This master curriculum includes lessons for 4th Grade. Fourth graders will learn about the evolution of farming from the 1900's until now. They will develop an understanding of the diversity of the United States and how that influences what each state is able to produce.

Educators may find this curriculum useful to use prior to attending the Borlaug farms. The Norman Borlaug Heritage Foundation provides educational opportunities for schools to attend. Whether attending a tour or participating in Inspire Days, children will become aware of Norman Borlaug's work and his everlasting impact on the current day.

Want to learn more about Norman Borlaug or the Norman Borlaug Heritage Foundation? VISIT OR CALL!

Contact Chamber of Commerce for more information
101 2nd Ave. SW, Cresco, IA 52136
Email: Jason@howard-county.com
Call: 563-547-3434

Borlaug Farms Addresses
Birthplace farm: 20399 Timber Ave Cresco, IA 52136
Boyhood Farm: 19518 200th St. Cresco, IA 52136

LESSONS FROM BORLAUG

Curriculum - Grades K-8

4th Grade

Farming Then and Now

Grade: 4th grade

Time: Two 45-minute class periods

Purpose: By the end of this lesson, students will be able to:

- Explain how farming has changed in this country.
- Compare and Contrast early farming practices and today's modern practices.
- Using what the students know, they will make inferences about what old farming practices Norman used on the family farm.
- Students will learn what agricultural advances Norman made.

Materials:

- Pens/Pencil
- Scissors
- Poster Board (for Venn Diagram)

Resources:

- Book: *Farming Then & Now* by Scott Foresman
- Video: Farming Past and Present: https://youtu.be/v7QrvJua2uE (3min)
- Video: The Evolution of Farming, Then and Now https://youtu.be/BC5rFsSWM_Q (3 mins)
- Website: http://www.campsilos.org/mod4/students/life.shtml

Essential Files (maps, charts, pictures, or documents)

- Photos showing various farm scenes and machinery from different timeframes
    - Farming Then & Now (attached)
- Vocabulary Foldable Worksheet (attached)
- Writing Paper (attached)
- Interview Paper (attached)

Vocabulary:

- Machines: devices that do particular jobs
- Harvest: that gathering of a crop
- Crops: plants grown and gathered t be used for food or sold to earn money
- Combine: a large machine used to cut, sort, and clean crops
- Acre: a unit of measure for land, 43,560 square feet (a little smaller than a football field)
- Yield: the amount of production
- Chore: complete everyday tasks on the farm
- Farmer: someone who owns or manages a farm
- Livestock: animals raised on a farm to be used for food and many other products

Spark Curiosity By…

Would you rather be a farmer today or from long ago? The teacher will pose questions similar to the popular question and answer game to induce students thinking about the past, present, and future of farming. Students can discuss in small groups or take votes.

Would you rather…

1. Farm 1,000 acres with machines or 10 acres by hand?
2. Scoop manure by hand or have a Roomba-like machine do it for you?
    a. Roomba: autonomous vacuum
3. Milk a cow by hand or with a robotic milking machine?
4. Ride a horse or ride a tractor?
5. Pull weeds by hand or have a robot do it for you?
6. Walk and spray for weeds or ride a ranger to spray?
7. Plow a field driving a team of horses or sit in the self-driving tractor?
8. Walk the field to pick corn or ride in a combine?

If you picked mostly the first answer, you would have been a great farmer long ago. If you picked mostly the second answer, modern farming is for you!

Agricultural Background

Farming today is just as important as it was in the past. Farmers have always produced food, but their methods of product change throughout time. Machines make it easier and more efficient to plant, care for, and harvest crops. Machines do a a lot of work that people and animals used to do, and they do it faster and more accurately. Before tractors, farmers mainly used horses to help with difficult work. Once tractors became economically feasible for each farmer to own, the number of horses decreased and the number of tractors increased. Farmers today continue to produce the food needed by human and livestock, as well as producing other resource, just as they did in the past, by with new technology and innovation.

Lesson (1 of 2)

1. Explain the purpose of the lesson: We are going to compare and contrast early farming practices with today's modern practices. When we get done, you should be able to tell me how farming has changed in this country and if you would rather be a farmer today or from long ago.
2. Discuss with the students the ways they already know/think farming has changed over time.

3. Introduce and dices vocabulary words we will be using. Go through each word and define it, making sure to write it so students can refer to the definitions when they work on their vocabulary foldable worksheet.
4. Practice vocabulary words by completing the vocabulary foldable worksheet. Students will work independently on this. Be prepared to assist with folding, cutting, and answering questions.
    a. Fold on bold line
    b. Cut on dotted lines
    c. Write definition under vocabulary word flap
    d. (early finishers can write a sentence using vocabulary word)
5. Read aloud and discuss: *Farming Then & Now* by Scott Foresman. Focus on key vocab words and discuss picture clues that help us determine if a photo is from long ago or today.

Lesson (2 of 2)

1. Use Vocabulary foldable to review vocabulary words with a partner.
2. Discuss the key points of the previous lesson (how early arming practices have changed over time).
3. Start a Venn Diagram as a class to compare and contrast farming in different time periods. Use Farming Then and Now as a reference to help get started, flipping through the pages and asking students to point out what they see.
4. Project the PowerPoint, Farming Then and Now Photos, and see what else can be added to the class Venn Diagram.
5. Watch both short videos and add to Venn Diagram if needed.
    a. Video: https://youtu.be/v7QrvJua2uE
    b. Video: https://youtu.be/BC5rFsSWM_Q
6. Discuss prediction about the future of agriculture and what changes we may see down the road.
7. Hand out writing paper. Have students decide if they want to be a farmer from long ago, or a farmer today. Students will write 3-5 sentences explaining why they chose the farming timeframe they did using what they learned about the different time periods.
8. Students will proofread, then read aloud to the teacher, then draw a picture that goes along with their writing.

Connection to Norman Borlaug

Watch the virtual tour of the birthplace, boyhood, and school house of Norman Borlaug -

_____

Have an open discussion with the class about what old farming practices Norman would have used to farm. Various topics might include school, raising animals, growing a garden, or planting trees.

Explain to the students that Mr. Borlaug grew up farming when it was hard work. As he got older, he started to do experiments to make farming easier. He later created a crop that fed the world! Because of this, he started a time frame called the green revolution – he inspired people to create equipment and crops that make farming easier! Because of Norman, farmers are now feeding the world fast!

Have the students write a thank you note to Norman Borlaug or another farmer for their farm work. Farming isn't always easy – but knowing you are appreciated makes the work seem better. If the class participated in a Farm Chat with a local farmer have the kids write a thank you card to that individual.

National Agriculture Literacy Outcomes

- T3.K-2.b. recognize that agriculture provides our most basic necessities.
- T5.K-2.a. Discuss what a farmer does.
- T5.K-2.b. Explain why farming is important to communities.

Iowa Core Standards

- SS.2.19. Make a prediction about the future based on past related events.
- SS.2.20. Determine the influence of particular individuals and groups who have shaped significant historical change.
- SS.2.21 Compare the perspectives of people in the past to those in the present with regard to particular questions or issues.
- K-2-ETS1-1. Ask questions, make observations, and father information about a situation people wanted to change to define a simple problem that can be solved through the development of a new or improved object or tool.

Students have now learned that there have been many technological advances within farming. Norman Borlaug had a great deal to do with the evolution of American farming. Let's next take a look at modern day farming across the United States. This lesson will give students insight to geographical area across the country and how states use the environment to produce unique products.

Agriculture in the U.S.

Grade: 4th grade
Time: 1 hour

Purpose:

- Students will use knowledge of climate and landforms to study production regions throughout the United States.
- Students will discuss and learn the geological significance of each country that Norman Borlaug worked in/with.

Materials:

- Smartboard or Whiteboard
- Tape or Magnets (put crops on map)
- Research Materials (books/computer)
- **Map.docx**
- **Crops and Livestock Picture Sheets.pdf**

Resources:

- Iowa Ag Today Issue 4 (www.iowaagliteracy.org)

Vocabulary:

- Agriculture – the production of crops and livestock for food, fiber, and/or fuel
- Crops – plants grown for food or fiber
- Livestock – animals raised by farmers for food or other products we use
- West Coast – the western coast of the U.S. bordering the Pacific Ocean and comprising the coastal areas of California, Oregon, and Washington
- Rocky Mountains – Chief mountain system in North America, extending from central New Mexico to Alaska
- Midwest – United States region including area around Great Lakes & upper Mississippi River valley from Ohio – sometimes considered to include Kentucky on the East to North Dakota, South Dakota, Nebraska, & Kansas on the West
- South – to or toward the south
- Northeast – to, toward, or in the north east

Spark Curiosity By…

Asking students if they have traveled outside of Iowa. Discuss how these places are similar and different than Iowa, focusing on weather, soil, plants, and animals they observed.

Agricultural Background

This lesson includes 5 main regions (plus Alaska and Hawaii). The regions are grouped based on commonalities within their agricultural sectors. They are as follows:

West Coast

The west coast includes Washington, Oregon, and California. These states are noted for fruit production (like apples, strawberries, and grapes), nut production, and vegetable production. California is also a major dairy producer. Washington and Oregon is prevalent there. California is home to many types of agriculture, as it spans so far north and south. California has three main regions that range in production from cotton and sugar beets to vegetables, grapes, dairy, and potatoes.

Rocky Mountains

The Rock Mountain region consists of Idaho, Montana, Wyoming, Utah, Nevada, Arizona, New Mexico, and Colorado. As this region is relatedly dry, things like wheat, hay, and rangeland livestock like beef and dairy cattle, and sheep are raised here.

Rangeland cattle and sheep may look different from the cattle and sheep seen in the Midwest. Since these animals need to walk farther to get the amount of grass needed to feed themselves, they can be leaner and more rugged. The dry air also lends itself better to wool production than our humid air does, so sheep in this region tend to be "white face breeds or wool producing breeds. In the Midwest, we tend to raise "black face breeds" or meat breeds of sheep. They have these nicknames, as the coloring between the two breed types is generally split with white face and black faces.

Midwest

The Midwest is much less dry than the Rocky Mountain states, and this extra rain and humidity lends itself well to corn production. Soybeans are often rotated between years of corn, and these two crops are used to feed many kinds of livestock, like pigs, chickens, turkeys, and cattle.

In the northern Midwest, sugar beets and vegetable crops for canning are grown. Wisconsin is known for its dairy production, as well. In Kansas, more wheat is grown. The wetter parts of the Midwest, like Iowa, don't grow as much wheat, as it performs better when it can avoid fungi with dry air.

South

The South is notable for many things, including cotton and fruit. Peaches, citrus fruits, etc. are abundant in the southeast. Chickens are also raised in the south. Here, chickens are raised more for meat (these chickens are called "broiler") whereas in Iowa we primarily raise chickens for egg production (we call these chickens "layers").

The top seven boiler producing state are all in the south! This includes Georgia, Arkansas, Alabama, North Carolina, Mississippi, Texas, and Kentucky. However, Texas is the 5$_{th}$ largest egg producing state as well.

Northeast

Berries are prevalent in the Northeast, as well as mushrooms and maple syrup production You can also find aquaculture and forestry in the Northeast, this region is notable for its forested area, and cold winters. In this region, large, plowed fields will be common, but high-dollar crops that can be grown in small areas, the ocean, or woodland areas can be.

Alaska

Reindeer aren't a myth! These creatures as well as musk oxen can be raised outdoors in the winters of Alaska with little trouble. Some other important commodities in the stat include hay, dairy, potatoes, and greenhouse and nursery crops. Alaska is also known for seafood and forestry.

Hawaii

Hawaii's agriculture utilizes their warm temps and long growing season to produce bananas, pineapple, and coffee. These production systems are very different from other types of crop production, and are quite different from what students imagine. For instance, pineapples don't grow on trees, they grow from bush-type plants on the ground. Bananas grow pointing upward, not hanging down like we store them at home. And coffee beans don't come off the tree brown! They are roasted to turn this color.

Though there are multiple examples here from each region, this is not an all-inclusive list. Corn is grown in all 50 states, for example. Some types of livestock, like cattle, sheep, and goats, might just have different breeds in different regions. Some breeds of cattle are more heat-tolerant, for example, so those breeds are found in the southern states, whereas more winter-hardy breeds are raised in the Midwest. The grouping of crops for this activity only highlight a few of the major products in each region.

For each crop, there might be a different reason why it is grown in the location it is. Use this opportunity to talk about economic concepts such as comparative advantage, trade, and cost of production. You can also use this to talk about Earth and life science concepts such as biomes, landforms, habitats, ecosystems, etc.

Lesson

1. Divide students into groups of 3. Explain to the students that each group will receive a different group of crops.
2. Hand our Crops and Livestock Picture Sheets (attached document) sheet, one page per group. Allow students 3 minutes to discuss where their crops or livestock may be grown.
3. Using a projector, project the map (attached document) onto a whiteboard. When students are done discussing their topics, open up to a class discussion about each colored region. Begin discussing landforms in each region (i.e. mountains, lakes, prairie). When a landform is identified, allow students to come up and label the region on the board.

    a. Repeat steps by discussing climate, soil, and history.
4. Direct the students back to their groups to discuss where their crops and/or livestock belongs. Allow them to use research materials such as books and the internet.
5. When students are confident in where their food is grown, have them to attach their picture to matching region on the board (using tape or magnets).
6. When everyone is done attaching their pictures, ask them to check their answers using pages 4 & 5 of Iowa Ag Today, Issue 4.
7. Openly discuss as to why the crops grow where they do. Why don't they go in other places? Do the landforms and crops relate to one another? What surprises them the most?

Connection to Norman Borlaug

Dr. Borlaug grew up on a small farm in Cresco Iowa. There, he grew many animals and crops.

1. Ask the students to make an inference about what crops and livestock Norman grew on his family's farm based on what they know about Iowa agriculture.

After college, Norm moved outside of the United States into Mexico. There, he studied agriculture and performed experiments.

1. Allow students to have a discussion within their groups about Mexico like they did for regions of the United States.
    a. Where is Mexico located in relativity to the United States?
    b. Landmarks
    c. Climate
2. Open the discussion up to the class. Ask them, based on their group's thoughts, what crops and livestock do you think are prominent in Mexico?
3. Explain that Norm grew wheat in Mexico because the climate there is drier and the soil is favorable for its growth.

Norman was able to create a type of wheat that didn't attract fungi… it 'perfect'.
At that time 2 countries across the world were in serious trouble. People in Pakistan and India were starving because they didn't have enough food. So, they wrote a letter to Norman asking for his help.

1. Ask the students to recall what types of climates that wheat likes to grow in. Write their responses on the board for later reference.
2. Divide the classroom into two groups. Designate one group as Pakistan and one as India. Allow each of the groups access to the internet and have them research the type of climate in their countries.
3. Based on what they found, openly discuss whether or not Norman should share his wheat seed with them (Norman will share his seed if he knows the climate is right in the countries).
4. Continue on with the story…

Norman decided to share his wheat seed with both Pakistan and India. Because he did, both countries were saved from starvation!

1. Provoke the student's thoughts by asking the question, "What word do we use to describe giving and receiving across distances?"

2. Explain the idea of trade between two countries

This story is an early example of global trade. The United States has continued to sell their products to other countries across the world because we have enough to. The United State also buys products from other countries that we cannot grow.

1. Based on what we learned, openly discuss why countries might want our products.
2. Based on what the students have learned, openly discuss why we buy products from other countries.

The United States has a lot of different climates. However, there are products that we like that we cannot, such as coffee beans and bananas. Climate plays a huge role in our lives from how we dress, how we travel, and what we eat. Just like Pakistan and India ate Mexican wheat, look to see where your food is coming from!

Sources/Credits

- Iowa Ag Today Magazine
- Stuff About States: http://stuffaboutstates.com/agriculture/farm_by_average_size.htm
- Alaska Agriculture: http://www.farmflavor.com/alaska-agriculture/
- New England Farmer's Union: http://www.newenglandfarmersunion.org/about-us/mission/
- Top Broiler Producing States: http://www.nationalchickencouncil.org/about-the-industry/statistics/top-broiler-producing-states/
- United Egg Producers: http://unitedegg.org/GeneralStats/default.cfm
- USDA Poultry Production Data, May 2015: http://www.usda.gov/documents/nass-poultry-stats-factsheet.pdf

National Agriculture Literacy Outcomes

- Agriculture and the Environment:
  - T1.K-2.a: Describe how farmers/ranchers use land to grow crops and support livestock
  - T1.K-2.d: Provide examples of how weather patterns affect plant and animal growth for food
- Culture, Society, Economy & Geography:
  - T5.K-2.d: Identify plants and animals grown or raised locally that are used for food, clothing, shelter, and landscapes

Iowa Core Standards

- Social Studies
  - SS.2.12: Identify how people use natural resources to produce goods and services.
  - SS.2.17: Explain how environmental characteristics impact the location of a particular place.
- Science

    - 2-LS4-1: Make observations of plants and animals to compare the diversity of life in different habitats.
    - 2-ESS2-2: Develop a model to represent the shapes and kinds of land and bodies of water in an area.
- Language Arts
    - RI.2.1: Ask and answer such questions as *who*, *what*, *where*, *when*, *why*, and *how* to demonstrate understanding of key details in a text.
    - RI.2.5: Know and use various text features (e.g., captions, bold print, subheadings, glossaries, indexes, electronic menus, icons) to locate key fact or information in a text efficiently.
    - RF.2.3: Know and apply grade-level phonics and word analysis skills in decoding words.
    - SL.2.1: Participate in collaborative conversation with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups.

Students now understand what each state specializes in with production and why. Most states are unique; however, crops can withstand multiple climates to help in them grow in many areas. Corn is one crop that is very common across the entire United States. It is the leading crop in Iowa as well. Let's learn more about corn!

Corn an A-maizing Plant: Food, Fuel, and Plastic

Grade: 4th grade
Time: 1.5 hours

Purpose:

- Students will examine the growth, comparison, history, and uses of corn through a close reading activity, discussion of renewable and non-renewable resources, an hands-on exploration of bioplastics made from corn.
- Students will understand how the corn industry is using sustainable practices to make more change using less product and machines.
- Students will identify the 3 major sustainable practices Norman Borlaug addressed during his lifetime: plant breeding science, education, and creating foundations for science.

Materials:

- Interest Approach - Engagement:
  - Corn/Corn-Free Products Image
  - Corn/Corn-Free Products List
  - Corn: A Golden Treasure handout
- Activity 1: A Brief History of Corn
  - United States Map
  - A Brief History of Corn handout
  - A Golden Nugget PowerPoint
- Activity 2: Renewable vs Nonrenewable Resources
  - Renewable vs Nonrenewable cards
- Activity 3: Making Bioplastic
  - 10 Styrofoam packing peanuts* (items for purchase in agclassroomstore.com)
  - 10 biodegradable packing peanuts* (items for purchase in agclassroomstore.com)
  - 2 sandwich-size resealable plastic bags
  - Physical and Chemical Change PowerPoint
  - Sandwich-size resealable plastic bags, 1 per group
  - Cornstarch, 1 teaspoon (14g) per group
  - Corn oil, 2 drops per group
  - Water, 1 tablespoon (15 ml) per group
  - Food coloring, 2 drops per group
  - Tablespoons, 1 per group
  - Bioplastic activity sheet

Resources:

- Bioplastic Activity Sheet
- Corn: A Golden Treasure Handout
- A Brief History of Corn Handout

- Renewable vs. Nonrenewable Cards
- A Golden Nugget PowerPoint
- Corn/Corn-Free Products Image
- Corn/Corn-Free Products List
- United States Map
- Physical and Chemical Change PowerPoint

Vocabulary:

- Corn Belt: the area of the United State where corn is the predominant crop grown
- Biodegradable: capable of being broken down through the actions of living organisms and natural processes over time
- Bioplastics: a group of plastics made from biological materials like plan starches, cellulose, oils, or protein
- Bushel: for corn, a unit of weight equal to 56 pounds
- By-products: in agriculture, secondary products produced from the main product of a crop or animal; for example, cornstarch is a by-product of corn.
- Compostable: capable of breaking down through the actions of living organisms in specific conditions to a defined outcome; generally, the conditions are moist, warm, and aerobic, and the end product is non-toxic compost that can enhance soil and support plant growth.
- Endosperm: tissue formed within a seed that contains energy (starch) and protein for the germinating seed.
- Germ: the living embryo of the corn kernel that contains the essential genetic information, enzymes, vitamins, and minerals for the kernel to grow into a corn plant
- Nonrenewable resources: limited natural resources that cannot be replaced or reproduced within a generation and cannot be managed for renewal. Examples: oil, oil, mineral resources (lead, iron, cobalt, zinc, etc.)
- Pericarp: The outer, protective covering of the corn kernel
- Recyclable: capable of being recycled
- Renewable resources: natural resources that can be replaced naturally or by human efforts at a sustainable rate. Examples: forest, fish, wildlife, agriculture, plants, animals.

Spark Curiosity By…

1. Provide each student with the Vorn/Corn-Free Product List and project the photograph of the corn and corn-free products on the classroom screen. Explain that every item on the list is shown in the photograph. Ask the students to circle each item on the list that they think contains corn.
2. After the students have finished circling the items, tell them that only one of the items does not contain corn. Ask the students to tell you whichitem they think does not contain corn.
3. Reveal to the class that the only item on the list that does not contain corn is the pasta. It contains wheat flour, not corn flour. Refer to the list below to explain what form of corn each remaining item contains.

Aspirin - Cornstarch	*Baking Powder - Cornstarch*
Batters - Cornstarch (insulation)	*Bubble Gum - Corn Syrup*
Coke - Corn Syrup	*Corn Tortillas - Corn Flour*
Crayons - Corn Oil	*Crunch Berries - Corn Syrup*
Diaper - Cornstarch	*Gain Detergent- Cornstarch*
Matches - Cornstarch (match seed)	*Pasta - Does not contain corn*
Shoelaces - Cornstarch (for smooth tying)	*Snickers Bar - Corn Syrup*

4. Show students the Corn: A Golden Treasure handout. Explain that corn is not only used in food products but also in many non-food items we use every day.

Agricultural Background

The **Corn Belt** is a region of the United States where corn is the predominant crop grown. Iowa and Illinois are the top corn-producing states, and they typically grow just over one-third of the US crop. Other major states for corn production include Nebraska, Minnesota, Indiana, Wisconsin, Michigan, South Dakota, Kansas, Missouri, Kentucky, and Ohio. These twelve states can be considered part of the Corn Belt. Warm, rainy summers and deep, fertile soils make this region particularly well suited for growing corn.

An ear of corn has an average of sixteen rows with 800 kernels. There are approximately 1300 kernels in one pound of corn. An acre (about the size of a football field) of corn can yield more than 13 million kernels. In the United States, corn production is commonly measured in **bushels**. This measurement originated as a unit of volume but has been standardized to units of weight for different commodities. One bushel of shelled corn is equivalent to 56 pounds (25 kg).

First domesticated in Mexico, corn is now grown on every continent of the world except Antarctica. The United States produces more corn than any other country. The scientific name for corn is *Zea mays*. All types of corn belong to this species, including sweet corn, popcorn, dent (field) corn, flour corn, and flint corn. Dent corn is the type most widely grown and processed in the United States. Hybrids of corn, produced by crossbreeding different varieties, have been developed to grow well in varying conditions and locations worldwide. The development of hybrid varieties, along with synthetic fertilizers and new farm machinery, has facilitated huge increases in corn productivity. Today, more corn can be grown on less land than ever before.

Similarly, advances in technology allow us to use more components of the processed corn kernel than ever before. One hundred years ago, starch was the main product used from refined corn, while the rest of the kernel was thrown away. Today, there are uses for every part of the kernel—even the water in which it is processed. The corn seed (kernel) is composed of four main parts: the **endosperm**, the **pericarp**, the **germ**, and the **tip cap**. The endosperm makes up most of the dry weight of the kernel and provides the source of energy for the seed. The pericarp is the hard, outer coat that protects the kernel both before and after planting. The germ is the living embryo of the corn kernel. It contains genetic information, vitamins, and minerals that the kernel needs to grow. The tip cap is where the kernel is attached to the cob and is the major entry path into the kernel for water and nutrients.

Corn is a versatile crop. It is the major grain grown for livestock feed by farmers in the United States, leading all other feed crops in value and volume of production. Corn is a major component in foods like cereals, peanut butter, and snack foods, and it is also processed into a wide range of industrial products, including ethanol. The kernel is used as oil, bran, starch, glutamates, animal feed, and solvents. The silk is combined with other parts of the corn plant to be used as part of animal feed, silage, and fuels. Husks are made into dolls and used as filling materials. The stalk is used to make paper, wallboard, silage, syrup, and rayon (artificial silk).

Corn can also be used to make a type of plastic known as **bioplastic**. Commonly, plastic is made from petroleum, a fossil fuel that is a **nonrenewable resource**. In contrast, bioplastic is made from biological materials—plant starches, cellulose, oils, or proteins. Unlike petroleum-based plastics, bioplastics are made from **renewable resources** such as corn, potatoes, tapioca, and casein (milk protein). One example of a bioplastic application is packing peanuts—the loose fill that goes all over when you open a package. Some packing peanuts are made of polystyrene (Styrofoam), which is a petroleum-based plastic. Corn-based packing peanuts are made of over 99% cornstarch and a very small percentage of food-grade oil. These packing peanuts are non-toxic, biodegradable, and **compostable**.

It is important to note that there are pros and cons to both bioplastics and petroleum-based plastics. There are also some common misconceptions about the differences between these groups of plastics. For example, both bioplastics and petroleum-based plastics can be **biodegradable**, meaning that over time they break down into compounds like carbon dioxide, water, and methane when exposed to naturally occurring microorganisms like bacteria, fungi, and algae.[1] Also, some bioplastics are **recyclable**.[1] The ability of a plastic to be recycled or to biodegrade depends on the chemical structure of the plastic, not whether the plastic is made from renewable or nonrenewable materials. In addition, many people are unaware that the raw materials used to make petroleum-based plastics are the by-products of refining crude oil for fuel. If these by-products were not used to make plastics, they would be industrial waste that would need to be disposed of. For more information, see the segment from *D News*, The Truth About Biodegradable Plastic.

Lesson

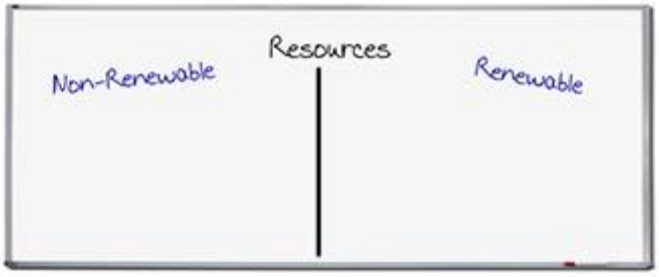
Activity 1: A Brief History of Corn

1. Provide each student with a copy of the *A Brief History of Corn* handout. Have students do a close reading of the text. For more information about the close reading strategy, refer to the resource guide *Supporting Students in Close Reading*.
2. Using the map of the United States, have students identify and highlight the states that are part of the Corn Belt—Iowa, Illinois, Nebraska, Minnesota, Indiana, Wisconsin, Michigan, South Dakota, Kansas, Missouri, Kentucky, and Ohio. Explain to the students that the warm, rainy summers and deep, fertile soils in this region of the United States are particularly well suited for growing corn.
3. Use the *A Golden Nugget* PowerPoint to discuss the different types of corn plants and their uses, the structure of a corn kernel, and the functions of each part of the kernel.
4. Using the information from the *Background Agricultural Connections*, discuss the uses of corn. Use the following questions to guide the discussion:
    - Who used corn in ancient times?
    - What are some of the ways corn is used today?
    - Where is most of the corn grown in the United States?
    - How have the uses of corn changed over time?
    - What are the parts of the corn kernel called, and how are these parts useful?

Activity 2: Renewable vs. Nonrenewable Resources

1. Write the word "Resources" on the center of the white board. Discuss what kinds of resources are essential to our everyday lives. We use many resources to provide our basic needs—food, water, shelter, and clothing.
2. Write the word "Nonrenewable" on one side of the board and "Renewable" on the other side. Discuss the definitions of each word.
    - **Nonrenewable resources** are made naturally by the earth but do not renew themselves fast enough for people to count on having the resource for an indefinite period of time. Some resources are considered nonrenewable because access to the resource is limited. For example, glass and metal are nonrenewable resources. The elements and minerals used to make glass and metal are found in the structure of the earth's crust, but we are limited to what we can access through mining.
    - **Renewable resources** are either naturally reproduced at a sustainable rate or they can be produced in agriculture at a rate equivalent to the demand or need. For example, corn can be used

for ethanol fuel, and a new crop of corn can be grown and harvested each year. Corn is a renewable resource.

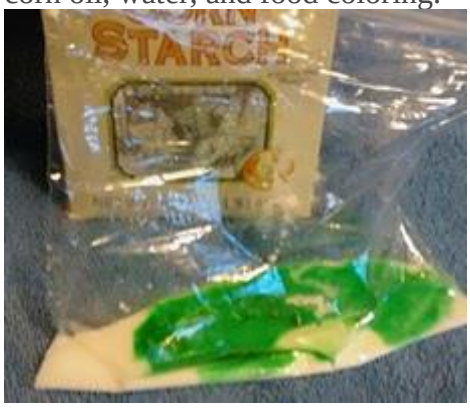


3. Divide the students into ten groups and give each group one of the *Renewable vs. Nonrenewable* cards. Each of these cards represents something that we use in our day-to-day activities. Ask each group to read their card and determine if the resource is renewable or nonrenewable. Once they have decided, they should place their card on the appropriate side of the board.
    - **Nonrenewable:** gasoline, plastic, glass, metal
    - **Renewable:** energy from the wind, energy from the sun, biodiesel, paper, food, and clothing
4. Discuss the placement of the cards as a class. Emphasize that renewable resources are often grown or produced by farmers in a relatively short amount of time. Most nonrenewable resources are produced naturally by or in the earth. They can take thousands of years to form.
5. Pick up or point to the "Plastic" card, which should be on the nonrenewable side of the board. Transition to the next activity by telling students that there is a method of making plastic that can be renewable.

Activity 3: Making Bioplastic

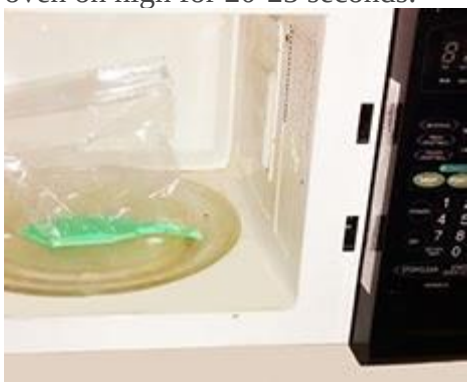
1. Introduce the word "bioplastic" by writing it on the board and breaking it into two parts. "Bio" means that it comes from a living thing. "Bioplastic" is plastic that comes from a living thing.
2. Place ten Styrofoam packing peanuts and ten biodegradable packing peanuts into two separate sandwich-size resealable bags. Add one cup of water to each bag, seal tight, and shake. The biodegradable peanuts will dissolve in less than ten seconds, while the Styrofoam will remain unchanged. Refer to the *Physical and Chemical Change* PowerPoint to discuss the physical change that takes place when the biodegradable packing peanuts dissolve in water.
3. Explain to the students that the biodegradable packing peanuts are made of over 99% cornstarch and a small amount of food grade oil. The Styrofoam packing peanuts are made from petroleum. As a class, discuss the pros and cons of the two types of packing peanuts.
4. Explain to the students that they will be making another type of bioplastic out of materials that come from the corn plant. Divide the class into groups of 4-5 students. Provide each student with a copy of the *Making Bioplastic* activity sheet and a resealable sandwich-size plastic bag. Give each group cornstarch,

corn oil, water, and food coloring.



5. To make the bioplastic, have the students combine 1 tablespoon (14 g) of cornstarch, 2 drops of corn oil, 1 tablespoon (15 mL) of water, and 2 drops of food coloring in the plastic bag.
6. Instruct students to seal the bag and mix the ingredients by rubbing the outside of the bag with their fingers until the ingredients are thoroughly combined.

7. Open the bag slightly, making sure it can vent, and place it into a microwave oven on high for 20-25 seconds.



8. Carefully remove the bag from the microwave, and let it cool for a few minutes. While it is still warm, allow the students to form their plastic into a ball. Refer to the *Physical and Chemical Change* PowerPoint to discuss the

chemical change that occurs when the bioplastic is made.

9. Ask the students to complete the *Making Bioplastic* activity sheet and then discuss their observations as a class.

Concept Elaboration and Evaluation

1. After conducting these activities, review and summarize the following key concepts:
    - Corn is a versatile crop used for human consumption, livestock feed, and a wide range of industrial products, including bioplastics.
    - Renewable resources can be replaced naturally or by human efforts at a sustainable rate.
    - Bioplastics are made from renewable, biological materials produced on farms.
2. To promote critical thinking, ask students, "Is corn plastic *better* than plastic made from petroleum-based products?" Allow students to offer their ideas. Consider showing the *D News* segment, The Shocking Truth About Biodegradable Plastics to stimulate thought.

Connection to Norman Borlaug

The main idea supporting renewable resources is sustainability. Sustainability is the avoidance of the depletion of natural resources in order to maintain an ecological balance. The Iowa Corn industry addresses sustainability each and every day. We are learning how to use corn in ways that leave little impact on the environment.

1. Ask students for one example of a sustainable use of corn (corn starch in packing peanuts rather than petroleum so they decompose when in contact with water)

Another sustainable practice is to reduce waste. The Iowa Corn industry has distinguished various ways to use a stalk of corn to meet the needs of many people. Oftentimes, when the corn is being processed for one thing, by-products are produced. By-products are secondary products produced while the primary product is being processed.

1. Ask students to brainstorm what each part of a corn plant could be used for.
    - Kernel: Ethanol fuel, Animal feed, Cooking supplies, Clothing.
    - Stalk: Bedding for animals, Feed for animals, Cover farm ground

Ultimately, the application of sustainable practices revolves around the idea of “Doing less for more”.

1. Read aloud the bibliography about Norman Borlaug: https://www.nobelprize.org/prizes/peace/1970/borlaug/biographical/. While you are reading, students should identify 3 sustainable practices applied by Norman. Keep in mind that his goal was to feed the world.
2. Have students Think-Pair-Share with a neighbor talking about their idea of the 3 practices.
3. Open the discussion to the class and identify the 3 sustainable practices applied by Norman.
    - Plant Breeding Science: strong, high yielding plants can feed more people using less land
    - Teaching Others: educate other farmers about farming allows multiple experts
    - Creating Foundations: programs the keep the legacy alive keeps people motivated for years to come
4. Ask students to reflect on this question; How can you "do less for more"? After 2 minutes of reflection time, let students share their thoughts with the class. Examples may include…
    - Shut the water off when brushing teeth
    - Take shorter showers
    - Help younger students learn
    - Compost pile for house biodegradable trash

Sources/Credits

The bioplastic or corn plastic activity has been part of numerous presentations and published informally by several Agriculture in the Classroom programs and agricultural science programs. The original source for the bioplastic mixture is unknown.

1. http://www.bpiworld.org/resources/documents/washington%20state%20biobased%20fact%20sheet%20aug%2014.pdf
2. http://www.usda.gov/nass/PUBS/TODAYRPT/cropan16.pdf
3. http://www.agintheclassroom.org/TeacherResources/AgMags/Corn_AgMagforSmartBoard_3.pdf

National Agriculture Literacy Outcomes

Plants and Animals for Food, Fiber, & Energy

- Distinguish between renewable and nonrenewable resources used in the production of food, feed, fuel, fiber and shelter (T2.3-5.b)

Education Content Standards

Within Science

- 3-5ETS1: Engineering Design: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

- 4-ESS3: Earth and Human Activity: Obtain and combine information to describe that energy and fuels are derived from natural resources and that their uses affect the environment
- 5-ESS3: Earth and Human Activity: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Common Core Standards

Mathematics: Practice Standards

- CCSS.MATH.PRACTICE.MP1