The 21st Century Farm
Illinois Institute of Technology
Chicago, IL

Professor: Blake Davis
Sponsor: John Edel & Kristin Ostberg of The Plant, LLC

Team Members:

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Frank Lockom
Michael Schmidt

Ivan Silvestre
Claire Simmonds
Jake Skaggs
Konrad Sobon
Philip Speroff
Ralitza Todorova
Travis Valmores
Alexander Wiff
Where does Chicago get fresh produce in January?
• California - 2,200 miles

• Arizona - 1,800 miles

• Chile – 5,300 miles
Wouldn’t it be nice to have...

• Fresh local produce all winter

• Local growing season extended 3 months

• Zero waste farming
Indoor Farming

- Controlled Environment
- No Chemical Treatment
- Fresher, Healthier Product
- Local Economic Boost
- Aid Regional Agriculture Stability
The Plant, LLC

• Indoor Farm
  • 100,000 sq. ft.
    3 story building
  3 acres
• 50% farming operation

Our sponsors: John Edel & Kristin Ostberg, Chicago Center for Sustainable Manufacturing
The Team

• 25 students, 4 sub-teams, 8 disciplines

Our Mission:
Make The Plant a Reality

• Agricultural systems
• Computer Control
• Building systems
• Marketing
Agricultural Systems

• Explore growing systems
• Expand prototype
• Introduce fish into Aquaponics system
• Monitor system performance
Aquaponics System

- Light source
- Growing bed
- Fish tank
- O₂
Aquaponics System

Tilapia tank

Growing beds

Chicago High School for Agricultural Sciences
Aeroponics System
Aeroponics System
Drip System
Computer Control Team

• View/change environment variables
• Minimize maintenance of farm
• Gather operational data
• Integrate with building systems
This Semester

• Prototype the control system
  • Lights
  • Air temperature thermostat
  • Water temperature
  • Grow logs
  • Operations database
Progress

Previous Semester

Research similar systems

Architectural layout

Choose implementation platform

This Semester

Implement protocol

Server backend

Embedded system farm automation

GUI

Installation
Building Systems

- Wall construction design
  - Affordable
  - Sustainable
  - Volunteer friendly
- Lighting analysis
- Energy management analysis
Straw Bale Walls

5/8" GYP. BOARD
FIRE PROOF STRAW BALE
VAPOR BARRIER
1" AIR GAP
2X2 WOOD STUD
SLAB ON GRADE
Combined Heat & Power System

- **Water** → Heat Recovery Unit → Steam or Hot Water → Cooling/Heating
- **Fuel** → Engine or Turbine → Generator → Electricity → Building or Facility, Grid
Lighting Systems

Metal Halide

Luxim Plasma

T5 High-Output Fluorescent
Marketing Team

- Double-check and expand the previous semester’s work.
  - Lighting
  - Wholesale information
- Create a business plan for The Plant
  - Examine areas of interest to the sponsor concerning the business plan.
- Determine the cost of the growing systems
Viability Check

- Initial production: 18.5k lbs/year
- Initial construction costs paid in 5 years

Estimated Payback Time

![Graph showing payback time with Projected Revenues, Construction Debt, and their linear approximations over the years 2011 to 2014.](image-url)
Potential Markets

• Chicago Public Schools
  • Require 20% of all served food to be locally grown or produced.

• Restaurants

• Community Supported Agriculture (CSA) farms
Accomplishments

• Completed Aquaponics prototype
• Implemented and installed control system
• Developed wall and lighting systems
• Created marketing plan
The Next Step

• Moving and expanding the prototype into The Plant
• Continue exploring different growing systems
• Increase capabilities of control system
• Comprehensive evaluation of The Plant's existing building systems
• Create complete business model
Questions ?
<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Vendor &amp; Manufacturer Provided Information</th>
<th>Coverage Calculations (per fixture)</th>
<th>Annual Costs</th>
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</thead>
<tbody>
<tr>
<td>T5 HO</td>
<td>54</td>
<td>216</td>
<td>14,400</td>
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<tr>
<td>MH Horizontal</td>
<td>1000</td>
<td>1,075</td>
<td>45,630</td>
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<tr>
<td>MH Horizontal</td>
<td>250</td>
<td>269</td>
<td>8,970</td>
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<tr>
<td>Luxim Plasma</td>
<td>200</td>
<td>266</td>
<td>17,595</td>
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<tr>
<td>MH Horizontal</td>
<td>400</td>
<td>430</td>
<td>15,600</td>
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Straw Bale Cost Estimating

- 7’ x 14’ x (76 bays) = 7448 square feet total area to be insulated (excluding the glazed area)

- Straw Bale Size: 18“ x 14“ x 36” to 24“ x 18“ x 48”

- Therefore, If using the smaller bales (18” x 14” x 36”) horizontally so that it covers an area of 36”(L) x 14”(H) x 18”(D), the area covered by a single bale would be 3.5 square feet and a total of 2128 bales costing approximately $8512 would be needed to cover the total area of the wall surface.

- If we use the smaller bales vertically so that it covers an area of 36”(L) x 18”(H) x 14” (D), the area covered by a single bale would be 4.5 square feet and a total of 1655 bales costing approximately $6620 would be needed to cover the total area of the wall surface.

- If using the larger bales (24” x 18” x 48”) horizontally so that it covers an area of 48”(L) x 18”(H) x 24”(D), the area covered by a single bale would be 6 square feet and a total of 1242 bales costing approximately $4965 would be needed to cover the total area of the wall surface.
Jeans Insulation
## Production Assumptions

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<tr>
<th></th>
<th>lbs/sf/yr</th>
<th>$/lb</th>
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<tbody>
<tr>
<td>Non-Mushroom Crops (Retail)</td>
<td>2.27</td>
<td>$4.04</td>
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<tr>
<td>Non-Mushroom Crops (Wholesale)</td>
<td>2.27</td>
<td>$1.86</td>
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<tr>
<td>Mushrooms (Wholesale)</td>
<td>10.95</td>
<td>$4.17</td>
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<tr>
<td>Tilapia (Restaurant)</td>
<td>1.4</td>
<td>$7.39</td>
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</table>
Production/Distribution Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
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</thead>
<tbody>
<tr>
<td># of Bays</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>Sqft. of Growing Beds</td>
<td>4320</td>
<td>4320</td>
<td>4320</td>
<td>5040</td>
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<tr>
<td>Pounds of Product</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-Non-Mushroom Crops (Retail)</td>
<td>6374</td>
<td>6374</td>
<td>6374</td>
<td>6864</td>
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<tr>
<td>-Non-Mushroom (Wholesale) Crops</td>
<td>2452</td>
<td>2452</td>
<td>2452</td>
<td>3432</td>
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<tr>
<td>-Mushrooms (Wholesale)</td>
<td>4730</td>
<td>4730</td>
<td>4730</td>
<td>5519</td>
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<tr>
<td># of Fish</td>
<td>4899</td>
<td>4899</td>
<td>4899</td>
<td>5715.36</td>
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# Farm Operating Projections

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of Bays</strong></td>
<td>30</td>
<td>30</td>
<td>35</td>
<td>35</td>
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<tr>
<td><strong>Gross Potential Revenue</strong></td>
<td>$79,430.63</td>
<td>$79,430.63</td>
<td>$92,669.07</td>
<td>$91,422.02</td>
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<tr>
<td><strong>Shrinkage Loss(%)</strong></td>
<td>25.00%</td>
<td>23.00%</td>
<td>21.00%</td>
<td>19.00%</td>
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<tr>
<td><strong>Effective Gross Revenue</strong></td>
<td>$59,572.97</td>
<td>$61,161.59</td>
<td>$73,208.56</td>
<td>$74,051.84</td>
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<tr>
<td><strong>Cost of Operations</strong></td>
<td>$53,688.00</td>
<td>$53,688.00</td>
<td>$60,636.00</td>
<td>$63,478.40</td>
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<tr>
<td><strong>-Initial Buildout</strong></td>
<td>$64,493.19</td>
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<td></td>
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<tr>
<td><strong>-Buildout on Farm Revenues</strong></td>
<td></td>
<td>$10,147.01</td>
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<tr>
<td><strong>Total Farm Operating Revenue</strong></td>
<td>$5,884.97</td>
<td>$13,358.56</td>
<td>$15,784.12</td>
<td>$26,357.56</td>
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