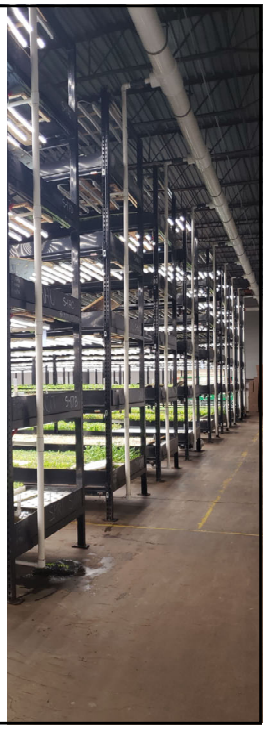
OptimIA

MICHIGAN STATE UNIVERSITY

Indoor farming: Introduction and industry status

Erik Runkle

Dept of Horticulture
Michigan State University



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Greenhouse farming

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Vertical greenhouse farming



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Indoor farming: past and present

- **Not new, but has rapidly expanded in much of the world, especially in the US, in the past 6-8 years**

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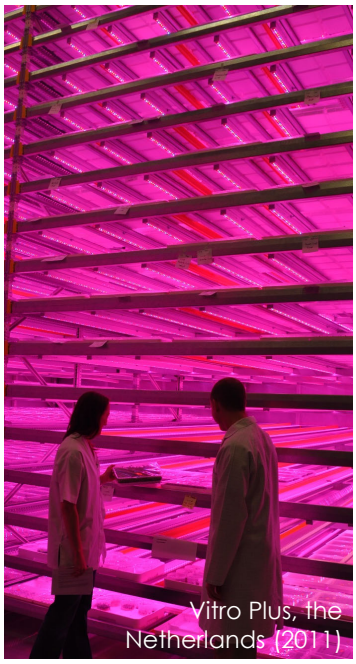
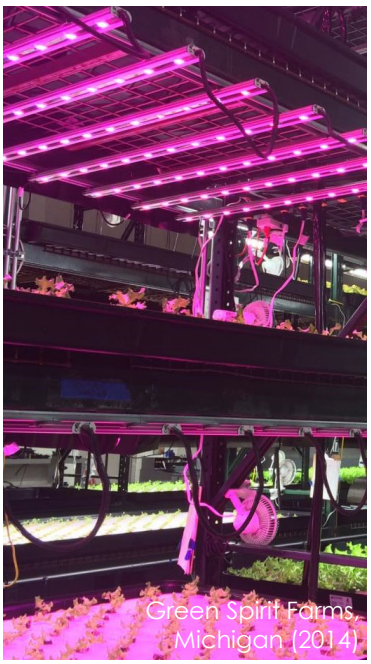
Indoor farming: past and present

- Not new, but has rapidly expanded in much of the world, especially in the US, in the past 6-8 years
- Production primarily of leafy greens and other high-value specialty crops
- Facilitated in part by advances in LED lighting
  - ↑ output and efficacy
  - ↓ cost





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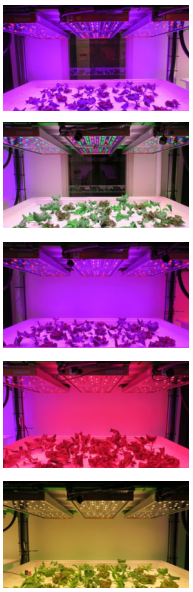
Indoor farming: crops



- Having (nearly) complete control of the environment and culture is expensive (capital and operational expenditures)
- Crops potentially suitable for indoor farming:
  - High value
  - Short production cycle
  - Compact habit
  - High harvest index
  - Year-round demand
  - Added value (more flavorful, nutritious, etc.)
  - Need or premium for consistency/uniformity
  - Production processes can be automated
  - Perishable

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Indoor farming: crops

- Leafy greens (lettuce, kale, arugula, spinach, etc.)
- Microgreens
- Culinary herbs (basil, mint, etc.)
- Cannabis
- Ornamental propagules (tissue culture, plugs, and liners)
- Fruiting crops (strawberry, tomato, etc.)
- Plant-made pharmaceuticals

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Compelling reasons for indoor farming

- Increasing demand for nutritious, locally grown, and pesticide-free food
- Consistent, year-round production not subject to weather conditions
- Substantially less use of water and fertilizer, and usually no pesticides
- Potential to produce more nutrient-dense, fresh, and flavorful vegetables and fruits
- Substantially greater yields and more efficient use of land

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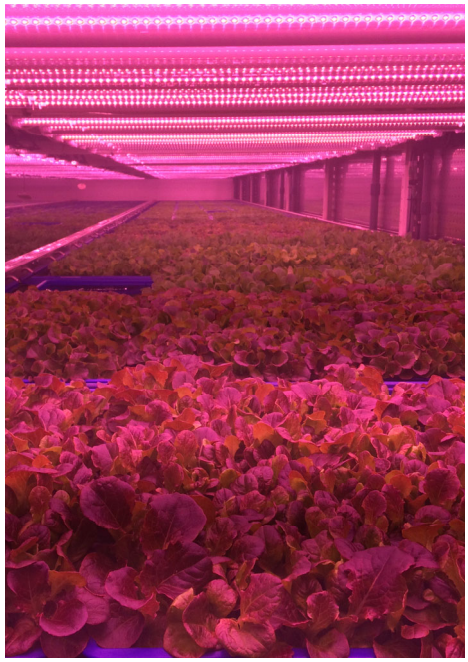
Compelling reasons for indoor farming

- Food security, especially in countries that have little land suitable for field production, scarce water resources, etc. (e.g., UAE, Kuwait, Singapore)
- Insufficient availability of labor
- #1 food trend in 2022 for Whole Foods: Ultraurban farming



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Types of indoor farms

Small farms primarily for restaurants and consumers

AeroGarden

Farmshelf

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Types of indoor farms

Small companies dedicated to the production of a large variety and/or niche crops, primarily serve one local/regional area

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Types of indoor farms

Small companies dedicated to the production of a large variety and/or niche crops, primarily serve one local/regional area

Large companies that produce relatively few products, sell primarily to grocery stores and food service companies

Photo: Aerofarms

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Indoor farming statistics

- **Much of the information available on the indoor farming sector is speculative**
- **Significant investments (tens to hundreds of millions $) are being made in companies, especially in the US**

f'fth season

80 ACRES FARMS

AEROFARMS

Plenty

KALERA

SQUARE ROOTS

BOWERY

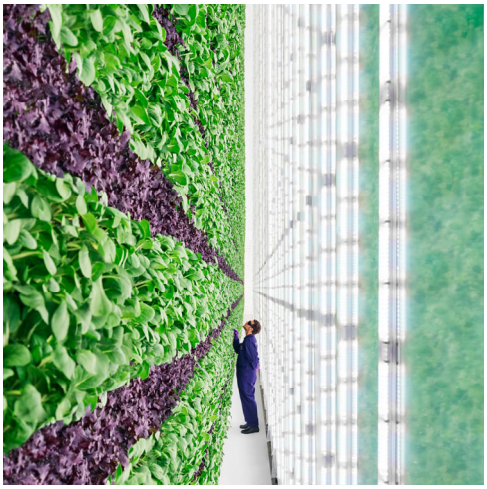

Photo: Plenty

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Major challenges of indoor farming

Economics

- **Development of the facility**
- **Labor**
- **Electricity**

Environmental optimization of growth

- **Maximize harvestable yield**
  - **Considering time, space, and input costs**
- **Quality attributes such as color, texture, flavor, nutrition, and shelf life**

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Vertical farming considerations

Environment

- Temperature
- Lighting
- CO_2 enrichment
- Humidity
- Wind speed
- Postharvest

Business

- Marketing
- Shrinkage
- Profitability

Crops and culture

- Crop(s): species/cultivar/age
- Growing/irrigation method
- Nutrition/pH management
- Pests (algae, insects, and pathogens)
- Pollination (fruiting crops)
- Food safety
- Labor and automation
- Harvesting/Packaging

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For questions, please contact Erik Runkle: runkleer@msu.edu

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