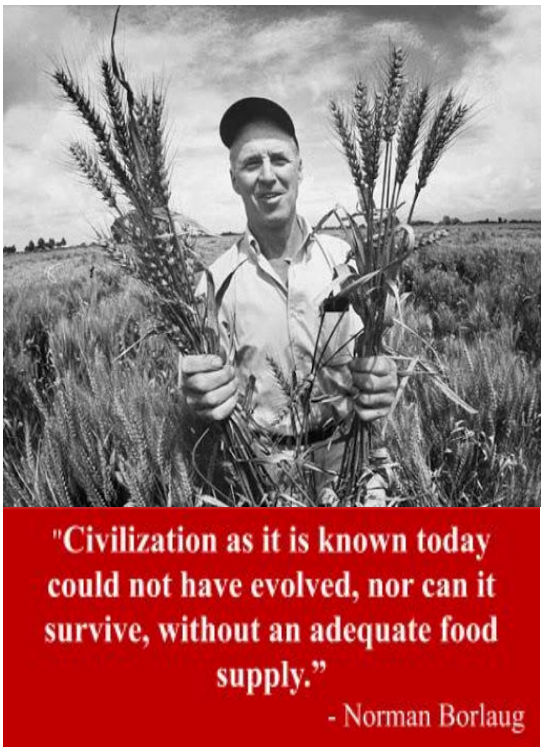
Norman Borlaug- Hunger Fighter

Grades 6-8

Math, Science

Objectives

Through classroom experiences, students will solve math word problems related to the reading. They will conduct an experiment to isolate DNA in wheat germ. They will also describe Norman Borlaug's influence in beginning the Green Revolution and apply concepts to current local and world events.



Vocabulary

crop failure—reduction in crop yield to a level that there is no marketable surplus or the nutritional needs of the community cannot be met
developing nation—a nation with a low level of material well-being
dwarf—an animal or plant much below normal size
gene—a part of DNA or RNA that is usually located on a chromosome and that contains chemical information needed to make a particular protein controlling or influencing an inherited bodily trait or activity or that influences or controls the activity of another gene or genes
plant breeder—someone who propagates plants sexually under controlled conditions
resistant—capable of withstanding the force or effect of a disease
stalk—a plant stem especially of a plant that is not woody

Background

Norman Borlaug was a **plant breeder**. He used high-yield agriculture techniques to help people get more food from their land. For 50 years he worked in **developing nations** like Mexico, India, and Pakistan. Before he began his work, mass starvation had been predicted in many parts of the world. Since then, food production has expanded faster than human population in all parts of the world except sub-Saharan Africa. Borlaug received the Nobel Peace Prize in 1970, mostly for his work reversing food shortages in India and Pakistan during the 1960s.

Norman Borlaug was born in Cresco, Iowa, in 1914. When he was a young man, the Dust Bowl hit the Midwestern US. Some people blamed modern farming methods, but Borlaug believed just the opposite was true. He noticed that the effects of the Dust Bowl were not as bad in Iowa and other places where high-yield agriculture techniques were being tried. He decided that his life's work would be to help people grow more food in places where **crop failures** were regular facts of life.

Borlaug helped found the International Maize and Wheat improvement Center (CIMMYT) in Mexico. There he helped develop high-yielding semi- **dwarf** wheat varieties. Today this wheat feeds a large portion of the world's population.

Borlaug's leading research achievement was the development of dwarf spring wheat. He found many benefits to growing plants with shorter **stalks**. Nature favors **genes** for tall stalks because in nature, plants must compete for sunlight. Borlaug found that plants with stalks that were short and of equal length would receive equal amounts of sunlight when they did not have to compete with taller-stalked plants. In addition, dwarf wheat used more energy growing valuable grain rather than using its energy to grow tall stalks with no food value. Stout, short stalks also support wheat kernels better. Tall-stalked wheat may bend over at maturity, making it more difficult to harvest.

Borlaug also developed cereal grains that were day neutral (insensitive to the number of hours of light in a day) and could, therefore, be grown in many climates. He particularly favored growing wheat in countries where starvation was a concern because wheat grows in nearly all environments and is **resistant** to insects.

Additional Reading

Bartoletti, Susan Campbell, *Black Potatoes: The Story of the Great Irish Famine, 1845-1850,* Houghton-Mifflin, 2001.
Hesser, Leon, *The Man Who Fed the World: Nobel Prize Laureate Norman Borlaug and His Battle to End World Hunger*, Righters Mill Press LLC, 2019.
Mann, Charles C., *The Wizard and the Prophet, Penguin Random House, 2018*
Smith, David J., *If the World Were a Village*, Kids Can, 2002
Vietmeyer, Noel, *Our Daily Bread; The Essential Norman Borlaug,* Bracing Books, 2012

Websites

https://www.worldfoodprize.org/en/dr_norman_e_borlaug/about_norman_borlaug/
https://allianceforscience.cornell.edu/blog/2020/04/norman-borlaug-legacy-documentary/
https://www.purdue.edu/discoverypark/food/programs/borlaug-fellows/norman-borlaug.php

REV 9/2020

Activity 1: Global Grain Production, (Math) 1 50 minute class period

Students will solve equations regarding global grain production.

Oklahoma Academic Standards

Activity 1: Global Grain Production (Math)

6.N.2.3 7.N.2.3	Solve real-world and mathematical problems involving addition, subtraction, multiplication and division of rational numbers, use efficient and generalizable procedures including but not limited to standard algorithms.

Materials:

- Activity 1 Worksheet 1 "**Global Grain Production**"

Procedures

1. Arrange students into groups of two, and hand out the "**Global Grain Production**" worksheet.
2. Students will complete the worksheet and then discuss processes and answers as a class.
3. Ask two or three volunteers to read aloud their paragraphs from the journal writing.

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Activity 1 Worksheet 1: Global Grain Production

Name: _____ Date: _____

Complete the questions below. Be prepared to share your answers with the class.

In 1960, before Borlaug's techniques were widely adopted, the world produced 692 million tons of grain for 2.2 billion people. By 2017, largely as a result of Borlaug's pioneering techniques, it was producing 2.6 billion tons for 7.5 billion people.

1. How many pounds of grain did the world produce per person in 1960?

2. How many pounds of grain did the world produce per person in 2017?

3. How many pounds of grain per person would there have been in 2017 if Norman Borlaug had not done his work and the grain production had stayed the same?

4. In your opinion, what would the world hunger situation have been in 2017 if Norman Borlaug had not committed himself to his life endeavors? Justify your reasoning mathematically.

5. Write a paragraph or more explaining how one person can make a difference in the world.

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Activity 1 Worksheet 1: Global Grain Production

ANSWER KEY

Name: _____ Date: _____

Complete the questions below. Be prepared to share your answers with the class.

In 1960, before Borlaug's techniques were widely adopted, the world produced 692 million tons of grain for 2.2 billion people. By 2017, largely as a result of Borlaug's pioneering techniques, it was producing 2.6 billion tons for 7.5 billion people.

1. How many pounds of grain did the world produce per person in 1960?
(There is more than one way to solve this problem. The following is only one possibility.)
692,000,000 tons divided by 2,200,000,000 billion people = 0.314 tons per person
I want to know pounds, so 0.314 tons x 2000 lbs = 628 pounds per person

2. How many pounds of grain did the world produce per person in 2017?
(There is more than one way to solve this problem. The following is only one possibility.)
2,600,000,000 tons divided by 7,500,000,000 billion people = 0.347 tons per person
I want to know pounds, so 0.347 tons x 2000 lbs = 694 pounds per person

3. How many pounds of grain per person would there have been in 2017 if Norman Borlaug had not done his work and the grain production had stayed the same?
(There is more than one way to solve this problem. The following is only one possibility.)
692,000,000 tons divided by 7,500,000,000 billion people = 0.092 tons per person
I want to know pounds, so 0.092 tons x 2000 lbs = 184 pounds per person

4. In your opinion, what would the world hunger situation have been in 2017 if Norman Borlaug had not committed himself to his life endeavors? Justify your reasoning mathematically.
Answers may vary.

5. Write a paragraph or more explaining how one person can make a difference in the world.
Answers may vary.

Activity 2: Stalks and Heads, (Math) 1 50 minute class period

Students will solve mathematical equations using stalks of wheat.

Oklahoma Academic Standards

Activity 2: Stalks and Heads (Math)

7.GM.3.2	Calculate the circumference and area of circles to solve problems in various contexts, in terms of Π and using approximations for Π.
PA.GM.2.2	Calculate the surface area of a cylinder, in terms of π and using approximations for Π, using decomposition or nets. Use appropriate measurements such as cm^2.

Materials:

- 4 wheat plants per student or group
- Pencil
- Scale
- Scissors
- Pipe cleaners and beads if wheat is not available
- Activity 2 Worksheet 1 "**Stalks and Heads**"

Procedures

1. Divide students into groups of three or four and provide each group with four or five stalks of wheat. Note: if stalks of wheat are unavailable, students may use pipe cleaners and beads or beans to create wheat stalk models to measure and weigh. They should try to build the largest wheat head the stalk is able to support.
2. Provide a copy of the "**Stalks and Heads**" worksheet.
   —(Grade 7) Using the bottom of the wheat stalk, students will find the area of the circle.
   —(Grade 8) Students will find the area of the cylindrical wheat stalk.
3. Students will weigh the wheat heads.
4. Students will record the data in a table format.
5. Tape a classroom graph to the wall.
6. Students will plot their data on the classroom graph.
7. Students will determine if there is a trend (connection) between the area of the stalk and the weight of the head.

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Activity 2 Worksheet 1: Stalks and Heads

Name: _____ Date: _____

Plants must be able to support the seeds they produce until harvest. For plants to be able to produce more grain, their stalks or stems must be able to support the extra weight. Dr. Norman Borlaug was interested in breeding these sturdier plants. He was able to save millions of people from starvation in the 1960s and 1970s through his innovations. You will explore the basis of Dr. Borlaug's research using measurement, calculations, and graphing. What would our world look like today if we could continue to breed higher yielding plants?

Materials

- 4 wheat plants
- Pencil
- Scale
- Scissors

Procedures

1. Trace the bottom of your wheat stalk. Then trace the bottom of the wheat head.
2. Measure the diameter of the wheat stalk and the wheat head. Find the area of the circle and cylinder shape of the wheat head. Record in the table.
3. Cut the head off the stalk as depicted in the figure.
4. Weigh the head and record in the table.
5. Repeat steps 1-3 for each of your stalks of wheat.
6. Plot your wheat stalks on the class graph provided by your teachers.

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Wheat Plant Measurements Table

Plant	Stalk Area	Head Area	Head Weight
1			
2			
3			
4			

Activity 3: Wheat Germ DNA, (Science) 1 50 minute class period

Students will use the following experiment to isolate the DNA in a wheat germ.

Oklahoma Academic Standards

Activity 3: Wheat Germ DNA, (Science)

6.LS1.1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.
8.LS1.4	Use arguments based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.
8.LS3.1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

Materials

- Graduated cylinder
- 400 mL or larger beaker
- Raw wheat germ
- Spoon
- Liquid soap
- Baking soda
- "**Wheat Germ DNA Experiment**"
- Meat tenderizer
- Eyedropper/Pipette
- Test tube
- Denatured alcohol
- Pencil
- Lab notebook
- "**Parts of Wheat a Kernel**"

Procedures

1. Hand out copies of the "**Wheat Germ DNA Experiment**". Students will work in groups to complete the experiment.
2. Pour 100 ml of warm water into a cup/beaker.
3. Add one spoonful of raw wheat germ and stir a few times.
4. Add one squirt of liquid soap and stir a few more times but not so hard that you generate bubbles.
5. Add 1 tsp baking soda and 1/8 tsp meat tenderizer. Stir for 5-10 minutes, then let solids settle to the bottom.
6. Draw off some of the clear liquid at the top with an eyedropper. You do not want solids at the bottom.
7. Put into a test tube.
8. Fill the test tube 1/3 full of liquid.
9. Add denatured alcohol slowly with the eyedropper and watch the DNA strands appear at the interface between the wheat germ slurry and the alcohol.
10. Discuss what you saw. Record your observations.

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Activity 3 Worksheet 1: Wheat Germ DNA Experiment

Name: _____ Date: _____

When farmers are making decisions about what varieties of wheat to plant, they are thinking about DNA. Each kind of wheat has DNA that gives it certain characteristics to help it grow better in a particular region, season, etc. Wheat varieties are genetically changed over time through natural selection. Some varieties grow better in drought conditions while others might be better at resisting certain pests. The varieties best suited to survive in their particular circumstances have a greater chance of passing their traits on to the next generation. Norman Borlaug used knowledge of wheat DNA to breed wheat for the conditions that would grow best in the areas where he was conducting his research. Wheat germ is one part of the wheat kernel. Read the "**Parts of a Wheat Kernel**" page to learn more about the wheat germ. Use the following experiment to isolate the DNA in wheat germ.

Materials

- Graduated cylinder
- 400 mL or larger beaker
- Raw wheat germ
- Spoon
- Liquid soap
- Baking soda
- "**Wheat Germ DNA Experiment"**
- Meat tenderizer
- Eyedropper/Pipette
- Test tube
- Denatured alcohol
- Pencil
- Lab notebook
- "**Parts of a Wheat Kernel**"

Procedures

1. Pour 100 ml of warm water into a cup/beaker.
2. Add one spoonful of raw wheat germ and stir a few times.
3. Add one squirt of liquid soap and stir a few more times, but not so hard that you generate bubbles.
4. Add 1 tsp baking soda and 1/8 tsp meat tenderizer. Stir for 5-10 minutes, then let solids settle to the bottom.
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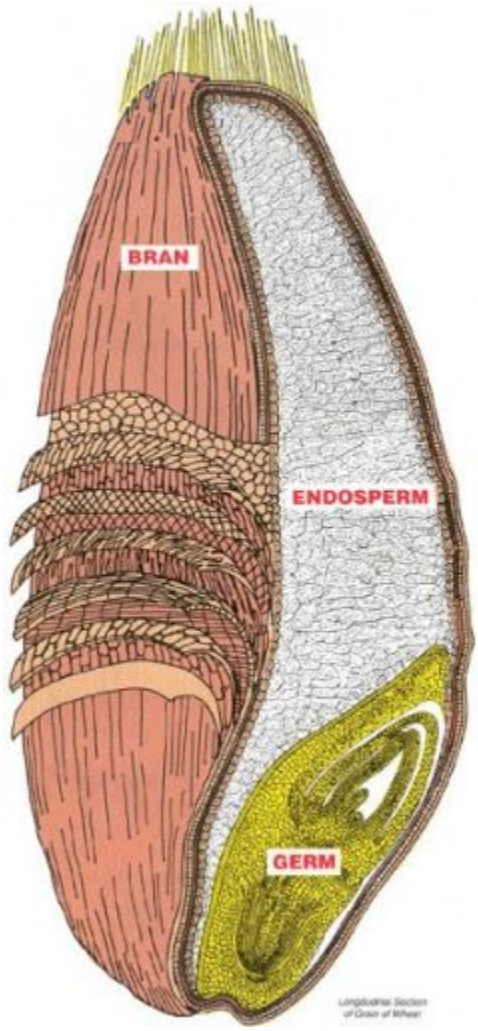
7. Fill the test tube 1/3 full of liquid.
8. Add denatured alcohol slowly with the eyedropper and watch the DNA strands appear at the interface between the wheat germ slurry and the alcohol.
9. Discuss what you saw. Record your observations.

Sometimes called the wheat berry, the kernel is the seed from which wheat plant grows. Each tiny seed contains three distinct parts that are separated during the milling process to produce flour.

Endosperm - Endosperm is the germ's food supply and the source of white flour. In its natural state, the endosperm provides essential energy to the young wheat plant, allowing the plant to send roots down for water and nutrients and shoot sprouts up for sunlight.

Bran - the bran is a multi-layered, hard outer coating of the wheat kernel. Bran is included in whole wheat flour and can be purchased as a stand-along grain.

Germ - the germ is the embryo, or sprouting section of the kernel. The germ is the part of the wheat kernel that will sprout and grow into a new wheat plant. During the milling process, the germ is often separated from flour because the fat content limits the flour's shelf life. In whole wheat flour, it is stabilized and then put back in to keep the flour "whole". Wheat germ is also sold as a health food to be added to other foods.



These three parts are protected by tough outer husk that protects the kernel from potential hazards such as sunlight, pests, water and disease. This protective structure is separated from the grain, along with the straw when wheat is harvested with a combine. Wheat kernels vary in both texture and color, from white to red to sometimes even purple.

Source: Wheat Foods Council