Establishing New York as a Leader in Local, Year-Round Vegetable Production

Julie L Stafford, PhD
Dept. of Food Science
Cornell Institute for Food Systems
Economic Outlook, January 24, 2017
Team Acknowledgements

Neil Mattson    Lou Albright     Miguel Gomez

Tessa Pocock
Irin Nishi, Rachel Joseph
Charles Hage

Advisory Board Committee Chairs:
Joseph Berman, Keith Sernick
Tim Madden, Wil Hemker
George Slilaty
William Vogelgesang
Overview

• Demand for Local Food

• Year-round: Controlled Environment Agriculture

• Cornell CEA & NYS Industry: Collaborative Efforts to Grow a Market Sector
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

• *Locally grown* - top produce trend for 2015 – National Restaurant Association
## Status Quo NYS

<table>
<thead>
<tr>
<th></th>
<th>Lbs per capita</th>
<th>% produced out of state</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce(^1)</td>
<td>12</td>
<td>93%</td>
</tr>
<tr>
<td>Spinach(^1)</td>
<td>2.4</td>
<td>95%</td>
</tr>
<tr>
<td>Strawberries(^2)</td>
<td>4</td>
<td>93%</td>
</tr>
<tr>
<td>Tomatoes (fresh)(^1)</td>
<td>18</td>
<td>95%</td>
</tr>
</tbody>
</table>

\(^1\)Peters et al., 2002  
\(^2\)Peters et al. 2003
## Average Food Miles NYS

<table>
<thead>
<tr>
<th>Produce</th>
<th>Miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lettuce</td>
<td>2,953</td>
</tr>
<tr>
<td>Spinach</td>
<td>2,897</td>
</tr>
<tr>
<td>Strawberries</td>
<td>2,742</td>
</tr>
<tr>
<td>Tomatoes (fresh)</td>
<td>2,026</td>
</tr>
</tbody>
</table>

¹ Albright and de Villiers, 2008
NYS Aspiration: To Become the Food Capital of the East Coast

New York will do this by making smart, strategic investments in agriculture, plant sciences, food processing and added value innovation.
Controlled Environment Agriculture
Definition of Controlled Environment Agriculture

“CEA is 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.”

Lou Albright, Professor Emeritus, Biological and Environmental Engineering, Cornell University, April 2015
Why CEA?

• Fresh, high-quality produce, free of pesticides
• Locally grown
• Year-round
• Water – *can* be 20 times more efficient than field production
• Space efficient
Production intensity ...

Production capacity is 1245 heads/day\(^1\) (more than 70 heads/ft\(^2\)-year)

\(^1\)6400 sf production area Albright and Langhans
Most Common Hydroponic Crops

- Tomato
- Lettuce
- Cucumber
- Pepper
- Herbs (basil, dill, cilantro, parsley, chives)
- Leafy greens (arugula, bak choi, kale, swiss chard, spinach)
- Niche crops: edible flowers, micro greens
New York State Greenhouse Vegetables

NYS ranks 2\textsuperscript{nd} in U.S. for greenhouse vegetables

\begin{tabular}{lcc}
\textbf{Production Operations} & 2007 & 2012 \\
\hline
Wholesale Value (millions) & 17.7 & 27.4 \\
Acres of greenhouses & 69 & 114 \\
\end{tabular}

Growth in greenhouse vegetables, 54\% increase in value in 5 years

USDA NASS, Census of Agriculture
Why isn’t there more CEA in NYS?

1. Securing **financing** for capital intensive business with low margins
2. Availability of skilled and unskilled **labor**
3. Need processing and marketing infrastructure (**food hubs**)
4. Relatively expensive **electricity**
Challenges Even After Success

• Site selection (utilities, wetland, light, transportation...)

• Approval process at the local level

• Finding well-trained staff
Cornell CEA & NYS Industry: Collaborative Efforts to Grow a Market Sector

2014 - 2016

Mr. Charles Hage
“Chuck”

100 Stakeholders
New York State CEA Growers and Suppliers

Grower
1. Stonebridge Farms - Gansvoort
2. Gartham Greens LLC - Brooklyn
3. BrightFarms Inc. - New York
4. Bubon Farms - Hilton
5. Paul's Nursery - Fulton
6. Shuhan Valley Hydro Farm - Shuhan
7. Intergrow - Albion
8. Floral Beauty Greenhouses - Elmsford
9. Kupper Cross - Cattaraugus
10. Hygrow - Boonville

Supplier
1. Baeruk Farms - Long Island City
2. MVH Contracting - Evans Mills
3. ECO Convergence - Cohoes
Formation of Committees

- Capital
- Policy
- Education
- R&D

Growing the Market
Committee Goals

Capital
- Educate the financial markets on and stimulate demand for debt and equity investment opportunities
- Establish financing sources (banks, other debt providers, equity sources) for CEA projects of all sizes —family farmers to multi-site organizations

Policy
- Develop a state CEA industry trade association, which includes all segments of the industry
- Provide a nexus for collaboration and to advocate for the industry statewide

Education
- Establish CEA Certificate and Associate Degree programs
- Establish a CEA Masters Degree program at Cornell

R&D
- Create a market & technology-driven CEA model by applying innovative research in markets, products, processes & related technologies
- Identify market opportunities, establish partnerships among cross-disciplinary scientists, commercialize products
Industry Activities

- Gotham Greens
- Intergrow
- Pure Spinach
- CEA Fresh Farms
- Indoor Organic Gardens of Poughkeepsie
Gotham Greens in Queens, 2016

- 60,000 sf, largest of their 4 facilities
- $1 Million in NYSERDA funding for energy efficient technologies
- ESD Excelsior Jobs Program Tax Credits
• Established in 1998
• Main facility located just south of Lake Ontario in Albion, NY
• Year-round, locally-grown with lights
• Total of 70 acres of greenhouse under glass in New York - 45 acres of tov’s, 3 acres cherry tomatoes and 22 acres of beefsteaks
Opportunities – Funding - Incentives

• Strong Dollar
• Hydro infrastructure in Canada is limited (for now)
• Year round “local” supply is in demand
• Greenhouse sector is growing

• Local Bank
• State: Job Development Authority (JDA) direct loan program
• Equity

• Empire State Development (ESD) --> Tax incentives based on job creation and retention
• NYSERDA
  - New construction
  - Process efficiency (>kg/< energy)
  - Energy efficiency (energy curtains)
• Local Utility
  - Capital investment
  - Utility infrastructure
Pure Spinach

**PureSpinach. History**

1. **Identified Problem & Gap in Market**
   - Lack of tasty, locally sourced fresh spinach available year-round.

2. **Evaluate Consumer Response to Idea**
   - To uncover consumer behavioral insights in order to shape our strategy, we conducted: in-depth interviews, surveys, and a blind taste test.
   - At the same time, we were testing the growing process at a research scale.

3. **Developed Value Proposition & Marketing Strategy**
   - Value and strategy were shaped based on the following findings: quality/benefits of product are more important than the method of production; taste/texture are associated to benefits consumers care about; benefit claims coupled together have a stronger impact on end user.

4. **Pitched Business Plan to Advisors & Potential Stakeholders**
   - Business plan was presented to mentors, advisors, professors, farm owners, and potential investors.
Pure Spinach

**PureSpinach. Current State**

**PRODUCTION**
- Recruited 10 Cornell students to work part-time in greenhouse.
- Growing at a commercial scale (weekly seeding & harvesting).
- Automating certain processes of seeding and harvesting.

**MARKETING & BRANDING**
- Finalized company logo.
- Designed packaging.
- Developing social media presence.
- Gathering consumer feedback (on product and packaging) weekly.

**ADMINISTRATIVE & LEGAL**
- Incorporating under the name of Element Farms, Inc.
- Applying for product liability insurance.
- Request “Good Agricultural Practices” audit and certificate.

**BUSINESS DEVELOPMENT**
- Cultivating relationships with buyers/suppliers.
- Partnering with local retailers.
- Won first-place at “NYC Entrepreneurship Summit” pitch competition.
- Selected to pitch at global competition in Thailand.
# Pure Spinach

## Future Plans

<table>
<thead>
<tr>
<th>Category</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Greenhouse</strong></td>
<td>• Build/lease larger greenhouse closer to NYC.</td>
</tr>
<tr>
<td><strong>Fundraising</strong></td>
<td>• Raise funds from angel investors and VCs.</td>
</tr>
<tr>
<td><strong>Retailers</strong></td>
<td>• Sign-on larger supermarkets (nationwide retail chains).</td>
</tr>
</tbody>
</table>
| **Team** | • Recruit engineers and horticulturists.  
           • Expand team to include sales force. |
| **Technology** | • Design the PureSpinach control box.  
                  • Sell the control box to greenhouse operators. |
CEA Fresh Farms

Strategic Growth-Partnership & Alliance
High-Impact Growth Opportunities

CEA’s Indoor Farms will be strategically located in three regions, reaching nearly 200 million consumers:

1. Improving yield efficiency
   The world population, of which 10% remain undernourished, is rapidly growing, thereby creating severe urgency to increase yields.

2. Increasing supply chain efficiency
   Reducing the average value chain loss of 33% of initial production is a substantially stronger lever in increasing effective output than upfront yield improvement.

3. Decreasing complexity along farmers’ value chain
   Since today’s farmer already faces high complexity and tomorrow’s farmer will deal with even more players and technologies after the disruption, farmers/customers are willing to invest/partner for integrated solutions and ecosystems.

To accelerate the growth, meet the future market demands and tackle the stated challenges, Public-Private Partnerships are essential to incentivized this young industry with the heavy up-front infrastructure costs; sourcing capital from large strategic food companies, institutional equity, foundations and financial intermediaries are needed to jump-start this segment of Agriculture.

Source: Monitor Deloitte Research

185 million US Consumers Eastern United States
15-20 million Canadian Consumers
Large Up-Front Capital-Long-Term Benefits

The confirmed large market opportunity; available technology and labor; awareness & acceptance – consumers who value food which is fresher, safer, tastier, environmentally friendly, nutritious and local are key underpinnings to CEA’s investment thesis. Older-line food companies are seeing significant market share erosion and are re-inventing and investing in their businesses or buying younger companies who have a commercially scaled and innovative solution. Capital formation remains the most challenging for Indoor Ag.

A key differentiated component of CEA’s strategy is to capitalize on key partnerships (public and private), alliances, and a seasoned team committed to growing the business. The proposed 20+ acre build is a 18-24-month process to bring online, fully operational and growing in year three with 35%+ operating margins, with total debt reduction in 5-6 years, delivering strong returns.

Scaling the company into the main-stream market as the first mover with superior capital efficiency and lowest cost unit economics, while building long-term relationships with key customers, will create a defensible franchise and further provide long-term benefits to stakeholders by creating an estimated Billion dollars in enterprise value in five years with more than 100 acres under CEA operations.
New York State Leadership, Innovation & Management = Economic Development-Jobs

- **Substantial Growth in Fresh Indoor Food Production**: 500+ acres & more - 7-10 yrs.
- Operating Efficiencies with Commercially-Scaled Indoor Operations compared to Vertical, Warehouse or Container Facilities.
- “Best in Class Technology” **Proven & Energy Efficient; Environmentally Sustainable.**
- Geographically Scalable restoring “displaced manufacturing and production jobs” in Upstate New York with several thousand sustainable year-around. (Direct-Indirect)
- Large Market Opportunities: Leafy Greens $4+ Billion Eastern US plus other crops
- Leveraging Public/Private Partnerships, Education, Research and AgTech Innovation
- Customer and Consumer Demand-Pull will Drive Market Growth seeking Locally-Grown, Food Safety, Freshness, High Nutrition & Transparency in Future Food.

Team members have designed, built and operated several indoor grow facilities of 1-3 acres in size, and one facility 10 – 12 acres in size located in the US. Management has over 100+ years of combined experience, including project management expertise, to successfully oversee the installation and operations in New York and Georgia with CEA’s strategic partners. The company’s management experience comes from both privately-held and large publicly-traded companies with P & L responsibility, providing the foundation of knowledge and expertise to scale and operate a growing business.
Indoor Organic Gardens of Poughkeepsie

Indoor urban farming community project:
• Utilizes unoccupied building space
• Employs Veterans and Youth
• Provides fresh, nutritionally rich, locally-grown produce for
  – Restaurants
  – Retail Stores
  – Schools
  – Hospitals
  – Assisted Living Facilities
Indoor Organic Gardens of Poughkeepsie

• “Breakout Market”: Nutritional density of microgreen stage of plants

• Current Signature Project: “Healthy Cities & Counties”
  – To determine if nutritional units can be formatted that will be ingested, digested and absorbed by Youth and Seniors
  – Collaborating with multiple local agencies

• Working hard to meet demand
Synergistic Research Activities

• Historical Foundation

• Business Tool Development

• GLASE
CEA Research at Cornell

1. Plant growth models
2. Row cover thermal model
3. Greenhouse energy management models
4. Plug production as improved by lighting
5. Light and DLI control, LASSI
6. DLI and CO$_2$ concentration control algorithm
7. Computer-based fault detection
8. Spinach root disease protocols
9. Incorporation of systems approach

1990’s to 2010’s

1. Collaboration with Challenge Industries
2. Banker plant biological control for aphids
3. Light and CO2 control algorithms
4. Growth rate control to prevent lettuce tip burn
5. Carbon footprints of plant factories compared to greenhouses
6. Evaluation of energy from anaerobic digester to run greenhouse
Business Tools to Stimulate Growth of NYS’s Year-round Greenhouse Vegetable Industry

• NYS Dept. of Ag and Markets Specialty Crop Block Grant, 2-year project Dec. 2015-2017

• Spring 2016 – Consumer Willingness to Pay Study
  – Consumers are willing to pay a premium price for local produce (18% for NYS tomato, 19% for NYS lettuce), while production systems do not affect their WTP

• Produce buyers survey

• Business simulation tool to estimate year-round CEA facilities

• At least 10 new CEA vegetable production operations
Greenhouse Lighting and Systems Engineering (GLASE) Advances possible:

- Dynamic greenhouse control of light and CO$_2$
- Efficacy of light delivery
  - Improvements in diode efficiency
  - Better thermal management and optics - direct light where needed
CEA Economic Outlook
Summary

• Momentum around local, year-round produce, with consumers willing to pay a premium

• Capital investment remains a constant challenge – with a mix of resources necessary

• Continued synergy from academia, industry and government will galvanize NYS leadership
Team Acknowledgements

Neil Mattson    Lou Albright     Miguel Gomez
Tessa Pocock
Irin Nishi, Rachel Joseph
Charles Hage

Advisory Board Committee Chairs:
Joseph Berman, Keith Sernick
Tim Madden, Wil Hemker
George Slilaty
William Vogelgesang
Thank You!

- NYS Dept. of Ag and Markets Specialty Crop Block Grant
- NYSERDA
- NYS Empire State Development
- Industry Partners
Thank you!

jls653@cornell.edu