# Hydroponic Vertical Farming: Helping Feed Our Growing Population



## Brief Description:

By 2050, it's estimated that 80 percent of the world's 9.2 billion population will live in urban areas. In this lesson students will gain an understanding of what a seed needs in order to grow into a healthy plant, and what a vertical farm is by comparing and contrasting this method of food production with conventional farming methods. Students will design their own rubric; research best practices; create blueprints; and modify and build a working model of an indoor vertical hydroponic farm through collaborative efforts using recycled materials. This closed system should last six or more months, which allows students time for reflection, entertainment and a healthy snack.

## Objective:

Students will:

1. Understand what a seed needs to grow into a healthy plant.
2. Know what a vertical farm is and compare and contrast that method of food production with traditional farming methods.
3. Design and build a working model of a hydroponic vertical farm.

## Time:

Up to two weeks
Activity 1: 30 to 60 minutes
Activity 2: 30 to 60 minutes
Activity 3: 60 to 90 minutes
Activity 4: 60 to 120 minutes
Activity 5: 30 to 60 minutes
Activity 6: 60 to 90 minutes

## Materials Needed:

- Recycled materials such as plastics bottles
- Soilless growing medium
- Wire
- String
- Metal chain
- Five gallon aquarium/reservoir
- Water pump, hydroponic hose
- Barbed valves
- Plastic flex net cups
- Seeds or seedlings
- Hydroponic fertilizer
- Optional: grow lights, pH test kit, thermometer

## Background:

The impact that humans have had on Earth include deforestation, urbanization, desertification, erosion, poor air and water quality, and changing the flow of water. Through innovative techniques such as hydroponic vertical gardening, we can mitigate some of the effects of urban sprawl.

Hydroponics is a method of growing edible crops in soilless, nutrient-rich water. Advantages of hydroponic gardening include: reduction in runoff; less water usage; crops can be grown indoors year-round; plants require less space, and can have higher yields.

## Florida Standards:

SC.7.E.6.6, LAFS.6.SL.1.1, LAFS.6.SL.2.4, LAFS.7.SL.1.1, LAFS.7.SL.2.4, LAFS.8.SL.1.1, LAFS.8.SL.2.4, LAFS.68.RST.3.7, LAFS.68.RST.3.9, SC.912.E.6.6, SC.912.L.17.12, SC.912.L.17.15, SC.912.L.17.16, SC912.L.17.18, SC.912.L.17.20

## Possible Sequencing Calendar

| | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 | Day 6 |
|---|---|---|---|---|---|---|
| **Science** | **Engage:** Introduce project and vertical farming to students. | **Engage:** Facilitate a lesson on traditional farming. | **Explore:** Students research vertical farming and learn the requirements of their project. | **Explore:** Students build their model. | **Elaborate/Extend:** Students test their model and make changes to their model based on their test and findings. | **Evaluate:** Students present their project to the class. |
| **Math** | **Engage:** Introduce project and facilitate a lesson on proportions with Gizmo activity. | **Explore:** Students learn about scale drawings. | **Explore:** Students brainstorm ideas about how their vertical farm can look and make a sketch of their farm to scale. | **Explain:** Students learn about budgets and create a budget for their vertical farm. | | |

### Activity 1:

1. Introduce the project to the students by explaining to them that the end goal will be for them to make a hydroponic vertical farm with specific requirements. They will get their rubric on day three of project.
2. Show students two pictures, one picture of vertical farming and the other of conventional farming (see page 154). Ask students to analyze the pictures and consider what they see in the picture, what they think about the pictures and what they wonder about the pictures, and fill in the *See-Think-Wonder Handout*. Lead the students in a class discussion by having them share.
3. As a class, complete a *KWL: Farming* chart (K-what the student knows, W-what the student wants to know, L-what the student has learned). Students should complete a class *KWL: Farming* chart for their personal notebooks. Students will add to the chart as they continue to go through the activity.
4. Play Windowfarms Project video or locate your own hydroponic vertical video (https://www.youtube.com/watch?v=PkCuPrsPn_I). This video provides students with information on vertical farming.
   - Ask students the following questions:
     - "What are the advantages of vertical farming?"
     - "What are some of the difficulties with vertical farming?"
     - "How is vertical farming different from conventional farming?"
     - "What are some reasons that vertical farming would be preferred over conventional farming?"
     - "If you were a politician being asked to vote on the issue of whether to approve a vertical farm in your neighborhood, would you be in favor of it? Why or why not?"
5. Facilitate a lesson with the students on proportions and common multipliers. As students complete the examples, have them explain their thought process for the solution. At the end of the lesson, have students write a real-world problem that involves a proportion.

### Activity 2:

1. Students will need to research factors involved in conventional and hydroponic farming such as space needed on average for a set amount of plants, amount of water needed/used, nutrients needed, costs, etc. Students will complete a Venn diagram comparing and contrasting vertical/hydroponic and conventional farming.
2. Discuss with students the feasibility of vertical/hydroponic farming feeding the world. Have students think about countries with less available water, no power and the cost of shipping food grown on hydroponic farm. After discussion, ask students to write an opinion paper titled "Can hydroponics feed the world?"
3. Introduce the design build aspect of this lesson by giving students an example of a big figure, for example, the blueprint of a home and the actual home. Explain the importance and process of forming a scale. Create scale models of classroom objects such as tables or desks. Assign students the task of creating a scale model of a textbook from your classroom. Students will complete this task using graph paper.

### Activity 3:

1. Provide students time for research on the internet to learn more about vertical farming, what it fully entails and possible design options. If you do not have time for research find multiple articles from reputable websites to print out for the students.

2. Have students assign point values to the *Blue Print Rubric*.
3. Explain to the students their task by saying:
   - By 2050, the world's population is expected to reach 9.1 billion or more.
   - Local crops could reduce the costs of transporting food from distant places.
   - As the world population grows, soil is being used increasingly to create housing while continuing to produce crops used to feed livestock.
   - Alternative farming methods will also be needed such as hydroponic farming.
   - Using provided materials, design a model of a vertical farm that meets the following criteria:
     - Must be a minimum of three levels.
     - Light must reach all seedlings.
     - Water must be able to move from each level to the lower levels, while still allowing saturation for each seedling.
     - Students determine their needs based on the list of materials provided.
4. Students will work together in teams of three to four students. Teams will design a system from recycled materials in which their plant will fit into a grid of their classmates' plants, all benefiting from the communal nutrient rich water. The teacher will assist in setting up communal nutrient-rich water using an aquarium. All designs and inventions are acceptable as long as all plants have access to water, sunlight and are in a closed system. Once set up, your vertical hydroponic garden should need very minimal care. If growing indoors, collard greens, lettuces, celery and herbs grow very well.

## Activity 4:

1. Once the model has been approved by the teacher, students will build their model to satisfy the construction criteria of their model.
2. Provide students an example of a budget and have them create a budget for their vertical garden design, including a shared nutrient tank and distribution supplies. Students should include the unit price of each resource. Have students prepare their presentation on the cost of using their system to produce crops equivalent to five acres.

## Activity 5:

1. Students will test their design with water to see if it meets all four of the design criteria requirements.
2. Students reflect on their testing of their model and determine how they can make any changes.

## Activity 6:

1. Students present their designs to the class. The students and teacher complete a rubric on their peers as they are watching the presentation.

## Resources:

**Text Reference(s)**

Silverman, Jacob. "Will there be farms in New York City\ u0027s skyscrapers?" 26 June 2007. HowStuff Works.com. <http://science.howstuffworks.com/environmental/conservation/issues/vertical- farming.htm> 24 January 2013.

Ogden, Andy. "The Vertical Farm" 31 December 2010. < http://eatinggoodly.com/2010/12/31/the-vertical-farm/> 24 January 2013.

**Electronic References**

*(web sites, Gizmo, other, paste hyper-links or URLs here)*

http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=615

http://www.florida-agriculture.com/

http://en.wikipedia.org/wiki/agriculture

http://www.ms.uky.edu/algebracubed/lessons/ScaleDrawingLessonPlan.pdf

**The windows farm project** https://www.youtube.com/watch?v=PkCuPrsPn_I

Image 1

Image 2

# See-Think-Wonder Handout

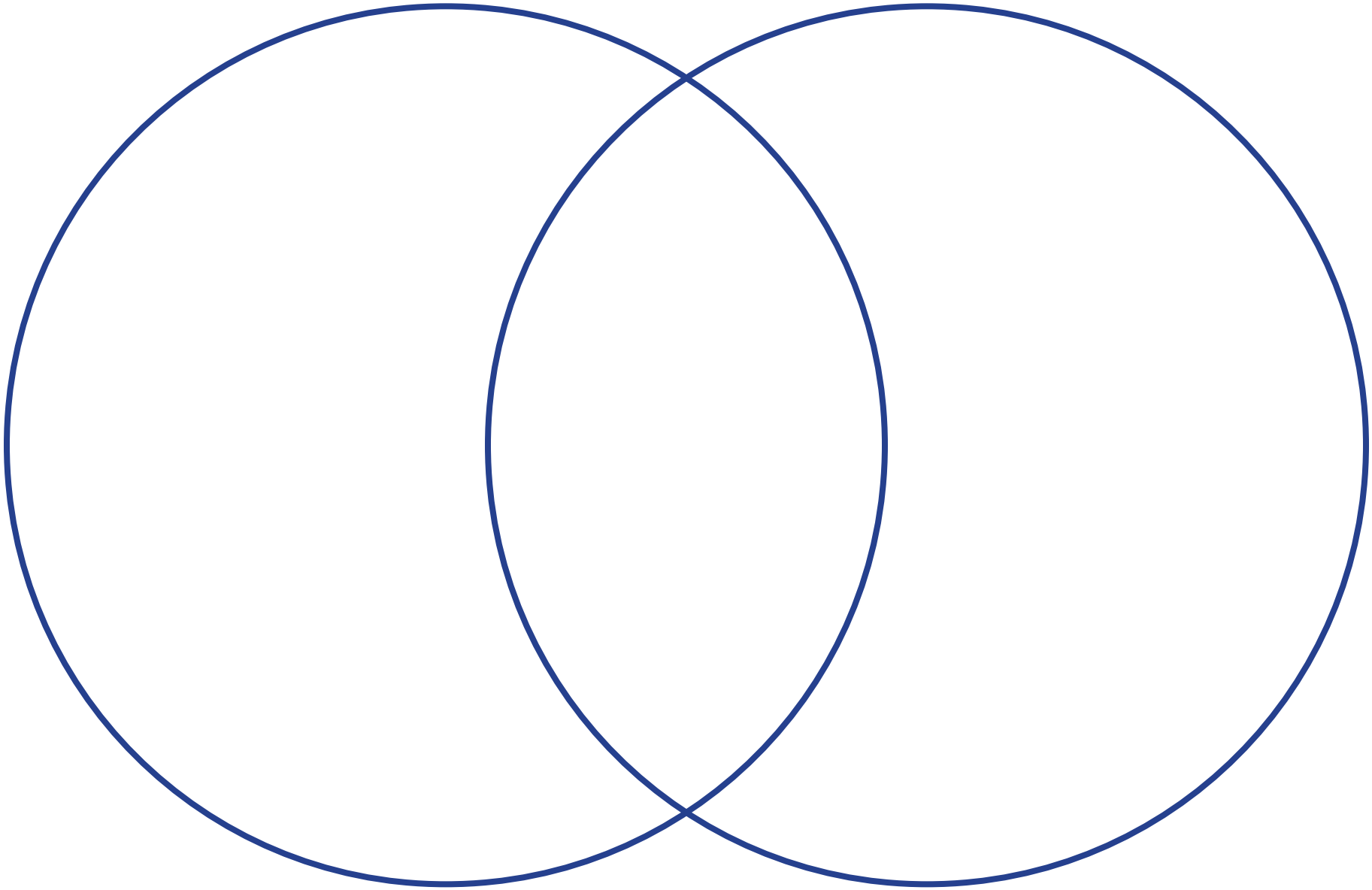
**Directions:** Examine the two images of farming and record what you see, think and wonder about.

| Image #1 | Image #2 |
|---|---|
| I See: | I See: |
| I Think: | I Think: |
| I Wonder: | I Wonder: |

# KWL: Farming

| Know<br>What I know | Wonder<br>What I want to know | Learn<br>What I've learned |
|---|---|---|
| | | |

**Directions:** Read the articles provided by your teacher. Use the Venn diagram to compare and contrast traditional farming and vertical farming.



# Blue Print Rubric

| RUBRIC | Possible Points | Self - Assessment | Teacher Assessment |
|---|---|---|---|
| Design solution has three levels | | | |
| Light is able to reach all seedlings | | | |
| Water is able to move through all levels leaving each seedling saturated | | | |
| Team showed effective collaboration with everyone participating equally | | | |
| Total | | | |

# Hydroponic Vertical Farming

## Sample Pre-Post Test Assessment

**Directions:** Answer each question as thoroughly as possible.

1. Why may it be necessary to grow produce vertically in the future?

2. Pure water has a neutral pH. What is the pH of pure water?

3. What are some benefits of growing vertically?

4. What is the benefit of a hydroponic system that is closed?

5. Compare and contrast conventional farming methods and vertical farming methods.