

# Manure Happens

## Managing Nutrients in Livestock Manure

Skills: Science, Math

Objective: Students reinforce math and science skills while learning about the nutrients found in livestock manure.

### Background

In addition to meat, livestock and poultry operations produce another valuable commodity—manure. Animal manure can be a valuable fertilizer when properly used on field crops. Besides providing macro- and micronutrients to the soil, manure supplies organic matter to improve the soil's physical and chemical properties. It also increases infiltration of water, keeps nutrients in the soil, helps hold the soil in place, and promotes growth of beneficial organisms.

What we normally consider livestock manure is actually a mixture of feces, urine, soil, bedding material, and wash water. Its characteristics depend upon the type of animal being raised, its diet and bedding, the manure handling system, and even the climate. The nutrients in manure, such as nitrogen and phosphorus, occur in both organic and inorganic forms, though organic nutrients must first be converted or mineralized to inorganic forms before plants can use them. This conversion process is carried out by micro-organisms and other biota in the soil.

Application on crop land is the most common and efficient method of handling livestock manure. However, without proper management, manure application over a period of years can cause a build-up of nutrients and salts in the soil. Excess manure can contaminate groundwater when soluble nitrate and salts leach through the soil. Runoff from manured land can carry phosphorus, nitrogen, organic sediments, and pathogens to surface water bodies. As the runoff decomposes in surface water, it absorbs oxygen and can cause fish to suffocate.

Good nutrient management involves manure application rates that are based on the actual nutrient content of the manure and the specific requirements of the crops being grown. Nutrient content in manure can vary, so regular testing of soil and manure is important for maintaining a proper balance.

Background Sources: Zhang, Hailin, "Fertilizer Nutrients in Animal Manure, Oklahoma Cooperative Extension Service Fact Sheet PSS 2228; "Manure Nutrient Management," Irrigation Branch, Alberta Agriculture

### P.A.S.S.

#### GRADE 6

**Science Process**—1.1,2,3; 3.1,2,3,4,5;  
4.1,3; 5.1,3

**Physical Science**—1.1

**Math Process**—1.2,3; 2.2; 3.3; 4.1; 5.1

**Math Content**—2.3; 5.3

#### GRADE 7

**Science Process**—1.1,2,3; 3.1,2,3,4,5;  
4.1,3; 5.1,3

**Physical Science**—1.1

**Math Process**—1.2,3; 2.2; 3.3; 4.1; 5.1

**Math Content**—2.1ab,2b; 5.1

#### GRADE 8

**Science Process**—1.1,2,3; 3.1,2,3,4,5;  
4.1,3; 5.1,3

**Physical Science**—1.2

**Math Process**—1.2,3; 2.2; 3.3; 4.1; 5.1

**Math Content**—2.1b; 5.2b

### Resources Needed

manure (Available from horse stables, fairgrounds, etc. Check with students whose families raise farm animals. **DO NOT USE MANURE FROM DOGS OR CATS.**)

garden soil  
soil testing kit  
Petri dishes  
surgical gloves  
calculators

## Vocabulary

**application**—something put or spread on a surface

**beneficial**—producing results that are good for health and happiness

**biota**—the plants and animals of a region

**feces**—bodily waste discharged through the anus

**infiltration**—the act of passing into or through by filtering

**inorganic**—being or composed of matter that does not come from plants or animals either alive or dead

**leach**—to pass a liquid through to carry off the soluble components

**livestock**—animals kept or raised; especially farm animals kept for use and profit

**macronutrient**—a chemical element (as nitrogen, phosphorus, or potassium) of which relatively large quantities are essential to the growth and health of a plant

**manure**—animal excrement or other substance put on or into the soil to fertilize

**micronutrient**—a chemical element (as iron, zinc, manganese, zinc) essential in minute amounts to the growth and health of an animal or plant

**mineralize**—to convert into mineral or inorganic form

**nitrate**—a salt or ester of nitric acid

**nitrogen**—a colorless, tasteless, odorless gaseous chemical element forming nearly four-fifths of the atmosphere

**nutrient**—of food value

**organic**—of, relating to, or derived from living organisms

**pathogen**—a specific causative agent (as a bacterium or virus) of disease

**phosphorus**—a nonmetallic chemical element, normally a white, phosphorescent, waxy solid, becoming yellow when exposed to light

**runoff**—water from rain or snow that flows over the surface of the ground and finally into streams

**sediment**—material deposited by water, wind, or glaciers

**soluble**—capable of being dissolved in a liquid

**urine**—waste material that is secreted by the kidneys, is rich in the end products of protein breakdown, and is usually a yellowish liquid in mammals but semisolid in birds and reptiles

and Food,

[http://www1.agric.gov.ab.ca/\\$department/deptdocs.nsf/all/irr5716](http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/irr5716)

## Activity

1. Read and discuss lesson background.
2. Students will use the “Scientific Method Format” included in the “Resources” section to test for the presence of nutrients in garden soil, manure and a mixture of the two. Students will design their own experiments to test the effects over time of air, temperature and other factors on manure. Some possibilities are listed below:
  - Place samples outdoors and expose them to the air.
  - Leave samples uncovered indoors.
  - Keep samples covered.
  - Place samples in the refrigerator.
  - Place samples in the oven.
  - Test the water retention of garden soil with and without manure.
  - Test the difference between store-bought bagged manure and fresh manure acquired from a horse farm or other animal operation.
  - Test manure from different animals.
3. Discuss findings. Were results consistent? Discuss the importance to farmers of testing to make sure they use the correct amount of manure and other fertilizers in the soil.
4. Before handing out the worksheet included with this lesson, list the following animals on the chalkboard: cow, pig, sheep, chicken, horse.
  - Students will predict which animal produces the largest amount of manure and which animal’s manure contains the highest level of nitrogen.
  - Students compare their predictions with the weights listed in the table.
  - Students use calculators to complete the worksheet.
  - Students compare findings from the first two questions with a partner before completing the last three questions.
  - Students explain in writing how they found the percentages, including calculations from a decimal to a percent.
5. Each student will write a paragraph discussing the differences in the pigs listed and compare/contrast the differences in percentage of body weight excreted as nitrogen.

## Extra Reading for Students

Bial, Raymond, *A Handful of Dirt*, Walker, 2000.

Eberts, Marjorie, *Nature*, McGraw-Hill, 1996.

Stille, Darlene R., *Soil, Digging into Earth’s Vital Resource*, Compass Point, 2005.

# Typical Amounts of Nitrogen Found in the Manure of Some Livestock Species

Animal	Animal Weight (lb)	Total Nitrogen (lb/yr)	Percentage of Body Weight Excreted as Nitrogen
dairy cow	1400	210	
beef calf	500	62	
beef cow	1000	124	
horse	1000	99	
nursery pig	35	5.7	
finishing pig	200	33	
sow	275	23	
boar	350	28	
sheep feeder	100	16	
laying hen	4	1.05	
broiler	2	0.85	

Source: "Nutrient Value of Fresh Livestock Manure," Washington State University,  
<http://gardening.wsu.edu/stewardship/compost/manure/manure3.htm>

1. Complete the table by calculating the total nitrogen excreted per animal per year as a percentage of its body weight.
2. What animal produces the most nitrogen per pound of body weight? \_\_\_\_\_

WAIT: Compare your findings with a partner before completing the last three questions.

Mean = the sum of the data divided by the total number of values in the set.

Median = the value in the middle when all values are arranged from lowest to highest.

Mode = value in a set of data that occurs most often.

3. What are the mean, \_\_\_\_\_ median, \_\_\_\_\_ and mode \_\_\_\_\_ of the animal weights?
4. What are the mean, \_\_\_\_\_ median, \_\_\_\_\_ and mode \_\_\_\_\_ of the total nitrogen in the manure per year?
5. What are the mean, \_\_\_\_\_ median, \_\_\_\_\_ and mode \_\_\_\_\_ of the percentages?

## Typical Amounts of Nitrogen Found in the Manure of Some Livestock Species (answers)

Animal	Animal Weight (lb)	Total Nitrogen (lb/yr)	Percentage of Body Weight Excreted as Nitrogen
dairy cow	1400	210	<b>15</b>
beef calf	500	62	<b>12.4</b>
beef cow	1000	124	<b>12.4</b>
horse	1000	99	<b>9.9</b>
nursery pig	35	5.7	<b>16.29</b>
finishing pig	200	33	<b>16.5</b>
sow	275	23	<b>8.36</b>
boar	350	28	<b>8</b>
sheep feeder	100	16	<b>16</b>
laying hen	4	1.05	<b>26.25</b>
broiler	2	0.85	<b>42.5</b>

Source: "Nutrient Value of Fresh Livestock Manure," Washington State University,  
<http://gardening.wsu.edu/stewardship/compost/manure/manure3.htm>

1. Calculate the total nitrogen excreted per animal per year as a percentage of its body weight. (answers above)
2. What animal produces the most nitrogen per pound of body weight? (broiler chickens)

WAIT: Compare your findings with a partner before completing the last three questions.

Mean = the sum of the data divided by the total number of values in the set.

Median = the value in the middle when all values are arranged from lowest to highest.

Mode = value in a set of data that occurs most often.

3. What are the mean, 442.36 median, 275 and mode 1000 of the animal weights?
4. What are the mean, 54.78 median, 28 and mode no mode of the total nitrogen in the manure per year?
5. What are the mean, 16.69% median, 15% and mode 12.4 of the percentages?