Hydroponic Farming

The following lesson plan is adapted from the Exploring Hydroponics Guide, a joint project of KidsGardening, National Farm to School Network and The Scotts Miracle-Gro Foundation. For additional resources, download the full guide.

Overview: As the demand for food grows because there are more people to feed, the amount of land available to grow our food will decrease as more of that land is used for housing and industry. Farmers are faced with the challenge of finding a way to grow a larger harvest on less land — land that is also further away from urban centers. Hydroponic farms are being explored as a possible solution to this problem.

Grade Level/Range: 3rd – 8th Grade

Objective: After completing this lesson, students will be able to:

- Track the path their school food takes from the farm to the cafeteria
- Explain how we use land in the United States and specifically how much of our land is used to produce food and how much is used as living space for humans
- Discuss some of the challenges facing our food system and evaluate possible solutions
- Describe the potential ways hydroponic farms can impact our community and environment

Time: 1- 2 hours

Materials:
Exploring Hydroponics Guide
Land Use Worksheet (pp. 55-56)
Map My Plate Worksheet (pp. 57-58)
Guest Speaker or Internet Access

Background Information

Our food system has changed dramatically over the last century, and even more so in recent decades. Today much of our fresh produce is shipped thousands of miles and we rely heavily on processed and packaged foods. Most kids growing up in our society have only a vague idea of where food comes from and how it is produced. Additionally, very few understand the important link between the environment, their food, and their health.

With the majority of our population living in urban areas, it is easy to argue that in many cases, it is just not possible to grow a majority of foods locally because of limited land availability. Traditional growing

methods require good soil, a steady water supply, and lots of space. Hydroponic farms are being explored as a way to overcome some of these challenges to producing foods in urban areas.

Hydroponic farms can offer the following benefits to our food supply:

- Food can be grown indoors under artificial grow lights in spaces of all different sizes and shapes. Gardens can be stacked on top of each other and/or located in multi-floor buildings to take advantage of vertical space and decrease the land footprint needed for a sizeable production rate.

- Many hydroponic farming techniques use little water and/or recycle water, resulting in a reduction in overall usage compared to plants grown using traditional methods. Access to high-quality water supplies are a pressing concern for many areas around the globe and efficient use of water is a growing priority.

- Hydroponic farms can be placed in urban areas where populations are highest so that crops do not have to travel a long distance to the end consumer, decreasing the cost and environmental impact of transportation.

- Indoor hydroponic farms are protected from the environment. This means they are not subject to unfavorable weather conditions, and with proper hygienic practices and safety precautions in place, they experience fewer disease and weed problems than traditionally grown crops.

- Hydroponically grown produce usually does not require the same amount of pre-consumer cleaning as crops grown in soil, which is another water savings.

- Because systems can be designed so that the optimal amount of light, nutrients, and water reaches the plant, harvest size can also be optimized (efficient input-to-output ratio).

- Plants grown hydroponically grow faster than plants grown through traditional farming methods. Because plants are being provided with optimal amounts of nutrients, water and light, they can grow faster than crops grown using traditional horticultural techniques resulting in increased production rates per square foot of space.

Although there are many benefits, hydroponic farming is not without its challenges. Some of those challenges include:

- -Currently there are very few crops that have been cultivated to thrive in hydroponic conditions. Edible crops commonly grown hydroponically include lettuce and other greens, herbs (especially basil), peppers, tomatoes, cucumbers, and strawberries. For the use of hydroponic farming to increase, scientists must work to identify existing or develop new plant varieties that will grow well hydroponically. New hydroponic system designs may also help increase the number or crops that can be grown successfully through hydroponic techniques.

- Most hydroponic farms are very reliant on a secure source of electricity both to maintain temperature and to provide water

and air to plant roots. Under normal conditions, weather may not be a factor for hydroponic crops; however, extreme weather conditions like a blizzard or hurricane that impacts energy sources can also impact hydroponic farms. (Most farms will likely have fossil fuel-powered back up generators to be able to cover short-term loss of electricity).

- Cost is another big challenge to hydroponic production. In most cases, hydroponic farming operations are still more expensive than traditional farms, even when factoring in their associated transportation costs. The cost comparison between the two methods could change as land availability decreases and if transportation costs increase. Cost is a driving force in the supply and demand process, so even though there may be environmental benefits, until the cost of hydroponic production is closer to the cost of traditional production, it will struggle to gain a larger portion of the market.

As world populations grow and agricultural crops are impacted by environmental concerns such as climate change and water shortages, the security of our food supply will continue to be a major issue in the 21st century. Currently food resources are not equally distributed and there are inequities by geographic location and income. This gap is projected to widen as costs increase due to rising demand and shrinking supplies. Alternatives to traditional farming practices such as hydroponic operations will definitely be part of the discussion as scientists and farmers begin looking for solutions to our food supply needs.

Laying the Groundwork

Ask the class to brainstorm some of the ways we use land (for houses, schools, businesses, farms, parks, etc.). Next, provide copies of the Land Use worksheet to look at the data collected by the U.S Department of Agriculture Economic Research Services. Ask the following questions:

What is the largest percentage of the land in our country used for?
Animal pasture/ range currently demands the most amount of land in the United States.

What percentage of our land is used as cropland?
About 17%.

What region is most of our cropland located in?
The Midwest.

What region of our country has the least number of acres of cropland per person?
The Northeast.

What region do we live in? How many acres of cropland do we have per person?

What does this information tell us about where our food comes from?
Our food is not grown equally across all regions. This means much of our food is grown in one place, but must be transported to another place for consumption.

If our population continues to grow, what will that mean about the amount of cropland we need?
We would need to convert other land to cropland or learn how to make our existing cropland more productive.
Is all land suitable to be cropland? *No.*

Exploration

Challenge students to map the food on their plate. For one or multiple days depending on time available, record the menus for your school's breakfast and lunch using the Map Your Meals Worksheet at the end of this lesson. For items with multiple ingredients, just list the top 3 ingredients (for example pizza could be listed as wheat, tomato sauce, and cheese).

Connect with your school food service staff to find out if any of the items on the menu were obtained from a local source. If your school participates in a farm-to-school initiative, some of the items may be coming from local farmers. Also ask your food service staff if they have access to information about any of the other sources of food on the menu. If you do not have a food service staff member available to provide information about the origins, another resource you can use to approximate where your food might have come from is the USDA's Food Purchases Resource available at: https://www.fns.usda.gov/fdd/food-purchase-resources. Although not all school foods are procured through the USDA, some are and from this web page you can download spreadsheets under the "State of Origin Information" heading for many of their purchases organized by fiscal year.

Once you have approximated the origin of your foods, you can use a mapping program to estimate the miles each food traveled to get to your school. Use this data to spark discussions about the benefits and challenges of obtaining and consuming local foods. Use the Background Information above to explain how hydroponic farms fit into the picture of increasing local produce availability and potentially decreasing the environmental impact of food production. Possible questions to spark discussion include:

- Is the number of people living in the United States increasing or decreasing?
- Where do most of the people in the United States live? Where does their food come from?
- What are some of the challenges facing our food system today?
- How could hydroponic farms help solve some of the problems facing our food system?
- What are some other solutions that could help with the distribution of food in the United States? How do these compare to the use of hydroponic farms in terms of cost and environmental impact?

Making Connections

Invite a local farmer (if possible, a hydroponic farmer) to come in to speak to the class about the journey of food from farm to table. If you are unable to locate a guest speaker, the following videos provide interviews with hydroponic farmers offering tours of their facilities:

Go Green Agriculture in Encinitas, California

Pierre Sleiman from Go Green Agriculture has a number of videos available spotlighting their spinach and lettuce production facilities:

1. Go Green: https://www.youtube.com/watch?v=3O8WgmYO2A0

2. Harvest of the Month – Organic Bloomsdale Spinach - Pierre Sleiman
https://youtu.be/dA6NW_s6XKc

3. San Diego Hydroponic Farm
https://www.youtube.com/watch?v=zod-246VCkg

Bowery Farming, New Jersey

This video from Bloomberg Technology provides an interview and tour of a hydroponic facility growing greens and herbs in New Jersey.
This High-Tech Farmer Grows Kale in a Factory:
https://www.youtube.com/watch?v=AGcYApKfHuY

Branching Out

As an extension of this activity, hold a class taste test of foods that have been harvested from different locations and grown using traditional and hydroponic methods. Hydroponic and traditionally grown lettuce, tomatoes, and cucumbers are often available in grocery stores, you can grow your own in your school gardens or you can also do a search for local food resources like farmers markets.

Learn more about our food system and how it is impacting and being impacted by climate change. Check out the Understanding Food and Climate Change Interactive Guide by the Center for Ecoliteracy at: https://www.ecoliteracy.org/download/understanding-food-and-climate-change-interactive-guide. After studying this publication, encourage students to prepare a presentation for a target audience in your community (such as peers, family members or younger students), sharing their findings. Additionally or alternatively, ask students to brainstorm ways your community could help your local food system through changes in every day practices and discover ways to advocate for larger policy changes to help mitigate the impact of climate change.

Link to Standards:

5-ESS3 Earth and Human Activity

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

3-ESS3 Earth and Human Activity

3-ESS3-1. Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.

3-5-ETS1 Engineering Design

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.