Sustainable Farms - Session 3

How can more sustainable growing techniques innovate how we grow plants for food?

Context:
In this session learners will be introduced to contemporary farming methods for growing plants for food and learn what is meant by a 'hydroponics system', its advantages and disadvantages. Learners will think about the key components within a hydroponic system and consider how they interact. They will apply their science knowledge to this real-life application. Learners will then be challenged to work in teams and use recycled materials to create a simple hydroponic farm to successfully grow the seedlings and evaluate their prototype.

Engineering focus:
Learners will be working as an engineer by systems thinking thinking, creating and adapting in their creative problem solving.

Learning time:
2 hours

Suggested age group:
11-14 years old

Keywords
hydroponics
vertical farm
aquaponics
sustainable
systems thinking
reservoir
growing chamber
growing medium
nutrient solution
delivery system
wick system
drip system
ebb and flow system
nutrient film system

Curriculum links: Design Technology
Learners will

- Learn that food is produced, processed and sold in different ways, e.g. conventional and organic farming and fair trade.
- Use learning from science to help design and make products that work.

Resources:

- Sustainable Farms Session 3 PPT
- Advantages and Disadvantages card sort Activity
- Access to computers for research
- Seedlings for a quick growing crop such as radishes or lettuce
- Low tech approach: Plastic bottles, craft knife, absorbent fabric strips/string, glue gun, sponge/gravel to support seedling, nutrient water (See CLEAPSS recipe card 66 for Sach's culture solution (complete recipe), Chemicals are LOW HAZARD)

Suggested Activities

1

Show learners a collection of photos of contemporary farms (Slide 2)

In talking pairs learners should decide on an odd one out and be able to justify their choice. Challenge them to also come up with a list of what all of these future farms have in common? (Sustainable/hydroponics/indoors/growing plants for food etc)

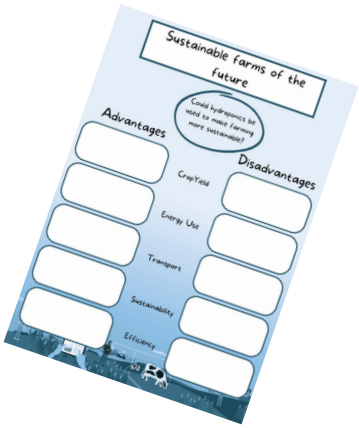
1. Offendam Vertical Farm, Scotland
2. Nordic Harvest, the largest vertical farm in the world, Denmark. Supplying fresh produce to all of Copenhagen's markets.
3. Closed loop system, aquaponics, where fish and veggies are grown together with recirculated water.
4. Growing Underground, the world's first underground farm, London - growing herbs, lettuce and other vegetables, and even fruit.

2

What are hydroponics?

The image on this slide shows a NASA scientist working on hydroponic systems for growing plants on the Moon or Mars. Could hydroponics be a possible approach to net zero farming here on Earth? (Slide 3)

Learners work in teams to sort the statements into advantages of hydroponics farms and disadvantages. A graphic organiser is available to support this activity. Ask learners to share how they grouped the cards and discuss key questions: What problems have you found with hydroponics? What problems with sustainable farming might hydroponics help to solve? (Slide 4)



What do you think could be grown with hydroponics? Show learners 12 vegetables/fruits - ask them to decide which ones they think could be grown with hydroponics. Then reveal the answers (Slide 5-6)

Optional activity: Allow learners time to independently research hydroponics focusing on how they work, different systems for hydroponics and where they are being used as a contemporary farming method.

Optional Activity: Using systems thinking to explore hydroponics

To help prepare your learners for the Sustainable Growing Challenge you may want to take some additional time to explore how hydroponic systems work. Explain to the learners that they are going to be working like engineers by **systems thinking**. They will be identifying the parts in a hydroponic system and using their prior science knowledge to explain how things work together and why each part is there (Slide 7).

Learners deduce which number on the diagram corresponds to which component in the hydroponic system using the table of definitions and their prior scientific knowledge (Technical vocabulary focus). Use questioning to elicit learners' ideas, while doing this get them to explain the importance of each component in the system using their science knowledge.

3

Reservoir	**7**	Watertight container to hold nutrient solution
Growing chamber	**2**	Container with drain holes that holds the plant
Growing medium	**3**	Non-soil substance that plants grow in
Nutrient solution	**9**	A solution of the 16 elements essential for plant growth
Submersible pump	**8**	Moves nutrient solution from reservoir to plant chamber
Delivery system	**4**	Tubing or wick that carries nutrient solution from the reservoir to the plant chamber
Simple timer	**5**	Controls when the pump and or lights come on
Return pipe	**6**	Unused nutrient solution returned to the reservoir tank
Light	**1**	8-10 hours of daily light
Air pump	**10**	To oxygenate the nutrient solution as roots use oxygen for aerobic respiration

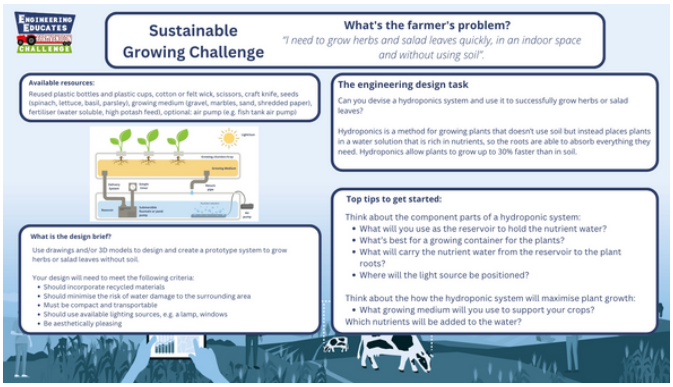
Introduce learners to the different ways that hydroponic systems can be put together. You could organise the class into groups and give them all one to find out about and explain to the other groups (Slide 8).
Research website: https://www.custommade.com/blog/introduction-to-hydroponics/

4

Sustainable Growing Challenge: Create a working hydroponic prototype

Learners apply their knowledge and understanding while working in teams, to design and create an inexpensive, compact, portable, working hydroponic gardening system that can be conveniently used on your window sill or table top to grow lettuce, radishes, basil, or another quick growing, edible plant. Encourage them to make their system aesthetically appealing since it will be highly visible for a long period of time as they test them.

Provide learners with the Problem on a Page: Sustainable Growing Challenge handout to support them with imagining & planning, then creating their prototype (Slide 9).



5

Evaluate

Provide some time for learners to self and peer evaluate how well their prototypes meet the success criteria on their design brief. This could then be revisited after a number of weeks when their crops are starting to grow.

There is a useful evaluation grid on the Problem on a page handout to support this activity.

Take it further

- Medium tech approach: For ideas on increasing the complexity of your learners hydroponics prototypes explore this website or watch this video.
- High tech approach: For ideas on how to include a timer, pump, lighting system and data loggers to support monitoring explore these teacher notes from SAPS available from the STEM learning resource collection.

Sustainable farms of the future

Could hydroponics be used to make farming more sustainable?

Advantages		Disadvantages
	CropYield	
	Energy Use	
	Transport	
	Sustainability	
	Efficiency	

What do the experts say about hydroponics?

Hydroponic systems use 10 times less water that soil-based growing methods.

Microbes in the soil are beneficial for plant growth.

Hydroponic systems can produce year round crops.

Hydroponic systems can produce higher yields that soil-based alternatives.

Hydroponic systems that use artificial lighting can use lots of electricity.

Hydroponic systems can be located close to where the food is needed reducing travel distance and time from the farm to the table.

Hydroponic systems can be stacked high and don't need as much land as conventional soil-based farming.

Hydroponic equipment including pumps, pipes, lights, air filters, lights, fans can all be expensive.

Weeds are not an issue with hydroponic methods because they need soil to grow.

Systems are made of materials which require resources to build and maintain.

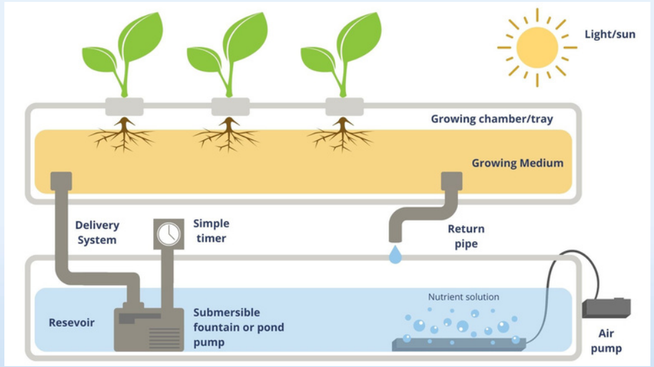
Sustainable Growing Challenge

What's the farmer's problem?

"I need to grow herbs and salad leaves quickly, in an indoor space and without using soil".

Available resources:

Reused plastic bottles and plastic cups, cotton or felt wick, scissors, craft knife, seeds (spinach, lettuce, basil, parsley), growing medium (gravel, marbles, sand, shredded paper), fertiliser (water soluble, high potash feed), optional: air pump (e.g. fish tank air pump)



The engineering design task

Can you devise a hydroponics system and use it to successfully grow herbs or salad leaves?

Hydroponics is a method for growing plants that doesn't use soil but instead places plants in a water solution that is rich in nutrients, so the roots are able to absorb everything they need. Hydroponics allow plants to grow up to 30% faster than in soil.

What is the design brief?

Use drawings and/or 3D models to design and create a prototype system to grow herbs or salad leaves without soil.

Your design will need to meet the following criteria:

- Should incorporate recycled materials
- Should minimise the risk of water damage to the surrounding area
- Must be compact and transportable
- Should use available lighting sources, e.g. a lamp, windows
- Be aesthetically pleasing

Top tips to get started:

Think about the component parts of a hydroponic system:

- What will you use as the reservoir to hold the nutrient water?
- What's best for a growing container for the plants?
- What will carry the nutrient water from the reservoir to the plant roots?
- Where will the light source be positioned?

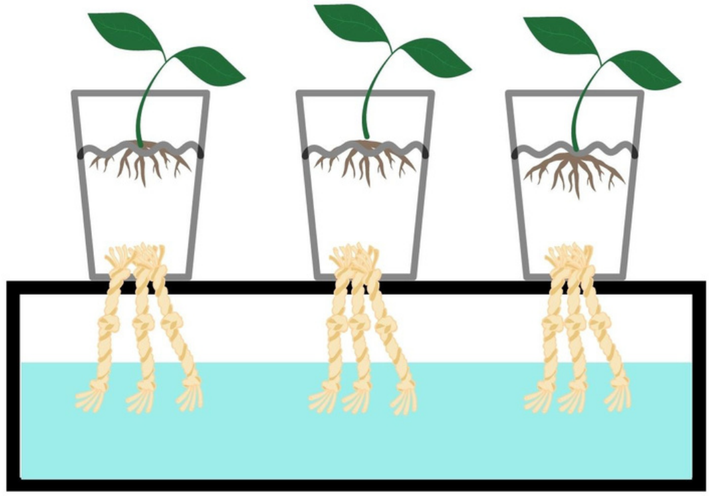
Think about the how the hydroponic system will maximise plant growth:

- What growing medium will you use to support your crops?

Which nutrients will be added to the water?

Background Information:

The wick system is simple and easy hydroponics system to set up which is cheap and easy to set up.



Water is drawn into the wick by capillary action. Water is sticks to the porous material of the wick and keeps moving up, this is how the water and nutrients get from the reservoir to the plants. Each plant will need one or more wicks, connecting it to the reservoir.

In hydroponic systems the water needs to be a nutrient solution as the plants are not grown in soil. You could research the best nutrients to use but a high potash feed with nitrogen, phosphorus and Potassium would work well.

Glossary:

Hydroponic system: a system that grows plants without soil.
Reservoir: somewhere water is stored.
Growing chamber: containers that give space and support to plants as they grow.
Growing medium: the material that plants are grown in.
Nutrient solution: a mix of concentrated minerals that plants need to grow.
Crop: a plant grown on a large scale for commercial use.
Yield: a measurement of the amount of crop harvested per unit area of farmland.
Wick: a strip of porous material that liquid is drawn up by capillary action.
Prototype: a version of a made-up design that can be improved and developed.
Compact: something that is small and conveniently shaped.
Aesthetic: the look and feel of something – related to beauty.

More information and inspiration!

Find out more about hydroponics from the Royal Horticulture Society.
For ideas on setting up a hydroponic system read the SAPS guide.
Example Youtube videos to inspire you by demonstrating how to make a simple hydroponic system and wick system.

Want to take it further?

Can you plan a science investigation to gather some data to evaluate the effectiveness of your hydroponic system? How does your data compare with others?
Can you evidence how effective your system is?

How well did you do?

Success Criteria	Score /5
The system grows plant without soil.	
The system uses recycled materials.	
Water is contained in the system, it doesn't leak.	
The system allows plants to get the light they need.	
The system is compact, portable and aesthetically pleasing.	