Cream of the Crop

Assessing the Environmental Benefits of Prairie Strips

MEET THE SCIENTISTS!

Photo courtesy of Randy Kolka, USDA Forest Service.

◄ RANDY KOLKA, Soil Scientist

My favorite experiences are working with students on research. Research topics range from the importance of putting native prairie strips in crop areas to studying the effect of climate change on wetlands in northern Minnesota, Indonesia, and Peru. Also, one of the topics I study is mercury cycling. Mercury is a pollutant that can affect our nervous system, brain functioning, and reproduction. In one study, we looked at the effect of forest fires on mercury. We found that the amount of mercury deposited during and after a fire was a lot, about 40 percent of what is deposited annually from rain and snow. Wildfires and prescribed fires can be good for our environment, but they can also be sources of mercury in the food chain.

Photo courtesy of Lisa Schulte-Moore, Iowa State University.

◀ LISA SCHULTE-MOORE, Ecologist

I love science – the whole process from conceiving an idea to publishing the results of a project. I think my favorite experience is feeling like, bit by bit, I'm helping to make our world a better place for current and future generations. I also like that I get to learn something new every single day. In my photo, I'm standing in a prairie strip on a farm in north central Iowa doing nest checks. We find and monitor bird nests to understand whether or not prairie strips are providing quality habitat for birds, especially birds of greatest conservation need.

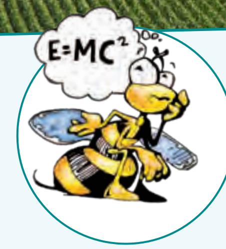
What Kind of Scientists Did This Research?

Ecologist: This scientist studies the relationship of living things with each other and with the nonliving environment.

Soil Scientist: This scientist studies soil.

Glossary words are in **bold** and are defined on page 27.

Thinking About Science



One goal of scientific research is to discover solutions to problems affecting society. Scientists are interested in finding solutions which are both effective and **practical**. Together, the effectiveness and practicality of a solution gives scientists an idea of whether a solution will be widely used. For instance, one solution to a problem may be effective but expensive. If people cannot afford the solution, it may not be widely used. Similarly, if a solution is easy, but requires many hours to complete, people may be unwilling or unable to use it.

The scientists in this research tested prairie strips as a solution to the environmental damage occurring in some agricultural areas. Additionally, the scientists determined where the solution could be used and whether people desired a solution to the problem. This information enabled the scientists to determine whether the solution was also practical.

Thinking About the Environment

Many agricultural areas are designed to maximize growth of a desired product. To do so, land is changed from **native** ecosystems, such as forests, grasslands, and wetlands. Converting native ecosystems to agriculture can have negative impacts. Some negative impacts include soil loss and water and air pollution.

The loss of native plants and animals is another impact of creating agricultural lands. Native plants and animals can provide many **ecosystem services**, including carbon storage, healthy soil and water, pest control, and **pollination**. Not only are native plants and animals often lost on agricultural lands, but **nonnative** plants are sometimes introduced. Nonnative plants and animals can cause further problems by competing with remaining native species.

The Midwestern States contain large amounts of agricultural land where native plants and animals have been lost. The scientists in this study saw an opportunity to combine both native plants and agricultural lands. This strategy, they believe, could enable landowners to achieve multiple goals, like environmental health and crop production.

Introduction

Agriculture is a major part of the midwestern U.S. landscape. In Iowa, for instance, the scientists discovered that corn and soybean farms cover 69 percent of the landscape (figures 5-6b). Before being changed to agricultural land, the scientists knew that much of Iowa's native ecosystems consisted of **prairies** (figure 7). As you read in "Thinking About the Environment," converting native ecosystems to agriculture can negatively impact the environment.

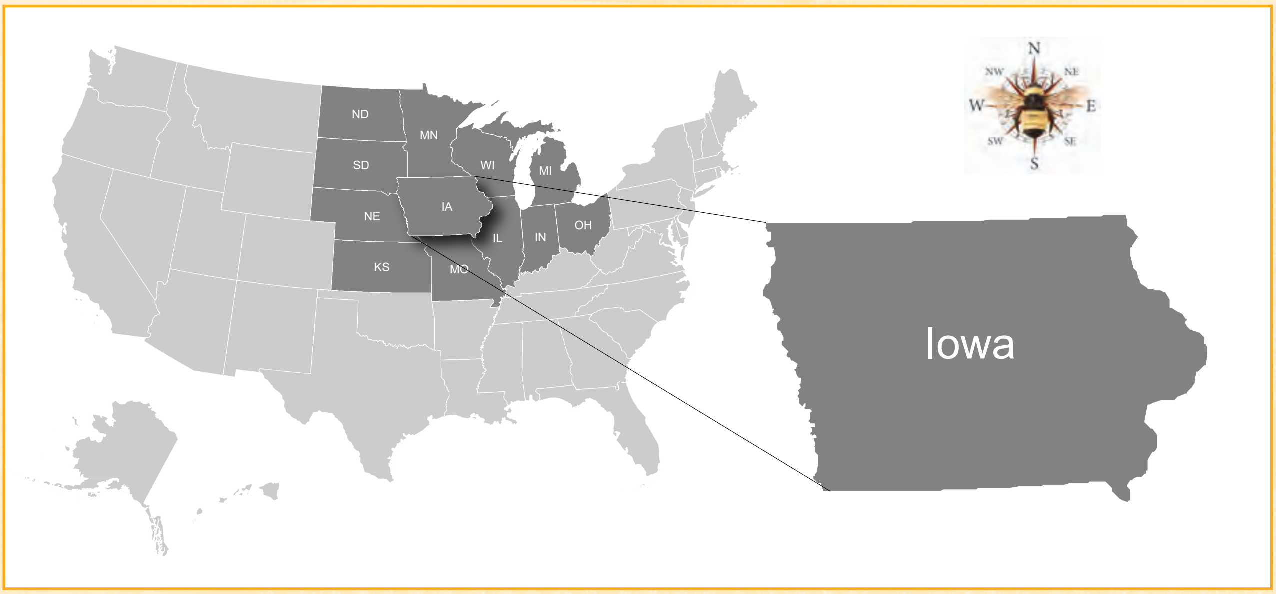


Figure 5. Iowa is in the Midwest region of the United States.

Map by Carey Burda.

Figure 6a. Corn is a common agricultural plant in the Midwest. Corn is used for several products, and American farmers often trade with or sell it to people from around the world.

Photo courtesy of Stephen Kirkpatrick, USDA Natural Resources Conservation Service.

Figure 6b. The United States is one of the largest producers of soybeans, pictured here on this farm. Soybeans are often processed and used to feed farm animals. Soybeans are also eaten by humans in products like tofu.

Photo courtesy of Lynn Betts, USDA Natural Resources Conservation Service.

Figure 7. Prairies are ecosystems dominated by shorter plants, like grasses, instead of trees. Prairies, often called grasslands, can be found in many regions of the United States. The Midwest has the largest amount of prairie habitat in the United States.

Photo courtesy of Doug Mosser, U.S. Fish and Wildlife Service.

Where Did the Tallgrass Prairie Go?

Tallgrass prairie is an ecosystem that once covered 150 million acres of North America, including Iowa, its surrounding States, and even Texas and Canada (figure 8). Today, however, only 4 percent of the original area consists of tallgrass prairie.

As you might have guessed, the tallgrass prairie ecosystem contains tall grass species. Some species can reach an average height of 6 feet, with some stalks reaching over 9 feet high. Although the height of the grasses is impressive, their root systems are often even more impressive. Many prairie plants, including the tall grasses, have root systems that are longer than the grass is tall (figure 9).

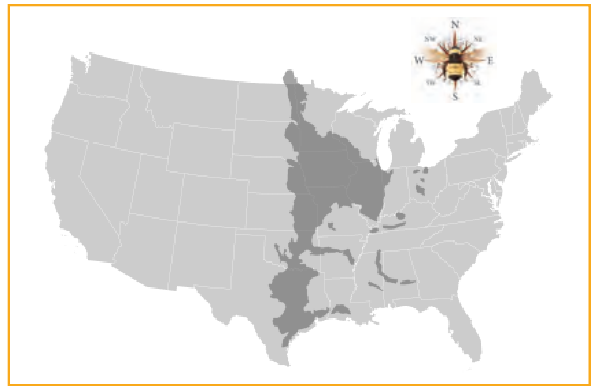


Figure 8. Tallgrass prairie once covered many States.

Map by Carey Burda.

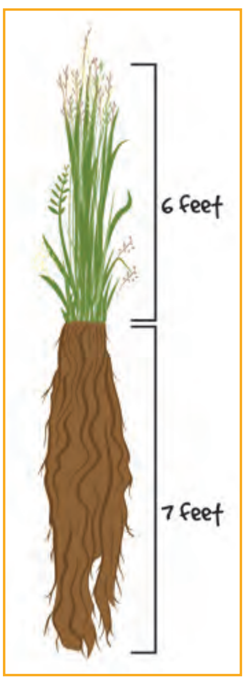


Figure 9. Tallgrass prairie plants often have a large root system hidden in the soil below.

Illustration by Stephanie Pfeiffer.

The dense and deep root system of tallgrass prairies slows water runoff and traps nutrient-rich soil in place. As the United States grew and people settled the tallgrass prairie region, they started farming to take advantage of the nutrient rich soil. Farmers grew as much as they could on their farms, turning tallgrass prairie into agricultural land. The change from tallgrass prairie to agricultural lands has its benefits. Today, the area is a productive agricultural region. However, as tallgrass prairie has disappeared, so have the ecosystem services they provided.

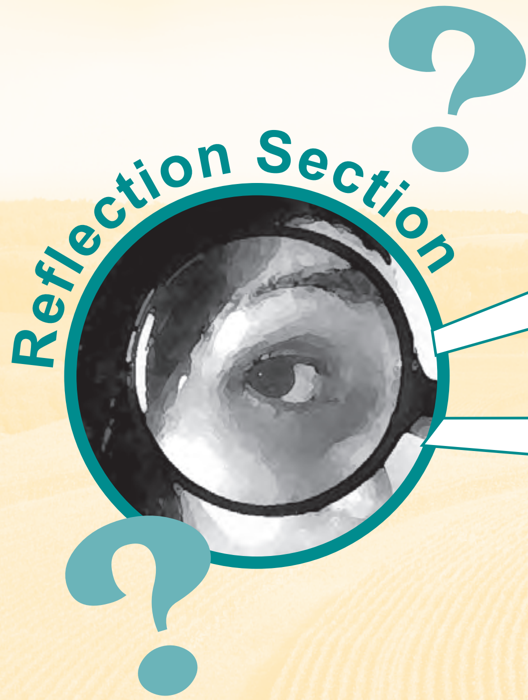
Did You Know? In 1996, The Midewin (pronounced mi-DAY-win) National Tallgrass Prairie was established in Illinois. It encompasses approximately 19,000 acres and is home to a bison herd. You can even watch the herd on the BisonCam! https://www.fs.usda.gov/main/midewin/home

The scientists determined that reintroducing prairie plants in agricultural lands was one way to improve the environment. They started a large experiment in 2007 to test the use of "prairie strips" in agricultural lands (figure 10). Prairie strips are rows of native prairie plants that are grown alongside agricultural crops, like corn or soybeans.

Results of the experiment showed that prairie strips were an effective solution to improve the environment. However, the scientists determined that they still needed to show that prairie strips were also a practical way to improve the environment. More specifically, the scientists wanted to understand the effects of prairie strips relative to the amount of land they occupy. They also wanted to know whether prairie strips could be used widely in Iowa and if the people of Iowa wanted the benefits provided by prairie strips.

Figure 10. Prairie strips are rows of prairie plants grown alongside crops, like this prairie strip located between rows of soybeans.

Photo by Omar de Kok-Mercado, Iowa State University.



State in your own words the questions the scientists were trying to answer with this research.

The scientists knew their previous research showed the benefits of prairie strips. Why did scientists need to show that prairie strips were a practical solution? (Hint: Think about what you read in “Thinking About Science.”)

Methods

The scientists used data from their experiment which had been conducted at Neal Smith National Wildlife Refuge since 2007 (figure 11). The experimental area was divided into 12, approximately equal sized **catchments**. Each catchment received one of four treatments, with each treatment repeated three different times (figure 12):

1. 100% crops (**control**)
2. 90% crops, 10% prairie strips planted only at the bottom of the slope
3. 90% crops, 10% prairie strips planted throughout
4. 80% crops, 20% prairie strips planted throughout

The prairie strips contained 32 plants native to the Iowa area. Each prairie strip was at least 4 meters wide and at least 36 meters from another prairie strip. The crops used were corn and soybeans, which are common in Iowa, and they were managed using common farming techniques.

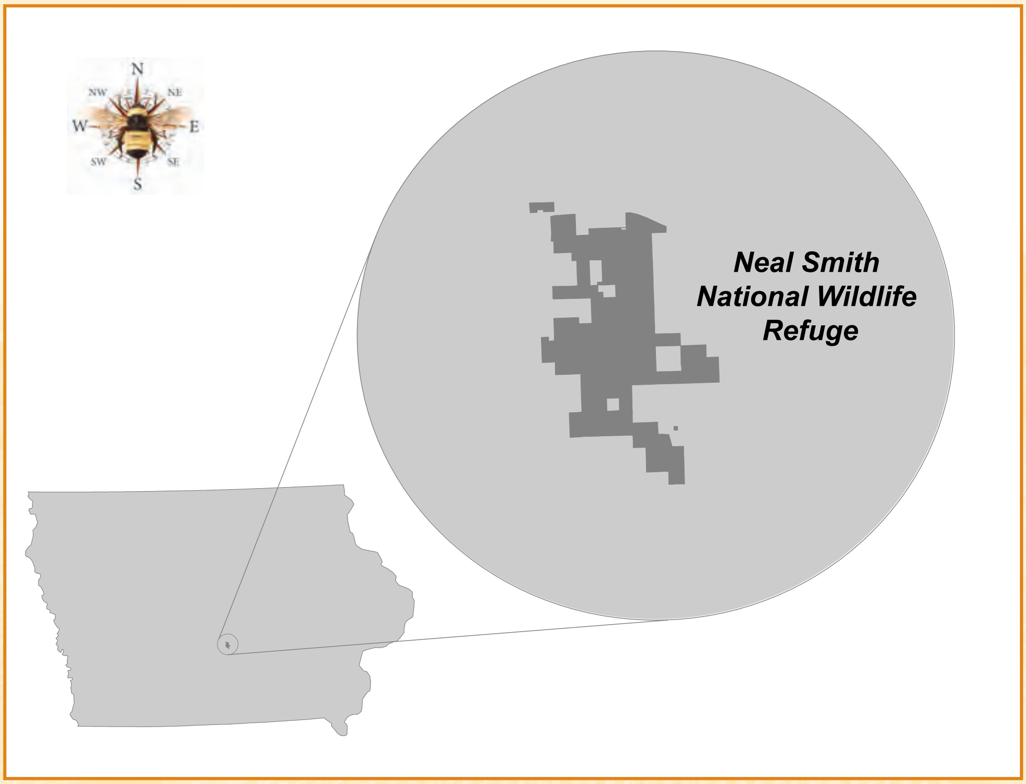


Figure 11. Neal Smith National Wildlife Refuge is located in central Iowa. It was protected to preserve the prairie ecosystem.

Map by Carey Burda.

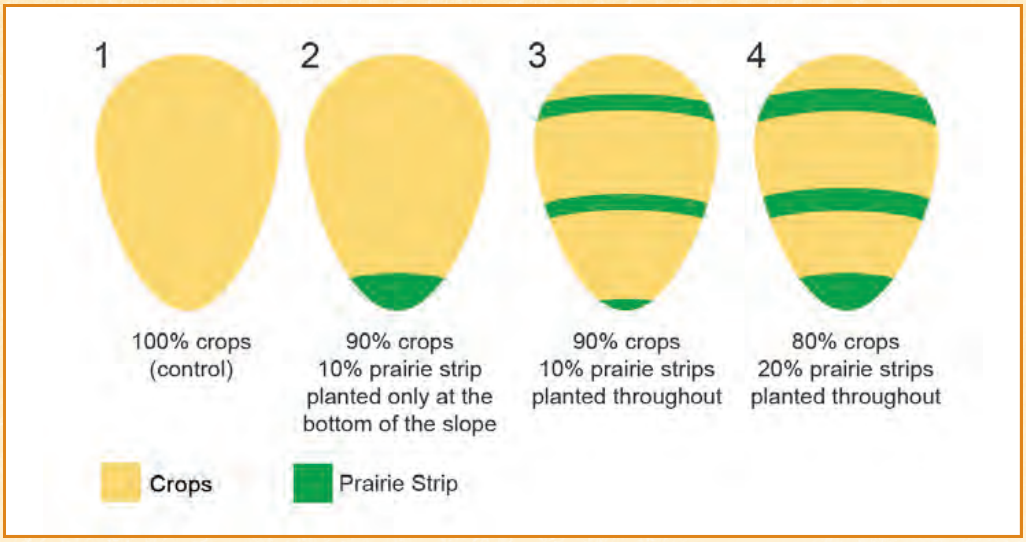


Figure 12. The scientists tested four different treatments, including the crop-only control treatment. Each treatment had a different combination of crops and prairie strips.

Illustration by Stephanie Pfeiffer.

Number Crunch

Prairie strips were at least 4 meters wide. There are 3.28 feet in one meter.

How many feet wide is a 4-meter-wide prairie strip?

Plants within prairie strips were **inventoried** each year for 4 years during the summer. Insects were inventoried in both prairie strips areas once per year for 3 years and in crop areas once.

Birds were inventoried each year for 5 years. Data about water flow and water chemistry were collected at each of the 12 catchments using an H flume and groundwater wells (figure 13a & 13b).

Figure 13a. An H flume is placed in a stream to calculate water flow. The H flume forces all water into one space so scientists can accurately measure how much water is flowing in a particular location.

Photo courtesy of Stephanie Laseter, USDA Forest Service.

Figure 13b. The scientists installed groundwater wells to measure groundwater on the high end of each catchment and the low end of each catchment. Groundwater wells are usually plastic pipes placed in the ground that can be opened at the surface.

Photo by Anna McDonald, Iowa State University.

As crops were **harvested** from each catchment, the scientists measured the crop production using a Case IH AFS Pro-600 monitor (figure 14).
The scientists calculated **revenue** from crop production on each catchment.

Lastly, the scientists calculated the total amount of land in Iowa on which prairie strips could be used using a computer program, and they surveyed 2,400 Iowa residents regarding their opinions of agriculture and the environment.

Figure 14. A Case IH AFS PRO-600 is a computer mounted to the machinery which farmers use to harvest crops. The computer calculates the quantity of crops being harvested, among other things.
Photo by LivingImages, via http://www.istockphoto.com.

Reflection Section

The scientists tested 4 treatments, and each treatment was repeated 3 times.

Why did the scientists test each treatment multiple times?

Have you ever taken a survey? Do you think surveys are a good way to get people's opinions? Why or why not?

Think of a recent survey of which you are aware. Describe that survey.

Findings

The scientists found that the control treatments, those catchments planted with 100 percent crops, had similar production and revenue as other Iowa farms. Catchments with prairie strip treatments resulted in lower crop production than the control treatments. Production in prairie strip treatments, however, decreased only by the amount of area taken out of production.

Despite lost production and revenue, catchments with prairie strip treatments resulted in many benefits. First, catchments with prairie strip treatments had greater native plant diversity than catchments with the control treatment. Water runoff was lower in the catchments containing prairie strip treatments, and as a result, soil and nutrient losses were lower.

The results, however, did not show many differences between the three treatment types containing prairie strips. Catchments with the 20 percent prairie strips treatment showed greater diversity of native plants and greater amounts of grassland bird species. Pollinating insect abundance was greater in catchments with treatments containing 10 percent or 20 percent prairie strips planted throughout.

Analysis of Iowa land showed that prairie strips were a suitable solution on 40 percent of agricultural lands with crops and 27 percent of total land in Iowa (figure 15).

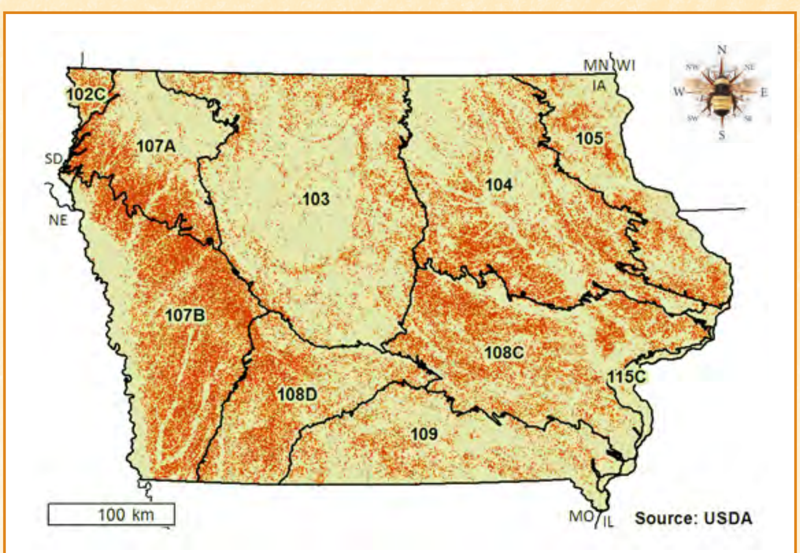


Figure 15. The red color on the map indicates the 40 percent of Iowa land containing crop land that is suitable for using prairie strips.

Map courtesy of the USDA, National Agricultural Statistics Survey.

The survey of Iowa residents indicated that the benefits provided by prairie strips are priorities for Iowa residents (figure 16). Iowa residents indicated that water quality was their highest priority. Survey respondents who lived on farms and those who did not live on farms differed, however, in some of their other priorities.

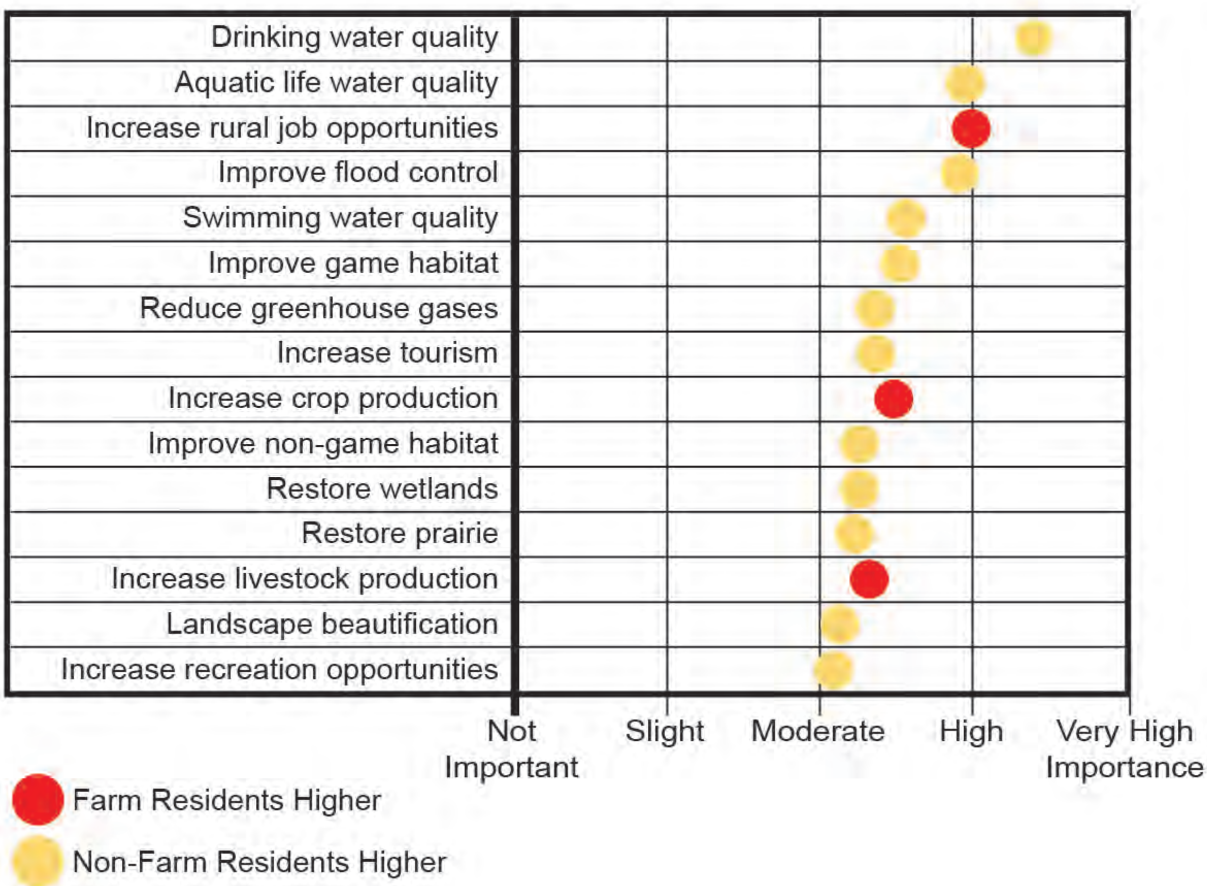
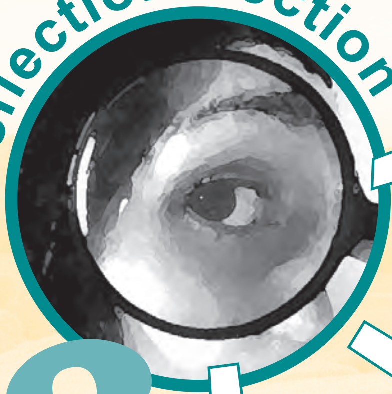


Figure 16. The scientists surveyed Iowa residents living on farms and those that didn't live on farms. They wanted to see how the two groups compared on certain issues. The circles indicate the mean (average) answer from both groups of Iowa residents. The color of the circle indicates which group (farm residents or non-farm residents) had a higher mean survey result for that issue.

Illustration by Stephanie Pfeiffer.

Reflection Section



The scientists found little difference in benefits between the three prairie strip treatments. What does this tell you about how prairie strips should be arranged in agricultural areas?

Review the various priorities listed in figure 14. Think about the place where you live. What is your top priority from that list? Why?

Are you surprised that Iowa residents shared the priority of improving water quality? Why or why not?

Discussion

The experimental results confirmed the scientists' expectations about the differences between catchments with and without prairie strips. Prairie strips replace some crop land, therefore reducing crop production and revenue. However, many of the environmental benefits created by prairie strips outweigh the benefits lost from reduced crop land.

As discussed in "Thinking About the Environment," restoring native ecosystems provides environmental benefits. Planting native prairie plants was effective at slowing water runoff, therefore reducing soil and nutrient loss. Native prairie plants are also better for pollinating insects and may be less attractive to harmful pests.

The scientists found that prairie strips were a suitable solution for a large portion of Iowa. Compared to other farm conservation techniques, prairie strips are low cost and don't require much change to farm operations. Additionally, the benefits provided by prairie strips are of high priority to Iowa residents. Specifically, Iowa residents valued improved water quality.

The results of this study illustrate that prairie strips are both a beneficial and practical solution for improving the environment on agricultural lands. Despite these results, the scientists believe the government must provide policy, **incentives**, and education to encourage farmers to use prairie strips.

The scientists recognize that farmers may need encouragement to adopt prairie strips as a solution. What would you tell a farmer to convince them to adopt prairie strips in their agricultural lands?

Do you think replacing crops with prairie plants is a good idea? Why or why not?

Adapted from Schulte, L. et al. 2017. Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn-soybean croplands. Proceedings of the National Academy of Sciences of the United States of America. 114: 11247-11252. https://www.fs.fed.us/nrs/pubs/jrnl/2017/nrs_2017_schulte_001.pdf.

Cream of the Crop
GLOSSARY

agriculture (**a** gri **kəl** chər): The science or practice of preparing the soil, producing crops, and raising livestock.

annual (**an** yü əl): A plant living for a year or less, reproducing by seed.

biodiversity (**bī** ō dī **vər** sə tē): A measure of the differences between the types and numbers of living things in a natural area.

catchment (**kach** mənt): (1) A small watershed; (2) Something that catches water.

control (kən **trōl**): A control is something used for comparison when checking the results of an experiment.

ecosystem services (**ē** kə **sis** təm **sər** vəs es): Environmental benefits provided by a community of plant and animal species.

harvest (**här** vəst): To gather, collect, or take a crop.

incentive (in **sen** tiv): Something that makes a person try or take an action.

inventory (**in** vən tȯr ē): A complete list of goods, supplies, possessions, or items.

native (**nā** tiv): Naturally occurring in an area.

nonnative (nän **nā** tiv): Not naturally occurring in an area.

perennial (pə **ren** ē əl): Present at all seasons of the year.

pollination (pä lə **nā** shən): The transfer of pollen from a stamen to a pistil of a flower or from a male cone to a female cone.

practical (**prak** ti kəl): Likely to succeed and reasonable to do or use.

revenue (**re** və nü): The total incomes produced by a given source.

Accented syllables are in **bold**. Marks and definitions are from https://www.merriam-webster.com. Definitions are limited to the definition used in the article.

FACTivity

This FACTivity was adapted from the "Roots - Why So Fine?" lesson plan produced by the University of Northern Iowa Tallgrass Prairie Center. To learn more, visit https://tallgrassprairiecenter.org/sites/default/files/lesson_plans/why_so_fine.pdf.

Common Core Connection

Time Needed

One class period

Materials

- Electronic kitchen scale
- Clock or timer
- Sugar, finely ground coffee, cocoa powder, or similar item
- Measuring cup or tablespoon

Materials (per student or group of students)

- 3 6-inch pieces of ½ inch, twisted rope (hemp or cotton)
- 3 plastic cups with water
- 3 pencils
- 3 binder clips
- Plastic sandwich bag
- Permanent marker
- Why So Fine? Graphic Organizer

In this FACTivity, you will use every-day materials to explore how root size impacts the exchange of materials between roots and their surrounding environment.

FACTivity **Background**

As you read in the "Cream of the Crop" article, the tallgrass prairie ecosystem provides many ecosystem services. For instance, the deep and dense root system of native prairie plants slows water runoff and helps preserve soil and nutrients. The roots of these prairie plants provide structure for the soil. The roots also absorb water and exchange material with the soil.

Many of the tallgrass prairie plants are **perennial**. These root systems are working all year, even though you might only see the aboveground grasses growing during the warmer months. The life cycle of perennial plants is different than many crops grown in similar areas, which are **annuals**.

Much of the exchange between roots and soil occurs at the root tips where many very small roots are found, called "root hairs" (figure 17). The root hairs increase the surface area of root systems, enabling plants to exchange more water and nutrients.

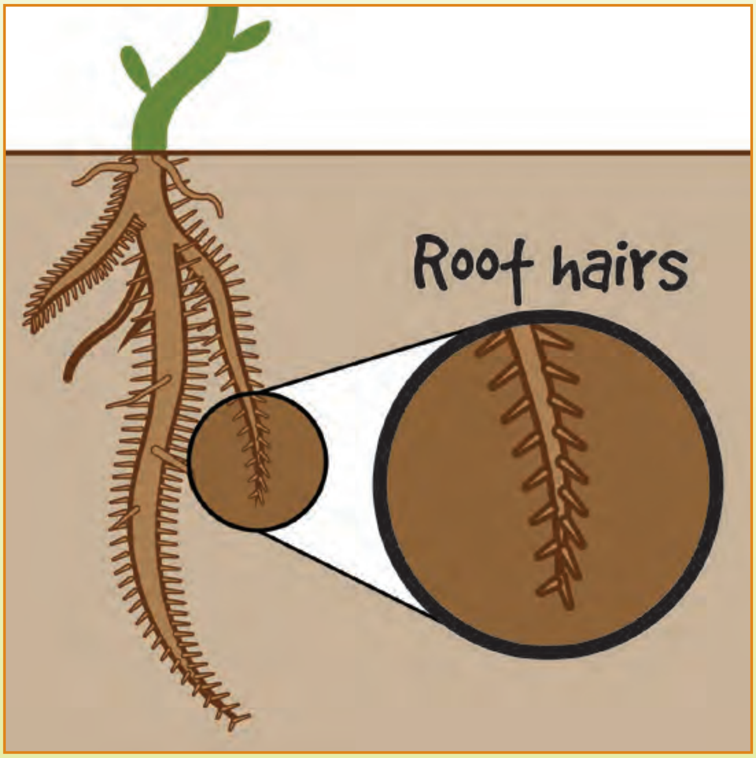


Figure 17. Root hairs are the very small, hair-like roots that grow on the larger roots. Root hairs increase the surface area through which plants can take up nutrients and water with the soil.

Illustration by Stephanie Pfeiffer.

FACTivity **Methods**

Begin by discussing the ecosystem services provided by the native tallgrass prairie ecosystem, like how roots slow water and soil runoff. Images of prairie root systems can be found at: https://www.tallgrassprairiecenter.org/curriculum_images. What do you notice about these roots?

Your teacher will provide each student or group of students with the ropes, plastic cups, pencils, binder clips, plastic sandwich bag, permanent markers, and copies of the "Why So Fine? Graphic Organizer."

Using a permanent marker, label one cup "Thick," one "Medium," and one "Fine."

Fill each cup with the same amount of water. Cups should be filled at least halfway with water.

The three pieces of rope will be made into models of three types of roots or root structures (figure 18). One piece will stay completely twisted to represent a thick root. Another piece should be unraveled half of its length, leaving a few medium strands of rope. The last piece should be unraveled over half its length and separated into many fine strands.

Figure 18. Each of your three pieces of rope should be different. One should represent a thick root, one should represent a few medium-sized roots, and one should represent many fine roots.

Illustration by Stephanie Pfeiffer.

Using the scale provided by your teacher, weigh each of your ropes. Record the weight of each in the appropriate spot on your graphic organizer.

Which root structure will absorb more water? Why? Write your answers to these questions in the appropriate spots on your graphic organizer.

Start the experiment by first attaching the thick rope to the binder clip, then threading the pencil through the metal arms, then placing the rope and clip together next to the appropriate cup of water (figure 19). Repeat this step with each of the other root structure models.

Put each of the root structure models into the appropriate cups, allowing them to rest in the water. Let sit for 10 minutes.

Your teacher will come around after the 10 minutes to help you measure the weight of each model root structure using the electronic kitchen scale. Record the weights of each model root structure in the appropriate spot on your graphic organizer.

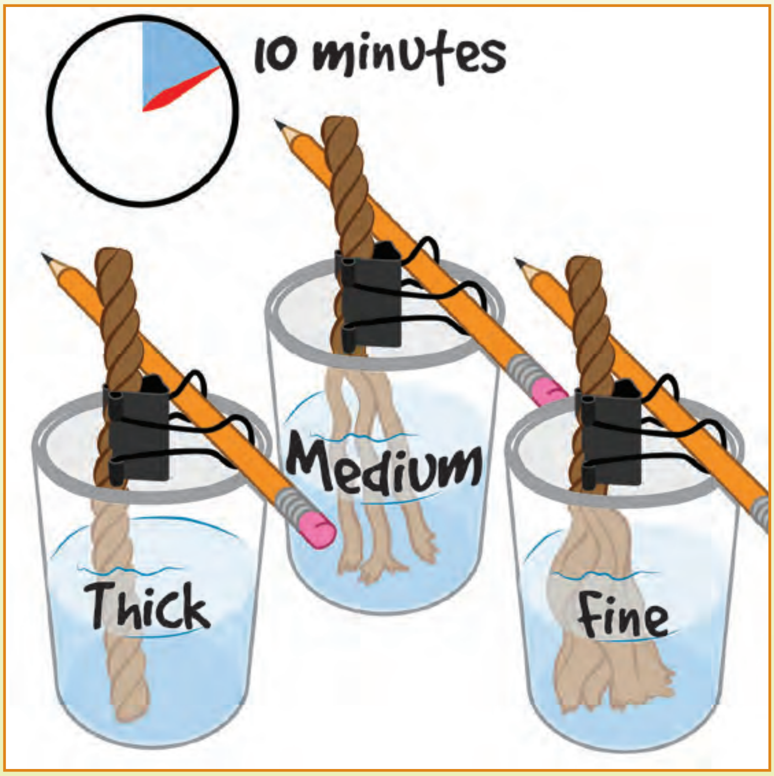


Figure 19. Each piece of rope should be clipped into a different binder clip, and a pencil should be slipped through the metal arms of binder clip.

Illustrations by Stephanie Pfeiffer.

Your teacher will also fill your plastic sandwich bag with sugar, finely ground coffee, cocoa powder, or a similar item. This material represents nutrients that can be exchanged with the roots.

One at a time, take each model root structure, place it in the bag. Close the bag and shake the bag for 10 seconds (figure 20).

Once all three have been individually shaken in the bags, look at the model root structures and rank them based on how much material is attached to the rope. Number one should be the root with the most nutrients and number three should be the root with the least nutrients. The more material attached, the more "nutrients" the model root structure could exchange with the soil.

Record these rankings on the appropriate spot on the graphic organizer.

Figure 20. Place each piece of rope individually into the bag and shake for 10 seconds. Remove the rope and place it on the table until each rope has been shaken and compared to one another.

Illustration by Stephanie Pfeiffer.

As a class, discuss the results of the experiment. Were your predictions accurate? Why or why not? What did you learn about roots and root structure from this experiment? Why is root structure so important to a plant?

Why So Fine? Graphic Organizer

Complete this graphic organizer as prompted in the Methods section of the FACTivity.

WEIGHT BEFORE		
Thick	Medium	Fine

Which root structure will absorb more water? Why?

WEIGHT AFTER		
Thick	Medium	Fine

Which root structures absorbed the most nutrients?
Rank the root structures 1-3, with 1 being the best and 3 the worst.

1. ________________ 2. _________________ 3.____________________

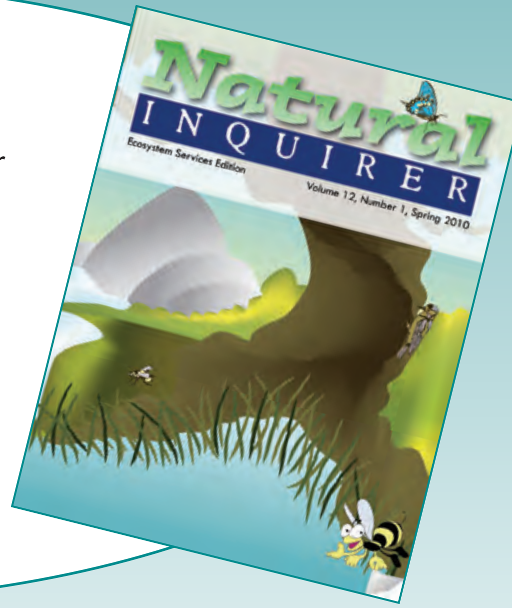
Were your predictions accurate? Why or why not?
What did you learn about roots and root structure from this experiment?
Why is root structure so important to a plant?

Natural Inquirer Connections

You may want to reference this *Natural Inquirer* article for additional information:

- For more information on ecosystem services, read the *Natural Inquirer* Ecosystem Services edition.

This article, along with others, can be found at: http://www.naturalinquirer.org/all-issues.html.



If you are a trained Project Learning Tree educator, you may use “Pass the Plants, Please” and “Field, Forest, Stream” as additional resources.

Web Resources

Science-based Trials of Row Crops Integrated with Prairie Strips – Iowa State University
https://www.nrem.iastate.edu/research/STRIPS/

Tallgrass Prairie Center – University of Northern Iowa
https://tallgrassprairiecenter.org/

Midewin National Tallgrass Prairie
https://www.fs.usda.gov/main/midewin/home

National Forest Foundation Midewin Tallgrass Prairie Restoration Video
https://youtu.be/YQ_eF5zIhSU

Tallgrass Prairie National Preserve – National Park Service
https://www.nps.gov/tapr/index.htm

Welcome to Your National Grasslands – USDA Forest Service
https://www.fs.fed.us/grasslands/

GrasslandsLIVE
https://grasslandslive.org/

World Rangeland Learning Experience (WRANGLE) - University of Arizona
https://wrangle.org/