Soybean Crush

Suggested Grade Level: 3-5

Time: 60 minutes (45 minutes + 15 minutes the next day); expandable to 3-4 more sessions using the lesson plans listed in Companion Resources.

Subject: Science, Plant Life Cycle and Anatomy, Properties of Matter, English Language Arts, Informational Reading, Speaking and Learning, Agriculture, Soybeans, Food Science

Overview: Soybeans are a vital food source for both people and livestock and are utilized in numerous everyday products. Soybean oil is widely used as a cooking oil, biodiesel fuel, in crayons, and as a component in printing ink. In this lesson, students will learn about soybeans, explore their everyday uses, and participate in a hands-on activity to extract oil from soybeans.

Objectives:

1. Explain what soybeans are.
2. List at least five uses of soybeans in everyday life.
3. Describe how to extract oil from soybeans.

Background Information:

Although soybeans have been a significant food crop in China for over 5,000 years, they were not cultivated in the United States until the 1800s. They were grown for animal forage until a scientist, George Washington Carver, began studying them in 1904. He discovered numerous new ways to utilize soybeans. Today, soybeans are a valuable crop in our country because they possess oil and protein that can be used in various products (Soybeans).

Soybeans are sometimes nicknamed "magic beans" because they can be made into many products. From foods to ink, paints to plastics, soybeans are essential in our lives. Some of the products that include soybean oil or soybean protein are: tofu, edamame, cereal, chocolate, hot dogs, candy, baby food, flour, soup, ice cream, cookies, soap, shampoo, fabric softener, cosmetics, pet food, and vitamins. Soybean oil is widely used in cooking oil, biodiesel fuel, crayons, and printing ink. Cooking oil made from soybeans is low in saturated fat and is used to help reduce fat and lower cholesterol in our diets. Diesel fuel made from soybean oil is biodegradable, sulfur-free, and does not produce explosive vapors, and emits significantly fewer pollutants. "Prang Fun-Pro" crayons are made from soybean oil and provide brighter, smoother colors that don't flake. Printing ink, used by newspapers and other commercial printers, is often

made with varying amounts of soybean oil. Soy ink is used because it prints more paper per pound and offers better color reproduction (Knott).

Kansas Connections:

The bushy, green soybean plant is a legume related to clover, peas, and alfalfa. In Kansas, soybeans are typically planted in April and May, then harvested in September and October. When they flower in the summer, they can produce up to 80 pods per plant. Each pod contains two to four pea-sized beans. Soybeans are grown primarily to be processed into meal and oil. In Kansas, specifically, soybeans are more prevalent in the eastern third of the state, with production decreasing further west. Soybeans can be picky about their growing conditions, and the drier climate in the west isn't as well-suited for production. The primary soybean-producing areas are located in the Corn Belt and the lower Mississippi Valley. The three top-producing states in 2020 were Illinois, Iowa, and Minnesota (Soybeans).

Nationwide, soybean production in 2020 totaled 4.14 billion bushels, up 16 percent from 2019. The average yield per acre was estimated at 50.2 bushels, an increase of 2.8 bushels from 2019. Harvested area was up 10 percent from 2019 to 82.3 million acres. A bushel of soybeans weighs about 60 pounds. Each bushel can be converted into 11 pounds of oil and 48 pounds of protein-rich meal, which can be sold worldwide. Kansas ranks 10th in the nation for soybean production, with 2020 totaling 190 million bushels, up 2% from 2019, across 4.7 million harvested acres. Yield averaged 40.5 bushels per acre (Barrett).

Materials:

Engagement

- "Can You Guess the Crop?" Soybean Poster

Discussion

- Kansas Kids Connection Magazine "Super Soybeans" https://ksagclassroom.org/education-center/kansas-kids-connection-magazines/

Activity

- Frozen soybeans (at least ¼ cup)
- Electric coffee grinder (or soybean meal to skip grinding your own)
- Pyrex glass

Instructional Format:

1. Conduct engagement exercise.
2. Lead a class discussion.
3. Complete the activity.
4. Review vocabulary.
5. Conduct assessment exercise.

Engagement:

To introduce this lesson, show the "Can You Guess the Crop?" Soybean Poster. As you read off the facts on the poster, have students guess which crop it is. See if anyone gets it before the reveal at the end!

Procedures:

Discussion

1. Hand out Kansas Kids Connection Magazine "Super Soybeans," one per student, pair, or group.
2. Popcorn read or other reading method of choice (pair, share, reading groups, etc.) to introduce soybeans to the class. Discuss the life cycle of soybeans, introduce vocabulary from the magazine, and label the parts of a soybean plant on page 3.
3. Have the class watch a short video. Illinois Soybean Commission: Pod to Plate, Read Aloud by Betsy Emerick https://www.youtube.com/watch?v=lqwqiX_aq1k
4. List or show examples of different ways soybean oil is used daily. Refer to the Kids Connection magazine again or the list below.

- Human Consumption: Cooking oil, baby food, batters and breading, mayonnaise, candy, bakery products, breads, cakes, salad dressing, cheeses, tofu, soy flour, margarine, grits, coffee creamer, noodles, cereal, peanut butter, and snack foods
- Animal Consumption: Fish foods, bee foods, cattle feed, dairy feed, poultry feed, swine feed, and pet food
- Consumer and industrial: All-purpose lubricants, animal care products, auto care products, building products, medicine, table tops, car wax, sunscreen lotion, candles, carpet backing, cleaning products, crayons, paint, soap, body lotion, cosmetics, ink, rubber, engine oils, furniture, insulation, paint strippers, soy biodiesel, weed and insect killer, plastics, fire extinguisher foam.

5. Display “What’s in a Soybean?” pie chart.
6. Elaborate that most soybeans are used for animal feed, but they have important roles in products for human consumption. In addition, more and more non-edible products are using soybeans or soybean by-products. Ideally, gather several products or pictures containing soybeans, especially a bottle of vegetable oil made from soybeans. This display would be ideal for showcasing during the final oil extraction project.
7. Announce the next activity. Explain to students that they will be acting like a food scientist, experimenting with soybeans by extracting their oil.

Activity

You can do this activity in two different ways. You can ask a local soybean farmer or co-op for untreated soybeans, or visit your grocery store to purchase soybean meal or soy flour. If you use whole soybeans, freeze them before this lesson. If you use soybean meal, skip step one.

1. Measure ¼ cup of frozen soybeans and place them in an electric coffee grinder. Pulverize and grind to a fine powder.
2. Place the finely ground soybeans into a Pyrex glass container and cover them carefully with boiling water. Use enough water so that the mixture can separate into layers. Stir the mixture for approximately one minute and let it sit.
3. Ask students to describe what the mixture looks like and whether it has an odor.

4. Let the mixture sit, preferably overnight, until later in the day.
5. Ask students if the appearance of the mixture has changed (i.e., if any layers can be seen).
6. Using an eyedropper, carefully extract a sample from the top layer of the mixture.
7. Place a sample drop onto a slide with a cover and place it under a microscope. Oil beads should be observable as students take turns looking through the microscope. You may need to draw what they should look for on the board.
8. Have a student barely touch the top layer of the mixture in the Pyrex glass container with their finger. Then, have them rub their finger on the palm of their other hand. Have this student describe what it feels like.
9. Have another student touch the top layer with their finger and then rub it on an absorbent brown paper/paper towel. Have this student describe what it looks like. Your students should be able to see and touch the results of crushing, stirring, and soaking soybeans. Oil is released from the soybeans and collects on top of the mixture because it is less dense than the other substances. This oil is what the students saw under the microscope and what they felt when they touched the top layer of the mixture. The soybean meal should settle to the bottom of the jar, while the middle layer is a solution of water and protein.
10. Show the bottle of vegetable oil from the grocery store and point out that the commercial process of extracting oil from soybeans is much more complex and involves a chemical solution.

Vocabulary:

- **Cotyledon:** the portion of a soybean seed that develops into the first leaves
- **Edamame:** immature green soybeans boiled or steamed in their pods and harvested before the ripening stage
- **Embryo:** the portion of a seed that develops into a new or "baby" plant
- **Legume:** a type of plant that has seeds contained in a pod, such as a soybean, pea, or alfalfa plant
- **Seed coat:** a very thin layer on the outermost surface of the seed that offers protection to the seed
- **Soybean:** a cultivated plant of the pea family that produces edible seeds used in a variety of foods

Kansas Standards:

Next Generation Science Standards:

3rd Grade

Heredity: Inheritance and Variation of Traits

3-LS3-2. Use evidence to support the explanation that traits can be influenced by the environment.

4th Grade

From Molecules to Organisms: Structures and Processes

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

5th Grade

Energy
5-PS3-1. Use models to describe that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun.
From Molecules to Organisms: Structures and Processes
5-LS1-1. Support an argument that plants get the materials they need for growth chiefly from air and water.

Language Arts:
3rd Grade
Reading: Foundational
Fluency
RF.3.4 Read with sufficient accuracy and fluency to support comprehension.
Reading: Informational
Key Ideas and Details
RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
RI.3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.
RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts or steps in technical procedures in a text, using language that pertains to time, sequence and cause/effect.
Craft and Structure
RI.3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a third grade topic or subject area.
RI.3.5 Use text features and search tools (e.g., key words, sidebars, hyperlinks) to locate information relevant to a given topic efficiently.
Integration of Knowledge and Ideas
RI.3.7 Use information gained from illustrations (e.g., maps, photographs) and the words in a text to demonstrate understanding of the text (e.g., where, when, why and how key events occur).
Language in Reading: Informational
RI.3.10 Use knowledge of language and its conventions when reading.
RI.3.11 Determine or clarify the meaning of unknown and multiple-meaning words and phrases to expand language comprehension.
Range of Reading and Text Complexity
RI.3.13 Read and comprehend high-quality informational text of appropriate quantitative and qualitative complexity for third grade.
Speaking and Learning
Comprehension and Collaboration
SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse on third grade topics and texts, building on others' ideas and expressing their own clearly.
SL.3.2 Determine the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively and orally.
SL.3.3 Ask and answer questions about information from a speaker, offering appropriate elaboration and detail.
Presentation of Knowledge and Ideas

SL.3.4 Report on a topic or text, tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

4th Grade
Reading: Foundational
Fluency
RF.4.4 Read with sufficient accuracy and fluency to support comprehension.
Reading: Informational
Key Ideas and Details
RI.4.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
RI.4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.
RI.4.3 Explain events, procedures, ideas or concepts in a historical, scientific or technical text, including what happened and why, based on specific information in the text.
Craft and Structure
RI.4.4 Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a fourth grade topic or subject area.
Language in Reading: Informational
RI.4.10 Apply acquired skills in writing and speaking.
RI.4.11 Determine or clarify the meaning of unknown and multiple-meaning words and phrases to expand language comprehension.
Range of Reading and Text Complexity
RI.4.13 Read and comprehend high-quality informational text of appropriate quantitative and qualitative complexity for fourth grade.
Speaking and Learning
Comprehension and Collaboration
SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on fourth grade topics and texts, building on others' ideas and expressing their own clearly.

5th Grade
Reading: Foundational
Fluency
RF.5.4 Read with sufficient accuracy and fluency to support comprehension.
Reading: Informational
Key Ideas and Details
RI.5.3 Explain the relationships or interactions between two or more individuals, events, ideas or concepts in a historical, scientific or technical text based on specific information in the text.
Craft and Structure
RI.5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a fifth grade topic or subject area.
Language in Reading: Informational
RI.5.10 Use knowledge of language and its conventions when reading.
RI.5.11 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on fifth grade reading and content, choosing flexibly from a range of strategies.
Range of Reading and Text Complexity

RI.5.13 Read and comprehend high-quality informational text of appropriate quantitative and qualitative complexity for fifth grade.
Speaking and Learning
Comprehension and Collaboration
SL.5.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on fifth grade topics and texts, building on others' ideas and expressing their own clearly.

National Ag Literacy Standards:
Agriculture and the Environment
- Recognize the natural resources used in agricultural practices to produce food, feed, clothing, landscaping plants, and fuel (e.g., soil, water, air, plants, animals, and minerals) (T1.3-5 e)

Plants and Animals for Food, Fiber, and Energy
- Provide examples of specific ways farmers/ranchers meet the needs of animals (T2.3-5 d.)

Culture, Society, Economy & Geography
- Explain the value of agriculture and how it is important in daily life (T5.3-5 d.)

Supporting Resources:

Iowa Agricultural Literacy Foundation "Mighty Soybean," written by Cindy Hall: https://naitcconference.usu.edu/archive/2015/Uploads/Handouts/680CindyHall_5.pdf

National Agriculture in the Classroom "Topsy-Turvy Soybeans," written by Cindy Hall: https://www.agclassroom.org/matrix/lesson/97/

National Agriculture in the Classroom, "From Soybeans to Car Parts," written by Sue Knott https://www.agclassroom.org/matrix/lesson/296/

National Agriculture in the Classroom, "Full of Beans: Henry Ford Grows a Car," written by Bekka Israelsen https://agclassroom.org/matrix/lesson/740/

"Pod to Plate: The Life Cycle of Soybeans" by Julie Blunier
https://bookscouter.com/book/9780692769454-pod-to-plate-the-life-cycle-of-soybeans

"My Family's Soybean Farm" by Katie Olthoff.
https://www.barnesandnoble.com/w/my-familys-soybean-farm-katie-olthoff/1138280722

"Full of Beans: Henry Ford Grows a Car" by Peggy Thomas:
https://www.barnesandnoble.com/w/full-of-beans-peggy-thomas/1130336425

Soybean Byproducts Poster
https://ksagclassroom.org/supporting-resources/soybean-byproducts/

Soybean Fun Facts Poster
https://ksagclassroom.org/supporting-resources/soybean-fun/

Soy New Uses Website https://soynewuses.org/.

Career Information: Food Scientist
Food scientists study the composition, properties, and processing of foods. Their responsibilities may include investigating the molecular composition of food, improving food sustainability, and/or enhancing its nutritional content. Food scientists can work for agricultural, chemical, or food production companies. They typically require a bachelor's degree in microbiology, biology, chemistry, or a related field such as food science. Some positions may require more advanced degrees.

Assessment:

1. Have students list or tell their classmates at least five things that include soybeans as an ingredient.
2. Give students a blank chart from Kids Connection magazine and have students label parts, with or without a word bank.
3. Use a vocabulary quiz to gauge understanding.
4. Example exit ticket questions:

- Soybeans are an important source of what two things?

Answer: *Oil and protein.*

- Who did the first soybean research in the U.S., and when?

Answer: *George Washington Carver in 1904.*

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References:

Barrett, J. (2020). *Corn and soybean production up in 2020, USDA Reports: Corn stocks down fractionally, soybean stocks down sharply from year earlier, Winter Wheat Seedings up for 2021.* National Agricultural Statistics Service; United States Department of Agriculture. https://www.nass.usda.gov/Newsroom/archive/2021/01-12-2021a.php

Knott, S. *Bean Seed Cycle*. [Sample lesson plan] (n.d.). National Agriculture in the Classroom. Retrieved December 2, 2024, from https://agclassroom.org//matrix/lesson/79/

Soybeans. (2022). Illinois Agriculture in the Classroom. agintheclassroom.org/media/5gfk2gpg/soybean-reader-pages-updated-2022.pdf

CAN YOU GUESS THE CROP?

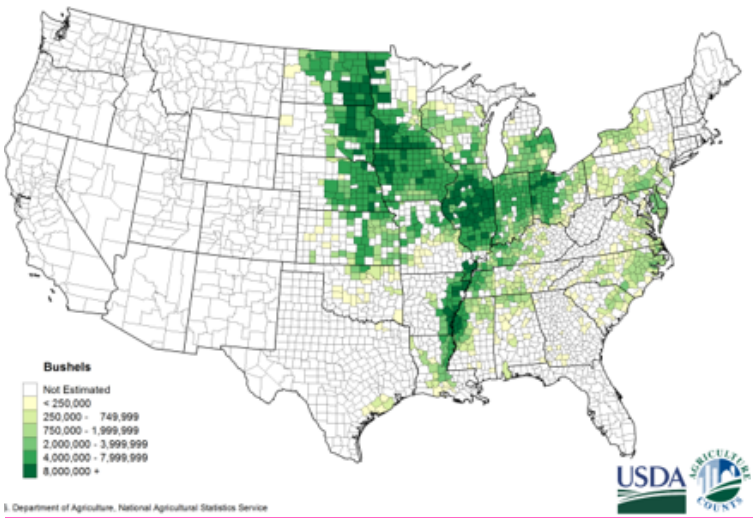
It was first brought to the United States from China in **1765**.

The United States now leads the world in its production.

75,000,000 acres of United States farmland are used to grow it.

This major U.S. crop is used to make many household items, including...

paint, crayons, furniture, cereal, biodiesel, candles, sunscreen, fire extinguisher foam, cosmetics, margarine, baked goods, cooking oil, rubber, and even carpet!



It's typically grown in the **Midwest**, but you can also find it in some areas of the **South** and **New England**.

It contains **18% oil** and **38% protein**.

It contains **all eight amino acids.**

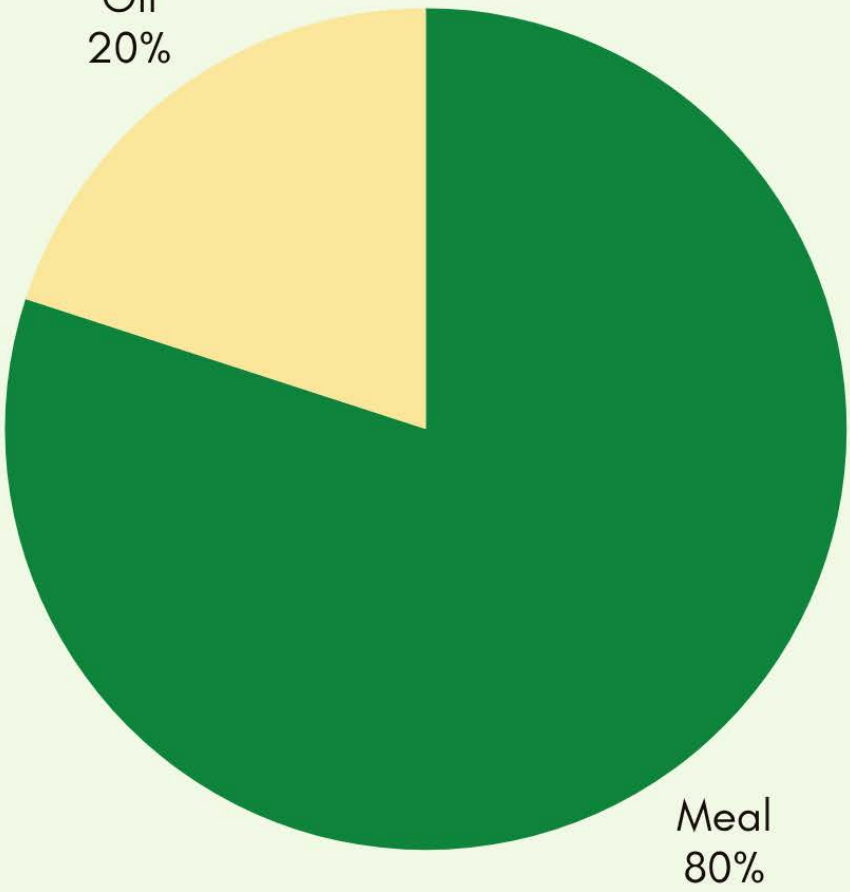
ONE acre of this crop can produce **40,000 servings of tofu**, **2,500 gallons of soymilk**, or **82,368 crayons**.

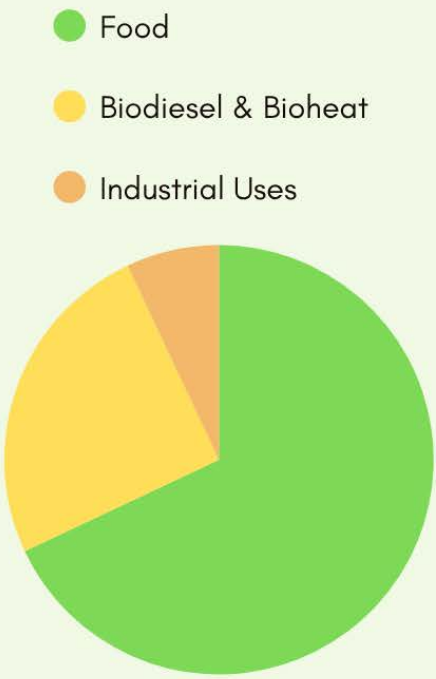
IT'S SOYBEANS!

Kansas Foundation for AGRICULTURE IN THE CLASSROOM
KFAC

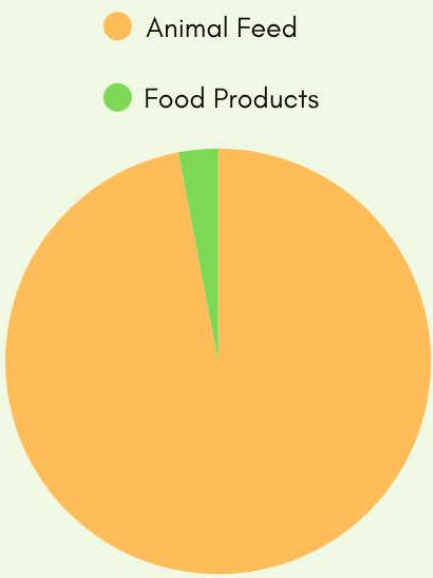
What's in a Soybean?

Kansas Foundation for AGRICULTURE IN THE CLASSROOM
KFAC





OIL



MEAL