

Introduction to CEA, common crops, systems, and market trends



Cornell CALS

College of Agriculture and Life Sciences



CIFS CORNELL INSTITUTE
FOR FOOD SYSTEMS



NY farm viability

INSTITUTE



Cornell University
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Broome County

What is Controlled Environment Agriculture?

An innovative method of growing plants that involves creating optimized aerial and root zone environments, focusing on production benefits such as:

- *high plant quality*
- *predictable crop timing*
- *consistently available quantity, and limited environmental impact*

High Tunnels Modified Environment Agriculture



Controlled Environment Agriculture



Plant Factories / Vertical Farms

Brightbox
Venlo, Netherlands

Research Vertical Farm



It's Control!

- Environmental control
 - Temperature (air temperature)
 - Light
 - Carbon dioxide
 - Relative humidity
- Hydroponic/soilless growing system
- Automated processes
 - Seeding
 - Transplanting
 - Packaging



Why CEA?

- Fresh, high-quality produce, free of pesticides
- Locally grown
- Year-round
- Consistent, reproducible
- Water – *can* be 20 times more efficient than field production
- Space efficient
 - Ex: Lettuce 20-50x field production

Market for locally grown

- National market demand for “local food” has expanded from \$1 billion to \$7 billion in the last 9 years
- Consumer demand and sales for locally-sourced vegetables at Whole Foods have doubled since 2012

Status Quo New York State

	lbs per capita	% produced out of state
Lettuce ¹	12	93%
Spinach ¹	2.4	95%
Strawberries ²	4	93%
Tomatoes (fresh) ¹	18	95%

¹Peters et al., 2002

²Peters et al. 2003

Average Food Miles NYS

Lettuce	2,953
Spinach	2,897
Strawberries	2,742
Tomatoes (fresh)	2,026

¹Albright and de Villiers, 2008



U.S. Food Crops Grown Under Protection

Crop	Production (tons)	Hydroponic production (tons)	Value (\$million)
Total	260,966	165,557	796
Cucumbers	36,310	33,101	78
Herbs (cut fresh)	17,761	3,811	71
Lettuce	10,965	7,719	56
Peppers	3,851		6
Strawberries	353		1
Tomatoes	96,265	82,797	401
Other	95,461	36,791	184

U.S. Food Crops Grown Under Protection

Year	Number of Operations	Sales in U.S. Dollars (millions)
1998	1015	\$223
2009	1476	\$553
2014	2521	\$797

Production acres greenhouse vegetables

	Canada	USA	Mexico
Tomato	432	408	1,951
Cucumber	282	105	330
Pepper	296	61	550
Total	1,010	574	2,831

CEA Crops and Systems

- Leafy greens/herbs
 - Lettuce, kale, pak choi, baby leaf greens, basil, microgreens
 - Systems
 - Deep water culture (raft/pond)
 - Nutrient film technique (channels)
- Vine crops
 - Tomatoes, cucumbers, pepper, egg plant
 - Systems:
 - Rockwool or coconut coir slabs
 - Bato buckets / Dutch buckets (with perlite/expanded clay)
 - Bag culture (with potting mix)

Deep water culture



Seedlings in Rockwool/Oasis



Seedlings transplanted

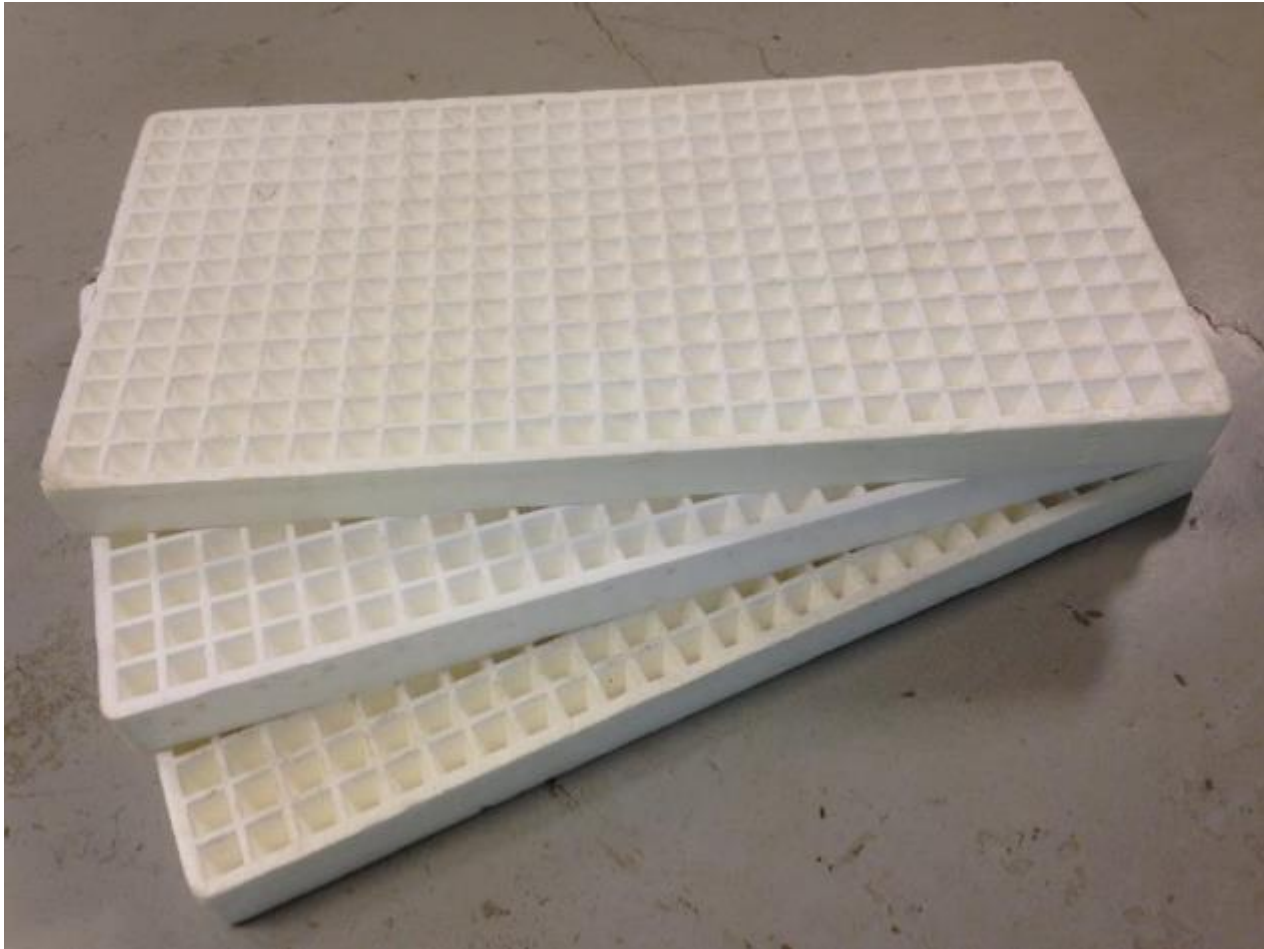


Baby leaf greens in pond



Speedling Trays

336 cells (13 x 26), 13.625" x 26.625" x 1.75"
= 2.5 square feet





Nutrient Film Technique



Hybrid system containers with substrate in gutters



High Wire Production

- Wire supports the vine
- Gutter height of greenhouse 18-21 ft (6-7 m)
- Drip irrigation
- Rockwool/Coir slabs
 - Small roots for large plant, frequent irrigation
- Plants growing in tall canopy sometimes >10 feet
- Double row system



Address
11-KM P.O. Box

RZ 72-528
Kanavaro



Grotop

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Rockwool slabs





Dutch buckets
aka Bato buckets



High wire cucumbers





Eggplant



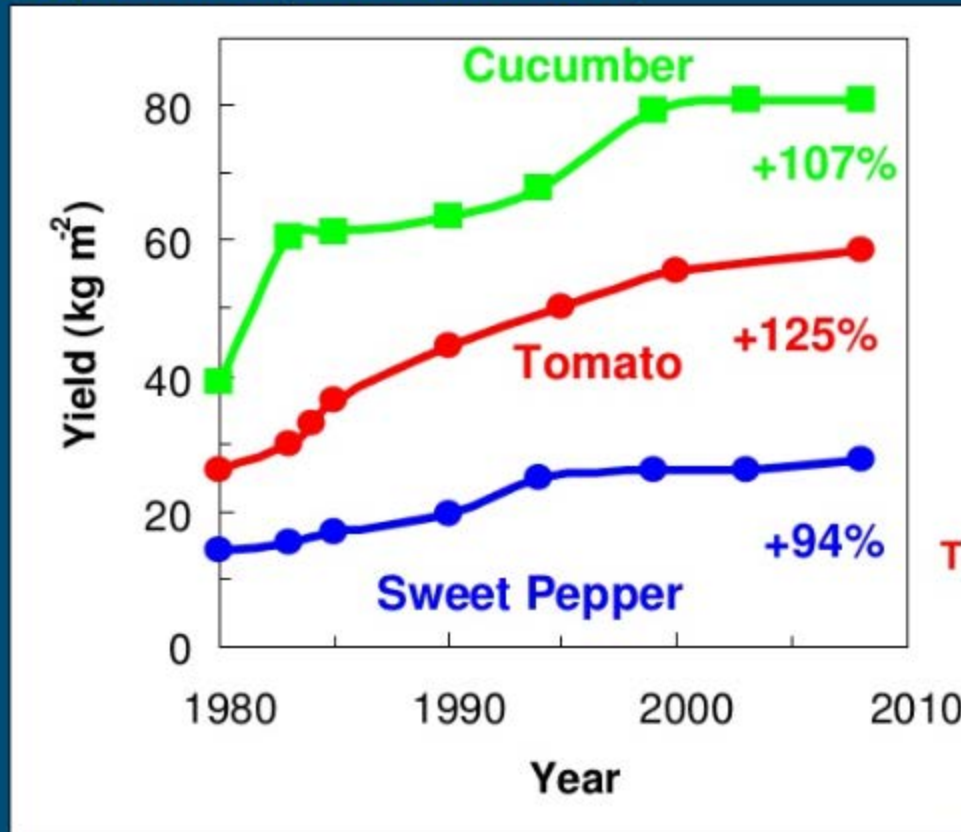


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Pollinators required:
tomatoes, peppers, eggplant

Yield development (Netherlands)



Tomato in Morocco

- Dutch greenhouse yields
- Source: Ep Heuvelink, 2009

Yield in CEA

(when everything is going well!)

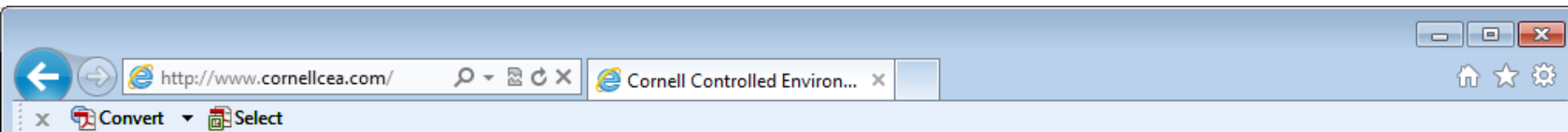
Crop	lbs / square ft / yr	lbs / acre / yr
Lettuce	23	1,000,000
Cucumber	16	697,000
Tomato	12	523,000
Sweet pepper	6	261,000

Example 1 acre CEA Lettuce*

Construction cost	\$1-2 Million
Annual electricity cost	\$125,000
Employment	7
Yield	up to 1 million pounds
Gross revenue	\$1-3 million



*CEA Technology is scalable to any size farm



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Cornell Controlled Environment Agriculture

Controlled Environment Agriculture or CEA facilities can range from the very low-tech such as row covers and high/low plastic covered tunnels, to fully automated glass greenhouses with computer controls. There have even been some CEA facilities on the international space station where astronauts have grown leafy greens both to eat and to advance scientific knowledge. The Cornell CEA program has worked with many different types of CEA facilities through the years. We developed a greenhouse hydroponic production method geared toward local food production. A prototype facility was built in Ithaca in the late 1990's and continues to function today producing more than 1000 heads of lettuce every day of the year. We continue to do research in the areas of supplemental lighting and commercial hydroponic vegetable production. [Learn more about the CEA.](#)

Aquaculture presentation: [.pptx](#) | [.pdf](#)

Thinking About Starting Your Own Company?

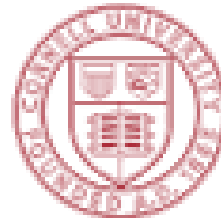
How indoor ag is a boon to foodies

The infographic below was co-created by Cornell greenhouse horticulture specialist [Neil Mattson](#), for the October 2015 Indoor Ag-Con NY conference, where he was one of the conference's featured speakers. [Download printable .pdf.](#)



Thank You!

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