NPS

ActivitY

SHEETS

Activities to Accompany

Improving Old MacDonald's Farm

For Grades 6–8

Objectives:
This exercise is designed to further explore topics addressed in the accompanying article. Students work through calculations to determine how much fertilizer is needed to meet a plant's nutrient requirements. From these calculations, students draw conclusions about the most cost-effective and environmentally sound farming practices.

Exercises:
Exercise I. Old MacDonald's Farmland Fertilizer Dilemma
Exercise II. Mooooving Those Cows

Time Required:
Individual exercises are designed to be approximately ½ hour to 45 minutes long. These exercises are also ordered progressively: each builds on concepts introduced in the previous.

Curricular Standards and Skills:

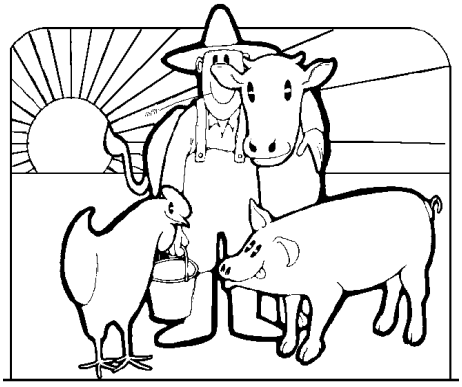
Math:
word problems
addition
subtraction
multiplying decimals
working with money
order of operations

Thinking Skills:
deductive reasoning

Language Arts:
reading comprehension

Vocabulary:
dead zone
eutrophication
pesticides, herbicides, and fungicides
sedimentation

Exercise I. Old MacDonald's Farmland Fertilizer Dilemma

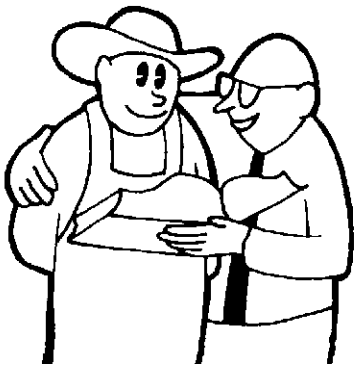


Why Worry About Old MacDonald?
Old MacDonald has some big decisions to make. In this exercise, you will help him decide how much fertilizer his crops need. At the same time you will help him to keep costs down and prevent nutrient runoff into nearby lakes and streams.

Old MacDonald's Farm
Verse 1: Old MacDonald had a farm. . . E-I-E-I-O
And on this farm he had 900 chickens. . . E-I-E-I-O
with a cluck-cluck here and a cluck-cluck there,
here a cluck,
there a cluck,
everywhere a cluck-cluck
Old MacDonald had a farm. . . E-I-E-I-O

Verse 2: And on this farm he had 10 pigs
Verse 3: And on this farm he had 12 cows

Old Macdonald has a small farm. The cows graze in a 15-acre pasture, and he grows corn to feed his chickens, pigs, and cows in a 35-acre field. Altogether, Old MacDonald's animals produce about 170 tons of manure every year! That manure contains 1,200 pounds of nitrogen and 800 pounds of phosphorus.



Old MacDonald knows that manure is an unbalanced fertilizer for corn because it has too much phosphorus and not enough nitrogen. Corn plants use 5 to 20 times as much nitrogen as phosphorus, and there is less than twice as much nitrogen than phosphorus in manure. Farmers usually apply manure to fulfill the nitrogen requirements for crops. Because crops do not use up the phosphorus in the manure, the result is an overapplication of phosphorus. This phosphorus then builds up in the soil until a rainstorm washes it into nearby streams or rivers, where it can cause water quality problems and threaten aquatic life.

Solving the Problem

Old MacDonald wants to fertilize his pasture and cornfields with the manure that his cows, chickens, and pigs produce. After all, it's free, and he doesn't have to haul it from somewhere else! And commercial fertilizer is expensive—nitrogen costs 15¢ per pound and phosphorus costs 50¢ per pound.

However, his choice is not easy. Either he spreads enough manure so that the crops get enough nitrogen (leaving large amounts of leftover phosphorus that could run off into streams and lakes), or he spreads only enough manure so that the crops get the right amount of phosphorus (but not enough nitrogen).

After testing the soil, Old MacDonald is able to determine that the pasture requires 80 lb/acre of nitrogen and 5 lb/acre of phosphorus for the best growth. He also discovers that his corn crop needs 125 lb/acre of nitrogen and 25 lb/acre of phosphorus for the best growth.

Fill in the table below with information from the preceding paragraphs.

	Number	Units
Pasture size		
Corn field size		
Manure produced		
Nitrogen in manure		
Phosphorus in manure		
Cost for extra nitrogen		
Cost for extra phosphorus		
Nitrogen needed to fertilize pasture		
Phosphorus needed to fertilize pasture		
Nitrogen needed to fertilize corn		
Phosphorus needed to fertilize corn		

Doing the Calculations . . .

Part I.
Find the amounts of nitrogen and phosphorus required on the farm:

1. How much nitrogen does Old MacDonald need to fertilize his farm?

[ ]	acres pasture	x	[ ]	lb nitrogen per acre =	[ ]	lb
[ ]	acres cropland	x	[ ]	lb nitrogen per acre = +	[ ]	lb
						lb = nitrogen requirement

Remember your order of operations.
Multiplication is done before addition.

2. Now compare the amount of nitrogen required on the farm to the amount of nitrogen in the manure. Is there enough nitrogen in the manure to fertilize both the pasture and corn?

3. How much more nitrogen does he need?

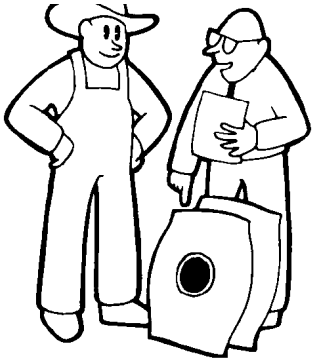
4. How much phosphorus does Old MacDonald need to fertilize his farm?

[ ]	acres pasture	x	[ ]	lb phosphorus per acre =	[ ]	lb
[ ]	acres cropland	x	[ ]	lb phosphorus per acre = +	[ ]	lb
						lb = phosphorus requirement

5. Now compare the amount of phosphorus required on the farm to the amount of phosphorus in the manure. Is there enough phosphorus in the manure to fertilize both the pasture and corn?

6. How much more phosphorus does Old MacDonald need?

Part II.
Option 1: Fertilize with enough manure to meet nitrogen needs



From the calculations in Part I, we discovered that the pasture needs 1,200 pounds of nitrogen. This is exactly the amount of nitrogen contained in the manure produced on Old MacDonald's farm. So, let's assume that Old MacDonald uses all the manure to fertilize his pasture. This will completely satisfy the pasture's need for nitrogen and phosphorus. However, he still needs to fertilize his corn crop.

Because Old MacDonald used all the manure produced on his farm to fertilize his pasture, he must buy commercial fertilizer for his corn. He needs to buy both nitrogen and phosphorus.

7. How many pounds of nitrogen would Old MacDonald need to buy? *Hint: Look at your calculations in #1.*

8. How much would Old MacDonald have to pay to buy enough commercial nitrogen?

9. How many pounds of phosphorus would Old MacDonald have to buy? *Hint: Look at your calculations in #3.*

10. How much would Old MacDonald have to pay to buy enough commercial phosphorus?

11. How much would Old MacDonald spend in all on commercial fertilizer for Option 1?

Option II. Fertilize with enough manure to meet phosphorus needs

Old MacDonald does not have to use all the manure from his farm to fertilize his pasture. From the calculations in Part I, we found that if Old MacDonald puts some of the manure on the pasture and some on the corn field according to the amount of phosphorus each field needs, he will need to buy only 10 pounds of phosphorus. However, he will then have to put nitrogen on both his pasture and his corn field. Will this method of distributing fertilizer be worth it? Let's find out.

12. After spreading manure according to the phosphorus needs of each field, how many pounds of phosphorus would Old MacDonald need to buy?

13. Find the total price that Old MacDonald would have to pay for commercial phosphorus.

14. How many pounds of nitrogen would Old MacDonald have to buy? *Hint: Subtract the total amount of nitrogen Old MacDonald needs from the amount of nitrogen in the manure that he spread.*

15. Find the total price that Old MacDonald would have to pay for commercial nitrogen.

16. How much would Old MacDonald spend in all on commercial fertilizer for Option 2?

Making the Right Decision

17. Which is cheaper for Old MacDonald, Option 1 or Option 2?

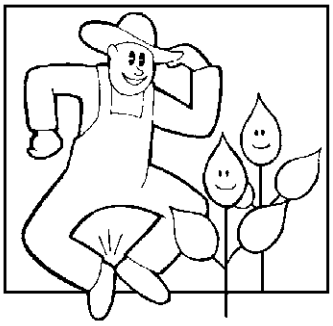
18. How much would Old MacDonald save if he used the cheaper method?

19. Which method of fertilization would lead to less excess phosphorus accumulation in the soil? (Remember that excess phosphorus in the soil is washed away by rainwater and leads to pollution in nearby waterways.)

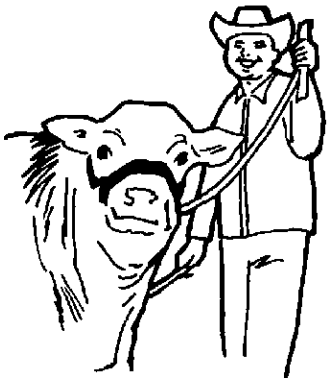
Other Farmer-ly Considerations...

Manure also contains other nutrients such as manganese, calcium, sulphur, boron, and iron that plants need to survive. If Old MacDonald applies manure only to his pastureland (as was the case for nitrogen-based application), he might still have to buy and apply these additional nutrients to satisfy crop needs.

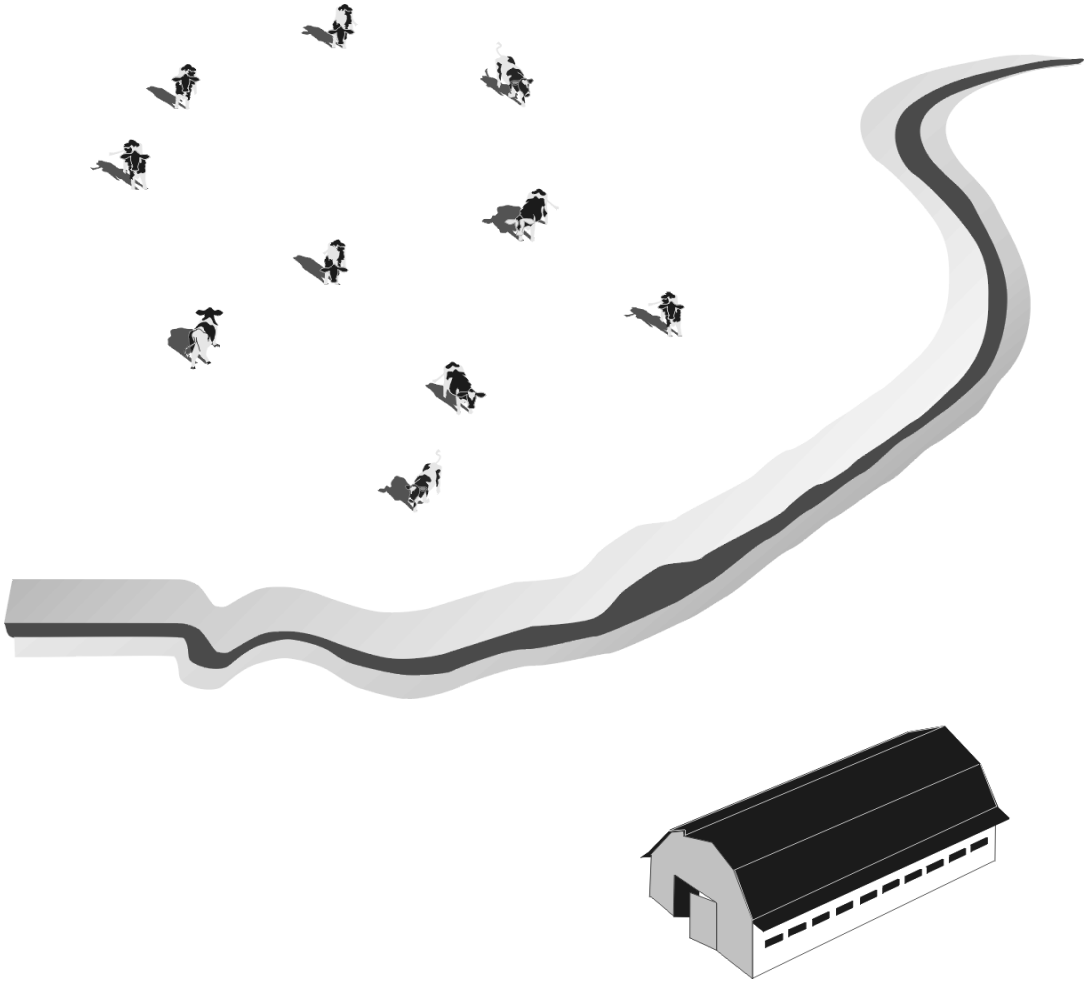
Manure application will also increase the health of the soil because manure contains organic matter that is used as food by worms and other organisms in the soil. The result is a healthier soil that grows healthier crops while, at the same time, reducing the environmental damage of excess nutrient runoff into lakes and streams.



Exercise II.
Mooving Those Cows



Old MacDonald has a second dilemma. A small stream runs between the cow pasture and the barn, as shown in the picture below. Your job is to draw a plan that will allow the cows to roam between the barn and the pasture and will also provide water for the herd. Label any devices that you use and their purpose. When you are finished with your drawing, write a paragraph about the benefits and drawbacks of your design.

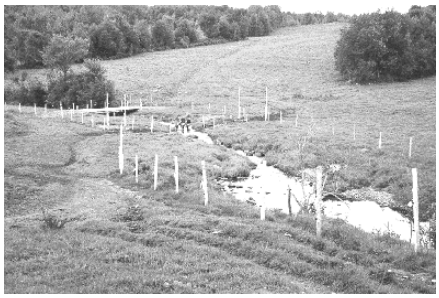


Things to think about

- How would you get your cows water but keep them out of the stream?
- What problems can you cause for the stream if you let the cows drink directly from it?
- How else can you get water from the stream to the cows?
- How will the cows get across the stream to their barn?
- What streamside practices would you use to make sure water quality, the physical stream structure, and the fish and organisms living in the stream are protected?

Some Examples

For years, farmers have been working on new ways to keep cows out of nearby streams. They have come up with a number of practices that help reduce the damage cows can do to a stream. You can use some of these practices to help Old MacDonald with his cows, or you can come up with some practices of your own.



Wire fences (left) keep cows from walking on streambanks and digging them up with their hooves. Planting vegetation (right) along streambanks can help filter out nutrients and bacteria from rainwater that runs off cow pastures.

- A watering trough is a place where cows can drink away from the stream. Use a water pump to get water out of the stream and into the trough.
- Wherever cows gather together in a large group, they dig up the ground with their hooves. Rainfall washes the loose dirt down the stream as sediment. Use cement in places where cows are expected to gather to keep this from happening.
- Put up a wire fence to prevent cows from getting into the stream or breaking up mud along streamside areas with their hooves.
- Plant grasses or bushes to protect the stream from mud and sediment washing into it off the banks.
- Remember that cows poop wherever they stand around for a long time. If rain falls on these high-use areas, it will wash manure down into the stream. Plant grasses, shrubs, and trees along the streambank to capture and filter some of that runoff.
- Catch water from high use areas in a settling pond. This practice allows bacteria and pollutants from the manure to settle out of the water before it runs into the stream.
- Ever heard of a cow path? Cows typically find a path and stick to it. They will find their way back to the barn from the stream. But they might crowd around trying to get back into their pens! Create an outdoor holding area/exercise area outside the barn door that is fenced off.
- You can expect cows to poop in the exercise area. A water ditch can divert water to wash manure out of this area. Then the water should be directed into a settling pond before flowing back into the stream.
- Create a bridge over the stream so that cows will be able to cross over the stream without trudging in it or pooping in it.