

A futuristic indoor farm with hydroponic plants and a person working in the background. The scene is brightly lit with blue and green tones. The text "Farms of the Future" is overlaid in white, pixelated font.

# Farms of the Future

# History of Controlled Environment Agriculture and Vertical Farming

- The hanging garden of Babylon poses as the earliest method to grow plants vertically
- In 1915, Gilbert Ellis Bailey coined the term “Vertical farming” and wrote a book titled “Vertical Farming”
- In the early 1930s, William Frederick Gerick pioneered hydroponics at the University of California at Berkley
- In the 1980s, Ake Olsson a Swedish ecological farmer, invented a spiral-shaped rail system for growing plants and suggested vertical farming as a means for producing vegetables in cities
- Using advanced greenhouse technology such as hydroponics and aeroponics, the vertical farm can theoretically produce fish, poultry, fruit and vegetables ([Despommier, 2010](#)).

# Hydroponics

- Method of growing plants without soil.
- Instead of having their roots supported and nourished by soil, the plants are supported by an inert growing medium like cocopeat.
- Typically fed via a nutrient-rich water solution that is recycled in the system.
- Uses about 70% less overall water than traditional farming.

# Aeroponics

- Aeroponics is the process of growing plants in an air or mist environment without the use of soil or an aggregate medium.
- The basic principle of aeroponic growing is to grow plants suspended in a closed or semi-closed environment by spraying the plant's dangling roots and lower stem with an atomized or sprayed, nutrient-rich water solution.
- Plants in a true aeroponic apparatus have 100% access to the CO<sub>2</sub> concentrations ranging from 450 ppm to 780 ppm for photosynthesis.
- High rate of crop growth and uses 70% less water than hydroponics.

# Aquaponics

- Aquaponics is a recirculating system that combines hydroponics (growing plants in water without soil) and aquaculture (fish farming) to create an efficient closed loop system.
- Aquaponics uses these two in a symbiotic combination in which plants are fed the aquatic animals' discharge or waste.
- In return, the vegetables clean the water that goes back to the fish. Along with the fish and their waste, microbes play an important role to the nutrition of the plants.
- Fish are the ones feeding your plants. The fish used in this type of aquaculture are freshwater fish, most popular being tilapia and barramundi because they can tolerate diverse water conditions and they grow fast.

# Controlled Environment Month 2023

*Governor Glenn Youngkin proclaimed March 2023 as Virginia Controlled Environment Agriculture (CEA) Month to highlight the importance and impact of next generation agriculture in Virginia. CEAs utilize innovations in technology in various growing*

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24 photos • 13 views



By: Virginia Dept. of Agriculture & Consumer Services

PRO

## VIRGINIA DEPARTMENT OF AGRICULTURE AND CONSUMER SERVICES

OFFICE OF COMMUNICATIONS, Contact: [Michael Wallace](mailto:Michael.Wallace@vdaacs.virginia.gov), 804.786.1904, [www.vdaacs.virginia.gov](http://www.vdaacs.virginia.gov)

For Immediate Release: Thursday, March 2, 2023

### Governor Glenn Youngkin Proclaims March as Virginia Controlled Environment Agriculture Month

*~ CEAs are advancing agriculture and excelling in Virginia's surging entrepreneurial spirit ~*

Governor Glenn Youngkin proclaimed March as [Virginia Controlled Environment Agriculture Month](#) to highlight the importance and impact of next generation agriculture to the Commonwealth of Virginia. Controlled Environment Agriculture (CEA) utilizes innovations in technology in various growing methods such as hydroponics, aeroponics, aquaponics, and fogponics. These methods are used to grow produce in a variety of settings to include indoor farming, vertical farming, greenhouses, and protected cropping environments. Officials will recognize the CEA month by visiting operations around the state.



# Virginia

A guide to the Commonwealth's farms, food and fiber

# AGRICULTURE

2023 Edition | VAagriculture.com

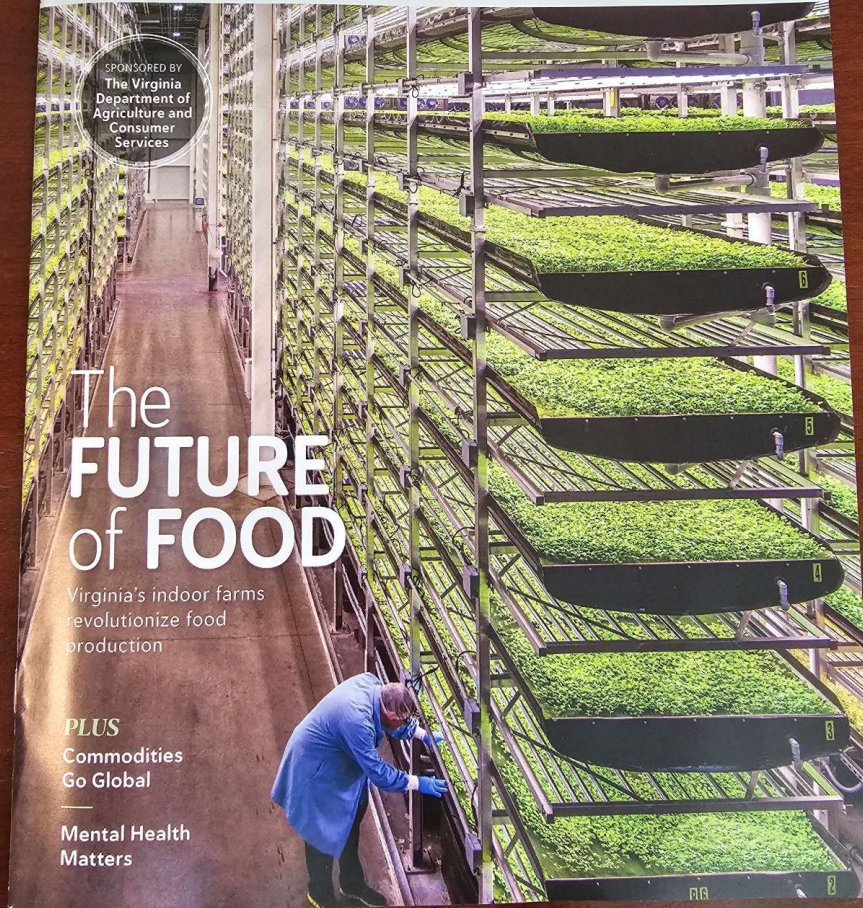
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The Virginia  
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Consumer  
Services

## The FUTURE of FOOD

Virginia's indoor farms  
revolutionize food  
production

**PLUS**  
Commodities  
Go Global

Mental Health  
Matters



**FOR IMMEDIATE RELEASE:** May 16, 2023

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## **Governor Glenn Youngkin Signs Controlled Environment Agriculture Legislation**

**RICHMOND, VA** - Today, Governor Glenn Youngkin signed HB1563 and SB 1240, highlighting the Commonwealth's continued commitment to Controlled Environment Agriculture (CEA). House Bill 1563 and Senate Bill 1240 expand the agricultural sales tax exemption to include items used to produce agricultural products for market in a CEA commercial facility. Following the signing at Virginia Tech's Shenandoah Valley Agricultural Research and Extension Center in Raphine, VA, Governor Youngkin announced that the "Great Indoors" Virginia symposium to address global food security through innovation is scheduled for September 25 and 26th.

"Targeted investments and support for advanced training in cutting-edge agricultural technology training is vital in making Virginia the number one destination in the nation for controlled environment agriculture," said **Governor Glenn Youngkin**. "Innovation is critical to creating a resilient food system that prevents a rapidly growing world population from suffering food insecurity, while responding to consumer demand for healthier, more sustainable food options.

Under current law, CEA facilities may receive sales tax exemptions for some, but not all, of the purchases they make. The agricultural technology tax exemption legislation, patron by Senator Mark D. Obenshain, Senate District 26, and Delegate Hyland F. "Buddy" Fowler, Jr., House District 65, expands the exemption to include tangible personal property items that are used in construction of a CEA facility.

The planned "Great Indoors" symposium will bring together leading innovators to explore CEA's role in helping address global food safety and security concerns, security crisis through innovation. The conference will bring senior leadership across the public and private sectors together to discuss how to scale new technologies to address food insecurities, while also addressing challenges often faced in outdoor farming, including extreme weather, labor costs and availability, soil erosion, water availability, and pests' growing resistance to pesticides.

"Virginia is quickly becoming the destination of choice for CEA operations to locate and expand, due to the state's strategic access to domestic consumer markets, plentiful and competitively priced resources, skilled workforce pipeline, and the availability of public and private partnerships," said **Secretary of Agriculture and Forestry Matthew Lohr**. "The Governor's budget amendments seek to capitalize on these advantages and solidify Virginia's position as the best state for CEA business in the nation."

Governor Youngkin's 2023 budget amendments provide \$1,250,000 more in both FY2023 and FY2024 for agricultural technology grants or loans to advance the industry, assist in the development of agricultural products, and improve infrastructure growth, productivity, or efficiency. From the Governor's Agriculture and Forestry Industries Development (AFID) program, \$1,000,000 is provided in FY2024 to fund agricultural technology research projects over the biennium.



# Controlled Environment Agriculture Companies in Virginia



## Vice President Kamala Harris visits small business in Richmond



By NBC12 Newsroom

Published: May. 4, 2023 at 5:19 PM EDT | Updated: 16 hours ago



RICHMOND, Va. (WWBT) -Vice President Kamala Harris toured a local small business for National Small Business Week along with other local lawmakers in Richmond Thursday afternoon.

Rep. Jennifer McClellan (D-4th) and Richmond Mayor Levar Stoney accompanied the vice president on a tour of Babylon Micro-Farms in Scott's Addition.

While there, Harris heard presentations from employees on the concept and technology of micro-farming. She inspected produce in a grow tent and asked questions about the process.

[https://www.nbc12.com/2023/05/04/vice-president-kamala-harris-visits-small-business-richmond/?utm\\_source=facebook&utm\\_medium=news\\_tab](https://www.nbc12.com/2023/05/04/vice-president-kamala-harris-visits-small-business-richmond/?utm_source=facebook&utm_medium=news_tab)

# AeroFarms, Danville, VA

AeroFarms



AeroFarms uses proprietary aeroponic growing technology to produce highly flavorful leafy greens at a rate 390-times more productive than field-grown plants. A mission-driven company, AeroFarms is committed to growing the best plants possible with processes that use significantly less water and no pesticides while offering extremely high levels of food safety. By hiring locally and creating year-round employment, AeroFarms is able to grow all year to nourish its communities with high-quality produce that delivers optimal nutrition and flavor.



## LOCAL NEWS

Alyssa Rae, Reporter

Published: September 12, 2022 at 8:00 PM

Tags: Southside, Agriculture, Farming, Community

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## LATEST NEWS

50 MINUTES AGO

Two students hospitalized with minor injuries after crash involving Henry County



# AeroFarms celebrates ribbon cutting in Danville

The 'World's largest indoor vertical farm' will employ more than 150 workers



The future of agriculture is planting roots in Southside, as today marked the grand opening of AeroFarms

**DANVILLE, Va.** – The future of agriculture is planting roots in Southside.

Monday marked the ribbon cutting of AeroFarms. At 140,000 square feet, the facility in Danville is the world's largest indoor vertical farm.

# AeroFarms Leads the Industry in Vertical Farming and More



AeroFarms built and operates **the largest vertical farm in the world** and sells great tasting leafy greens. To date, the company has **grown over 550 different varieties** of fruits and vegetables and uses its understanding of plant biology to optimize farming systems.



There is an incredible spirit of partnership here that made us feel right at home as we built our latest world-class commercial indoor vertical farm to serve the community with fresh, safely grown, nutritious, and delicious leafy greens all year round.

**DAVID ROSENBERG**  
Co-Founder and CEO

**AEROFARMS**

## AeroFarms Has Been Recognized With Over 50 Awards Since 2011:

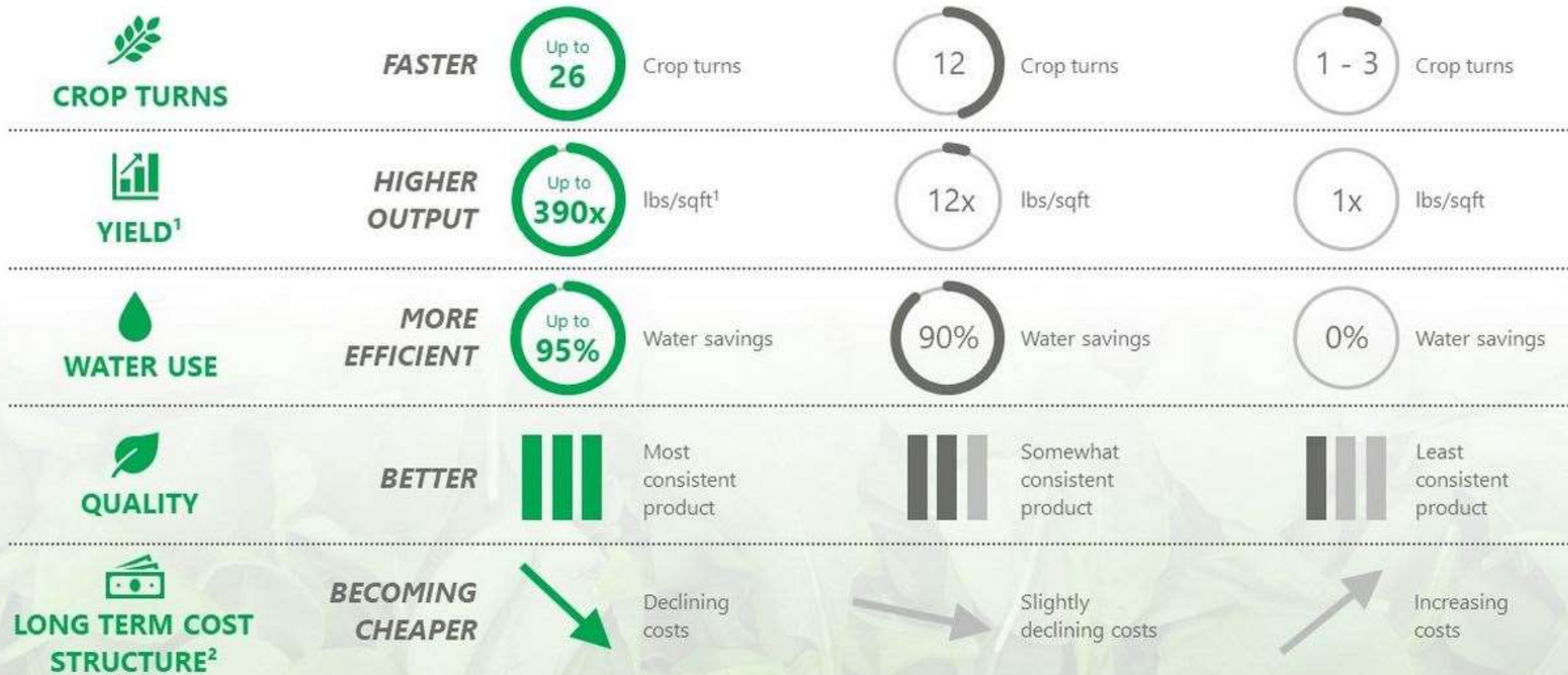


# Unrivaled Sustainability and Productivity

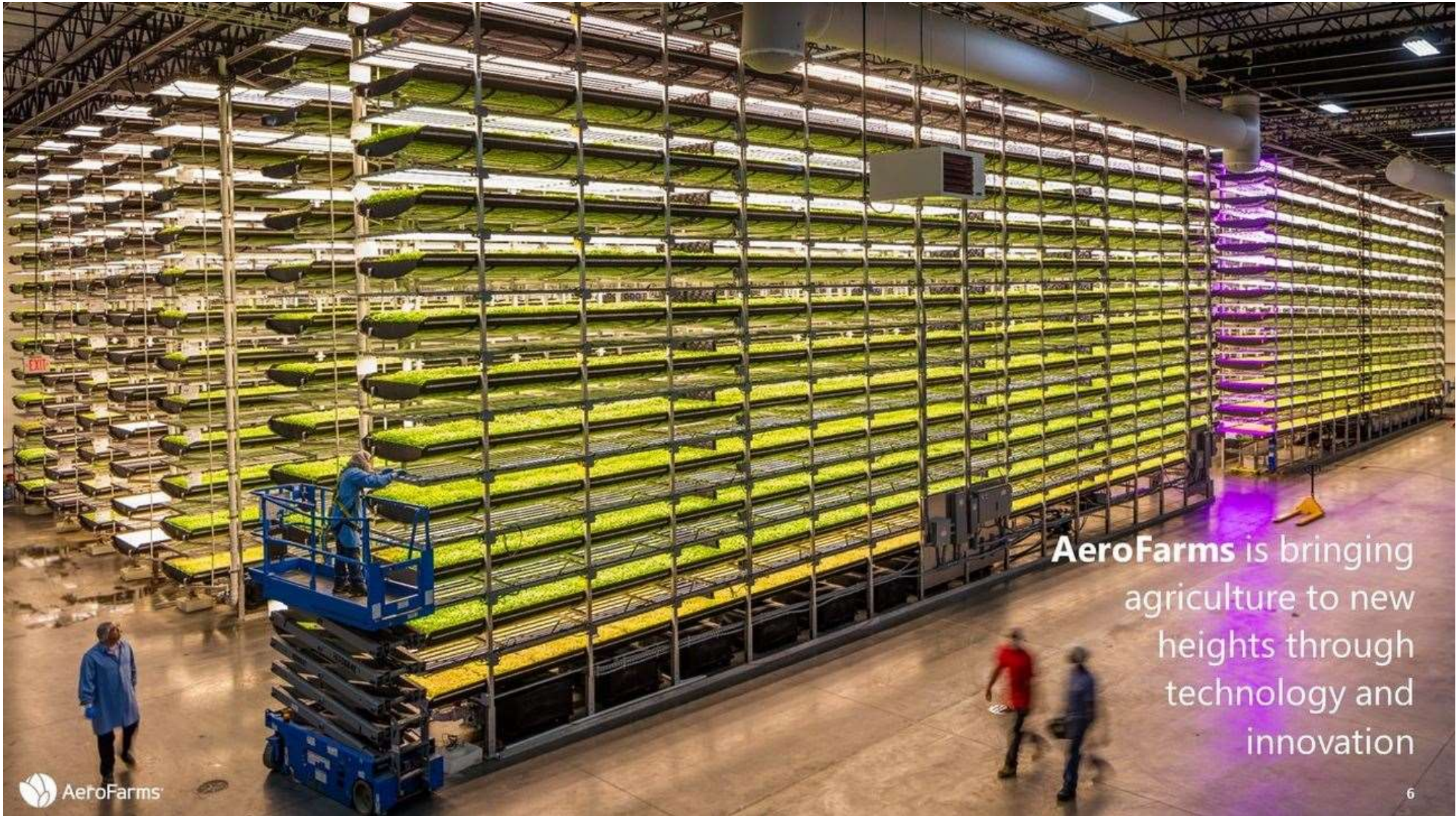


High-tech Greenhouse

Conventional Farming



\* Calculation is based on AeroFarms' annual crop turns, levels of vertical growing and output per square foot versus values for a conventional field farm in a region like New Jersey with one crop turn per year; <sup>2</sup> Farmland Prices in The United States according to the USDA



**AeroFarms** is bringing  
agriculture to new  
heights through  
technology and  
innovation

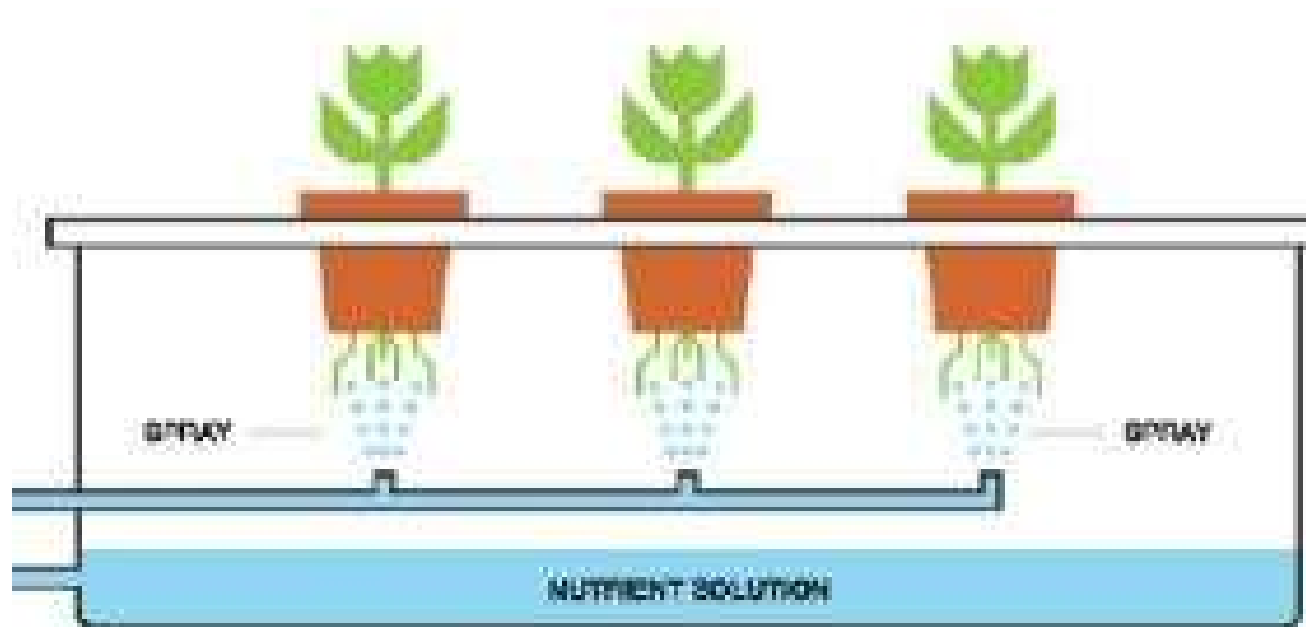


Fig 2 Aeroponic System





## Precision Aeroponics

- We use our proprietary aeroponic technology to mist the roots of our plants with targeted nutrients, water, and oxygen. Our aeroponic system is a closed loop system, using up to 95% less water for leafy greens than field farming and even less than hydroponics, as well as a fraction of the fertilizers.

## Patented Growing Cloth Medium

- We have developed a patented growing **cloth medium** for seeding, germinating, growing, and harvesting leafy greens. The cloth acts as a barrier between the mist and the plants, keeping the plants pristine and ready-to-eat with no washing needed. In addition, the cloth is a very flexible growing medium with the ability to grow hundreds of different varieties, allowing us to be very market driven with our product offerings.
- Elevated Food Safety + Traceability
- **We have built unprecedented levels of food safety into our growing operations with over 200 robust food safety standard operating procedures and full traceability from seed to package.** We are food safety certified under all major industry schemes including; Good Agricultural Practices, Good Manufacturing Practices, and Safe Quality Food (SQF). AeroFarms is also a founding member of the Controlled Environment Agriculture (CEA) Food Safety Coalition.

# AeroFarms is Ready to Bring its Leafy Greens Farms to New Markets



### SITE SELECTION METHODOLOGY

Prioritize locations for new farms considering:

- ✓ **CUSTOMER:** quality, expansion strategy
- ✓ **MARKET DEPTH:** population within 1 day drive
- ✓ **COSTS:** utilities, labor, construction, logistics
- ✓ **SPEED TO BUILD:** Permitting, ready utilities and infrastructure
- ✓ **INCENTIVES:** Ability to attract incentives that reduce costs or create capital

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AeroFarms also won a **World Wildlife Fund** RFP to partner in developing a potential future farm

## DEVELOPMENT TIMELINE



~3 – 4 months

**Priority Market Selection**

Competitive multi-state RFI  
Comparative site analysis  
Incentive negotiations



4 – 5 months

**Site Selection**

Engineering and design  
Competitive bids  
Permitting



~12 months

**Financial Closing / Start of Construction**

Construction of farm  
Equipment commissioning  
Hiring and training of personnel



**Start of Commercial Operations**



<sup>1</sup> Date represents financial closing / start of construction for each farm location; <sup>2</sup> Maps are illustrative; 300-mile target areas not to scale



# Plenty, Chester, VA

Plenty Unlimited Inc.

Plenty Unlimited Inc. will build the world's largest campus for advanced indoor vertical farming in Virginia, a \$300 million investment that will create 300 jobs in the Greater Richmond region. The company recently secured \$400 million in a Series E financing round, the largest investment to date for an indoor farming company. Plenty's proprietary climate-control, LED lighting, and growing technologies allow for the efficient and sustainable production of a variety of clean, flavorful produce on its 52-foot grow towers year-round. The company's first farm will be completed by 2024 and will focus on strawberry production.



09/14/2022

## World's Largest Indoor Vertical Farm Coming to Virginia

Plenty's sprawling facility will initially produce strawberries for Driscoll's



**Emily Crowe**  
Multimedia Editor



**Plenty Unlimited Inc.** is poised to build the largest indoor vertical farm in the world with a \$300 million, 120-acre campus near Richmond, Va. Ground has already been broken on the new facility and it is expected to begin rolling out produce by late 2023 or early 2024.

The vertical farm company has plans to deploy several large-scale vertical farms on the Virginia campus in the coming years, and annual production capacity could exceed 20 million pounds for crops including strawberries, leafy greens and tomatoes. To start, the campus will grow **Driscoll's** strawberries, and will be the first farm in the world to grow indoor, vertically farmed berries at scale.

**[Read more: "100 Iconic Brands That Changed Grocery"]**

"Through more than a decade of investment in research and development



Plenty's indoor vertical farm in Virginia will initially produce Driscoll's strawberries for distribution in the Northeast.



Our plants are grown in water and sterilized plant media. It's easier to control the nutrient mix than soil, and produces more consistent results.

**Plenty Strawberries are optimized in size and packed with flavor.**





# Greenswell Growers, Manakin-Sabot, VA

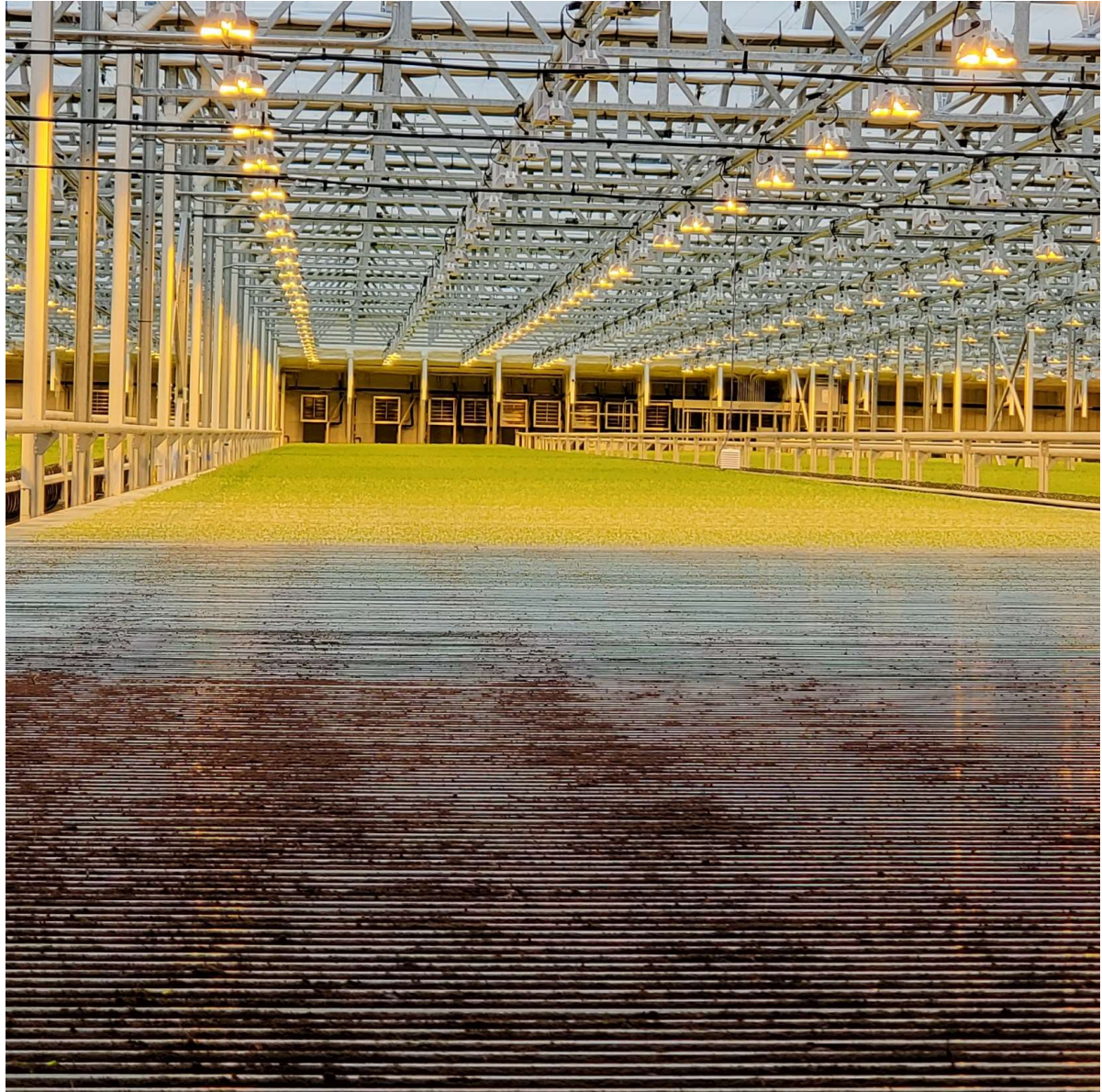
## Greenswell Growers

Greenswell Growers uses a fully automated, indoor system with both natural and artificial light to produce leafy greens year-round, prioritizing food safety, freshness, consistency, and reliability. The company has worked with Dominion Energy to utilize 100 percent of its energy from zero carbon sources. The hydroponic greenhouse is expected to produce nearly 3.7 million pounds of leafy greens for distribution in the mid-Atlantic during its first three years of full production. The facility will be able to produce 28 times more product per acre than a traditional growing operation.





GREENSWELL  
GROWERS













# Red Sun Farms, Dublin, VA

Red Sun Farms

Headquartered in Michoacán, Mexico, Red Sun Farms is a producer of high-quality hydroponic vegetables founded in 2001 as part of a family owned agro-industrial group. The company erected state-of-the-art, climate-controlled greenhouses on 45 acres of land in the New River Valley Commerce Park to grow quality greenhouse-grown, non-GMO, pesticide-free vegetables.







# Bright Farms, Culpeper, VA



**VIRGINIA IS  
FOR  
(LETTUCE)  
LOVERS!**

Our farm in Culpeper County, Virginia services stores in the Greater Washington D.C., Baltimore and Northern Virginia area. At 150,000 square feet, this greenhouse produces one million pounds of produce per year.



-  SELINGSGROVE, PENNSYLVANIA
-  WILMINGTON, OHIO
-  ROCHELLE, ILLINOIS
-  CULPEPER, VIRGINIA
-  HENDERSONVILLE, NORTH CAROLINA
-  LOUDON, NEW HAMPSHIRE
-  VIRTUAL TOUR

SUNNY BACON CRUNCH KIT™ | CHICKPEA CAESAR CRUNCH KIT™ | SUNNY CRUNCH® | BABY SPINACH | SPRING MIX  
BABY BUTTER | BUTTER CRISP® | HARVEST CRUNCH® | 50/50 SPRING AND SPINACH | BABY ROMAINE |  
MIGHTY ROMAINE® | NUTRIGREENS® | BASIL





# BrightFarms Virtual Field Trip



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# BrightFarms Virtual Field Trip



Copy link









**Conveyor belt**



**Harvest machine**





## BrightFarms recalls packaged salad greens as FDA points to firm as likely source of Salmonella outbreak

By News Desk on July 16, 2021

### Summer of 2021

- A total of 31 people infected with the outbreak strain of Salmonella Typhimurium were reported from 4 states (WI, IL, MI, PA).
  - 4 hospitalizations
  - 0 deaths
- On July 15, 2021, BrightFarms recalled packaged salad greens produced in its Rochelle, Illinois greenhouse farm sold in (IL, IA, IN, WI, MI).

# CEA Grown Leafy Greens – *Salmonella* Typhimurium

## Outbreak Investigation Report (January 2022)



### FDA Issues Report Highlighting *Salmonella* Outbreak in Packaged Leafy Greens Produced in a Controlled Environment Agriculture Operation

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#### Constituent Updates

January 14, 2022

The U.S. Food and Drug Administration (FDA) has released a [report on its investigation of the \*Salmonella\* Typhimurium outbreak](#) that caused 31 reported illnesses and four hospitalizations in the U.S. between June and August 2021. The FDA worked with the U.S. Centers for Disease Control and Prevention (CDC) and state partners to [investigate the outbreak](#), which was linked through epidemiology and traceback to packaged salad greens during the summer of 2021. This outbreak is believed to be FDA's first domestic investigation of a foodborne illness outbreak associated with leafy greens grown in a Controlled Environment Agriculture (CEA) operation. The CEA operation produces leafy greens using common commercial high density hydroponic growing techniques with deep water culture and floating raft production methods. The report released today includes an overview of the traceback investigation, investigation results, and various factors that potentially contributed to the contamination of packaged leafy greens with *Salmonella*.

<https://www.fda.gov/food/outbreaks-foodborne-illness/factors-potentially-contributing-contamination-packaged-leafy-greens-implicated-outbreak-salmonella>

# Key Findings

- A conclusive root cause was not identified.
- General sanitation practices were inadequate.
  - Nutrient-rich growth media used in production rafts in an outdoor location that was not adequately protected from animal intrusion, bird droppings, or water runoff.
- Stormwater retention basin adjacent to the CEA farm cause for concern.
  - Sample collected here had genetic match to the outbreak strain.
- Growing pond water is not routinely treated, disinfected or changed out.
- Lettuce leaves that contacted production pond water were not eliminated from harvest and post-harvest production.
  - No control to consistently exclude harvesting of leaves that may have come into contact with the pond water.
- Condensate accumulated on the overhead chiller lines and dripped onto product located near growing ponds.

# Positives Associated with CEA

- Reduced footprint. Fraction of the overall size/acreage of a traditional farm.
- Can produce crops year-round, regardless of geographical location.
- Less spoilage, pest infestation.
- Protected from severe weather events.
- Less deforestation and land use. This means less erosion and less flooding.
- Abandoned or unused properties can be used productively.
- Controlled ventilation, irrigation and fertigation.
- Reduced pollution.
- Increased traceability.

# Concerns Associated with CEA

- Raw materials and inputs used may be potential sources and routes of contamination.
    - Coco coir, rock wool, soil, seeds, etc.
  - Is the water safe and of adequate sanitary quality for its intended use?
  - Effective rapid cooling and cold holding of harvested leafy greens after harvest.
    - Verify the effectiveness of the cooling and cold holding procedures.
  - Is cooling for food safety or for product quality?
  - Condensation forming on ceiling, equipment.
    - Roof leaks, bird feces, storm damage
  - Employee health and hygiene during the harvesting process.
- 
- LEDs and have a short shelf life and premium price point.
  - The industry is extremely vulnerable to increases in electricity prices.
    - Around 25 percent of their operational costs are for electricity

# Regulatory Oversight

- Mixed type facility?
  - Produce Safety Rule (21 CFR 112)
  - Will need both 112 and 117 inspection?
  - Can both inspections be done by same Program? Same Agency? Need for MOU?
  - See Field Bulletin #67 and #69
- Will the facility need to register with FDA as a food facility?
- Produce is typically packaged and labeled
  - 112 does not address packaging and labeling
  - Does Program have adequate regulatory authority?
- Other CFRs or FD&C Act?
  - Misbranding and Adulteration
  - 112 only covers pathogens
  - What about chemical, physical and radiological concerns?

# Additional Resources

- NECAFS Produce Safety in hydroponic and aquaponic operations

[https://www.uvm.edu/extension/necafs/ponic\\_resources](https://www.uvm.edu/extension/necafs/ponic_resources)

- Cleaning and sanitizing (pdf)
- Fish health and handling (pdf)
- Harvest and post harvest handling (pdf)
- Personal health and hygiene (pdf)
- Wildlife and domesticated animals (pdf)

