# CENTER OF EXCELLENCE FOR INDOOR AGRICULTURE

# -FEASIBILITY STUDY ASSESSMENT-




Prepared by:

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## ACKNOWLEDGEMENTS

This analysis of a Center of Excellence For Indoor Agriculture: A Feasibility Assessment was carried out by the Barisoft Consulting Group (BCG) on behalf of Kennett Township (PA), New Garden Township (PA) and Kennett Square Borough (PA).

This assessment involved intensive data collection from July 1, 2017 to February 1, 2018. Data collection came in the form of in-depth interviews with key stakeholders including local and regional government officials, university administrators, mushroom farmers, vertical farmers, investors, suppliers, and consultants, as well as consumers and hobbyists. Data were also collected using an online survey developed by BCG that was filled out by over sixty invitees representing the key stakeholders noted above.

The assessment team was hired under an agreement approved by the Kennett Township's Board of Supervisors. We express our sincere thanks to them and to Lisa Moore, the township manager of Kennett Township, for their unwavering support for the project:

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- Whitney Hoffman, Supervisor, Kennett Township
- Richard Leff, Supervisor, Kennett Township
- Lisa Moore, Township Supervisor

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# GLOSSARY OF TERMS AND ABBREVIATIONS

| Term | Description |
|---|---|
| **Aeroponics** | The process of growing plants in an air or mist environment without the use of soil. |
| **Aquaponics** | The method of growing crops and fish together in a re-circulating system. |
| **BCG** | Barisoft Consulting Group |
| **Carbon Footprint** | A measure of the impact human activities have on the environment, and in particular climate change. It relates to the amount of green- house gases produced through burning fossil fuels for electricity, heating and transportation etc. |
| **CEA** | Controlled Environment Agriculture (CEA). See Indoor Agriculture. |
| **COE** | Center of Excellence |
| **Food Desert** | Geographic areas within a community with limited access to healthy, reasonably priced food |
| **Hydroponics** | A method of growing plants using mineral nutrient solutions, in water, without soil. |
| **IP** | Intellectual Property (IP) |
| **Indoor Agriculture** | Means of growing plants in a controlled indoor environment ranging from high-tech greenhouse structures to indoor vertical farms. Considered a form of CEA. |
| **Indoor Farm** | See indoor Agriculture and Vertical Farm |
| **RCB Analysis** | Risk-Cost-Benefit Analysis |
| **Rockwool** | Inorganic substrate used to grow plants in water. |
| **Sustainability** | Relating to or being a method of harvesting or using a resource so that the resource is not depleted or permanently damaged. |
| **SWOT** | Strategic planning method used to examine the Strengths, Weaknesses, Opportunities and Threats (SWOT) of a specific project or design. |
| **SOAR** | Strategic planning method used to examine Strengths, Opportunities, Aspirations, and Results (SOAR) of a specific project or design. |
| **Vertical Farm** | Growing system, usually indoors, that stacks growing channels several feet high to maximize plants per square foot. Vertical grow towers may also be used. See also VFARM. |
| **VFARM** | Vertical Farm. A concept that argues that it is economically and environmentally viable to cultivate plant on vertically inclined surfaces |
| **ZFARM** | Zero acreage farm and another term for VFARM |
| | |

## PROJECT SPONSORS

**Secondary Sponsor**

**Primary Sponsor**

**Secondary Sponsor**

## CONTRIBUTORS

Here is a partial list of organizations that contributed to our study by sharing their insights via our online survey, face to face discussions and through interviews. We are truly grateful for their participation.

- *Lincoln University*
- *University of Delaware*
- *Penn State*
- *DelVal University*
- *U. of Arizona*
- *Longwood Gardens*
- *Southmill Farms*
- *Pietro Industries*
- *Phillips Mushrooms*
- *Organic Mushrooms*
- *Oakshire Mushrooms*
- *Vertical Harvest*
- *TMACC*
- *CropKing*
- *Urban Crop Solutions*
- *Autogrow*
- *Pegasus Agriculture*
- *Independence LED*
- *Bright Agrotech*
- *Plenty*
- *Cultivated Power*
- *Agritecture Consulting*
- *Overbrook Center*
- *Economy League*
- *Smartyields*
- *Hort Americas*
- *Fluence Bioengineering*
- *Indoor Farms of America*
- *GrowFlux*
- *FutureBright*
- *Buona Foods*
- *Solar Cities*
- *Suncore*
- *Sanabio*
- *BoxCar Central*
- *Agrilyst.com*
- *Envirotech Cultivation*
- *Intag Systems*
- *Chester County Economic Development Council (CCEDC)*
- *Senate of PA*
- *PA House of Representatives*
- *Chester Water Authority*
- *USDA*
- *Route 1 Economic Development Initiative*
- *City of Philadelphia*
- *PA Dept of Ag*
- *Historic Kennett Square*

***Figure 1: Map of the Chester County Region***

## ABSTRACT

The purpose of this assessment is to provide our sponsors and other indoor agriculture stakeholders with information regarding the feasibility of setting up a Center of Excellence for Indoor Agriculture. The benefits expected to result from the center include but are not limited to:

- Serving as an international hub for indoor agriculture training, R&D, investment, and advocacy;
- Serving as a knowledge base for the industry with the cooperation with universities and schools in the area and across the country;
- Promoting diversification of the mushroom industry into other high value crops;
- Promoting economic development in the region in which it is situated.

What distinguishes this study from others is the amount of primary data that we have collected; i.e., this is not simply another "white paper," but an assessment grounded in over 35 hours of interviews with multiple stakeholders, over 60 high quality survey responses from key stakeholders, data collected at indoor agriculture conferences and meetings, and an analysis of scores of reports, documents and peer-reviewed studies.

Our findings and conclusions are summarized below.

*Agricultural Trends*

- Trends in population, migration, energy use, water use, availability of arable land, costs to grow food and climate change all point to future disruptions of our food supply resulting in price spikes and scarcity.
- Despite advances in plant genetics, agricultural technologies and farming methods, open field farming is reaching its limits, esp. in the production of fruits and vegetables. Open field farming also contributes to the release of pesticides into the eco-system, depletion of fresh water sources, and nitrogen loading of waterways.

*Advantages of Indoor Farms*

- Indoor farming has emerged as a viable alternative because of advances in lighting

technologies, substrates, growing systems, environmental controls, robotics and other forms of automation. Over half a billion dollars of venture capital has been invested in indoor agriculture in the past several years.

- Vegetables grown indoors under controlled conditions offer the promise of a consistent supply of *post-organic* and pesticide-free food, free of the disruptions of climate change and price fluctuations. Furthermore, production can be located closer to population areas, thus reducing transportation and distribution costs, as well as carbon emissions.
- Indoor growers can charge premium prices for produce that effectively competes with organics, the fastest growing segment in foods.

*Economics of Indoor Farms*

- There are several different types of indoor growing systems and technologies.
- Capital costs of indoor systems range from $55/ft2 to up to $400 per ft2 for a 15-tier farm (a.k.a. “plant factory”).
- The chief operating costs are energy (e.g., lighting, HVAC) and labor.
- Indoor farm yields can be up to 100 times as much as compared to open field farms.
- Current total costs to produce plants indoors range from about $1.00/plant for basil and about $1.33/plant for lettuce according to our analysis.
- A vertical acre can grow from $5-40 million dollars of product per year.
- Products from indoor farms need to be priced comparable to organics to be profitable.
- Gross margins on products from vertical farms can range from 11-57%.
- Once total costs to deliver a plant drop below $1.00/plant will indoor farming effectively compete with conventionally-grown produce.
- In our estimation, indoor vertical farms are attractive investment opportunities for steady and consistent growth but by no means are expected to be unicorns.
- Improvements in lighting, automation and climates control combined with decreases in farm input prices will improve the attractiveness of the industry further to investors and farmers.

*Feasibility of Centers of Excellence*

- The concept of a Center of Excellence is powerful and has good currency.
- Centers of Excellence (COE) can be found in many industries and organizations.
- Several COE's exist in agriculture. At present there are no COE's for indoor farming.
- According to our COE model, by focusing on industry leadership, innovation and learning, markets and industry structures, business operations, financial management, technology and sustainability, it can be a potent force for change and advancement.
- Indoor agriculture is by our assessment in the early stages of its development. A Center of Excellence for Indoor Ag can therefore have a huge impact on the evolution of the industry and can help to accelerate its development.
- Our respondents strongly agree that this an ideal time (nearly 4.5/5) to set up a COE for indoor farming.

*Industry Analysis and Feasibility*

- Competition in the indoor farming industry is low-moderate according our primary data and the application of Porter's Competitive Strategy model.
- Buyers have the most power given the numerous market outlets for fresh vegetables.
- Suppliers have low-modest power, with the most power being held by substrate providers. There is considerable competition in the lighting and data analytic sectors, which is favorable to indoor growers.
- The basis for competition is differentiation and value-based rather than low cost. Indoor growers can compete at organic level prices but not compete head on with conventional growers from CA, Mexico, and parts of South America at the present.
- The relatively high capital costs pose a barrier to new entrants. Given the nascent nature of the industry, the knowledge base for the industry is in flux, thus also serving as a barrier to entry.
- There are minimal substitution effects, although "artificial" food grown in laboratories may pose a threat in the next 5-10 years.

*Market Analysis and Feasibility*

- The market prospects for indoor farming are positive.
- Given that the total market for fresh vegetables is on the order of $14 billion per year, we conservatively estimate the market for indoor agriculture to grow to about $3 billion within five years given the state of current technology and other factors.
- Based on our survey and other data, we estimate 20-30% market growth per year.
- Our respondents ranked the top four target customers as: U.S. Consumers (4.4), specialty markets (4.3), restaurants (4.2), and supermarkets (4.0). We interpret this result to suggest that indoor farms plan to sell directly to US consumers through specialty markets and supermarkets.
- Specialty markets are likely to appeal to consumers who favor *local produce* vs. shoppers of larger supermarkets, which would sell brands from any part of the country.
- Selling to restaurants makes sense, esp. to higher end "farm to table" establishments that laud the benefits of organics, locally produced, or pesticide-free foods. This result also is supported by the fact that Americans continue to eat out in greater numbers.
- Large institutional buyers such as school, hospitals, and government agencies are also key target customers.

*Regional Assessment*

- Our assessment shows a good match between the proposed COE and the Philadelphia region, specifically Southern Chester County.
- Among the factors in favor of siting the COE in PA: packaging and distribution infrastructure, on-going indoor agriculture industry in the region, transportation network, historical and cultural fit, local, state and community support, available green-tech workforce, proximity to universities and schools, proximate to large costumer markets and the availability of land, capital and intellectual capital (IP).
- Nearly 68% of our respondents agreed that the COE should be sited in PA. New York was a distant second at about 5% followed by CA at 4%.

*COE Preliminary Design Parameters*

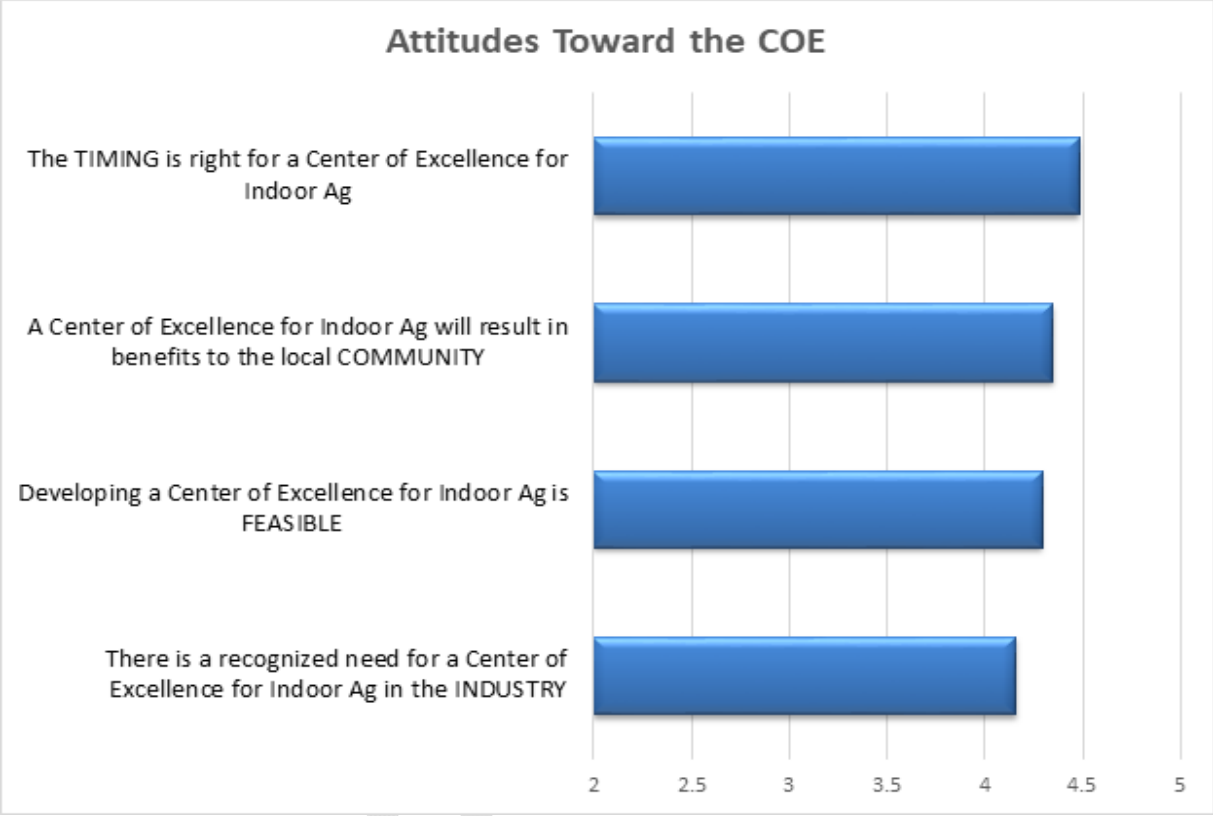
The results of the survey helped us build a preliminary vision for the COE with the following characteristics:

| Design Parameters of COE | Top Value(s) |
|---|---|
| **Functions** | • Workforce training<br>• Applied research<br>• Services to Indoor Ag industry<br>• Lead regional economic development |
| **Services** | • Best practices<br>• Leadership and advocacy<br>• Knowledge base for indoor agriculture |
| **Location** | • Philadelphia region including Chester County (Mushroom Capital) |
| **Clients** | • Indoor farms<br>• Local community<br>• Universities<br>• CEA suppliers, service companies and investors |
| **Structure** | • Public Private partnership |
| **Revenue Sources** | • Grants<br>• Contracted research<br>• Sponsorship fees |
| **Facilities and Technology** | • Testing<br>• Labs<br>• Workspaces |
| **Budget** | • $1-2 million |
| **Potential Partners** | • Netherlands<br>• Japan<br>• China<br>• Canada |

*Overall COE Project Feasibility*

We believe this to a feasible project. Our overall assessment of this project in terms of the application of a Risk-Cost-Benefit (RCB) model is that the benefits clearly outweigh the risks and the costs. Many of the perceived risks are as a consequence of the success in bringing indoor farming to the region and not due to the COE itself. Start-up costs are not a barrier to development, esp. if the effort starts in a bootstrapping mode.

Our respondents agree that the timing and feasibility of the COE are excellent. On a scale of 1-5, we obtained the following results:




*Summary and Next Steps*

In summary, development of a Center of Excellence for Indoor Agriculture is an excellent step for the industry and the region. Siting the COE in the hub of the largest indoor farming operation (e.g., mushrooms) in the world makes sense for several reasons. If built, we envision the COE playing a pivotal role in helping to bring green indoor farming from its relative infancy to maturity as it grows and develops over the next 5-10 years.

The next step in the project management process is to engage in a design study followed by an implementation plan to actualize the vision for the COE. We also see related opportunities to invite green indoor farm companies to build demonstration facilities in the region in which the COE is located, which would synergize with the COE and is mission.