Biotechnology in the North Carolina Sweetpotato Industry
Grades 6 - 8

Purpose: Students will explore agricultural biotechnology methods and careers as it applies to sweetpotatoes and GMO crops.

Subject Area(s): Science, Social Studies

Common Core/Essential Standards

Science
6th Grade
6.L.1.1 Summarize the basic structures and functions of flowering plants required for survival, reproduction, and defense.
6.P.3 Understand characteristics of energy transfer and interactions of matter and energy.
6.P.3.3 Explain the suitability of materials for use in technological design on a response to heat (to include conduction, expansion, and contraction) and electrical energy (conductors and insulators).
6.P.3.1 Illustrate the transfer of heat energy from warmer objects to cooler ones using examples of conduction, radiation, and convection and the effects that may result.

Social Studies
7th Grade
7.L.2 Understand the relationship of the mechanics of cellular reproduction, patterns of inheritance and external factors to potential variation among offspring.
7.G.2.2 Use maps, charts, graphs, geographic data and available technology tools (i.e. GPS and GIS software) to interpret and draw conclusions about social, economic, and environmental issues in modern societies and regions.

Science
8th Grade
8.L.1.1 Summarize the basic characteristic of viruses, bacteria, fungi, and parasites relating to the spread, treatment and prevention of disease.
8.L.2.1 Summarize aspects of biotechnology including: Specific genetic information available, careers, economic benefits to North Carolina, ethical issues, implications for agriculture.
8.H.3.2 Explain how changes brought about by technology and other innovations affected individuals and groups in North Carolina and the United States (e.g., advancements in transportation, communication networks and business practices).

Additional Standards:
WHST.6-8.2 Write informative/explanatory text, including narration of historical events, scientific procedures/experiments, or technical processes.

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

National Agricultural Literacy Outcomes

Agriculture and the Environment

(h) Recognize the factors of an agricultural system which determine its sustainability.

Plant, Animals, Food, Fiber, and Energy

(c) Identify farm practices for plant protection (e.g., using pesticides, integrated pest management, cultural practices) and the harvest of safe products for consumers.

Food, Health, and Lifestyle

(j) Identify the careers in food production, processing, and nutrition that are essential for a healthy food supply.

Science, Technology, Engineering & Mathematics

(b) Describe how biological processes influence and are leveraged in agricultural production and processing (e.g., photosynthesis, fermentation, cell division, heredity/genetics, nitrogen fixation).

(d) Discuss how technology has changed over time to help farmers/ranchers provide more food to more people.

(g) Identify science careers related to both producers and consumers of agricultural products.

(h) Identify specific technologies that have reduced labor in agriculture.

(i) Provide examples of science and technology used in agricultural systems (e.g., GPS, artificial insemination, biotechnology, soil testing, ethanol production, etc.); explain how they meet our basic needs; and detail their social, economic, and environmental impacts.

Culture, Society, Economy & Geography

(b) Distinguish between careers in production (farmers and ranchers) with those that directly involve consumers (business and nutrition).

Essential Questions

- What is agricultural biotechnology?
- What are GMO crops?
- What careers are related to agricultural biotechnology?
- What role does plant propagation play in biotechnology techniques?
- What is biotechnology's role in sweetpotatoes?
- Why are sweetpotatoes important to North Carolina?

Materials

- *From Farm to School – Crops of North Carolina: Digging for Sweetpotatoes* by Heather Barnes and Karen Baltimore (book)
  Printed by North Carolina Department of Agriculture and Consumer Services
  Publication supported by U.S. Department of Agriculture's (USDA) Agriculture Marketing Service North Carolina

- Technology: Computer/iPad/Chromebook, etc.
- Chart paper
- Markers
- Sweetpotatoes - talk with a local sweetpotato farmer (see *Essential Files/Links*)
- Pots, spoons, play food, picture cards about healthy foods, vitamins, and minerals (Food and Nutrition)
- DNA/genes model or play-dough (Genest/Geneticist)
- Beakers, colored water (yellow and blue liquid is great to use, when students mix the two colors, it turns to green. Another idea is to use oil and water), and specimen tubes (anything they can pour into and see the liquids mixing) (Chemist)
- Glass jar with lid (holes poked in the top or old hermit crab cage) for bug observations, ant farm, butterfly net kit, earth worms, etc. and magnifying glass (Entomologist)
- Plants (sprouts if possible), seeds, and soil in clear cups (use two different types of plant sprouts so they can compare and contrast the differences) (Agronomist)
- What is a GMO? infographic found at https://gmoanswers.com/
- Potting soil
- Disposable tin pans
- Mason jar/glass jar
- Tooth picks
- Water
- Toaster oven
- Baking sheet
- Tin foil
- Cooking spray
- Olive oil
- Cinnamon
- Sugar
- Sea salt
- Fry cutter (optional)
- Wax paper
- Any brand potato chip (Lays tends to be better for the observation of the experiment).
- Sweetpotato chips (any brand)

Essential Files/Links

- From Farm to School – Crops of North Carolina: Digging for Sweetpotatoes (book)
- https://gmoanswers.com/
- Biotechnology Sweetpotato Project Rubric
- Plant Propagation Activity

- Link to find growers: https://ncsweetpotatoes.com/sweet-potato-industry/growers/
- https://www.ncfb.org/
- https://www.ces.ncsu.edu/

Vocabulary

Agriculture: the science or practice of farming, including cultivation of the soil for the growing of crops and raising animals to provide food, wool, and other products.
Agricultural Biotechnology: scientific techniques used to improve plants, animals, and microorganisms.
Agronomist: an expert in the science of soil management and crop production.
Biotechnology: technology used on the basis of biological processes such as plant breeding.
Cells: smallest unit of life for the structural, functional, and biological unit of all living organisms – plants, animals, and humans.
Chemist – this scientist studies chemicals.
Commodities: raw materials or agricultural products that can be bought and sold such as a sweetpotatoes.
Consumer: a person who purchases goods and services for personal use.
DNA: deoxyribonucleic acid - a molecule that carries the genetic instructions used in the growth, development, functioning, and reproduction of all known living organisms.
Dominant: a dominant trait or gene, one that is most powerful or influential.
Entomologist: a scientist who studies insects.
Food Scientist – this scientist studies the vitamins, minerals and other nutrients people need to be healthy.
Flower: part of the plant for reproduction that can produce seeds.
Genes: a unit of heredity found in cells transferred from a parent to offspring that determines characteristics of the offspring.
Geneticist – this scientist studies genes and how traits are inherited.
Genetic modification: process of changing the gene structure of a living thing to make it healthier, stronger, or more useful to humans.
Genetically Modified Organism: also known as **GMO**, is the result of using a desirable trait found in nature and transfer it from one plant or organism to a plant scientists want to improve.
Leaf: part of the plant that uses energy from sunlight for photosynthesis.
Natural resources: materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain.
Plant Breeding: a scientific technique used to combine two sexually compatible sub-species to create a plant variety with desired traits from the parent plants.
Plant propagation: process of growing new plants from a variety of sources: seeds, cuttings, and other plant parts.
Producer: a person, company, or country that makes, grows, or supplies goods or commodities for sale.
Propagate: breed specimens of (a plant or animal) by natural processes from the parent stock.

Registered Dietician: regulated healthcare professionals licensed to assess, diagnose, and treat nutritional problems.
Stem: the body or stalk of the plant.
Storage roots: roots that are specifically modified for storage of starch, water, and nutrients such as carrots, beets, and sweetpotatoes that grow underground as protection from plant-eating animals.
Variety: taxonomic category that ranks subspecies or species in characteristics which vary from its immediate parent or type.

NC Ag Facts

- North Carolina grows nearly 60% of all United States sweetpotatoes (more than any other state in the United States).[1]
- The sweetpotato is North Carolina's state vegetable.[1] The single-word term helps differentiate the sweetpotato from the white or Irish potato, which is a tuber, not a root, and possess a different nutrient profile. Sweetpotato – *Ipomoea batatas*, a storage root is part of the morning glory family. [10]
- North Carolina sweetpotatoes are available every month of the year.[1]
- Most sweetpotatoes are grown in the piedmont and coastal plain regions of North Carolina because of the well-drained, sandy soil.[1]
- There are hundreds of varieties of sweetpotatoes and many are grown across North Carolina. Some you may see most often in grocery stores include the Japanese sweetpotato, the White sweetpotato, and the orange flesh Covington sweetpotato.[1]
- In 2017, nearly 89,500 acres of sweetpotatoes were harvested; 30,000 more acres than California, Louisiana and Mississippi combined.[9]
- North Carolina has produced more than one billion pounds of sweetpotatoes for the last seven years; this is the only state to exceed one billion pounds.[9]
- In dollars, North Carolina had the largest increase in 2017 at just over $37 million.[9]

Background Knowledge

Did you know that a sweetpotato is actually part of the morning glory family? It is a perennial (perennials regrow every spring); though it is cultivated as an annual (annuals live for one growing season). The creeping stems of this amazing plant can grow up to 20 feet long and frequently send out roots at the nodes which, in favorable seasons, bear small potatoes. There are three main types of leaves: round, shouldered, and lobed or split. The color of the stems and leaves varies from dark green to light purple. No flowers are produced except in southern latitudes.[2]

The skin color of a sweetpotato can range from white to yellow, red, purple, or brown. The flesh also ranges in color from white to yellow, orange, or orange-red.[3]

So, is it a yam, a sweetpotato, or are they the same thing? The truth: yams and sweetpotatoes are not the same thing at all. There are thousands of sweetpotato varieties. Sweetpotato varieties are classified as

either ‘firm’ or ‘soft’ – firm varieties were produced before soft varieties. When the soft varieties were grown there was a need to differentiate between the two (firm or soft). Africans actually named the ‘soft’ sweetpotatoes ‘yams’ because they resembled the yams in Africa. Their native word was ‘nyami’ and if the n & i are removed the term ‘yam’ remains. Despite this identification, this is not true. In fact, while the ‘soft’ varieties look like yams, they are not yams at all; it is just a variety of sweetpotato.

Yams are often imported from the Caribbean; they are rough and scaly—very different from our smooth, orange flesh variety sold in the United States. In the United States, people often use the word sweetpotatoes and yams interchangeably; however, this is not correct and often adds confusion for the consumer. When a consumer goes to the store and purchases ‘yams,’ they are more than likely purchasing a different variety of sweetpotato. Today, the U.S. Department of Agriculture requires labels with the term ‘yam’ to be accompanied by the term ‘sweetpotato.’[3]

According to the North Carolina SweetPotato Commission, North Carolina has ranked number one in sweetpotato production in the United States since 1971 (2018). North Carolina’s hot, moist climate and rich, fertile soil are ideal for cultivating sweetpotatoes. Sweetpotato production in North Carolina averages nearly 60% of the U.S. supply.[4]

Climate

Sweetpotatoes can be grown where there is a long frost-free period with warm temperatures in the growing season.[4] Most cultivars require a minimum frost-free period of 90-120 days, with a minimum average daily temperature of 77 degrees Fahrenheit. Sweetpotatoes also require an inch of water per week uniformly distributed throughout the growing season for highest yields.[4]

Uses for Sweetpotatoes

Sweetpotatoes have many uses. They can be prepared in a number of dishes, canned, preserved and dried. For drying, clean washed potatoes are placed in a suitable basket and immersed in boiling water for a short time; when taken out of the basket, they are cut into thin slices and spread over mats and exposed to the sun for two or three days. In order to make a superior quality, the skin of the potato is peeled off before slicing. Instances were reported wherein the dried product was successfully ground into flour.[2] In North Carolina a company named Glean produces a sweetpotato flour.[5] Sweetpotatoes can also be used as food stock for animals. They have been successfully fed to hogs, cattle, horses and poultry. [2]

How to Play **KAHOOT!**

Let’s play KAHOOT! If you do not have an account set up, please follow the link here: https://create.kahoot.it/register to register. Once you have registered you may begin creating an interactive game for your students to learn and enjoy. Log into KAHOOT and simply click discussion, survey, multiple choice, or jumble to start making a quiz. Then you will add your questions using the **NC Facts and Background Knowledge** section of the lesson plan. Once you have created your Kahoot

game, launch the game so players can join. A unique game pin will be provided and players will enter this pin to join. Remember this link: https://kahoot.com to be put in the browser of your device (computer, phone, iPad, tablet, etc.) to join the game. Kahoot can be used in many ways to ignite learning in your classroom. The following link provides more step by step instructions on how to use Kahoot: https://kahoot.com/files/2017/07/Kahoot_guide_to_creating_and_playing_learning_games.pdf

Activity 1: Agricultural Biotechnology
Objectives Covered: 6.L.1.1, 8.L.2.1

1. Begin by telling students, "We know that **cells** are the building blocks of all living things – both plant and animal. They make up all of the systems that carry out important functions that sustain life. Cells are made up of **genes** that carry information that determine what living things look like and how they function. All of our genes come from our parents; that is why we look similar to our parents."
2. Have students turn to a partner and discuss briefly a few thoughts on what genetic traits they inherited from their parents. If you should have a student that was adopted by their parents, simply have a brief discussion as a whole group.
3. Ask students if genetic traits work the same way in plants as they do in humans. Do plants exhibit similar traits from the parent plant? Are plants bred to produce offspring with the same traits? What parts of the plant are responsible for its reproduction? Review plant parts definitions for **flower**, **leaf**, and **stem**. Now ask, what is **plant breeding**? Review this definition listed in the vocabulary section.
4. Discuss with students their ideas for reasons why plant breeding would be important to the **agriculture** industry? Reasonable responses would be better plant genetics, higher crop yields, or improving the taste of agricultural **commodities** such as strawberries or blueberries.
5. Next ask the students why sweetpotato farmers would be interested in plant breeding. Make a list of student responses on the board. Best response would be to increase yields while using **natural resources** more efficiently or a more generalized answer would be to improve crops and produce new varieties.
6. Place students in small groups and give them five minutes to search the internet for examples of plant breeding and report their findings to the whole group. A good example is the work of Norman Borlaug with wheat. As student groups are reporting on their findings make sure they discuss the reasons and benefits for plant breeding and type of procedure.
7. Inform students that plant breeding techniques are known as **agricultural biotechnology** and in the 20th century it became more sophisticated because scientists were learning about genes responsible for desirable traits. For example, scientists can insert a specific gene into a plant seed allowing the plant to grow in special environments or to resist certain insects or weeds.
8. Write the word **biotechnology** on the board or chart paper and dissect the word by explaining to students that "bio" means the study of, and technology means a specialized tool. **Agricultural biotechnology** is the specialized tool that enhances a breeders' ability to create crop and livestock improvements.
9. Watch the video: What is Biotechnology? https://www.youtube.com/watch?v=SnkHmwTKksQ

Ask students, “Why do we need biotechnology? Why is biotechnology important to agriculture?” **Correct responses**: Biotechnology helps farmers and the environment in many ways for improving harvests and preserving land use while using fewer resources to increase efficiency. The use of biotechnology prevents plants from being damaged by insects and robbed of nutrients by weeds. In protecting plants like corn, soybeans, and cotton from pests, it improves a farmer’s productivity. This is very important because the world’s population by year 2050 is predicted to increase to 9.6 billion people, placing our food supply under stress. Farmers will need to produce enough food with fewer resources, such as land, to support our world population.

10. **Exit ticket**: Have students write down another industry other than agriculture they believe biotechnology is used for the enhancement of products. Correct answers are medical, industrial, and environmental.

Activity 2: **GMO Crops: What are they?**
Objectives Covered: 8.L.2.1

1. Tell the students that in the case with sweetpotatoes it is the actual root of the plant, known as a **tuber** or **storage root**, which scientists desire to improve upon using agricultural biotechnology techniques. However, centuries ago a wild sweetpotato plant “borrowed” a natural bacterial gene from the environment where plants grew larger and stronger to produce a more desirable sweetpotato. This is an example of **genetic modification** happening in nature and thought to be the world’s first known **GMO**.[8] Today, plant scientists use this example for making similar efforts to adapt desirable traits in new plants, known as genetic modification. The food or crop that a plant produces resulting from agricultural biotechnology is known as a genetic modified organism or **GMO**.
2. Use the infographic from GMO Answers called What Is a GMO? to discuss and show students today’s 10 GMO crops commercially available on the market: corn (field & sweet), soy, cotton, alfalfa, sugar beets, canola, papaya, artic apple, potato, and squash.
3. Ask the students why they think these crops have been genetically modified. Accept all answers.
4. Next identify the following reasons for which the 10 GMOs were created: a.) herbicide tolerance b.) non-browning c.) drought resistance d.) insect resistance e.) disease resistance f.) virus resistance and g.) resist bruising. Ask students to work in pairs and match the GMO crop to the property for which it was developed and determine the benefit to the farmer and consumer. **Answers: Corn (c), Soy (a), Cotton (d), Alfalfa (a), Sugar Beets (a), Canola (a), papaya (f), artic apple (b), potato (g) and Squash (e).**
5. Next, show students the video, Jake the GMO seed https://www.youtube.com/watch?v=L9tlirsBNg4 for a better understanding of biotechnology and genetically modified seeds.

6. Ask students the following questions, “Who supports and tests GMO seeds and other techniques related to biotechnology? What agencies approve the use of a GMO seed? Does a food crop change in its nutritional value if grown from a GMO seed? What advantages are there for using GMO seeds?”
7. **Exit ticket**: Ask students to write down one statement referring to new knowledge they have gained about GMOs, one statement that proved their previous knowledge was a misconception about GMOs, and one question they still have concerning agricultural biotechnology and GMOs.

Activity 3: Biotechnology Careers
Objectives Covered: **8.L.2.1**

1. When we think about **agriculture** we ultimately think about farmers as **producers** who grow crops, raise livestock, and produce the food and fiber that sustain life for **consumers,** but there are many other different careers related to agriculture. Today we are going to learn about careers related to agricultural biotechnology.
2. Show students a list of careers:

Agronomist: this scientist studies crops and soils
Chemist: this scientist studies chemicals.
Entomologist: this scientist studies insects
Food Scientist: scientist that studies the vitamins, minerals and other nutrients people need to be healthy.
Geneticist: this scientist studies genes and how traits are inherited.
Registered Dietician: healthcare professionals licensed to assess, diagnose, and treat nutritional problems.

3. Tell students they are going to become scientists of biotechnology. Divide students into groups of 3 to 4 each. Explain to students that they are going to learn about the different tools that each scientist uses by looking at pictures, exploring insects, mixing chemicals, learning about healthy foods and minerals, and genes carried by the molecule known as **DNA**.
4. These are the items you will need for this activity: iPad, computers, note taking paper, and simple stations with items for students to experiment with.
   Examples:
   - Pots, spoons, play food, picture cards about healthy foods, vitamins, and minerals (Food and Nutrition)
   - DNA/genes models or Play-Doh (Geneticist)
   - Beakers, colored water (yellow and blue liquid is great to use, when students mix the two colors it turns green; another idea is to use oil and water), specimen tubes (anything that they can pour and see mixing liquids) (Chemist)

- Glass jar with lid (holes poked in the top or an old hermit crab cage) for insect observations, ant farm, butterfly net kit, earth worms, etc. and magnifying glass (Entomologist)
- Plants (sprouts if possible), seeds, and soil in clear cups (Agronomist). Use two different types of plant sprouts so students can compare and contrast the differences.

5. Allow each group of students to rotate through each station for at least 4-5 minutes to experience what scientists do in utilizing information to create GMO seeds.
6. Once each group has completed their time at each station have them answer the following questions using resources from the website GMO Answers. Have them present at least two infographics from the website as proof for their responses.
    a. How many years on average does it take a GMO to become available on the market? (How Does a GMO Get to Market? The GMO Regulation, Review and Research Process infographic)
    b. What century did the work of plant breeders and researchers provide the first agricultural GMO to the market place? (The History of Genetic Modification of Crops infographic)
    c. The GMO potato is known to reduce food waste while in the past 400 million pounds were bruised or damaged from storage and transportation.[7] What jobs can you think of are related to providing these GMO potatoes to your plate? (The GMO Potato: from Farm to Plate infographic)
    d. Why do farmers choose to use GMO seeds for planting their crops? (What Does GMO Stand For? infographic)
    e. From the list of careers in this activity, which one are you most interested in and state two reasons why.
7. Allow each group to share out their responses; however, give each student an opportunity to tell which career from the activity they are most interested in.
8. For further investigation of careers, contact your local county Farm Bureau office and ask for suggested guest speakers. See Link: https://www.ncfb.org/

Extension Activity: Provide each student in your class with a sweetpotato and have them create a character matching one of the above careers related to Biotechnology. Students will research and write about what their biotechnology career sweetpotato would do in a day. Provide students with a rubric for writing – *Biotechnology Sweetpotato Project Rubric* (see **Essential Files**). Students can gather materials and props to complete their sweetpotato project at home. See link: https://www.ces.ncsu.edu/ for more careers related to Biotechnology.

Activity 4: Choose your Variety
Objectives: **6.P.3**, **6.P.3.1**, **6.P.3.3**, **7.L.2**

1. Say, “Did you know there are many varieties of sweetpotatoes grown in North Carolina? The majority are orange-fleshed, moist, sweet varieties.” But, varieties change rapidly and new varieties with superior qualities are released almost annually (NC SweetPotato Commission, 2019). For this project, you will need multiple varieties of sweetpotatoes, if possible. If not, the project can still be conducted.
2. Show students different varieties of sweetpotatoes. Explore this link for exploring different varieties grown by NC sweetpotato producers: https://ncsweetpotatoes.com/sweet-potato-industry/growers/
3. Explain to students that sweetpotatoes are **propagated** (breed specimens of a plant or animal by natural processes from the parent stock). Say: “Let’s talk a bit more about plant propagation.” Write meaning of plant propagation on white board or smart board. **Plant propagation** is the process of growing new plants from a variety of sources: seeds, cuttings, and other plant parts. Did you know that plant propagation is an example of biotechnology? If you recall from a previous lesson, **agricultural biotechnology** is the specialized tool that enhances a breeders’ ability to create crop and livestock improvements. Plant breeders use the technique of propagation for certain desirable traits in plants.
4. How do you think this is important to sweetpotato breeders? Allow students to discuss this amongst themselves. Provide students with a copy of the *Plant Propagation Activity* (see **Essential Files**). Allow students time to brainstorm and write their responses.
5. Provide students with an explanation. An example may be: Sweetpotato growers may breed varieties based on a certain trait. When propagating for certain traits, breeders will grow out a plant, and select only the offspring that show that selected trait. All others get discarded. Then, from the selected plants they breed the offspring. The results with the desirable trait get kept, and the process continues until all offspring show that certain trait. Sweetpotato growers may use this to grow popular varieties that consumers often buy. They may use varieties that produce higher yields, are less susceptible to disease, and are more tolerant to different soil types and weather conditions.
6. Say, “Now, we are going to propagate our own sweetpotatoes, although this time we are going to conduct different methods to see which is more effective.” Ideally, most grocery stores will offer different varieties of sweetpotatoes (suggestion would be to find a dark orange and a light colored or white sweetpotato).
7. Show students these materials: a sweetpotato, soil, disposable pan, mason jar/glass jar, water, toothpicks.

   Group A Project: (1) Fill a mason jar/glass jar half way with water. (2) Place toothpicks midway up the sweetpotato (as props to hold sweetpotato in the water). (3) Place sweetpotato in water and put in a well-lit area.

   Group B Project: Place whole sweetpotato(es) lengthwise in a pan of soil (disposable pan works best); pour in soil so the soil comes halfway up the sides of the potato. (2) Place the pan in a well heated, warm place (like a window sill). (3) Make sure the soil stays moist and wait for the sweetpotato to produce roots/slips (this should happen within 2 weeks). *Note:* It is suggested a seed heating pad or some form of heat be placed under the pan causing best growing conditions.

This is an opportunity to offer an explanation and illustration about energy transfer and interactions of matter and energy.

8. Allow students to observe and document changes over the 2 weeks. Additionally, have students notice why the two scenarios may be similar or different, and what makes them similar or different. Have students document their findings by taking pictures and notes with iPads/Chrome Books/etc. This will provide documents and artifacts to create a timeline or presentation highlighting the findings of their project.
9. After slips have grown allow students to plant sprouts. Make sure to plant two slips from each variety together as a way to observe the **dominant variety** or to determine if the two grow differently over time.
10. Have students make predictions or a hypothesis for what they think will happen. Create a name for the new variety of sweetpotato. *The growth of the actual sweetpotato will take 90 days, so students may not actually be able to see the true changes of the root vegetable itself, but the upcoming group of students can examine the work conducted by previous students.*

Example of how the experiment should look:

Photos credit of https://www.theartofdoingstuff.com/never-grow-sweet-potato-slips-this-way-again/

Activity 5: Biotechnology's Role in Sweetpotatoes
Objectives: 8.L.1.1, 8.L.2

1. Tell students that biotechnology has helped farmers and the environment in many ways to improve plant breeding resulting in higher crop yields. Insects and weeds are environmental

problems for farmers because they constrict or damage the growth of plants. Farmers and scientists have partnered in finding ways to combat these damaging issues using biotechnology techniques.

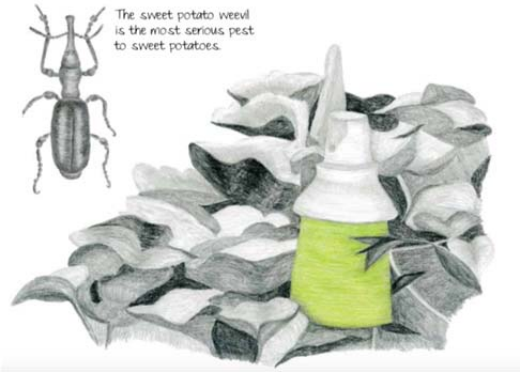
2. Divide class into two large groups and have them create a team name.
3. Explain to students, "Today you will take on the role of both an **entomologist** and an **agronomist**." Review the definitions of both occupations found in the **Vocabulary** section.
4. Post the following Scenarios:
   Scenario One: A sweetpotato farmer talked with his local cooperative extension agent with concerns of damage to his growing sweetpotato plants. It was determined that the farmer may be experiencing the wrath of the sweetpotato weevil. The cooperative extension agent contacted an entomologist to conduct tests to see if this was indeed the case. As an entomologist what plan of action can you suggest for the sweetpotato farmer that involves biotechnology?
   Scenario Two: A sweetpotato farmer has noticed different weed varieties growing in his sweetpotato fields. The farmer is confused as to why these weeds are overtaking his crop and why he is noticing sweetpotatoes he digs are suffering from certain diseases. As an agronomist what could you suggest as a prescribed solution that involves biotechnology?
5. First, students should conduct research on the role of each scientist and their role in agriculture. Once they have a good understanding of the career itself, students will brainstorm ideas and "plan an experiment" and gather supplies.
6. The following day or next class period, allow students to work together to conduct their experiments, pose hypothesis, and finalize any questions from the group.
7. Students will then create a presentation that can be shared with other classes or within their own class to explain what they learned and what they found from these experiments.
8. **Ending Assignment/Grade**: How do the roles of farmers and scientists impact the production of our food and fiber?

Additional information for students understanding and supporting student findings:

- Sweetpotato weevil is by far the greatest enemy of sweetpotato especially in the tropics. Production losses due to this insect attack can reach 60 to 100% in certain areas. The sweetpotato weevil feeds on stored roots, reducing their quality and yield. Secondary compounds produced by roots in response to weevil attack make even slightly damaged roots inedible.[4] https://www.ncagr.gov/plantindustry/Plant/entomology/SPW/index.htm NORTH CAROLINA is considered weevil free.
- There are several fungal, bacterial and viral diseases which infect the sweetpotato crop. As sweetpotato is grown primarily as a subsistence crop in most developing countries, chemical control of these diseases is not widely practiced. Frequent replanting with virus free stock is also no enduring solution as warm climates lead to a high reinfection rate.[4]
- Weeds can be a problem for farmers too. Weeds crowd out farm crops and rob them of water, light, and nutrients they need to grow. Thanks to biotechnology, a farmer can better manage weeds using seeds for planting that are resistant to herbicides.

Example to share with Class:

One example of how biotechnology has impacted the production of sweetpotatoes is the sweetpotato weevil trap.



This image is a pheromone trap that is set up in a field to help growers and researchers monitor sweetpotato weevil activity. The North Carolina Department of Agriculture and Consumer Services (NCDA&CS) issued these traps in the Sweetpotato Weevil Program to implement effective plant pest protection to keep NC free of sweetpotato weevils. Image taken from: *From Farm to School – Crops of North Carolina: Digging for Sweetpotatoes* by Heather Barnes and Karen Baltimore (book)

Concept Elaboration and Evaluation

- **What is agricultural biotechnology?**
  For agriculture, biotechnology has opened many doors for crop production responding to market needs and environmental changes. With the fast growing population in our world and limited space to produce food, biotechnology has given us hope that agriculture can sustain our growing population. Agricultural biotechnology techniques have improved crop yields, built resistance to diseases, and eliminated certain pests that affect crop production from breeding seed varieties. It has also helped in areas such as production of animal feed to reduce environmental waste and improve animal nutrition. But it goes far beyond that, biotechnology is being used to speed up breeding for plants, livestock, and fish for higher yields in feeding our growing world population. Without it, it would take an additional 44.7 million acres to grow the same amount of food produced during 1996 to 2014.
- **What are GMO crops?**
  Genetically modified organism or GMO is any organism whose genetic material has been altered using genetic engineering. Genetically modified or genetically engineered is a process of using the DNA of one species with DNA of another species to introduce a new trait to the plant which does not occur naturally in the species. Genetic modification can also occur naturally, farmers have been cross breeding plants for many years. GMO crops, sometimes referred to as biotech crops are crops that have been altered to withstand weather conditions, pest resistance, and

increased production. Take for instance GMO crops that have been designed to be pest resistant; drastically reducing the use of pesticides and herbicides applied to the crop reducing the risk to environmental and human health.

- **What careers are related to agricultural biotechnology?**
  A few careers related to agricultural biotechnology are an:
  Agronomist: this scientist studies crops and soils
  Chemist: this scientist studies chemicals.
  Entomologist: this scientist studies insects
  Food Scientist: scientist that studies the vitamins, minerals and other nutrients people need to be healthy.
  Geneticist: this scientist studies genes and how traits are inherited.
  Registered Dietician: Registered Dietitians are regulated healthcare professionals licensed to assess, diagnose, and treat nutritional problems.
- **What role does plant propagation play in biotechnology techniques?**
  Plant propagation is the process of growing new plants from a variety of sources: seeds, cuttings, and other plant parts. Plant propagation is a great example of biotechnology. Biotechnology or agricultural biotechnology is the specialized tool that enhances a breeders' ability to create crop and livestock improvements. Plant breeders use the technique of propagation for certain desirable traits in plants. This process allows scientists and farmers to create drought resistant corn and certain varieties of sweetpotatoes that can tolerate different climates.
- **What is biotechnology's role in sweetpotatoes?**
  Biotechnology and the research behind it have helped sweetpotato growers breed varieties based on a certain trait. When propagating for certain traits, breeders will grow a sweetpotato plant, and select only the offspring that show the trait they desire. All others get discarded. Then, from the selected plants they breed the offspring. The results with the desirable trait get kept, and the process continues until all offspring show that certain trait. This has helped farmers breed varieties that are best for marketing, to meet the needs of the consumer.
- **Why are sweetpotatoes important to North Carolina?**
  North Carolina is the largest producer of sweetpotatoes in the U.S. and this export contributes to the revenue brought into the state and the country through agriculture. Sweetpotatoes are an important food, and historically was a staple food for Native Americans many years ago. North Carolina sweetpotatoes have become a large export to other parts of the world, especially Europe. The importance of the sweetpotato goes far beyond the fields it grows in, but the millions of consumers that eat them throughout the year.

Sources and Credits

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Suggested Companion Resources

- *From Farm to School – Crops of North Carolina: Digging for Sweetpotatoes (*Activity Book) https://www.ncsweetpotato.com/sweet-potatoes-101/sweet-potatoes-in-the-classroom/materials-to-download/
- A Sweetpotato Tale (video) http://www.pbs.org/video/a-sweet-potato-tale-warnvs/
- The NC Sweetpotato Goes Abroad http://www.pbs.org/video/nc-sweet-potato-goes-abroad-jzu0ks/
- USDA Natural Resource Conservation Service (webpage) https://websoilsurvey.nrcs.usda.gov/app/
- The Science of Ag: Methods of Modification Episode 1 – Crossbreeding (Podcast) https://monsanto.com/company/outreach/education-outreach/research-resources/methods-of-modification/
- The Science of a GMO (Lesson Plan grades 9-12) https://www.agclassroom.org/teacher/matrix/lessonplan.cfm?lpid=598
- Genetically Modified Leaf Test (experiment kit) https://agclassroomstore.com/gm-leaf-test/
- Genetically Modified Soybean Seed (experiment kit) https://agclassroomstore.com/gm-soybean-seed/
- Plant Breeding Ag Mag (Reader) https://www.dmsfulfillment.com/FarmBureau/DMSStore/Product/ProductDetail/26237

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