

# TECH: Grow it Now, Drive it Later? (Ag)

## Summary

Students will discover potential careers in agriculture with a focus on the growing field of biofuel development.

## Time Frame

1 class periods of 45 minutes each

## Group Size

Large Groups

## Life Skills

Systems Thinking

## Materials

Ring stand or other type of can support, see Figure 1 in attached, downloadable lesson plan.

Aluminum pop can

Pyrex pie plate or dish (optional)

Flamin' Hot Cheetos® (soybean oil), peanuts, or dried algae

Modeling clay to hold paperclip

Large paperclip

Graduated cylinder or beaker

Celsius thermometer

Lighter or stick match

Water

Projected visual of "Calorie Calculation"

## Background for Teachers

Plants take in light energy from the sun and turn it into sugars. They store the sugars in their roots, leaves, stems, flowers, and seeds. The energy in the sugars makes them grow. When people or animals eat food made from plants like soybeans, corn, and wheat, the sugars or carbohydrates give them energy. In addition to the carbohydrates in plant parts, the seeds of plants contain sugars, protein, and fats or oils.

The sugar or carbohydrates in plants may be distilled to make ethanol, a fuel source for combustion engines. The seeds of plants have long been used as an energy or fuel source for diesel engines. Peanuts and soybeans have commonly been used to make diesel, but several other seeds high in oil have been used to make biodiesel. Soybeans belong to the legume family--plants that produce beans in pods. Legumes also take in nitrogen from the air and release it into the soil. Nitrogen is important for good soil and healthy crops. One soybean plant produces about 70 soybean pods with two to four beans in each pod. The seeds are about the size of peas and may be yellow, green, brown, black, or speckled.

Soybeans are native plants of Asia. Farmers in China have grown them for more than 5,000 years. They use soybeans for food, fertilizer, animal feed, medicines, and oils.

Soybeans were first grown in the United States in the early 1800s. They were used as a source of

food for humans and farm animals. During the Civil War, coffee beans were hard to get. Soybeans were roasted and used to make a coffee substitute. They were called coffee berries.

In 1904, George Washington Carver began studying soybeans. He discovered that soybeans are a valuable source of oil, as well as protein. A 60-pound bushel of soybeans produces 48 pounds of soy protein, 11 pounds of soy oil, and one pound of hulls (the coatings of the beans). Henry Ford used soy oil to make plastic parts for his cars. Farmers harvest the soybeans, which can be eaten fresh in their pods or dried and roasted. They can also be broken down into different forms. The beans are taken out of their pods by a machine called a combine. The beans are then sent to a processing plant where they are crushed, rolled into flakes, and mixed with a solvent to separate the oil and protein.

The oil and protein can be made into many kinds of animal and human foods, as well as products such as crayons, paint, glue, and plastics. Biodiesel can be blended (mixed) with regular diesel, which is a petroleum fuel. Many cities and school districts use a blend of 20 percent biodiesel and 80 percent diesel in their buses. This is called a B20 blend. Using B20 reduces pollution from the buses, making the air cleaner.

Most trucks, buses and tractors in the United States use diesel fuel. Diesel fuel is made from petroleum, a nonrenewable energy source. Petroleum is a fossil fuel; it takes millions of years to form under the ground, so we can't make more in a short time. We use so much petroleum in the U.S. that we have to buy two-thirds of it from other countries. When petroleum fuels are burned in vehicle engines, they can pollute the air. If they spill onto the soil or into the water, they can damage the environment for a long time. Petroleum fuels are toxic and should be handled carefully.

Biodiesel is a fuel made from vegetable oils or animal fats. It is usually made from soybean oil, but it can also be made from corn oil or used restaurant grease and oil. If it is made from restaurant oil, it can smell like French fries. Since biodiesel is made from plant and animal oils, it is a renewable fuel. We can grow more plants in a short time to make more biodiesel. However, with the demand for food and land resources increasing, some scientists are looking at a "plant-like" organism--algae--as a possible fuel source. High oil prices, competing demands between foods and other biofuel sources, and the world food crisis have ignited interest in algaculture (farming algae) for making vegetable oil, biodiesel, and other biofuels using land that is not suitable for agriculture.

Algae are not plants, algae lack the structures that characterize land plants, such as leaves and roots. Nearly all algae have photosynthetic capability and algae cells contain both carbohydrates (sugar) and fats (oils). Scientists are looking at efficient ways to grow algae for biofuels. Algae don't need fertile soil and can grow or colonize in wastewater. Several types of algae grow well in salt water. Algae use sunlight, little water, and produce oil in its cells 50 times faster than regular crops. The biodiesel can be used in a car and can be used to generate electricity. Among algal fuels' attractive characteristics: they do not affect fresh water resources, they can be produced using ocean and wastewater, and they are biodegradable and relatively harmless to the environment if spilled.

How do you get oil out of soybeans? Soybeans are crushed and then using hexane, a solvent, the oil is removed from the seed. If you crush soybeans in a mill and then boil the meal, the oil from the seeds will float on the surface of the water. How do you get the oil out of algae? It is similar to soybean oil extraction; you remove the oil from dried algae chemically with hexane, or mechanically using an expeller press or ultrasound. How much energy is in oil? Conduct the following activity to measure the calories in vegetable oil.

Student Prior Knowledge

## How do you convert ml to grams?

One gram of water is always equal to 1 ml. But for other substances, you need the density. For example, iron's density is about 7 grams for each 1 ml. So if you had 1 ml of iron powder, it would weigh about 7 grams.

1 ml of water = 1g, because 1ml of water weighs 1g

1 ml of iron = about 7 g, since 1 cc of iron weighs about 7 g

## Instructional Procedures

Use the ring stand to hold the aluminum can as pictured in Figure 1.

Place a handful of modeling clay on the bottom of the ring stand or in a Pyrex dish at the bottom of the ring stand.

Open one side of a large paperclip and place the bent portion into the clay as shown in Figure 2. Impale (spear) half a Cheeto® onto the paper clip. (If you use more than half a Cheeto®, you may set off a smoke detector.)

Move the can to within two inches or five centimeters of the impaled Cheeto®.

Measure and add 100 milliliters of water to the can.

Record the temperature of the water on the board. To find out how many calories are stored in the soybean oil in half a Cheeto®, light the Cheeto® and burn it to see how much energy is produced as noted by the rise in water temperature (see Calorie Calculation attached).

Record the water temperature as soon as the flame burns out.

Calculate the calories using the formula on the Calorie Calculation worksheet.

Repeat the procedure with a peanut or algae.

View algae oil videos from YouTube (search algae).

## *Evaluation*

Based on the recorded measurements, ask the students to calculate the number of calories in half a Cheeto. In addition to soybean oil energy, what other professional would need to know how to measure calories? (Nutritionists)

Ask a pair of students to view an algae video from YouTube (you may need to download these in RealPlayer for student access). New movies are added all the time, so go to YouTube and then search "algae biofuel." Check the "Links" section for more websites on algae biofuel movies. After the students have viewed the movies, ask each group to share something they have learned about algaculture (farming algae), a career associated with biofuels, and how this might affect what they drive later (biofuels can be used for cleaner electricity, electric cars?)

## Authors

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