


## Microbial Food Safety of Hydroponic/ Aquaponic Systems

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**I ILLINOIS**

Metropolitan Farms in Chicago  
New Day Hydroponics in Kankakee



1

## Fresh Produce Production in U.S.


### Industry Profile

- 230,755 farms
- 9.8 million acres
- \$57.2 billion market value
- 98% of fruit and vegetable are family farms
- \$7.4 billion in export of Fruit and Vegetables

### Crop Comparison

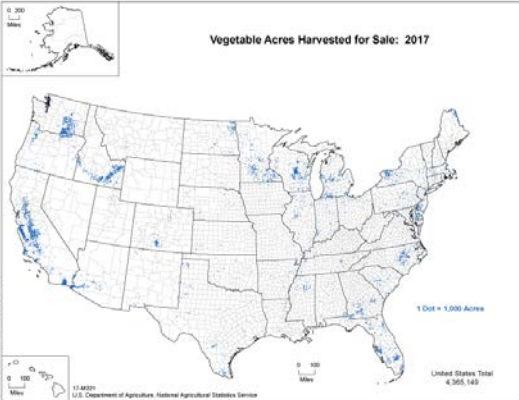
Commodity	Market Value	Acreage
Corn	\$67.2 billion	94.5 million
Soybean	\$38.7 billion	76.1 million
Fruits, Berries, Tree Nuts	\$25.9 billion	5.5 million
Vegetables, Melon, Potato	\$16.9 billion	4.2 million
Wheat	\$15.8 billion	49.0 million
Rice	\$2.9 billion	2.7 million

**I** (Source: United Fresh Produce Association [www.unitedfresh.org](http://www.unitedfresh.org))



2


## Map of Fresh Vegetable Production



Vegetable Acres Harvested for Sale: 2017

- California, Arizona, and Florida are the top-3 fresh produce producer in US.

USDA's National Agricultural Statistics Service, 2017





3

## Controlled Environment Agriculture (CEA)

CEA is a technology-based approach toward food production. Crops are usually grown in a greenhouse hydroponically within a controlled environment.

Controllable variables:

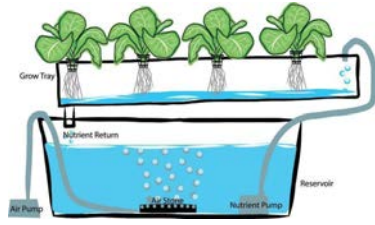
- Temperature (air, nutrient solution, root-zone, leaf)
- Humidity (%RH)
- Carbon dioxide (CO<sub>2</sub>)
- Light (intensity, spectrum, duration and intervals)
- Nutrient concentration (PPM of Nitrogen, Potassium, Phosphorus, etc.)
- Nutrient pH (acidity)
- Pests

4

## What is hydroponics/aquaponics?

- Soilless gardening
- Hydroponics: using mineral nutrient solution.
- Aquaponic: raise fish together with plants, using water from a fish tank containing fish waste.



(Source: <https://agritecture.tumblr.com/post/159976476812/10-new-trends-in-hydroponics-what-to-expect-in>)



((Source: <https://www.flseagrant.org/aquaculture/aquaponics/>)



5

## WHY HYDROPONICS?

Hydroponics is the method of growing plants in a nutrient-rich water-based environment. It comes with many incredible benefits over traditional gardening:

## Benefit of Hydroponics /Aquaponics



Zero soil



2x growth rate



80% less water



No weeds



Nutrient efficiency



Fewer pests



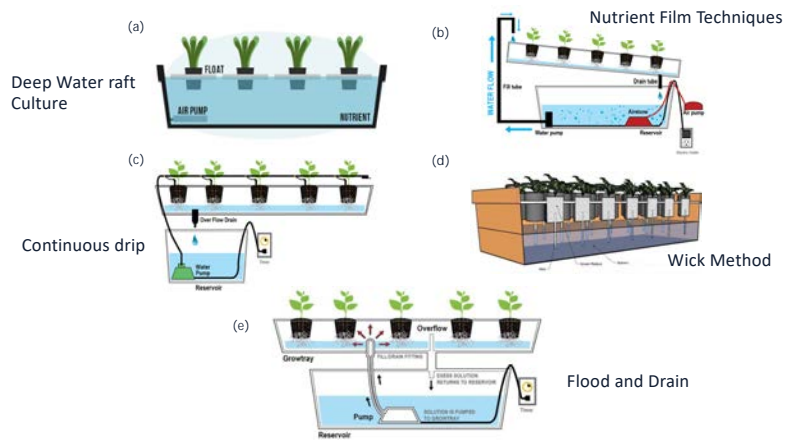
(Source: <https://gardeningheaven.com/vertical-hydroponics/>)

(Source: <https://www.trees.com/gardening-and-landscaping/advantages-disadvantages-of-hydroponics>)



6

## Different Types of Hydroponic Systems

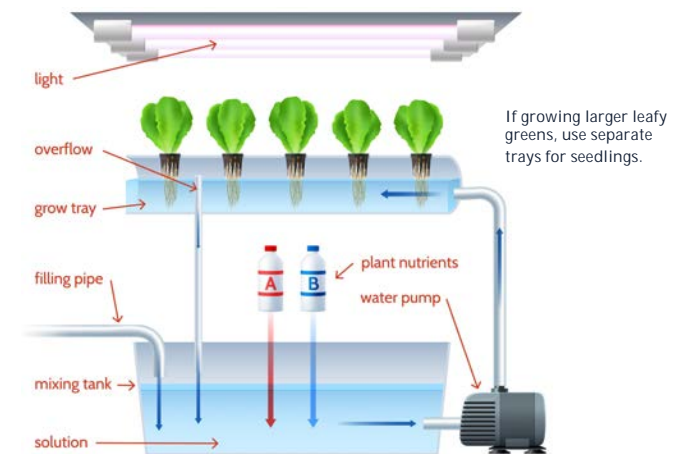


(Source Hydroponics.name, "Hydroponics Systems," 22-Apr-2015.)



7

## What Do We Need to Start?



If growing larger leafy greens, use separate trays for seedlings.

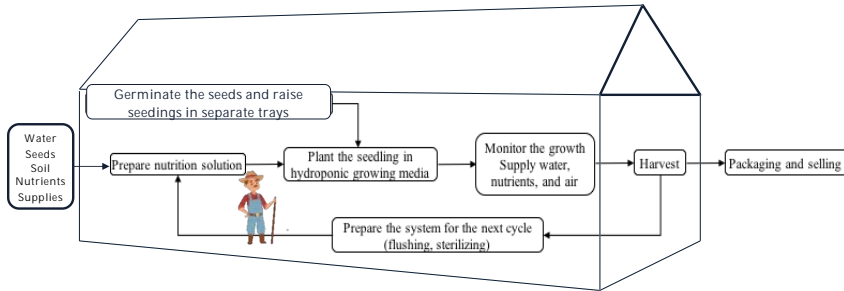


(Source <https://mollygreen.com/blog/diy-hydroponic-gardening/>)



8

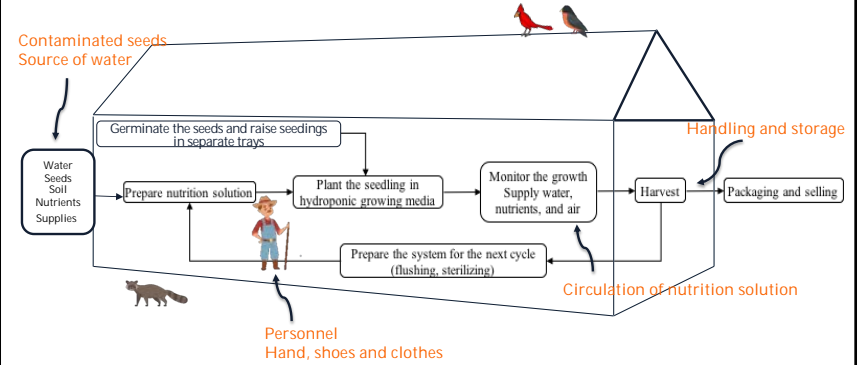
# Operating a Hydroponic Farm



9

# Food Safety Risks

- Presents different food safety risks from traditional field farming.



10

# Our Study

## Purpose:

- To investigate the food safety risks related to hydroponic and aquaponic farming.

## Approaches:

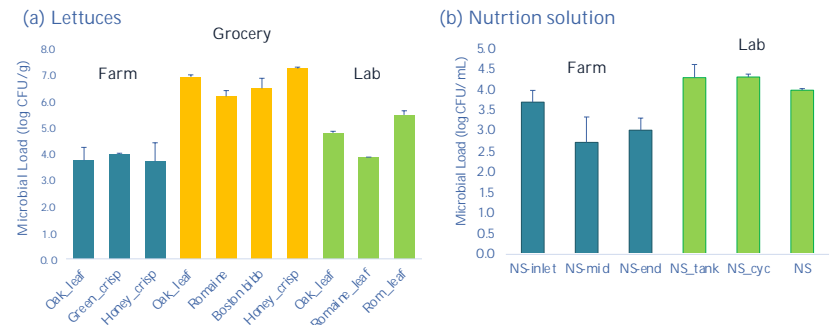
- Farm visit: food safety practice survey, and sampling of fresh produce, nutrition solution, and environmental swabs.
- Obtain similar varieties from local grocery stores.
- Sampling from hydroponic systems in the lab.



11

# Microbial Quality

Microbial Quality of Lettuce and Nutrition Solutions, Comparing Farm, Grocery Store, and Lab Systems



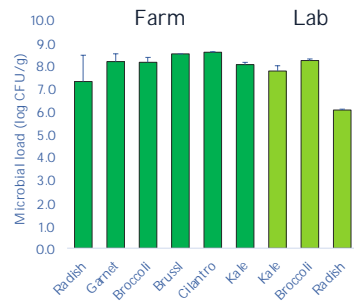
- Lettuce samples from grocery stores had the highest microbial load.
- The in-cycle nutrition solutions from the aquaponic farm showed lower microbial load than that of the lab systems.



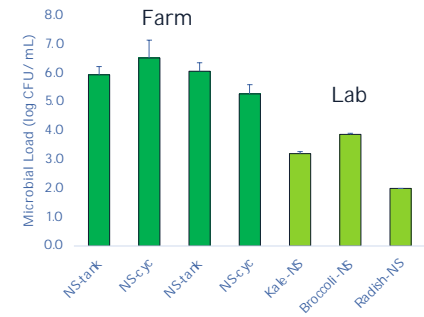
12

## Microbial Quality of Microgreens and the Nutrition Solutions, Comparing Farm and Lab systems

(a) Microgreens



(b) Nutrition solution



- Harvested microgreens had similar microbial loads.
- Lab systems' nutrition solutions were lower than the farm systems.

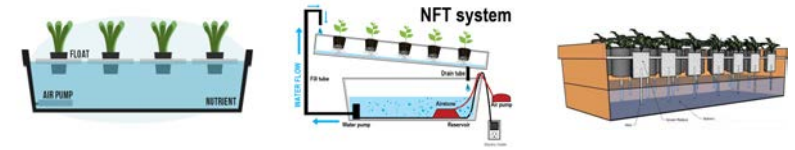


13

## What may cause the differences?

### 1. Type of systems:

- In the aquaponic farm, DWC was used, meaning a larger amount of water system compare to lab systems (smaller scale DWC and NFT).
- In the microgreen farm, NFT is used, while, in lab systems, we used wick method (roots were not directly soaked in the nutrition solution).



14

## What may cause the differences?

### 2. Circulation of nutrition solution:

- The hydroponic microgreen farm changes circulating water once per month, resulting in accumulated microbial load in the water system.
- The aquaponic farm replaces the water every week, resulting in low microbial load in the water system.

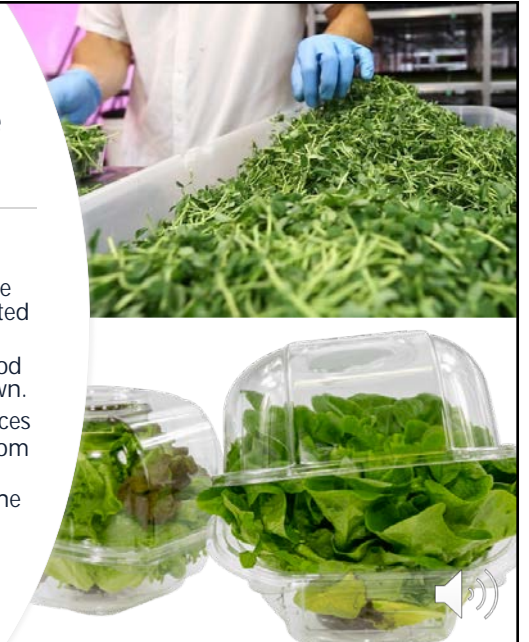


15

## What may cause the differences?

### 3. Harvesting process:

- Lettuces obtained from the grocery store were harvested and packaged in plastic containers, the process food safety control was unknown.
- Farm and lab-grown lettuces were directly harvested from the system into sterile sample bags, minimized the contamination during harvest.



16





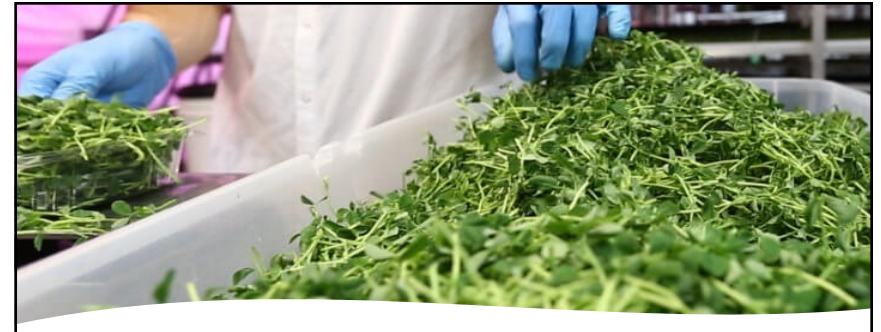
## Strategies to Ensure Food Safety



- Sanitize the seeds.
- Test the water quality and change circulating water regularly.
- Sanitize the equipment and tools after each use.



17



## Strategies to Ensure Food Safety



- Working shoes and clothes for inside the facility.
- Good worker health and personal hygiene practice.



18

## Summary

- Hydroponic/ aquaponic farming is soilless, indoor farming that works all year round.
- These farming systems present different food safety risks compared to the traditional farming.
- Food safety risks can be controlled by:
  - Monitor the water quality
  - Regular sanitation of tools and facility
  - Using PPE in facility
  - Practicing personal hygiene



19

## Acknowledgement



Illinois Department of Agriculture Specialty Crop Grants



20

