Trouble at Grainly Farms
Teacher Notes

Can your students identify and solve the problem at Grainly Farms? This case study incorporates the following scientific concepts: natural selection, adaptation, inheritance of traits, integrated pest management, and nematodes. This is a realistic, guided case study using a fictional situation. The characters and places in the module are not real, but the scenario is authentic and similar to what can happen on many farms. As students work through the module, they will receive new information about the situation on each page. They will view and analyze each of the videos and documents, and discuss the implications before new information is provided.

Each page of new information is followed by a "Stop and Consider" step to allow for small group and whole class discussion and for students to document their learning using the provided Student Guide. You will guide their discussion and analysis, assist students as they evaluate information and conduct independent research. Students can work in groups or independently as they apply their understanding of scientific concepts to suggest a plan to deal with the trouble at Grainly Farms.

Curriculum Connections

This module and supporting resources can be used and adapted for grades 7-12.

Primary Student Performance Expectations:

- Analyze and interpret the information in a library of documents (including videos) for evidence concerning natural selection, adaptation, and inheritance of traits that will support a sustainable strategy to reduce pest damage and maximize yields.
- Design or refine a solution to an agricultural pest problem. The solution should be based on the knowledge that those traits which positively affect survival are more likely to be reproduced, and thus become more common in the pest population.
- Communicate an argument for a specific pest management strategy using evidence that accounts for differential survival/reproduction of organisms and the cause and effect of altering specific environmental factors that affect expression of traits.

Engineering and Science Practices

- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument from Evidence
- Obtaining, Evaluating, and Communicating Information

Discipline Concepts

- Natural Selection
- Adaption
- Inheritance of Traits

Cross Cutting Concepts

- Cause and Effect
- Structure and Function
- Stability and Change

The content of this module connects with learning outcomes in the following NGSS standards (http://www.nextgenscience.org/):

- *From Molecules to Organisms: Structures and Processes: Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (MS-LS1-5)*
- *Biological Evolution: Unity and Diversity: Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. (MS-LS4-4)*
- *Biological Evolution: Unity and Diversity: Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. (MS-LS4-5)*
- *Biological Evolution: Unity and Diversity: Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. (MS-LS4-6)*
- *Biological Evolution: Unity and Diversity: Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment. (HS-LS4-2)*
- *Biological Evolution: Unity and Diversity: Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait. (HS-LS4-3)*
- *Biological Evolution: Unity and Diversity: Construct an explanation based on evidence for how natural selection leads to adaptation of populations. (HS-LS4-4)*
- *Biological Evolution: Unity and Diversity: Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species. (HS-LS4-5)*

Classroom Experience Notes

The module is organized into five sections. New information is provided on each page, followed by a “Stop and Consider” page for student analysis and classroom discussion. Documents are provided in pdf format for easy viewing and printing. Students should view and print the Student Guide as they work through the module.

Page 1: Welcome to Grainly Farms

Page Resources:

- Document: Welcome Letter
- Document: Grainly Farms: Field Report
- Document: Grainly Farms: Yield Data
- Document: Field Images

Student Questions:

1. Identifying the Problem
    1. Are there problems in any of these fields? What evidence led to your conclusion?
    2. Using the information provided and what you already know, consider what may be going on that has caused a problem. List at least three possible causes of the problem with the soybeans.

Page 2: Plants Get Sick

Page Resources:

- Video: Plants get Sick?
- Video: Diagnosing Plant Disease in Soybeans
- Document: Grainly Farms: Soil Sample Test Results
- Document: Merryweather County Sodbusters Society Online Forum

Student Questions:

2. Evaluating Possible Causes

After viewing the videos and documents on the Plants Get Sick page, re-consider the possible causes you identified for the soybean problem. Make sure to cite specific information from the documents and supporting videos to support your decision.

1. Which of the possible causes you listed in Part 1 can be ruled out as a cause of the problem?
2. At this point, what do you think is the likely cause of the reduction in yield?

Page 3: Understanding Nematodes

Page Resources:

- Video: What is a Nematode?
- Video: Soybean Cyst Nematodes
- Document: Yield Loss from SCN

Student Questions:
3. Understanding Nematodes
Soybean cyst nematodes (SCN) have an interesting way of interacting with the soybean plant. After viewing the videos and documents on the website, answer the following questions.

1. In your own words, describe what a nematode is.
2. Where can nematodes be found in nature?
3. Is a nematode always a bad thing?
4. How does a nematode affect a soybean plant, and how could this lead to a reduction in yield?

Page 4: Evolution of a Crop and a Pest

Page Resources:

- Video: History of SCN Resistance in Soybeans

Student Questions:
4. Evolution of a Crop and a Pest
Since soybean plants and nematodes are both living things, they are constantly evolving and adapting to their environment. After viewing the videos and documents on the website, answer the following questions.

1. In your own words, explain how soybean plant populations have adapted and thrived to become a major agricultural product.
2. How have natural and artificial factors influenced this adaptation?
3. How do SCN populations adapt to changing soybean populations?

Page 5: The Crop Management Plan

Page Resources:

- Video: Managing Plant Pests & Pathogens the Integrated Way
- Weblinks: Managing SCN

Student Questions:
5. Managing Nematode Populations
Farmers have different options to consider to reduce nematode populations and maintain a high soybean yield.

1. List three options for managing SCN populations. For each option, state how that approach might impact the nematode population in the first year.
2. Considering what you know about genetic variability and adaptation, what would happen to SCN populations if you used only one method over several years?
3. What management approach do you recommend for Grainly Farms? Explain why this is the best approach.