sediment
Compost: Decomposed organic material, sometimes including manure, that is often used as a soil amendment
Conservation District: Agencies within each county that provide technical assistance and education regarding management of soil and water natural resources
Conservation: The wise use of our natural resources
Cover Crop: A crop grown for the protection of the soil, preventing erosion during a time of the year when production crops aren’t growing and the soil would be bare
Decomposers: Organisms such as fungus, bacteria, and invertebrates that break down dead and decaying organic matter
Denitrification: Removing nitrates and nitrites from the soil, water, or air by chemical reduction, usually into nitrogen or nitrous oxide
Drainage: The loss or removal of soil water by percolation down through pores as a result of the gravity or purposefully removing excess soil water through the use of channels, ditches, and drain pipes
Drainage Swale: A depression or contour in the land, natural or man-made, that guides the movement rain water using gravity. When man-made, they are often designed to carry water away from structures. They often also serve as infiltration basins.
Ecology: the study of how the environment and the relationships of living things interact with their surroundings
Ecosystem: The living and non-living things that interact with each other in a biological community
Environment: The physical surroundings in which an organism (person, animal, plant, etc.) lives
Environmentally Sensitive Areas: Features or places on or near a farm where special care is needed to protect water quality, such as around streams, lakes, wellheads, sinkholes, and waterways
Erosion: the gradual wearing-away of topsoil or rock by water or wind, which can be caused by practices that disturb the soil (tilling, construction, and overgrazing)
Excrete: to expel waste, such as manure
Agricultural soils

The amount of water contained in the soil after all
the excess has drained and downward movement has stopped

Chemically produced or natural materials that are added
to the soil to provide nutrients and help the growth of crops

The practice of keeping the plant residue on the soil
surface and not plowing. As the plant decomposes nutrients return
to the soil.

Water that has infiltrated into the soil and is held
underground in pore spaces of rocks and soil

Moving manure from a storage area or barn into the field or
to another offsite location

The organic part of the soil that is made up of decaying
plants and animals as well as microorganisms

Mixing manure into the soil (or injecting it) after
or during spreading, reducing loss of nutrients due to runoff and
volatilization

The process of water soaking into the soil from the
surface and becoming groundwater

The practice of rotating livestock to graze in one
portion of pasture at a time, allowing the other portions to rest and
recover before grazing again. Similar to rotational grazing.

Water that drains from a manure pile or stacking area
containing nutrients and other dissolved substances it picked up
while passing through the manure

Plants that grow seeds in a pod such as peas, beans, alfalfa,
and peanuts. These plants pull nitrogen from the air and add to
the soil.

Manure combined with wash-water, rainwater, and/
or urine with a moisture content over 90% (less than 5-10% dry
matter) that must be stored in tanks, lagoons, or holding ponds

Animals raised in an agricultural way to produce
commodities or labor

Animal waste from stables or barnyards, sometimes
combined with bedding, wastewater, and other materials, often used
as a fertilizer

The amount of manure applied per acre, usually measured in tons or gallons

A site specific plan, written to describe
the agreed upon and acceptable practices that will be used when
land applying manure and wastewater

The amount of nitrogen (N), phosphorous
(P), and potassium (K) found in a certain type of manure which
determines how much manure is needed when fertilizing a crop

Analysis of a sample of manure in a laboratory to
determine the amount of nitrogen (N), phosphorous (P), potassium
(K), and other minerals.

Tiny living things, like bacteria and some fungi,
that can only be seen with a microscope

The form of nitrogen that is most readily taken up by plants
and stimulates their growth, the form of
nitrogen found in the greatest abundance in
agricultural soils

The process that converts ammonium into nitrate,
done by microorganisms in the soil

The part of the nitrogen cycle where atmospheric
nitrogen is converted into compounds that plants can use as
nutrients, legumes can perform this process.

a swelling on the root of a legume that contains bacteria
that can fix nitrogen from the air

Contaminants without a single
identifiable source that are carried in runoff from rain and snow melt

Substances essential for growth and maintenance, in
plants the primary nutrients are nitrogen, phosphorous, potassium,
and a variety of minerals

A managed area of land used for grazing livestock animals

Microorganisms that can cause disease

A value that indicates the acidity of a solution or of soil,
measured by the hydrogen ion (H+) concentration where 7 is
neutral, less than 7 is acidic, and greater than 7 is basic or alkaline

An element found in soils both in an organic form and an
un-organic (mineral) form that is an essential macro-element
required for plant nutrition

The process by which plants use light energy from
the sun to produce their own food (sugar) from water and carbon
dioxide

To work the soil by turning over the top layer, also the
machine used to turn the top layer of soil

Identifiable discharge of pollution.

One of the essential nutrients in plants associated with
the movement of water, nutrients, and carbohydrates in plant tissues

Practice of moving livestock between pastures
on a regular basis.

Rain, snow melt, and other water that drains over the
surface of the land, carrying away nutrients, soil, and other things it
encounters and promoting erosion

Careful preservation or protection of soil from
erosion and reduced fertility

The relative amounts of sand, silt, and clay particle
content, “coarse textured” means a high sand content, while “fine-
textured” means a high clay content

Manure, usually with added bedding, that can be
stacked and handled by equipment able to move bulk materials,
such as a front end loader

Accidental or unintentional loss of something that could harm
the environment, including any loss from storage, transportation, or
application at incorrect rates or on unsuitable sites

Responsible planning and management of resources,
including any loss from storage, transportation, or
application at incorrect rates or on unsuitable sites

The shape and features of the surface of the land,
often represented on a map using contour lines

The plants found in a particular area

The top of an underground water well, usually able to be
seen from above ground, and an indicator of the area that should be
protected to keep drinking water safe