# Gathering and Evaluating Evidence

## Week 3 – Day 3

## Lesson Overview

During this lesson the teacher will be using a gradual release instructional model to scaffold literacy skills around acquiring, evaluating, and citing textual evidence. Students will be working primarily independently to gather and evaluate multiple pieces of evidence to support their final essays.

## Lesson Vocabulary

textual evidence, quote, citation, and inference

| Standards and Learning Targets for Lesson |
|---|
| **Learning Targets**<br>• I can gather and evaluate textual evidence about potential solutions to my scenario. |
| Next Generation Science Standards<br>• 5-ESS3-1.C – Earth and Human Activity<br>- Obtain and combine information about the ways individual communities use science ideas to protect the Earth's resources and environment. |
| Idaho Science Standards<br>• 5.S.5.1.1 – Personal and Social Perspectives<br>- Identify issues for environmental studies. |
| Common Core ELA Standards<br>• RI.5.1 – Reading Informational Text<br>- Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text. |

## Materials

- Graphic organizer "Gathering Evidence", one copy for each student
- Scenario packet (scenario and articles) for each student, specific to his or her assigned scenario
- Graphic organizer "Problem and Solutions Statements", one copy for each student
- Computer and projector for projecting scenario text

## Lesson Duration

Approximately 2 hours

Fifth Grade Curriculum:
Wheat Farming and Climate Change in the Inland Pacific Northwest


## Lesson Description

This lesson has two stages. The first stage of the lesson is a gradual release instructional model (i.e., I do, we do, you do) where the teacher explicitly teaches how to gather, evaluate, and cite textual evidence and students gradually transition into gathering evidence from text independently. The second stage of the lesson involves students working both independently and collaboratively to extract evidence from texts specific to their assigned scenarios. They will use this evidence to support their proposed solutions to their scenario as they write their essays next week.

**Engage (10 minutes)**

- Begin this activity by explaining the final assessment that the students will be working on over the course of the next week. Each student will be tasked with summarizing their scenario and offering evidence-based solutions to the problem. This will be done in a three- to five-paragraph essay next week. This week the class will continue gaining an understanding of the main problems in their scenarios and start looking for potential solutions in scientific and informational texts.
- Briefly introduce the final assessment learning target: *I can craft a high-quality, evidence-based written opinion piece that explains potential solutions to my scenario*, before explaining the daily learning target. You will briefly introduce this learning target to provide students with an understanding of how today's work will feed into the writing project for the next several days.

**Mini-Lesson: "I do, we do, you do" format (40 minutes)**

- Unpack today's learning target: *I can gather and evaluate textual evidence about potential solutions to my scenario*. (5 minutes)
  - Write the learning target on the board or on chart paper.
  - Discuss the meaning of key words.
  - Discuss the purpose of the lesson in terms of what students will be able to do by the end of the lesson.
  - Give each student a copy of the scenario packet for their group's scenario.

- Part 1 of Mini-Lesson—Gathering Evidence: I Do (10 minutes)
  - Read the directions to the graphic organizer and explain the central question.
  - Project the scenario 1 text and read a section aloud to the class.
  - Model gathering one piece of evidence from the text and evaluate how that piece of evidence addresses the central question.
  - Model how to cite the page and paragraph number of where the evidence came from.
  - Have students observe this entire process and ask clarifying questions.

- Part 2 of Mini-Lesson—Gathering Evidence: We Do (10 minutes)
  - Have students collaborate in pairs to gather one piece of evidence from their scenario and explain in writing why they chose it.
  - Ask each student pair to share with the class what evidence they chose and why, and to show that they cited the page and paragraph number.




- Part 3 of Mini-Lesson—Gathering Evidence: You Do (10 minutes)
  - Ask students to silently and independently gather one piece of evidence, write down the evaluation, and cite page and paragraph number.
  - Differentiate this process by working with any students who do not yet understand the process.

- Part 4 of Mini-Lesson: Debrief (5 minutes)
  - Ask students to self-assess on the learning target: *I can gather and evaluate textual evidence about potential solutions to my scenario*.
  - Conduct a fist to five self-assessment (for students below a three, provide additional support as necessary).

**Independent Work (40 minutes)**

- Students will independently gather evidence from their text and fill out the "Gathering Evidence" graphic organizer.

**Summarizing (10 minutes)**

- Give each student a copy of the "Problem and Solutions Statements" graphic organizer.
- Ask each student to use complete sentences to write a problem statement and two potential solutions they have identified in their reading today.

**Debrief/Check-in (20 minutes)**

- Ask the students in each group to check in with each other and discuss what evidence they have gathered and why.
- During this time, have a representative from each group schedule a 5-minute appointment with you to discuss what is going well with each member and what obstacles or challenges the group needs help overcoming.

Fifth Grade Curriculum:
Wheat Farming and Climate Change in the Inland Pacific Northwest


## *Gathering Evidence*

**Name** _____

**Scenario** _____

Directions: As you read pull quotes/evidence directly from your text and into this graphic organizer. For each piece of evidence you collect you must also write down where you found the information (page and paragraph number (¶#) for articles, website addresses for online sources) and why you decided to collect each piece of evidence. You will use this information to write your final essay.

**Central question: What are the major problems presented in this scenario and what are the potential solutions?**

| Quote/evidence | Why you chose this evidence (evaluation) | Citation (page# and ¶#, website) |
|---|---|---|
| | | |
| | | |

Fifth Grade Curriculum:
Wheat Farming and Climate Change in the Inland Pacific Northwest


## *Gathering Evidence, continued*

| Quote/evidence | Why you chose this evidence (evaluation) | Citation (page# and ¶#, website) |
|---|---|---|
| | | |
| | | |
| | | |

Fifth Grade Curriculum:
Wheat Farming and Climate Change in the Inland Pacific Northwest


## *Gathering Evidence, continued*

| Quote/evidence | Why you chose this evidence (evaluation) | Citation (page# and ¶#, website) |
|---|---|---|
| | | |
| | | |
| | | |

Fifth Grade Curriculum:
Wheat Farming and Climate Change in the Inland Pacific Northwest


## *Gathering Evidence, continued*

| Quote/evidence | Why you chose this evidence (evaluation) | Citation (page# and ¶#, website) |
|---|---|---|
| | | |
| | | |

**Time for a thesis statement!**

A thesis statement is a sentence that provides a reader with the author's main opinion in an essay. Your task now is to write <u>your</u> thesis statement for your essay. Reread all of the evidence you gathered, and in the space below, write the opinion you are going to back up with all of your evidence. If you are stuck, try using the thesis statement starter example to get you started.

**Thesis Statement (starter model)**

Wheat farmers should _____
_____because _____
_____.

**Thesis Statement (independent model)**

_____
_____
_____
_____.

Fifth Grade Curriculum:
Wheat Farming and Climate Change in the Inland Pacific Northwest


## *Problem and Solutions Statements*

**Wheat farmer's name** _____

Scenario (# and brief description):

Problem Statement:

Potential Solution 1:

Potential Solution 2:

# Scenario 1 – Searching for Solutions
# Gathering and Evaluating Evidence

## Review of What's Happening on Your Farm

You have several aphid species on your wheat crop. Many farmers across the inland Pacific Northwest region report problems with aphid pests. With increasing temperatures in the Palouse region of the inland Pacific Northwest, aphids have become more abundant. With the decrease in yield from 2021 to 2025, you estimate that you have lost about $315,000. Aphid pests appear to be playing a role in your decreased wheat yield. You are still doing research to understand exactly why and how the aphids are damaging your wheat crops.

## Research You Have Done So Far

For several years with the help of scientists at the University of Idaho you have been doing research to find solutions to the problems you are facing on your farm. Below is information from three articles you have found. You have decided to summarize and evaluate the evidence you found so far and continue to do more current research. Your goal is to find a solution for the problems you are facing on your farm. After summarizing your research findings, you will write an evidence-based opinion piece to share your thoughts with the scientists. You will ask the scientists to critique your assessment of the problems you are having on your farm and your proposed solutions. Have fun!

## Scenario 1—Article 1

# Potential Effects of Climate Change on Insect Pest Dynamics

Authors: Sikha Deka, Sharmistha Barthakur, and Renu Pandey. From the National Research Centre on Plant Biotechnology, Pusa Campus and the Division of Plant Physiology, Indian Agricultural Research Institute, New Delhi, India. Article adapted from book chapter published in 2008.

http://www.academia.edu/3510694/POTENTIAL_EFFECTS_OF_CLIMATE_CHANGE_ON_INSECT_PEST_DYNAMICS

### Introduction

Climate change is the most important, and the most complex, global environmental issue to date. Effects of greenhouse gases and climate changes are being observed in rising temperature and changes in rain and drought patterns. Global climate warming over the next one hundred years is expected to reduce crop harvest and global agricultural production.

### Rising Temperature and Pest Population

Climate changes currently observed include increased temperature, changes in precipitation, and warmer and shorter winters. Climate factors like temperature and precipitation have a very strong influence on the development, reproduction, and survival of insect pests. Researchers have found that the numbers of leaf eating insects are likely to increase as a result of climate change. Climate change is expected to cause an increased frequency of pest outbreaks.

A key factor regulating the reproduction of insect pest is temperature. Because insects are cold-blooded organisms, the temperature of their bodies is approximately the same as that of the environment. Therefore, their growth and development is strongly influenced by temperature. Almost all insects will be affected by changes in global temperature. Scientific experiments show that agricultural pests are likely to respond to increased temperatures. Milder and shorter winters allow earlier reproduction of insects. With every degree rise in global temperature, the life cycle of insects will be shorter. Shorter life cycles will mean larger populations of pests.

### Conclusions

The greatest challenge facing humans in the next one hundred years will be the need to double our global food production to feed the growing world population. Growing enough food will be difficult as high quality water and soil become more rare. Food crops will also face increasing insect damage as insect populations increase with temperature.

## Scenario 1—Article 2

# Aphids in the Inland Pacific Northwest Region

Article by Regional Approaches to Climate Change (REACCH)—Pacific Northwest Agriculture Scientists.

Many cereal crops, including wheat, are attacked each year by multiple insects. Aphids are one of the insects that cause direct damage to wheat plants. Scientists in Oregon, Washington, and Idaho have been monitoring aphids on farms across the region. These studies give us a better understanding of how aphids are affecting farms and what farmers can do to better manage these pests.

Scientists have found that some aphid species are highly affected by changes in the climate. Warmer temperatures in the region will cause some aphid populations to increase. Like many insects, aphids respond to weather patterns such as long-term trends in temperature and precipitation. The ongoing warming and reduced precipitation in summer will influence the number of aphids in the region. As aphids become more common, farmers will see them as pests on their wheat farms.

Aphids damage crops in two major ways. First, when aphids eat the sugar produced in wheat leaves through photosynthesis, the plant is left with less food. This results in less wheat growth and lower wheat yields. Second, aphids carry viruses that infect plants and reduce yields. Some aphid species transmit the *Barley yellow dwarf virus* (BYDV), which negatively affects grain quality and grain yield of cereals, including wheat.

## Scenario 1—Article 3

# Barley Yellow Dwarf Virus in Idaho Cereal Crops

Authors: Juliet M. Marshall and Arash Rashed. University of Idaho Extension. Article adapted for fifth-grade readers.

### Introduction

*Barley yellow dwarf virus* (BYDV) is a serious and widely occurring viral disease of cereal crops and other grasses. It affects wheat, barley, oats, and occasionally rice and corn. BYDV is spread by aphids that colonize and reproduce on grassy host plants. BYDV is efficiently transmitted by different species of cereal aphids. Unusual weather conditions in 2012 contributed to the BYDV spread in wheat in Idaho. A long frost-free fall promoted large, healthy wheat growth. The warm winter weather was ideal for aphids. In late fall, large populations of aphids migrated from corn crops to wheat crops, bringing the infection to wheat. The extent and severity of the 2012 outbreak was unexpected and considered to be unusual for Idaho grains.

### Symptoms and Impacts of BYDV

Symptoms of BYDV can vary widely. The most characteristic symptom is yellowing of leaves and reddening starting at leaf tips (Figure 1). Plants affected by BYDV have smaller leaves and roots. Affected plants have small irregular wheat heads and smaller seeds. Smaller grains and reduced grain production with BYDV result in reduced grain yields. Yield reductions with BYDV are common.

*Winter wheat infected with BYDV in Idaho.* Photo by Juliet Marshall. May 30, 2013.

### Aphids and BYDV Spread

BYDV can be spread only by aphids. There is no evidence that the virus can spread through farm equipment or seeds. Several species of aphid can carry and transmit BYDV. Interestingly, aphid mothers do not pass BYDV to their young. Aphids get the virus when they eat infected plants, and the virus lives in their bodies for the rest of their lives. Then, when aphids eat other healthy plants, they pass the virus on to these plants and cause healthy plants to become infected. Aphids are attracted to wheat. Mild fall temperatures can lead to increases in aphid populations before

freezing winter temperatures reduce aphid numbers and stop transmission of the virus. Corn is considered to be a "silent carrier" because corn carries the virus, but BYDV does not cause harm or symptoms of disease in corn as it does in wheat.

**Control Recommendations**

The most effective way to control BYDV would be to use resistant varieties of wheat that do not become infected with the virus. However, resistant varieties of Pacific Northwest wheat do not yet exist. The following recommendations have shown to be helpful in reducing the risk of BYDV infection:

- Avoid planting winter wheat varieties in the fall when aphids are at their highest numbers. Instead, plant spring wheat varieties so the plants will grow out of the most vulnerable seedling stage before aphids move into the crop. This would reduce the extent of damage since crops would be larger and more mature during summer aphid infestations. Aphids cause more damage to younger smaller plants. Large plants are less affected by the virus than small seedlings.
- Control aphid flights from other crops like corn. Spraying corn with insecticides will reduce aphid movement from corn to wheat crops. However, this option might be hard to do if the corn crops are not on your farm.
- Insecticide spray treatment may reduce the spread of BYDV in wheat and barley. However, apply treatment to seeds instead of to leaves. This is because spraying leaves may also kill ladybugs and wasps. Both ladybugs and wasps are natural predators of aphids. Applying insecticides to wheat leaves can reduce the populations of these natural predators, which could then cause an increase in aphid numbers.

## Scenario 1—Article 4

# Idaho Grain Growers Brace for Yellow Dwarf Problems

Author: John O'Connell. Published March 17, 2016, in the *Capital Press*. http://www.capitalpress.com/Idaho/20160317/idaho-grain-growers-brace-for-yellow-dwarf-problems. Article adapted for fifth-grade readers.

*University of Idaho Extension cereal crop pathologist, Juliet Marshall, holds a sample of winter wheat infected with barley yellow dwarf virus. Growers from throughout Idaho have sent her samples of winter wheat infected with the virus. Marshall said that this sample did not have an insecticidal seed treatment, which is a recommendation for limiting damage. She warns growers to expect another tough year for diseases.*

ABERDEEN, Idaho — Based on the amount of recent farmer complaints about barley yellow dwarf virus infections in winter wheat, University of Idaho Extension cereals pathologist Juliet Marshall said it's clear the disease will be aggressive again this season.

Last season Idaho grain growers coped with the most widespread Barley yellow dwarf virus outbreak they'd ever experienced. The virus is spread by aphids, causing yellowing of leaves and stunted plant roots.

Though an abnormally wet May helped plants grow out of their symptoms in 2015, many growers still experienced yield losses of up to 40 percent, Marshall said. Marshall fears the disease is at least as widespread as last year, and without a break from Mother Nature, yield losses could be greater.

Coupled with slumping grain prices, Marshall worries Idaho wheat and barley returns could suffer.

"It's going to be widespread again," Marshall said. "There are some growers who feel like it's going to be worse, but at this point, we can't tell."

Marshall said growers have brought half a dozen samples of infected plants to her office and she's been flooded with calls, confirming the disease is present in fields throughout Idaho. She said growers have found infected plants throughout fields often with the heaviest infections occurring along field edges.

"Barley yellow dwarf virus is going to be pretty visible here in the next several weeks," Marshall said.

Marshall believes barley yellow dwarf virus  has been present in the region for a long time but said it first became a noticeable problem in 2008. She believes infection rates have risen as the state's corn acreage has increased. Corn supports aphids until fall grains sprout and lure them away.

Marshall advises farmers to use insecticidal seed treatments and delay planting fall grain as long as possible to reduce exposure to aphids before cold weather keeps them in check. Marshall said most of the reported infections were from early planted grain, but she acknowledges some growers wouldn't have enough time to plant if they delayed.

This spring Marshall advises growers to control potential sources of aphids and to plant spring grain as early as possible, allowing the plants to mature and be hardy when aphids arrive. She also advises growers to keep crops well watered and fertilized as the virus robs plants of the nutrients and moisture they need to grow.

UI agronomist Xi Liang is leading greenhouse and field studies to evaluate how sick plants absorb moisture. "We'll collect roots at the end of the study to see if the roots are affected by barley yellow dwarf virus and damage water uptake from the soil," Liang said.

# Scenario 2 – Searching for Solutions
# Gathering and Evaluating Evidence

## Review of What's Happening on Your Farm

With summer temperatures increasing, your wheat plants and the soil are losing a lot of water through evapotranspiration. Your soils are becoming drier every year and your wheat is not growing as well as it used to. Heat stress is affecting wheat throughout the inland Pacific Northwest region and many farmers are changing their practices to better fit the weather conditions they encounter each year.

## Research You Have Done So Far

For several years with the help of scientists at Oregon State University, you have been doing research to find solutions to the problems you are facing on your farm. Below is information from three articles you found. You have decided to summarize and evaluate the evidence you have found so far and continue to do more current research. Your goal is to find a solution for the problems you are facing on your farm. After summarizing your research findings, you will write an evidence-based opinion piece to share your thoughts with the scientists. You will ask the scientists to critique your assessment of the problems you are having on your farm and your proposed solutions. Have fun!

## Scenario 2—Article 1

# Farmers Expect Low Yields for Wheat Harvest: Umatilla and Morrow County Farmers Can Expect Reduced Yields on Wheat Harvest Following a Dry Growing Season

Published June 23, 2015, in the *East Oregonian*. http://www.eastoregonian.com/eo/local-news/20150623/farmers-expect-low-yields-for-wheat-harvest. Article adapted for fifth-grade readers.

Standing in a field of golden wheat that reached barely up to his knees, Joe Rietmann said this year's abnormally short crop is clearly feeling the effects of drought.

"This is all typical drought stress," said Rietmann, owner of JDR Farms in Ione. "If you look over the expanse of the field and see the darker areas, that's where it's stunted."

Like most dryland farmers in eastern Oregon Rietmann expects the hot, dry weather will cut into his winter wheat harvest and lower yields by more than half in some areas. Ione's precipitation is three inches below normal dating back to September 2014 (winter wheat is usually planted in September). Upcoming weekend temperatures forecast well into the triple digits.

If it weren't for about an inch of rain that fell in May Rietmann said things would look even worse. As it is, he figures to harvest somewhere in the high-teens to mid-30s bushels per acre, depending on the location of the field.

"In an agricultural endeavor, you just have to roll with it and stay in business," he said.

This year actually marks the third straight year of below-average precipitation for the region's wheat farmers after a solid season in 2012. That's compounded the problem for growers like Rietmann who manage their fields in a wheat-fallow rotation to build up moisture deep in the soil.

Larry Lutcher, soil scientist with Oregon State University Extension Service in Morrow County, said the cumulation of three dry years in a row has left farmers with virtually no water left in storage. He predicted yields could be less than 10 bushels per acre on land that typically grows 35-40 bushels per acre.

"Even with crop insurance, it gets difficult to make ends meet," Lutcher said. "They'll get by, but they certainly won't make any money generating yields like this."

Umatilla and Morrow counties rank first and second by a wide margin in Oregon wheat production. Last year the two counties combined to harvest 17.8 million bushels of winter wheat on 357,000 acres, according to the National Agricultural Statistics Service.

In 2012 the counties harvested 21.7 million bushels thanks in part to higher rainfall. Precipitation in Ione averaged 12.23 inches between the months of September and June from 2010-2012, but just 7.5 inches from 2013-2015.

The timing of rains is also an important factor, said Jason Middleton, director of grain operations for Pendleton Grain Growers. Dryland farmers always need precipitation in May and June to finish a winter wheat crop, and precipitation has essentially shut off the past month, he said.

"I would expect (yields) to be down across the board this year," Middleton said.

Lower yields means more farmers could fall back on crop insurance to make them whole. Debbie Morrison, an agent with Wheatland Insurance in Pendleton, said she expects a lot of claims in the coming weeks.

"I don't think we'll have the high yields we were looking for," Morrison said. "As soon as they start harvesting, they'll call me and tell me if they're light."

Crop insurance provides coverage based on a field's production over the past 10 years, marking a guaranteed value that can be set either to yield or revenue. If harvest comes in below the guarantee, insurance pays the rest.

Farmers can only insure up to 85 percent of their crop, and the higher insured percentage, the higher the premium, Morrison said.

Don Wysocki, soil scientist with OSU Extension in Umatilla County, said this is the kind of year crop insurance is designed to protect. He said the best farmers can do now is hope for a burst of rain in August or September, which will allow for earlier planting of next year's crop.

*Ione wheat farmer Joe Rietmann holds his hand out at the height his soft white winter wheat should be at this time of year with proper temperatures and moisture in one of his fields north of Ione.*

"An inch of rain in early September would do a lot of good," Wysocki said. "Yield expectations would be better if you can plant during the optimal time period."

Early rains also allow farmers to spray for grassy weeds, such as cheatgrass and feral rye, before planting, which saves money on specialized herbicides they would otherwise have to use to kill the weeds while sparing wheat.

Growers certainly don't enjoy the dry years, Rietmann said, but they always plan for difficult conditions and aren't surprised when they happen. Dry periods are normal for the area, he said, and conditions always turn back around from year to year.

"There are worse things in life than a dry crop year," Rietmann said. "This is just part of farming ... I suspect somewhere on the other end of this, it will pick back up again."

*Ione wheat farmer Joe Rietmann holds a malformed head of soft white winter wheat. Low moisture and hot temperature causes the heads of wheat to curl.*

*Thistles grow in a field of soft white winter wheat on Tuesday outside of Ione. Unusually high May temperatures and lower than normal spring precipitation has left a large amount of ground uncovered, giving the weeds a necessary foothold to grow.*

## Scenario 2—Article 2

# No-Till Agriculture Offers Vast Sustainability Benefits. So Why Do Many Organic Farmers Reject It?

Author: Nicholas Staropoli. Published June 2, 2016, by the Genetic Literacy Project. https://geneticliteracyproject.org/2016/06/02/no-till-agriculture-offers-vast-sustainability-benefits-so-why-do-organic-farmers-reject-it/. Adapted for fifth-grade readers.

One of the main images most Americans have of farming is of a plow being pulled by a tractor (or in more antiquated images, livestock) turning the land. Technically speaking this act is referred to as tillage: the preparation of soil for planting by simply turning it over.

Today, most farmland is prepared in this way and has been for thousands of years, but tillage has many side effects that injure both farmland and the environment.

In the push to make farming more sustainable, an increasing number of farmers have turned to what is called no-till agriculture. However, the technique is not being embraced by all farmers. Organic farmers, the group one would think would be most embracing of this tool, are shunning it.

In contrast, farmers that are growing genetically modified crops are its biggest proponents and it's helped reduce the amount of greenhouse gases released from farm fields. How did this odd situation come about?

Tillage is primarily a form of weed control. When a farmer plows, depending on the crop, as much as a foot deep of soil is overturned, leading to a loss of 90 percent of the crop residue (the decomposing plant from the previous year) from the top soil. The benefit of this high turnover is that it kills weeds. The problem is that tillage takes a lot of work, a lot of fuel, and often a plot of land needs to be tilled several times before planting commences.




Tillage also damages the soil and leaves it exposed to erosion, particularly by wind and water. The damage of tillage was very bad during the Dust Bowl (1930 – 1939), a time in which crops and farms were ruined by severe windstorms and droughts combined with eroding topsoil. This period of hardship for many farmers has led some to rethink tillage-based farming.

**How No-Till Works**

No-till farming, a type of soil conservation farming, prepares the land for farming without disturbing the soil. The previous year's crops, referred to as the crop residue, are chopped off and left on the topsoil. A no-till planter then only slightly punctures the ground to insert a seed. To overcome the lost advantages in weed control that tillage brings, herbicides and pesticides are applied to the land before and after planting.

There are countless benefits to the land, the farmer, and the environment from adopting a no-till system. First and foremost, by leaving the soil mostly undisturbed and leaving high levels of crop residues behind, soil erosion is almost completely eliminated through no-till farming. The USDA's National Resources Inventory credits the 43 percent reduction in soil erosion in the United States between 1982 and 2003 to the increase in conservation tillage.

Using crop residues in no-till farming also increases the amount of soil moisture. This means there is less runoff of pesticide-polluted water, as well as a reduction in the amount of watering necessary for a given crop.

Some estimates suggest crop residues provide as much as 2 inches of additional water to crops in late summer. The Natural Resources Conservation Service states that no-till farmed soils have a water penetration rate of 5.6 inches per hour, twice as much as for conventionally tilled land. This makes no-till farming an excellent opportunity for drought-stricken areas like the dryland wheat farms around Morrow County, Oregon.

The farmer significantly benefits by the adoption of no-till farming, in particular through a reduction in labor and fuel cost. Conventional tillage practices requires as many as five passes over the land with a plow; however, no-till requires just a single pass to plant the seeds. An estimate by Purdue University calculates that a farmer will save 225 hours of labor per year for a 500-acre farm, the equivalent of four 60-hour work weeks saved a year. Another study estimated a reduction in labor by as much as 50 percent compared to tillage.

**Climate Change Benefits**

The benefits in reducing farming's global warming footprint are huge. One estimate suggests that no-till can reduce fuel usage by as much as 80 percent. In addition to the reduced carbon emissions from mechanical equipment used in no-till farming, there are several other benefits to the environment. No-till farming, often when paired with crop




covering (a technique in which a crop is planted for the express purpose of soil health), reduces carbon emissions by holding carbon dioxide in the soil.

Carbon dioxide isn't the only greenhouse gas reduced by no-till; the release of nitrous oxide, a very dangerous greenhouse gas, is also reduced through no-till. As more nitrogen is immobilized in the soil, there is a reduced need for the application of nitrogen-rich manure.

Although there are benefits of no-till farming, there has yet to be widespread use of the technique. As of 2009, only 35 percent of U.S. farmland had at least some land dedicated to no-till practices. Furthermore, the USDA reports that no-till practices are increasing at just 1.5 percent and only 10 percent of farms are considered "continuously no-till."

Why haven't all farmers adopted it? No-till has some drawbacks.

For starters, some crops need to be planted on tilled lands, such as root crops (e.g., potatoes). There are also obstacles to adopting the practice, in particular start-up costs which include new no-till equipment (the planters) and chemical herbicides. A steep learning curve is also an obstacle as no-till practices can breed different pests, infections and weeds than those that are found in traditional tillage-based farming.

Despite the drawbacks of no-till farming, research into the technique continues and is expanding to many areas of the country. In Washington and Oregon, for example, where wheat is grown on fairly arid land, a study into farming of wheat there has shown that no-till matches (and possibly exceeds) yields compared to traditional tillage.

Although we may not be able to convert all cropland to no-till farming, the more we do the better it is for the environment, the farmer, and the land.

## Scenario 2—Article 3

# Study: Conserving Soil and Water in Dryland Wheat Region

Author: Sylvia Kantor, Washington State University, College of Agricultural, Human & Natural Resource Sciences. Published November 24, 2014. https://news.wsu.edu/2014/11/24/study-conserving-soil-and-water-in-dryland-wheat-region/. Adapted for fifth-grade readers.

In the world's driest rainfed wheat region, Washington State University researchers have identified new ways that can make all the difference for farmers, water, soil, and air quality.

Wheat growers in the Horse Heaven Hills of south-central Washington farm with an average of 6-8 inches of rain a year. Wind erosion has caused blowing dust that exceeded federal air quality standards 20 times in the past 10 years.

"Some of these events caused complete brown outs, zero visibility, closed freeways," said WSU research agronomist Bill Schillinger.

*Harvesting hard red winter wheat at the western trial site in 2008 yielded 16 bushels per acre.* *Photo by Steve Schofstoll, WSU*

He and WSU agricultural economist Doug Young compared three fallow management systems in the western part of the Horse Heaven Hills with 6 inches of annual rainfall and the same practices in the eastern part with 8 inches of rain. A fallow management system is a type of farming that has wheat growing one year and the soil recovering by having no crop on it the next year. Basically, it's one year on, one year off.

### Timing to trap moisture

Farmers in the Horse Heaven Hills practice a winter wheat-summer fallow rotation where only one crop is grown every other year on a given piece of land.

Average yields can be as low as 18 bushels per acre – compared to upwards of 120 bushels per acre in the higher rainfall area of the Palouse in eastern Washington. With careful management, wheat farming in the Horse Heaven Hills can be profitable.

To get the highest yield, farmers need to plant winter wheat in late August or early September after a year of fallow. The fallow period allows enough moisture from winter and spring rains to accumulate in the soil for seeds to get established.

*Alternating strips of undercutter tillage fallow and traditional tillage fallow in the eastern Horse Heaven Hills in 2009.* Photo by Bill Schillinger, WSU

"In east-central Washington if you can't plant in late summer into deep seed-zone moisture in fallow, then you have to wait for fall rains in mid-October or later," Schillinger said.

The longer it takes to get winter wheat seedlings established the lower the potential for good yields.

To help ensure precious soil moisture remains in the seeding zone, farmers till the soil in the spring, which helps slow soil moisture evaporation in the seed zone during the hot, dry summer months.

But too much tillage can cause soil loss through wind erosion that feeds hazardous dust storms.

**Undercutting**

Compared to traditional tillage, Schillinger and Young found that undercutter tillage was the best option for fallow in the slightly moister eastern region of the Horse Heaven Hills, where late-August planting is possible and spring tillage helps hold summer soil moisture.

With wide, narrow-pitched, V-shaped blades, the undercutter slices beneath the soil surface without causing much disturbance of the soil surface.

Schillinger said scientists and farmers have conclusively shown that spring tillage with the undercutter effectively keeps seed-zone moisture.


*An undercutter with V-shaped blades used for primary spring tillage with fertilizer injection during the fallow year.* Photo by Harry Schafer, Washington Association of Wheat Growers

In the western region of the Horse Heaven Hills, the best option for controlling wind erosion was to practice no-till fallow, that is, to avoid tillage altogether. Most of the time rainfall in this area simply isn't enough to establish an early stand of winter wheat. "There's no reason to till the soil when you already know in the spring that it will be too dry to plant wheat in late August," Schillinger said.

Economist Young found that, despite the modest grain yield potential, wheat farming in this environment can be profitable – with enough acreage and careful use of inputs to manage costs. In fact, late-planted winter wheat on no-till fallow was just as profitable as traditional-tillage and undercutter-tillage fallow treatments in areas that receive far more rainfall.

# Scenario 3 – Searching for Solutions
# Gathering and Evaluating Evidence

## Review of What's Happening on Your Farm

The climate has been changing over the course of the last 50 to 100 years. With winter temperatures increasing, winter precipitation falls more as rain and less as snow. You have been planting spring wheat for many years, a type of wheat that is planted in April (early spring). For the past few years the ground has been very wet in April after the winter rains. The soil is so wet that your tractor and seed drill get stuck in the mud. By the time the ground is dry enough to drive your plow and pull the seed drill, it is too late in the planting season and you lose an entire crop for the year. Many wheat farmers throughout the inland Pacific Northwest region are facing this same challenge planting wheat in the spring. Farmers are changing their practices in order to better fit the weather conditions they encounter each year.

## Research You Have Done So Far

For several years with the help of scientists at Washington State University you have been doing research to find solutions to the problems you are facing on your farm. Below is information from three articles you found. You have decided to summarize and evaluate the evidence you have found so far and continue to do more current research. Your goal is to find a solution for the problems you are facing on your farm. After summarizing your research findings, you will write an evidence-based opinion piece to share your thoughts with the scientists. You will ask the scientists to critique your assessment of the problems you are having on your farm and your proposed solutions. Have fun!

## Scenario 3—Article 1

# Wetter Climate Influences Inland Northwest Wheat Growers

Article by Regional Approaches to Climate Change (REACCH)—Pacific Northwest Agriculture Scientists. Adapted for fifth-grade readers.

In the inland Pacific Northwest region, spring precipitation amounts have been increasing and are expected to increase by 5 to 15% more in the next 40 to 70 years. Wet springs are expected to become more common. The timing of heavier spring precipitation will impact spring crop plantings.

The eastern parts of the region have more winter rain and more clay in soils so soils often have excess water in the spring. Some fields are completely saturated for weeks during early spring months due to poor drainage through the clay soils. Excess springtime moisture can prevent farmers from planting seeds in the ground. When the ground is too wet plows and seed drills just sink in the mud and get stuck.

A few years ago an unusually wet spring prevented farmers from planting more than 122,000 acres in the inland Pacific Northwest region. After the latest possible planting day passed most farmers decided to leave their land in summer fallow, or without any crops growing on it. Bare soil without crops over the summer often results in soil erosion. Soil erosion is a process where the top layers of soil are carried away from the farm by wind or rain. Erosion leaves farms with less soil that plants need to grow. When erosion increases future yields and profits decrease because plants can't grow as well.

Farmers in the wetter regions of the inland Pacific Northwest must find ways to deal with wet soils during the early spring months.

One option for farmers is to plant wheat in the winter instead of the spring. Spring wheat is planted in the spring, grows throughout the spring and summer, and is harvested in late summer. Winter wheat is a different type of wheat that is planted in the fall, germinates in the fall, remains as a small plant in the ground throughout the winter, and continues to grow in the spring.

If the ground is too wet for farmers to plant spring wheat they could consider planting winter wheat. However, winter wheat should not be planted every year. Farmers only plant winter wheat every other year. They often plant a different crop in between the winter wheat years. This technique of switching off crops planted each year is called crop rotation. Crop rotation can help farmers improve soil health, prevent erosion, prevent weed growth, save water, and increase future wheat yields.




Some options for crop rotation with wheat in the inland Pacific Northwest region are peas, lentils, and canola. Research has shown that replacing fallow (bare land) with peas, lentils, or canola can help improve wheat yields the following year. This is because these crops improve soil health so the wheat can grow larger and stronger next year. Research has also shown that wheat grown after canola has higher grain yield compared to wheat grown after wheat. Rotating wheat with cover crops every other year is an exciting option that growers are beginning to adopt.

## Scenario 3—Article 2

# It's Time to Go Seeding, but Mother Nature Disagrees

Blogpost. May 8, 2014. A Year in the Life of a Farmer. https://southsaskfarmer.com/2014/05/08/its-time-to-go-seeding-but-mother-nature-disagrees/#comments

Tomorrow is the day. I hope.

It has been a whirlwind this spring, spinning us from hope, to frustration, to anxiety, and nearly to despair. Back in early April, for the first time in many years, it looked like seeding would begin early. Fields only had a light coating of snow and a long and brutal winter was finally drawing to a close. The days were growing warmer and the snow was finally beginning to melt. It appeared as though spring had arrived and the forecasts for May looked excellent, with cool but dry weather taking us through seeding, until a wetter June would arrive just in time to germinate crops and get everything growing. There were some real concerns about dryness, with fields looking almost alarmingly dry.

All of that has now changed.

In April through the first week of May, we received twice our normal rainfall (and snowfall!), coupled with far below normal temperatures. The ground went from dust to mud and the cold weather never even let the frost come out. The soil profile still has frost in it a few feet down and now every low spot is wet. We have reached the 8th of May with virtually no fieldwork happening in the entire region. In fact, until just recently, almost seeding all on the Canadian Prairies was stalled; few farmers could even get in the field to do rudimentary fieldwork.

This weather pattern has been frustratingly persistent. In 2009 there was a late start to seeding and it was a cool, wet year right through until harvest. Although seeding was difficult and harvest even more so, a year like that grows an amazing crop. The next year, 2010, was much worse, with snow arriving in late April, shutting us down for some time. We were unable to finish seeding that year and the crop was very poor, with saturated soil conditions killing much of our crops.

The year 2011 was the worst of them all, with seeding being virtually nonexistent. It was a tough year to be a farmer. Since 2011, we have had two great crops, but spring has still been difficult, with wet and cool weather plaguing us. Low spots are continually underwater despite our best efforts to look after them and our drills spend more time turning than they do in the ground.




We need a weather pattern change. We need to get to drier and warmer weather, or we again run the risk of not completing seeding. We get a very short window to get the crop in the ground here. Usually, seeding starts in late April and ends on June 15 before the Crop Insurance deadline. Lately, it starts in mid-May, and the Crop Insurance deadline is what it is. We are losing three weeks of normal seeding weather and this year will be no different.

Oddly enough, last year was in some ways more conducive for seeding than this year. Although we still had snow all over the place a year ago today, warm, bright, windy weather swooped in just in time at the beginning of May, melting the mountains of snow and getting us to the field surprisingly early. This year, we had very little snow, but cold weather has kept drying rates down to nothing. In reality this is simply one of the weirdest springs I can ever remember.

This is one of the most stressful times of the year for every farmer when frighteningly large sums of money are thrown into the soil and into Mother Nature's unreliable and often thrifty hands. The last question any farmer, especially this one, wants to ponder is, "Will I be able to get my crop seeded this year?" Unfortunately, I have been on the "no" side of that question before, and it is a terrible feeling. It is so frustrating to once again be faced with that question. Frighteningly, we are one large rain event away from being in real risk of not seeding this year. All we can do is hope that that rainfall event doesn't come, and that heat graces us over the next few weeks.

## Scenario 3—Article 3

# Oilseeds Successful Crop for Northwest Farmers

Author: Kristi Pihl, staff writer. Published January 23, 2013, in the *Tri-City Herald.* http://www.tri-cityherald.com/news/business/article32109417.html

Canola has been the successful result of some Washington and Idaho farmers' search for a more profitable crop.

Adams County farmer Curtis Hennings told about 225 people Tuesday that he has made more money on canola than wheat for the past several years.

He was speaking during the Washington State University (WSU) Oilseed Production and Marketing Conference at Kennewick's Three Rivers Convention Center.

Hennings of Ralston and other farmers explained the benefits they have found in growing oilseeds like canola, including improving soil quality and preventing erosion, during the event.

"It's a rotational crop with return," said Hal Johnson, who farms near Davenport.

Dan Bernardo, WSU's dean of the College of Agriculture, Human and Natural Resource Sciences and director of WSU Extension, said he sees a developing vibrant biofuels sector in Washington, from growing oilseeds like canola to crushing them and processing them into biofuels like biodiesel and aviation biofuel.

"We can grow biomass as well or better than anybody in the country because of our unique climatic conditions," he said.

There's a need for more oilseeds, said Mary Beth Lang, Washington State Department of Agriculture's bioenergy and special projects coordinator.

Washington has the infrastructure for biofuels production, she said. There are four biofuels plants, including one in Odessa in Lincoln County.

Lang said Washington saw a 40 percent increase in production last year from the previous year.

Washington's 14,500 acres of canola produced 27.6 million pounds of canola in 2012, according to the state.




Most of Washington's biodiesel has gone to Oregon and British Columbia, Lang said. Both have renewable fuel standards calling for such fuels in the marketplace.

In Canada, canola is more than a $15 billion industry, said Phil Thomas of Alberta, who has worked with canola and rapeseed for 51 years. Canada has about 20 million acres of canola.

In the '60s, Canadian scientists developed canola from rapeseed. The canola name comes from "Canadian oil, low acid."

Canola plants, which are related to mustard, Brussels sprouts and turnips, stand 3 to 5 feet tall. Its pods hold the seeds that are crushed for the oil, which then is used for cooking and biodiesel.

Canola is part of the diversity adding to the economics of a farm, Johnson said.

Newer combines and headers have made a huge difference, he said. The insurance programs have improved and the University of Idaho has developed varieties to withstand winter better.

Canola can be forgiving in some ways, said Scott McLeod, a farmer from Nezperce, Idaho. It is tough and will try to come back after it is hit by hail, while most other crops won't.

During harvest, it sounds like a thunderstorm because so much is coming in, he said.

"I like to grow canola because it's pretty," McLeod said.

People will stop and ask about the crop, which has yellow blooms. He said that is good for the farming industry.

For irrigated eastern Washington, which includes Benton and Franklin counties, adding canola into a crop rotation can help keep yields up and disease down for wheat, said Jenny Ringwood Connolly, WSU School of Economic Sciences associate in research.

Rotations that include canola see higher returns overall, she said.

In general, Connolly said researchers have found that while growing canola increased a farm's input costs, it results in higher profits. Canola may not be the most profitable crop in a year, but it complements other crops, she said.

She said WSU researchers are creating budgets for different growing regions that will be released online so farmers can adapt them to their specific circumstances.




The conference, which continues today, is meant to allow growers who have not grown oilseeds to interact with those who have, said Karen Sowers, WSU extension and outreach specialist for the Department of Crop & Soil Sciences.

"There is a real need to increase the knowledge base of both growers and the ag industry," Sowers said.

Washington has taken a number of steps to encourage a biofuels industry in the state, including earmarking $1 million a year for WSU for research for bioenergy, including cropping systems, Lang said. While budget cuts have meant fewer dollars, the support remains.

The state Legislature also has asked state agencies to use biodiesel, she said. Washington ferries and ground vehicles are using some biodiesel.