

## Soy Plastic

**Suggested Grade Level:** 6-8

**Time:** Two 45-minute class periods

**Subject:** Science, Chemistry, Engineering Design, Language Arts, Research, Social Studies, U.S. History, Visual Arts, Design, Presenting Artwork, Creative Analysis, Agriculture, Agricultural Economics, Sustainable Agriculture, Soybeans

**Overview:** This lesson integrates science, engineering, language arts, social studies, visual arts, and agriculture to explore the many uses of soybeans. Students will learn how soybeans are used for human and animal consumption, as well as in innovative products like biodegradable plastics. They will create posters to showcase soybean-based products, make their own plastic, and then compare it to traditional petroleum-based plastics.

**Objectives:**

1. Identify two primary uses of soybeans.
2. Explain the historical significance of soybeans in agriculture and industrial development.
3. Design a visual poster that illustrates an innovative soybean-based product.
4. Create bioplastic using soybean oil.

**Background Information:**

Soybeans are an incredibly versatile crop, used in both food and industrial products. While most soybeans grown in the United States are used as livestock feed, a smaller portion is processed into human food products, including soy milk, soy flour, soy protein, and tofu. Approximately 20% of a soybean is oil, which can be used in a wide range of consumer and industrial applications (Stowe). In the 2023–2024 marketing year, the United States produced 27.1 billion pounds of soybean oil. Each bushel yields over 10 pounds of oil, which is used in products such as vegetable oil, biodiesel fuel, infant formula, lecithin (in cooking spray and chocolate), printing ink, crayons, and building materials like countertops and flooring (U.S.). Soybean oil can be converted into soy polyols. Soy polyols are chemical ingredients used to produce certain plastics, such as polyurethane and polyester thermosets. These soy-based plastics may be more sustainable and, in some cases, biodegradable. They are often found in various materials, including furniture, footwear, automotive parts, adhesives, sealants, coatings, toner, newspaper ink, automobile panels, and urethane foam (Blue).

Industries continue to find new applications for soy-based materials. For example, Goodyear has developed soy-based tires that perform better in rain, snow, and cold temperatures. Cargill has developed an asphalt rejuvenator using soybean oil, enhancing road durability. Soy is also used in concrete protectors, forming a water-resistant barrier to shield infrastructure from moisture and corrosive materials. Other soy-based products include engine oil, candles, furniture, paints, and shoes. Companies like Skechers, Oka-B, Okabashi, and Third Oak use soybean oil in their footwear, offering sustainable alternatives to petroleum-based materials. These soy-based items are not only better for the environment but also cleaner and safer to use.

### **Kansas Connections:**

According to the Kansas Soybean Association and the Kansas Soybean Commission, soybeans are one of the most important crops grown in Kansas. In 2024, Kansas farmers harvested about 154 million bushels of soybeans across 4.4 million acres. Most of the state's soybean production happens in the eastern third of Kansas, where soil and climate conditions are more favorable. Approximately 12,000 farmers in Kansas grow soybeans, making the state the 11th largest soybean producer in the country (Kansas). These farmers rely on soybeans as a key part of their operations, and the crop plays a significant role in supporting rural communities and the state's agricultural economy. From food and fuel to animal feed and everyday products, soybeans grown in Kansas have a wide range of valuable uses.

### **Materials:**

#### *Day 1: Soy Uses*

- Image of Henry Ford's soy plastic car (provided)
- "What's in a Soybean?" pie chart poster (provided)
- Computer or iPad with a drawing program
- Soy Uses Poster example (provided)

#### *Day 2:*

- "What's in a Soybean?" pie chart poster (provided)
- Ziploc bags or other plastic sandwich bags
- Cornstarch
- Vegetable oil
- Food coloring (optional)
- Microwave
- Water

### **Day 1: Soy Uses**

#### **Instructional Format:**

1. Review background information.
2. Conduct engagement exercise.
3. Complete the activity.

**Engagement:**

Show the class an image of Henry Ford and his soy plastic car. Students will likely be surprised by a picture of Henry Ford's soybean plastic car. This photo, along with the graphic of other uses for soybeans, should spark an interest in the various items that can be made from soybeans.

**Procedures:***Activity*

1. Visit [thehenryford.org](http://thehenryford.org) (or scroll down to the end of the lesson) to display pictures of Henry Ford's 1941 plastic car, made from soybeans, wheat, hemp, flax, and ramie. Explain that Ford wanted to connect with agriculture, create a safer vehicle, and replace metal (which was hard to get) with plastic. Unfortunately, by the end of World War II, efforts shifted to recovery from the war, and soy plastic cars faded into the past.
2. Show students the "What's in a Soybean?" pie chart. Help students understand that most soybeans are used for animal feed and human consumption, but new uses for soybeans are continually being developed.
3. Introduce students to [soynewuses.org](http://soynewuses.org) and have them navigate to "Common Uses." From here, students can use the drop-down menu to explore products made from soy.
4. Have students spend some time exploring the website.
5. Introduce students to the project by showing them the Soy Uses Poster example at the end of the lesson.
6. Instruct students to choose a product from [soynewuses.org](http://soynewuses.org) that they are interested in or that relates to them.
7. Explain that they will create a poster about this product using Google Draw, Publisher, Canva, or another program. Students should include a picture, a description of the product's use, an explanation of how soybeans are utilized, and any valuable and/or interesting information. To do this, students must click on the product to access more detailed information about it. Note that pictures of the product are typically available when the user clicks on the website link on the page.

**Day 2: Soy Plastic****Instructional Format:**

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

**Engagement:**

Introduce this lesson with a gallery walk featuring the artwork from yesterday. Have students display their posters around the classroom and complete a gallery walk to observe all the soybean-based products.

**Procedures:***Discussion*

1. Facilitate a class discussion on the wide range of soybean uses.
2. Refer back to “What’s in a Soybean?” Emphasize that new soybean-based products are continually being developed.
3. Explain that making products from soybean oil is relatively simple, and introduce today’s activity: making plastic from soybean oil.

*Activity*

1. Sort students into small groups and provide each group with cornstarch, water, soybean oil, food coloring, and a resealable plastic bag.
2. Provide students with the written instructions at the end of this lesson.
3. After students have made their plastic, ask them if they think it is biodegradable. Then ask them to research which types of plastic are biodegradable. They should consider developing some of the following options: soy-based plastics, cellulose-based plastics, natural fiber-reinforced plastics, and bacteria-based plastics.
4. Clarify that while all plastics eventually biodegrade, the rate at which they do so varies. Compare a typical plastic bottle (450 years) with soy-based plastic (4–6 weeks).
5. Optional: extend this lesson by comparing and sorting items made of plastic into easily biodegradable plastics and plastics that take a long time to degrade. Provide a selection of plastic items or ask students to bring examples from home for sorting and discussion. This could also be used to transition into topics such as environmental responsibility, fast food packaging, innovative uses of agricultural products, and recycling strategies.

**Vocabulary:**

- **Biodegradable:** waste that breaks down through biological processes.
- **Formaldehyde:** colorless, strong-smelling, flammable chemical used in pressed wood, glues, permanent-press fabrics, and paper coatings.
- **Polyurethane:** a flexible or firm plastic made from soy oil or petroleum, used in things like furniture cushions and shoes.
- **Polyester thermoset:** a type of strong plastic that is molded into shape and then hardened; it can’t be reshaped once set.

- **Soy polyols:** chemical building blocks made from soybean oil that are used to make soy-based plastics.
- **Renewable resource:** a natural material that can grow back or be replaced.

### **Career Information:** Agricultural Engineer

Agricultural engineers apply engineering principles to solve problems related to machinery efficiency, power supplies, pollution control, storage, and the processing of agricultural products. They typically hold a bachelor's degree in agricultural or biological systems engineering and may work for government agencies, equipment manufacturers, consulting firms, or food processing companies. Their work settings range from offices and labs to farms and factories.

**Assessment:** Exit slip, the day after making plastic: Give four examples of items made from soybean oil.

### **Companion Resources:**

Soybean Byproducts Poster

<https://ksagclassroom.org/supporting-resources/soybean-byproducts/>

Soybean Fun Facts Poster

<https://ksagclassroom.org/education-center/resources/fun-facts-poster-soybeans/>

Kids Connection Magazine: Super Soybeans

<https://ksagclassroom.org/resource-center/connection/>

### **Kansas Standards:**

#### ***Next Generation Science Standards***

Matter and Its Interactions

MS-PS1. Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Earth and Human Activity

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

#### ***Language Arts***

6th Grade

Writing

Text Types and Purposes



W.6.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly through the selection, organization, and analysis of relevant content.

Production and Distribution of Writing

W.6.6 Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of three pages in a single sitting.

Research to Build and Present Knowledge

W.6.7 Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

W.6.9 Draw evidence from literary or informational texts to support analysis, reflection and research.

Language in Writing

W.6.10 Demonstrate command of the conventions of standard English grammar and usage when writing.

W.6.11 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Speaking and Listening

Comprehension and Collaboration

SL.6.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on sixth-grade topics, texts, and issues, building on others' ideas and expressing their own clearly.

7th Grade

Writing

Text Types and Purposes

W.7.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

Language in Writing

W.7.10 Demonstrate command of the conventions of standard English grammar and usage when writing.

W.7.11 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Speaking and Listening

Comprehension and Collaboration

SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on seventh-grade topics, texts, and issues, building on others' ideas and expressing their own clearly.

8th Grade

Writing

Text Types and Purposes

W.8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

W.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.

Language in Writing

W.8.10 Demonstrate command of the conventions of standard English grammar and usage when writing.

W.8.11 Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Speaking and Listening

Comprehension and Collaboration

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups and teacher-led) with diverse partners on eighth-grade topics, texts, and issues, building on others' ideas and expressing their own clearly.

### ***History, Government, and Social Studies***

Standard 1: Choices have consequences.

1.1 The student will recognize and evaluate significant choices and consequences that have impacted our lives and futures.

1.2 The student will analyze the context and draw conclusions about choices and consequences.

1.3 The student will investigate and connect examples of choices and consequences with contemporary issues.

### ***Art***

#### **6th Grade**

Creating

(Cr2.1.6) Demonstrate openness in trying new ideas, materials, methods, and approaches in making works of art and design.

Presenting

(Pr5.1.6) Individually or collaboratively develop a visual plan for displaying works of art, analyzing exhibit space, the needs of the viewer, and the layout of the exhibit.

Responding

(Re8.1.6) Interpret art by distinguishing between relevant and non-relevant contextual information and analyzing subject matter, characteristics of form and structure, and use of media to identify ideas and mood conveyed.

#### **7th Grade**

Creating

(Cr2.3.7) Apply visual organizational strategies to design and produce a work of art, design, or media that clearly communicates information or ideas.

#### **8th Grade**

Creating

(Cr1.2.8) Collaboratively shape an artistic investigation of an aspect of present-day life using a contemporary practice of art and design.

(Cr2.3.8) Select, organize, and design images and words to make visually clear and compelling presentations.

Presenting

(Pr5.1.8) Collaboratively prepare and present selected theme-based artwork for display, and formulate exhibition narratives for the viewer.

### **National Ag Literacy Standards:**

#### **Plants and Animals for Food, Fiber, and Energy**

- Explain the role of ethics in the production and management of food, fiber (fabric or clothing), and energy sources (T2 6-8 b.)
- Identify renewable and nonrenewable energy sources. (T2 6-8 d.)



### **Food, Health, and Lifestyle**

- Identify sources of agricultural products that provide food, fuel, clothing, shelter, medical, and other non-food products for their community, state, and/or nation. (T3 6-8 i.)

### **Science, Technology, Engineering, & Mathematics**

- Explain how and why agricultural innovation influenced modern economic systems (T4 6-8 e.)
- Identify science careers related to both producers and consumers of agricultural products (T4 6-8 g.)
- 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 (T4 6-8 i.)

### **Culture, Society, Economy, & Geography**

- Consider the economic value of agriculture in America (T5 6-8 a.)
- Distinguish between careers in production (farmers and ranchers) with those that directly involve consumers (business and nutrition) (T5 6-8 b.)
- Explain how agricultural production and trade led to the development of industrialized societies (T5 6-8 c.)

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## Henry Ford's 1941 Plastic Car



## **PureBond Hardwood Plywood**



Made by Columbia Forest Products

Uses soy-based adhesive rather than formaldehyde to create wood panels

Reduces formaldehyde emissions

Costs less than panels made with other adhesives

Made in U.S. in Canada

# Make Your Own Plastic At Home!

## What you will need:

2 tablespoons cornstarch  
2 tablespoons water  
4-5 drops of soybean oil  
(found in grocery stores as vegetable oil)  
2-3 drops of food coloring  
(use your favorite color!)  
Resealable plastic bag

## What you do:

Place the cornstarch in the plastic bag and add the water, soybean oil and food coloring. Be sure to seal the bag completely and knead the bag for 3 minutes to mix all the ingredients together. Unzip a small opening in the bag to use as a vent and place in the microwave for 30 to 40 seconds. Remove the bag and open once the plastic has cooled. Tah-dah! Your own homemade plastic made from soybeans!

