Grasses for the Masses

Summary: Students will learn that different types of grass produce varying amounts of biomass by planting varieties of grasses and measuring their growth rate and leafy content.

Objectives

Students will be able to

- describe what biomass is;
- explain how biomass is produced;
- understand what makes a good biomass fuel; and
- consider which biomass fuels to use for optimum energy output.

Background

The term bioenergy, or biomass energy, means any plant-derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes, and other waste materials. These sources can provide energy in the form of electricity, heat, steam, and fuels. (See the activity *"Biomass Gazette"* for more background information on biomass.)

Biomass is a renewable resource—it can be replaced fairly quickly without permanently depleting Earth's natural resources. By comparison, fossil fuels, such as petroleum and coal, require millions of years of natural processes to be produced. Drilling for petroleum is considered a nonrenewable process because it depletes Earth's resources for thousands of generations.

There is more to consider than just energy input and output (the balance of energy put into growing and making a product compared to the amount of energy the fuel provides when used) when deciding which biomass fuel to use. Non-native plants may be an attractive biomass fuel to consider, however, the impact on the surrounding environment, on native animals, and other plants could be devastating and not worth the risk. Introducing non-native species always has a negative impact on ecosystems.

Current land use should also be considered. What exists on the land now and how would planting biomass fuels change the landscape or value of the land?

Grasses are an option for biomass fuels. Grasses are also used as food for livestock and are also processing into food and beverages for human consumption. According to the Wisconsin Department of Agriculture and Trade unmilled cereals such as corn, wheat, rye, and oats make up $256.8 million in exports for Wisconsin.

Economics Versus Sustainability

The use of biomass energy can lessen our dependence on fossil fuels. Nearly every source of energy, including renewable, comes with some kind of trade off. The main debate surrounding the use of bioenergy is the economic advantages versus the environmental/sustainability disadvantages.

For example, ethanol, an alternative fuel, is being made from corn in Wisconsin. The advantage to this is that the use of ethanol means that we use less foreign oil. This can strengthen national security. By increasing the supply of fuel for transportation, we also increase supply, which, in turn can steady the rises and slumps in fuel prices. The supply and demand would also help farmers get a better price for the corn they are harvesting.

On the other hand, the corn that is currently grown in Wisconsin is energy intensive and, depending on cultivation practices, there can be a number of environmental concerns. There can be run-off, which carries topsoil into waterways where the water becomes turbid (muddy) and this can threaten fish populations. The more corn we need for fuel, the more corn we will grow. This can create a monoculture of corn. A monoculture reduces diversity and can become a threat to the security of the crop. If a pest or disease becomes resilient

Grade Level: 5–8

Subject Areas: Agriculture, Environmental Education, Science

Setting: Classroom or laboratory

Time:
Part I–approximately two weeks,
Part II–two hours

Vocabulary: Biomass, Btu, Dry weight, Energy input, Energy output, Fresh weight, Light energy, Native and non-native species, Photosynthesis

Academic Standards:
Common Core Math: MP5, MP6, 6.SP.5a&b

NGSS: MS-LS1-5, MS-LS1-6, MS-LS1-7
SEP: Planning and Carrying Out Investigations
DCI: ESS3.A: Natural Resources, ESS.C: LS1.B: Growth and Development of Organisms, LS1.C: Organization for Matter and Energy Flow in
CCC: Energy and Matter

WI Env Literacy & Sustainability: C1.A.m, C1.B.i, C1.B.m, EX2.A.m, EX2.B.m, EX2.C.i, EX3.B.m, EX4.A.i, EN6.C.m

Materials

- 3 half-gallon milk cartons (large ice cream cartons work well also)
- Seeds: wheat or rye seed, corn seed, and oat seeds (whole seeds only, not milled)
- Potting soil
- Fluorescent grow lamp (optional) or window for plants to be near

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- Copies of ***Plant Growth and Development Chart***
- Scale (balance or kitchen)
- Copies of ***Weight Chart***
- Dehydrator or oven

Resources:

Biomass Resources Center
www.biomasscenter.org/

Pellet Fuels Institute
www.pelletheat.org

United States Department of Energy
www.energy.gov/science-innovation/energy-sources/renewable-energy/bioenergy

Related KEEP Activities:

"Corn in Your Car"–*BioFutures.*
"BioFuel Beliefs"–*BioFutures*

Credits:

to protective measures, a whole crop can be lost, which would mean the loss of not only a source of fuel but a source of food as well.

Procedure

Orientation

Ask students how they feel if they do not eat. Do they feel tired? How do they feel after they eat? Do they have more energy? Tell students when we eat our bodies use the energy stored in food to keep our bodies functioning.

Once students have determined that plants do indeed contain energy, ask them if they think plants could replace fossil fuels such as oil, natural gas, or coal. What plants do the students think contain the most energy? The larger, more dense plants probably have the most energy due to their mass.

Now ask the students how humans can get the energy from the plants. Some possibilities include eating the plants and burning the plants, which are both correct answers.

Explain the term biomass to your students and ask if any of them have a fireplace, wood stove, or pellet stove in their home. Discuss the fuels that are burned in fireplaces and distinguish between wood and wood pellets. There may be other fuels that students' families burn as well. Brainstorm why different fuels exist and what the differences may be between one fuel source and another. Discuss why some people may choose one fuel over another. Possibilities include size, mass, ease of use, availability, amount of heat produced, cost, etc.

Steps

Part I

1. Divide the class into groups. Provide each group with planting material and provide the class with the following instructions. Cut the milk cartons in half and fill them with potting soil.
2. Plant the same number of seeds in each milk carton and keep the soil moist. Plant different varieties of seeds in separate milk cartons. Plants will take approximately two weeks to grow (leave an extra week to be sure that the plants have plenty of time to grow).
3. Keep track of growth rates in the ***Plant Growth and Development Chart***. If one of the days falls on a weekend, feel free to change the measuring schedule. Make sure to measure each species of plant on the same day.

Steps

Part II

1. After the plants have grown for the same amount of time (14 days or longer), pull them out of the soil by the roots.
2. Wash off all of the dirt on the plants and dry them with a paper towel.
3. Weigh the plants and record the data in the ***Weight Chart***.
4. Place the grasses on separate pieces of paper and let them dry out. You can use a dehydrator or an oven to speed up the process.
5. Weigh the dry plants and record the data in the ***Weight Chart.*** Ask the students which plant has the most mass and discuss why it has the most mass.
6. Ask students to form a hypothesis on the relationship between the mass of the plant and the amount of energy that the plant contains. NOTE: There is a direct correlation between the dried mass of the plant and the amount of energy it will produce.
7. Take the grasses that were grown in this activity and burn the same weight of each variety to discover which grass possesses the most energy (the one that burns the longest or produces the most heat). Answer these questions: Was their

hypothesis correct? Would the plants hold more energy if they were allowed to mature? Do other types of grasses (or plants) produce more biomass?

Closure

Have students discuss the pros and cons to using agricultural crops such as wheat and oats as a source of energy. Consider using the Viewpoints Chart from the activity "*BioFuel Beliefs.*"

Assessment

Formative

- How well did the students conduct their experiments?
- Did the students use the scale and fill out their charts correctly?
- Can they make a conclusion as to what plant would work best for a biomass fuel and explain why?

Summative

Invite a guest speaker who uses biomass at home or in a business to present to the class. A list of guest speakers can be found on the KEEP Web site at www.keepprogram.org. Have each student prepare at least one question for your visitor. Also, have your students discuss their class experiment with the speaker. Make sure to ask the speaker why he/she chose the fuel he/she did.

Extensions

Have each student bring in a different plant seed and their own milk carton. Each student will be responsible for caring for their own plant species. Have each student graph the growth of their plant every two days. Have two or more students grow the same plant to see if their plants grow at the same rate. Possibly put the same plant species in different areas of the classroom to expose them to different growing conditions. Decide as a class whether the plants they brought in are native to the area and whether they would make a good fuel source for Wisconsin.

Have students research what biomass fuels are suitable to be grown in Wisconsin and whether they are native. Give them a map of Wisconsin and ask them to draw or color the areas of the state where that particular biomass fuel source grows. Ask them to compare Wisconsin's biomass fuel sources to other states and other countries. Where do the most biomass fuel plants grow and why? Are countries taking full advantage of the use of biomass fuels? Do the students think this type of alternative fuel source will grow and become more widely used? Are they (or their families) willing to use it in their homes or in their cars?

Charts

Plant Growth and Development

		Germination					Average Height				
Seed Type	Date Planted	Day of 1st sprout	Date of 10th sprout	Date of 20th sprout	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9
Wheat or Rye											
Corn											
Rye											

		Weight	
		Fresh Weight (oz.)	Dry Weight (oz.)
Test plants	Wheat or Rye		
	Corn		
	Rye		