

# Introduction to Hydroponics & CEA

---



# What is CEA?

*“**Controlled Environment Agriculture (CEA)** is an advanced and intensive form of hydroponically-based agriculture where plants grow within a controlled environment to optimize horticultural practices.” – From **Cornell University***



## CEA Pro:

- Local, fresh produce **365 days per year**
- **90-95% less water** and **space** used
- Plants grow **2-3 times faster**
- Tailored environment

## CEA Consideration:

Requires basic knowledge in:

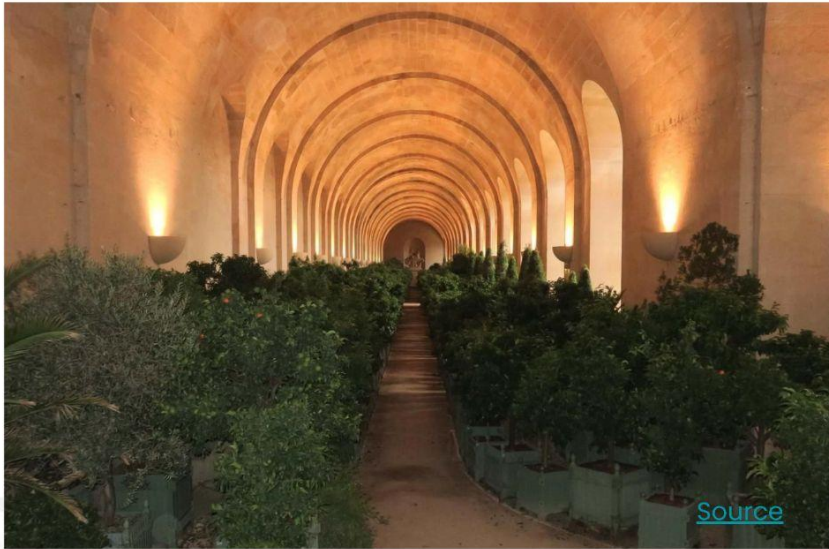
- **Horticulture**
- **Engineering**
- **Chemistry**



# What is CEA? A Quick History

**One of the earliest methods of producing crops using structures dates back to 14 to 37 CE in Rome.**

- (Paris and Janick, 2008)



Examples such as the Versailles Orangerie (Paris, 17th century) represent early adoption of CEA.

- Walls enclosing the growing space to protect crops.
- South facing growing spaces to optimize the warming effects of the sun.
- Double glazed windows to prevent frost without the use of artificial heating.
- During winter the trees were housed in cathedral-like spaces.
- During the extremely cold months, fires were burned to heat the space.

# Fast Forward to the 20th Century...

## The modern greenhouse design is born!



While very different from an *Orangerie*, they were designed to suit local climate.

- Multispan, tall, glass, insulated greenhouse.
- Wide aluminum or steel trusses with enough strength to withstand strong winds and snow.
- Good sunlight transmission.
- Improved soil health thanks to sprinklers and drainage systems that helped reduce salt buildup.
- Issues with greenhouse growing include difficult (supplemental) light and humidity management, crop limitations, and disease spread.

# And Now...

## Vertical Farming!



The modern concept of vertical farming was proposed in 1999 by a Public and Environmental Health professor, Dickson Despommier, at Columbia University.

- Increased yield per week & faster growth to reach their adult sizes.
- Smaller land use requirements.
- Many pros such as less water use, fewer pests, no worries of cross pollination, and a tailored environment.
- Less disruptive to local plants, animals, soil, and overall ecology.
- Cultivate a larger variety of crops at once, as crops traditionally do not share the same plot of land.
- Crops are resistant & independent to inconsistent weather.
- Compatible with large or small spaces, such as warehouses or shipping containers!

# Growing Techniques within CEA – Hydroponics



[Source](#)

In general, a hydroponics system features a solution of water and nutrients. The plants' roots are delivered the solution in a few different ways. We'll talk more about that in the next slides!

## Pros

- Consumes less water than traditional agriculture techniques.
- Higher plant yield.
- No herbicides needed.
- Reduced need for pesticides.
- Plants can grow 40-50% faster!

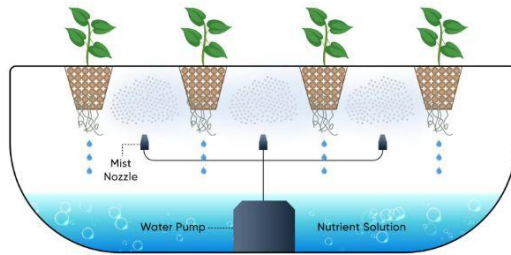
## Cons

- Requires more knowledge about nutrients and plant pH requirements.
- As more mechanical and technological systems are used, more maintenance is required.
- Setup and equipment are expensive.
- Power outages can lead to complete crop failure.

# Growing Techniques within CEA - Aeroponics

In an aeroponics system, the roots of the plants are suspended in a chamber of air. The roots are then misted regularly with a nutrient solution.

## Aeroponic System



[Source](#)

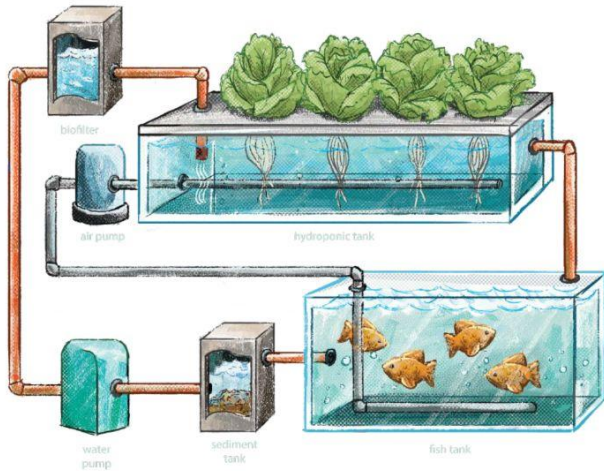
## Pros

- Consumes the least amount of water of the three techniques.
- Reduces nutrient solution usage.
- Faster plant growth.

## Cons

- Setup and equipment are expensive.
- Requires a higher level of technical knowledge.
- Constant monitoring of pH and nutrient levels.
- Power outages can lead to complete crop failure.
- Regular disinfection of the root chamber is required.

# Growing Techniques within CEA - Aquaponics



[Source](#)

Aquaponics involve growing plants and fish together within the same system. The fish waste provides nutrients for the plants, although only after intensive treatment of the waste. In return the plants help to filter the water for the fish to help provide a suitable environment.

## Pros

- Provides yields from both plants and fish.
- Faster growth rate for plants and larger, high quality yields (if performed properly).

## Cons

- High upfront and operational costs.
- Extra costs for feeding fish.
- Requires extensive knowledge of fish care and diseases.
- Not suitable for commercial growers (although fantastic for educational purposes)!



# What are the benefits of CEA growing?

- 1. You Can Grow Produce Year-Round**
- 2. Less Water Usage**
- 3. Less Land Usage**
- 4. Lower Labour Requirements**
- 5. Uses Fewer Chemicals**
- 6. Can Be Grown Hyper-Locally**



# What is Hydroponics?

A more indepth review

**It's the horticultural practice of growing crops, without soil, by using nutrient-rich water.**



Hydroponics stems from the latin words of “water” and “work”

Hydroponic growing dates as far back to the hanging gardens of Babylon in the 6th century with many more recent innovations in the 20th century.

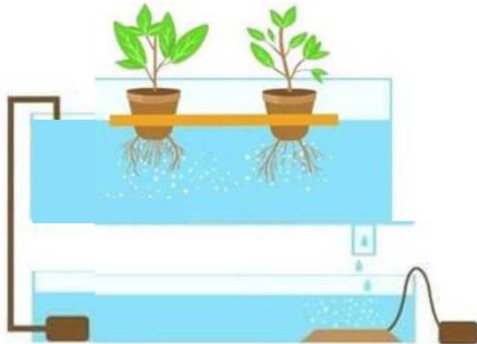
Hydroponic growing is a popular horticultural study even today with many advancements being made in indoor growing technology, including here at Growcer!

# Types of Hydroponic Systems

The goal is to deliver nutrient rich solution to the plants

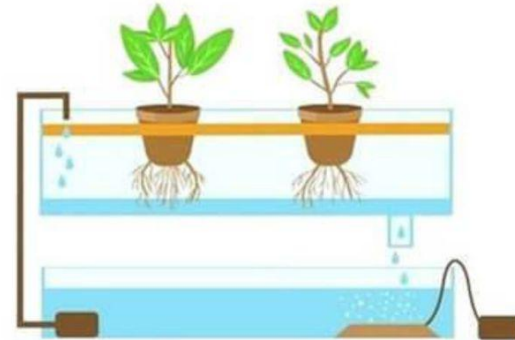
In terms of growing in a Growcer farm, we use **rockwool** as the soilless substrate and floating rafts in a **Deep Water Culture (DWC)** system.

Deep Water Culture (DWC)



vs

Nutrient Film Technique (NFT)

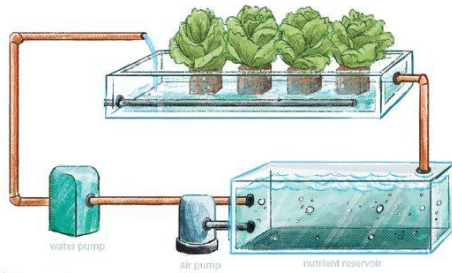


# Active System

An active system uses pumps to circulate the water and nutrients throughout the growing system

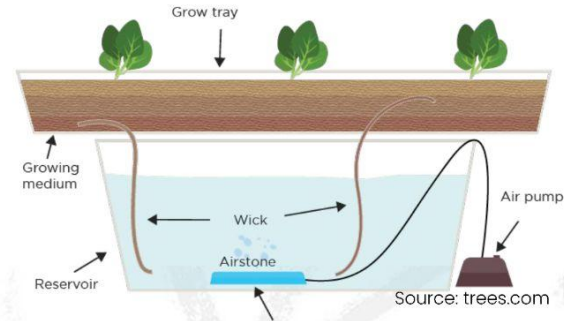
An **Active System** uses pumps to circulate the water and nutrients versus a **Passive System** which uses gravity to move liquid or a wicking system to bring the nutrients and water up to the plant.

Active System



Source: ag.purdue.edu

Passive System



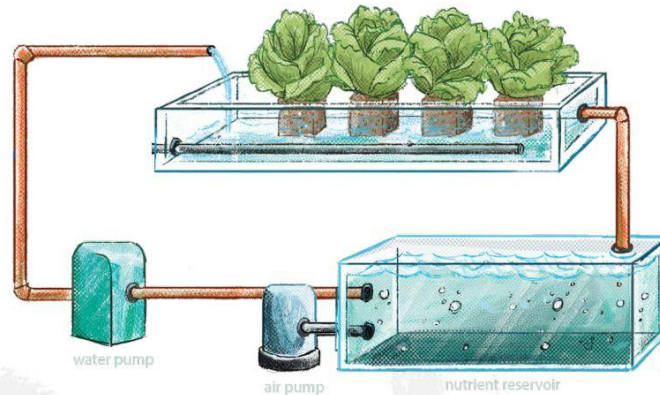
Source: trees.com

VS

# Closed System

**A closed system recirculates the nutrients and water in the system, essentially recycles the water.**

**Closed System** recirculates the nutrients and water in the system, continued use versus an **Open System** where the water and nutrients are not captured and are disposed of.



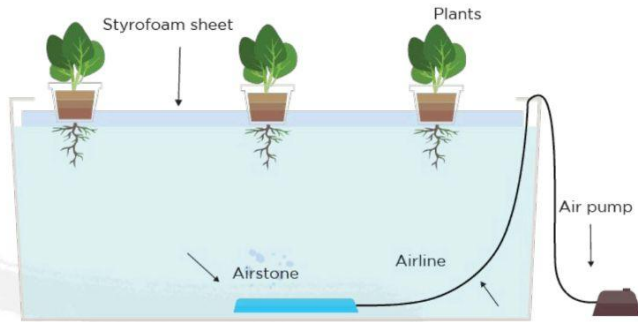
Source: [ag.purdue.edu](http://ag.purdue.edu)

# Liquid Based System

**Plant roots are supported by net pots or other structures that suspend the roots in the nutrient-rich water solution**

In a **Liquid-Based System**, plant roots are supported by structures such as a raft that suspend the roots in the the nutrient-rich water solution, Growcer has used Nutrient Film Technique (NFT) in the past, but now uses Deep Water Culture (DWC) vs. a **Media-Based System** that uses different techniques and media (organic or inorganic) to keep the root moist.

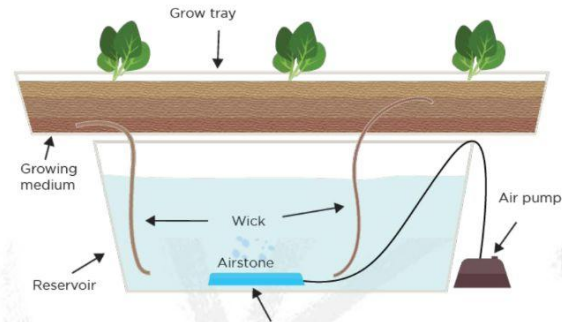
Liquid-Based System



Source: trees.com

VS





Media-Based System

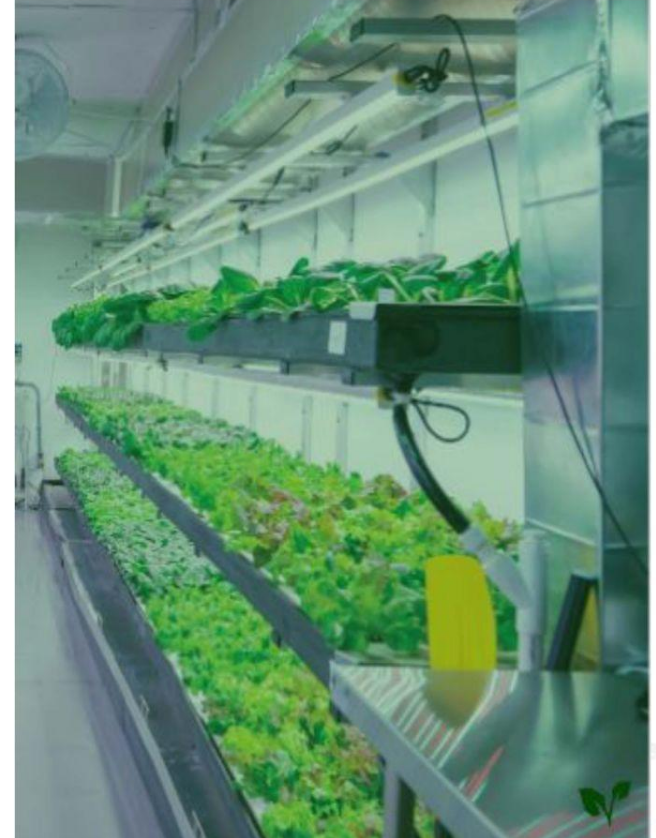


Source: trees.com

# Growcer Osiris System

## Growcer Osiris System

Growcer Osiris System			
NFT			DWC
Passive			Active
Open			Closed
Media-Based			Liquid-Based



# Traditional Farms vs. CEA Systems

## Traditional Farms:

- Plants can only grow in their natural climate
- Seasonal crops only
- Crops susceptible to weather or environmental changes



## CEA Systems:

- Tailored environment for desired crops
- Grow crops year round
- Highly reduced opportunity for crops to be impacted by weather, pests, and diseases.
- Reduced water, fertilizer, and chemical usage.
- Not limited by location and properties of agricultural land

