Oklahoma Ag in the Classroom

Norman Borlaug, Hunger Fighter

Objective

Students will read about the research of Nobel Prize-winning plant breeder Norman Borlaug and conduct interviews with one another about the reading. Students will solve math word problems related to the reading. Students will conduct an experiment to isolate DNA in wheat germ.

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. Instead, food production has expanded faster than human population in all parts of the world except Aub-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 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.

Oklahoma Academic Standards

GRADE 6

Humans and the Environment: 5.2,3,5
Life Science: 1-1,2,3,6
Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1,3. Research: R.1,2,3; W.1,2,3,4
Number & Operations: 3.1,2,3,4; 4.4. Algebra: 3.1

GRADE 7

Geography: 1.5. Humans and the Environment: 5.2
Life Science: 1-5; 3-1,2;4-5
Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1,3. Research: R.1,2,3; W.1,2,3,4
Number & Operations: 2.3. Algebra: 2.2,3; 3.3

GRADE 8

Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1,3. Research: R.1,2,3; W.1,2,3,4

HIGH SCHOOL

Contemporary Global Issues: 6.2
Biology 1: 1-1
Speaking and Listening: R.1,2,3; W.1,2. Speaking and Listening: R.1,2,3; W.1,2. Reading and Writing Process: R.1. Research: R.1,2,3; W.1,2,3,4

Materials

stalks of wheat
(Check with area farmers, local agricultural organizations, agricultural cooperatives, a nearby grain elevator, or your local county Extension office, listed under county government in the phone book. Wheat stalks will be most available around harvest season, late in the spring.)

For DNA experiment, per group
water

beaker

raw wheat germ (Look in the cereal section of your grocery store.)

liquid soap

spoon

stirrer

baking soda

meat tenderizer

test tube

eye dropper

denatured alcohol (Can be found in the paint section of your hardware store.)

English Language Arts/Social Studies

1. Students will pair up to read about Norman Borlaug from the Reading Page included with this lesson.
   —Students will write a narrative of an interview with Norman Borlaug, based on the reading. The interview should include the following:
   • When did Borlaug win the Nobel Peace Prize?
   • Why did he win the Nobel Peace Prize?
   • How did he become interested in his work on high-yield agriculture?
   • What difference did his work make in the world?
   • Other information students found interesting.
   —Students will perform their interviews for the class—live or videotaped.
2. Students will use online or library resources to conduct research on one of the following topics.
   Norman Borlaug
   Green Revolution
   Nobel Peace Prize
   Internatonal Maize and Wheat Center
   High-Yield Agriculture
   —Students will report to the class on the results of their research.

Math

1. Arrange students into groups of two, and hand out the worksheets included with this lesson.
   —Students will complete the worksheet and then discuss processes and answers as a class.
   —Ask two or three volunteers to read aloud their paragraphs from the journal writing.
2. Divide students into groups of three or four, and provide each group with four or five stalks of wheat.
   —(Grades 6-7) 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
   —Students will weigh the wheat heads.
   —Students will record the data in a table format.
   —Tape a classroom graph to the chalkboard.
   —Students will plot their data on the classroom graph.
   —Students will determine if there is a trend (connection) between the area of the stalk and the weight of the head.
   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.

Science

1. Hand out copies of the Wheat Germ DNA Experiment included with this lesson. Students will work in groups to complete the experiment.

Additional Reading

Bartoletti, Susan Camptell, *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*, Durban House, 2006.

Smith, David J., *If the World Were a Village*, Kids Can, 2002

Vocabulary

agriculture—the science, art, or practice of cultivating the soil, producing crops, and raising livestock

cereal—relating to grain or to the plants that produce it

climate—the average weather conditions of a particular place or region over a period of years

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

energy—the capacity for doing work

environment—the whole complex of factors (as soil, climate, and living things) that influence the form and the ability to survive of a plant or animal or ecological community

food value—the useful quality of a particular food

gene—a part of DNA or sometimes 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

grain—the edible seed or seedlike fruit of grasses that are cereals

harvest—the gathering of a crop

high-yield—producing a large amount

insensitive—not readily affected or changed by the action of a certain thing

maturity—full development

pesticide—an agent used to destroy pests

plant breeder—someone who propagates plants sexually under controlled conditions

population—the whole number of people or inhabitants in a country or region

resistant—capable of withstanding the force or effect of

stalk—a plant stem especially of a plant that is not woody

technique—a method of accomplishing a desired aim

Name_____

Norman Borlaug, Hunger Fighter

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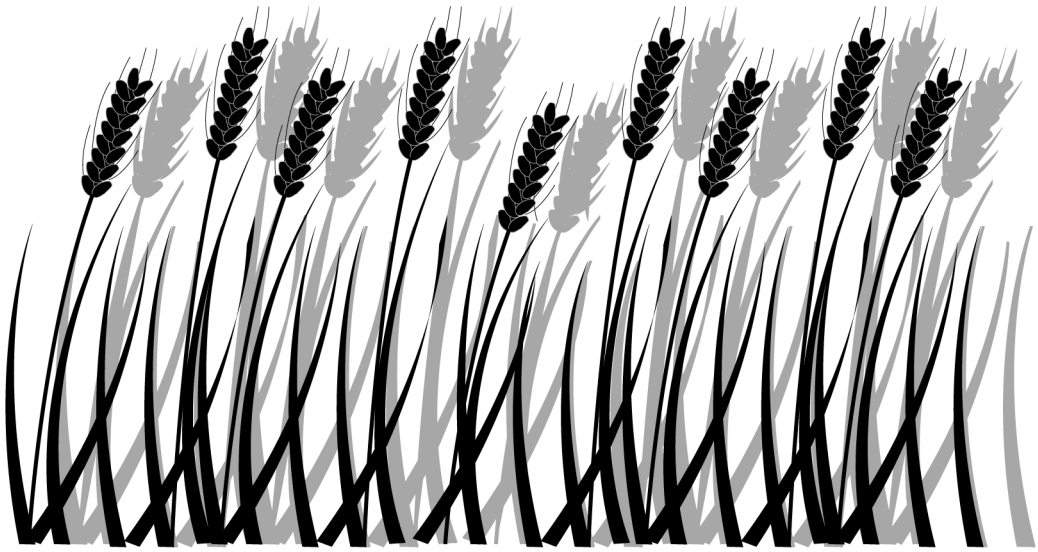
Borlaug founded the International Maize and Wheat Center in Mexico. There he helped develop a high-yield, low pesticide dwarf wheat. Today this wheat feeds a large portion of the world's population.

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 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.



Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Name_____

Norman Borlaug, Hunger Fighter

PROBLEM:

In 1960, before Borlaug's techniques were widely adopted, the world produced 692 million tons of grain for 2.2 billion people. By 1992, largely as a result of Borlaug's pioneering techniques, it was producing 1.9 billion tons for 5.6 billion people using only 1 percent more land.

How many pounds of grain per person in 1960?

How many pounds of grain per person in 1992?

How many pounds of grain per person would there have been in 1992 if Norman Borlaug had not done his work and the grain production had stayed the same?

Conjecture what the world hunger situation would have been in 1992 if Norman Borlaug had not committed himself to his life endeavors. Justify your reasoning mathematically.

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

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Name_____

Norman Borlaug, Hunger Fighter (Answers)

PROBLEM:

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How many pounds of grain per person in 1960?
(There is more than one way to solve this problem. The following is only one possibilty.)

0.692 billion tons divided by 2.2 billion people = 0.314 ton per person

I want to know pounds, so 0.314 x 2000 = 628 pounds per person

How many pounds of grain per person in 1992?

1 billion tons divided by 5.6 billion people = 0.339 ton per person

I want to know pounds, so 0.339 x 2000 = 678 pounds per person

How many pounds of grain per person would there have been in 1992 if Norman Borlaug had not done his work and the grain production had stayed the same?

0.692 billion tons divided by 5.6 billion people = 0.123 ton per person

I want to know pounds, so 0.123 x 2000 = 246 pounds per person

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Wheat Germ DNA Experiment

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 might 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. Use the following experiment to isolate the DNA in wheat germ.

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.
5. Draw off some of the clear liquid at the top with an eyedropper. You do not want solids at the bottom.
6. Put into a test tube.
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.

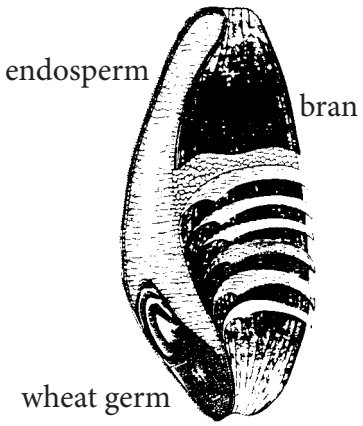
Sometimes called the wheat berry, the kernel is the seed from which the wheat plant grows. Each tiny seed contains three distinct parts that are separated during the milling process to produce flour.

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 the multi-layered, hard outer covering of the wheat kernel. Bran is included in whole wheat flour and can be purchased as a stand-alone 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. It is stabilized and then put back in to keep the flour "whole." Wheat germ is sold as a health food to add to other foods.

These three parts are protected by an inedible husk that shields the kernel from potential hazards such as sunlight, pests, water and disease. Wheat kernels vary in both texture and color, from white to red to sometimes even purple.



wheat kernel

Source: Wheat Foods Council

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