

# Controlled Environment Agriculture: a Technological Suite of Opportunities and Constraints

Richard Rosen, PhD

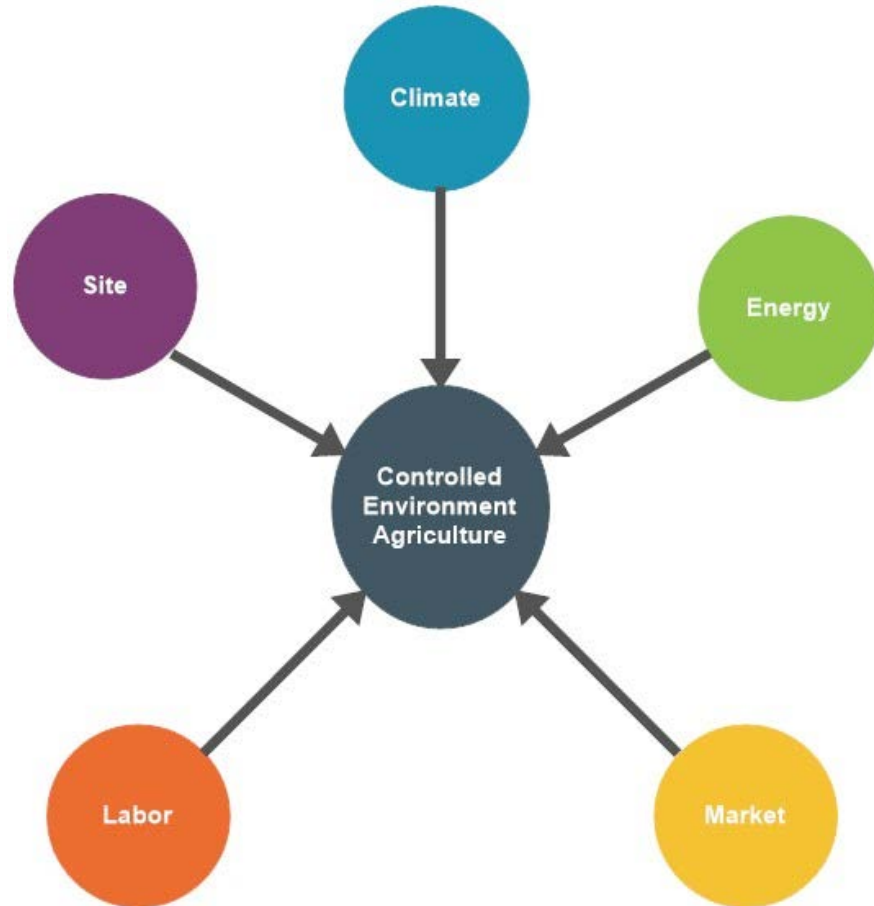
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# Outline

- Crucial factors
- Economic viability
- Intersection of food and energy
- Operational issues
- Upcoming technological innovations
- Labor and leadership



# Crucial Factors for Controlled Environment Agriculture



## Objective Functions

- Revenues per square meter
- EBITDA per square meter
- Kilograms per square meter

# Economic Viability of Controlled Environment Agriculture

	Berlin, NH	$\frac{1}{2}$ Revenues, $\frac{1}{2}$ Labor Cost	$\frac{1}{4}$ Revenues, $\frac{1}{4}$ Labor Cost, $\frac{1}{10}$ Energy Cost	$\frac{1}{4}$ Revenues, $\frac{1}{10}$ Labor Cost, $\frac{1}{2}$ Energy Cost	$\frac{1}{2}$ Revenues, $\frac{1}{10}$ Labor Cost, $\frac{1}{2}$ Energy Cost
Revenue (\$MM)	27.0	13.5	6.7	6.7	13.5
Labor Cost (\$MM)	6.4	3.2	1.6	0.6	0.6
Energy Cost (\$MM)	2.1	2.1	0.5	1.2	1.2
Agricultural Inputs Cost (\$MM)	6.9	6.9	6.9	6.9	6.9
EBITDA (\$MM)	11.7	1.4	-2.2	-1.9	4.8

# Intersection of Food and Energy

- Role of Combined Heat and Power (CHP)
  - Energy sustainability
  - CO<sub>2</sub> sequestration
- Photon flux density versus BTU requirements



# Operational Issues with State-of-the-Art Greenhouses

Importance of location:

- Light
- Temperature
- Proximity to market
- Site characteristics
  - Terrain
  - Wetlands
  - Geology



# Operational Issues with State-of-the-Art Greenhouses (cont.)

- Labor availability
- Fuel availability
- Disease
- Insects
- Climate control
- Packaging



# Upcoming Technological Innovations

- Photoperiod manipulation
- Disease and insect resistance
- Taste improvement
- Color improvement
- Adjusting ecological responses





# Upcoming Technological Innovations (cont.)

- Multiplying fruiting period
- Adjusting germination rates
- Creation of organic feedstocks
- Automated harvesting



# Labor and Leadership

- Proper compensation of all workers
- Appropriate benefit strategies (i.e. vacations, insurance, child care)
- Commitment through ownership
- Success oriented compensation



# Labor and Leadership (cont.)

- Education and training of all workers
  - Community ecology
  - Safety
  - Personal health
- Requirements for successful general manager
  - Minimum 15 years of experience in greenhouse operations
  - Prior profit/loss responsibility

