

Center of Excellence for Indoor Ag: Feasibility Study Findings

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About the Presenter

- Affiliations**
 - Associate Professor of Business, Penn State
 - Former Director “New Ventures and Entrepreneurship” MBA Program, Penn State
 - CEO, Barisoft Consulting Group
 - Founder and CEO of e3garden, an indoor R&D farm
- Areas of expertise**
 - Entrepreneurship
 - Corporate innovation and strategy
 - Sustainability and social ventures
 - Information Technology
 - Indoor Ag
- Experience**
 - Consultant to business and industry
 - Local leader in town government
 - Councilman (Media, PA 2009-2013)
 - Educator and researcher



Acknowledgements





Report Outline

1. Introduction	2. Project Methodology	3. World Trends Impacting Agriculture
4. Feasibility and Economics of Indoor Farms	5. Feasibility of Centers of Excellence	6. Feasibility of Indoor Ag Industry and Market
7. Regional Feasibility Assessment	8. COE Organizational Feasibility	9. Overall Feasibility Assessment
10. Summary, Conclusions and Next Steps		

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1. Project Context and Justification

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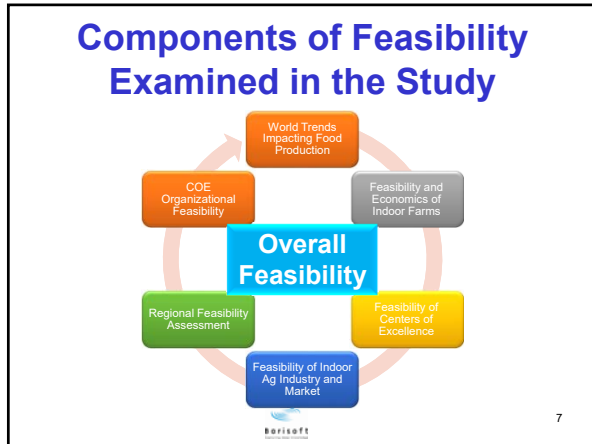
Project Justification

- The Township of Kennett (PA) was interested in fostering regional economic development by positioning itself as national hub for Controlled Environment Agriculture (CEA).
- The purpose of this study was to determine the feasibility of setting up a viable and self-sustaining *Center of Excellence for Controlled Environment Agriculture (CEA)* located in Kennett Township area.
- This study began in July 2017 with the support of Kennett Township
- Kennett Square and New Garden Township joined as sponsors in September 2017

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Feasibility Study Method

- 200+ Stakeholder Register
- Data Collection
 - 35+ hours of interviews
 - 60+ online surveys collected
 - Numerous formal and informal group discussions
 - Conferences on Indoor Ag
 - Analysis of documents, reports, peer reviewed articles and books
- Data Analysis & QA
- Synthesis and Reporting

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Partial List of Contributors to the Project

<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> CropKing Urban Crop Solutions Autogrow Pegasus Agriculture Independence LED Bright Agrotech Plenty Cultivated Power Agriitecture Consulting Overbrook Center Economy League Smartyields 	<ul style="list-style-type: none"> Hort Americas Fluence Bioengineering Indoor Farms of America GrowFlux FutureBright Buona Foods Solar Cities Suncore Sanabio BoxCar Central Agriylst.com Envirotech Cultivation Intag Systems 	<ul style="list-style-type: none"> Chester County Economic Development Council (CEDEC) 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
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3. World Trends Impacting Food Production





Key World Trends Impacting Food Production



Population Growth (3B -> 9B)


- Migration to cities
- Demand for energy
- Demand for food
- Costs to produce food
- Climate disruptions






INPUTS

- Access to Land
- Access to Water
- Supply chain stability




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Conclusions About The Future of Food Production

- We need to be more efficient and sustainable in food production
- We must maximize the use of existing space
- Production can be localized to urban and peri-urban areas
- Growing food without pesticides with less water, energy and resources is becoming a financial necessity
- Technology can help to produce sustainable and resilient food production systems



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4. Feasibility and Economics of Indoor Farms

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Different Forms of Indoor Ag

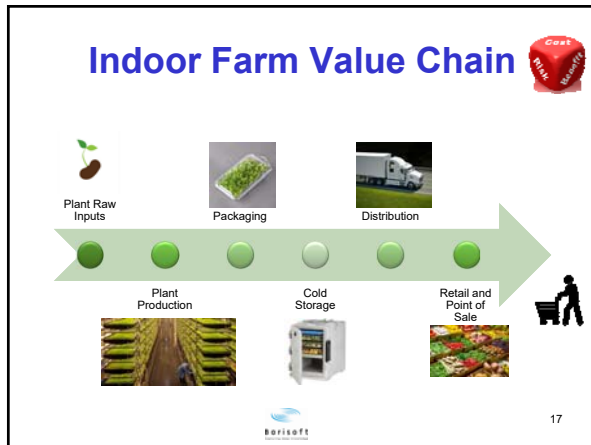


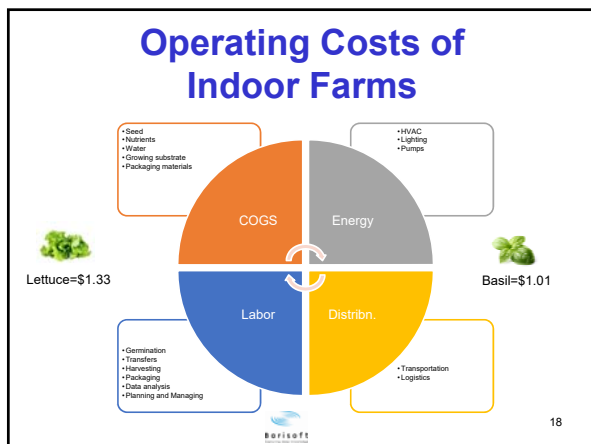
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Benefits of Indoor Farm Production Methods

	Indoor Farm	Vegan Open Field	Organic Open Field	Conventional Open Field
No Pesticides	✓	✓	✓	problem
Uses less water	✓	problem	problem	problem
Resilient to climate changes, drought, etc.	✓	problem	problem	problem
Price stability	✓	problem	problem	problem
Premium Pricing	✓	✓	✓	no
Organic & non-GMO Seed	✓	✓	✓	problem
Vegan Certified	✓	✓	no	no
Grow Media	water	soil	soil	soil
Prevents excess fertilizer run-off into ecosystem	✓	problem	problem	problem


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Indoor Farm Production Yields


	Field Plants per ft2	CEA Plants per ft2 per tier	# of tiers	Total Plants per Vertical ft2	Crop Turns per yr	Annual Total Plants per Vertical ft2	TOTAL PLANTS PER YEAR (1000 ft2)
Basil	2	8.0	5	40.0	9	360	360,000
Mature Lettuce	1.5	2.5	5	12.5	9	112	112,500




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Revenues and Profits of 5-tier One Acre Indoor Farm

	Value \$/v-ft2/yr	Revenues \$/v-acre/yr	Costs \$/v-acre/yr	Profits \$/v-acre/yr	% %
Basil	\$ 839	\$ 36,538,128	\$ 15,838,416	\$ 20,699,712	57%
Lettuce	\$ 168	\$ 7,318,080	\$ 6,488,698	\$ 829,382	11%



Price Basil=\$2.33





Price Lettuce=\$1.50

Conclusions about Economics of Indoor Farms

- Costs**
 - Several types of indoor growing systems and technologies.
 - Capital costs of indoor systems range from \$55/ft2 to \$400 per ft2 for a 15-tier farm (a.k.a. "plant factory").
 - Chief operating costs are energy (e.g., lighting, HVAC) and labor.
 - Current total costs to produce plants indoors range from about \$1.00/plant for basil and about \$1.33/plant for lettuce
- Revenues and Profits**
 - Indoor farm yields up to 100 times compared to open field farms.
 - An 5-tier v-acre generates \$5-40 million in revenues. 11-57% margins.
 - Pricing must be comparable to organics to be profitable.

- Reflections**
 - Once total costs to deliver a plant drop below \$1.00/plant will indoor farming effectively compete with conventionally-grown farm products.
 - 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

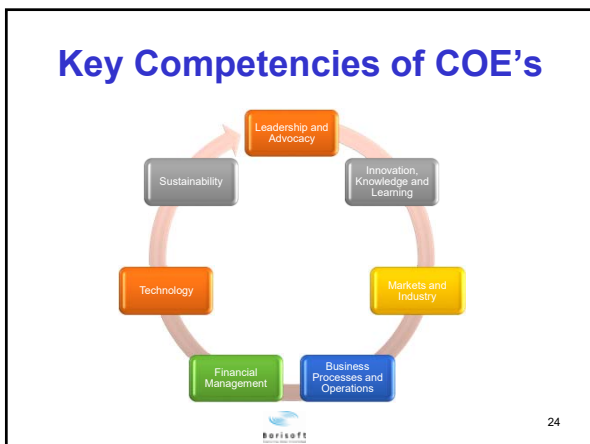
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Centers of Excellence


- Potent force for change and advancement
- Appear in numerous industries such as:
 - Education, research, infrastructure, technology, university partnerships
 - Engineering, manufacturing, computer science, software design, as well as business innovation, agriculture
- Structure and function of a COE based on a feasibility study or design study
- Opportunities for knowledge creation and management, sharing of best practices

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Conclusions About COE

- Several COE's can be found in agriculture areas such as dairy science, plant research, animal care
- Most are research based, not practice oriented
- No COE's exist for indoor ag
 - May be hampering growth of industry
 - Excellent opportunity for organization and region



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6. Feasibility and Analysis of Indoor Ag Industry and Market



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Industry Analysis

Power of Buyers	• Buyers have the most power given the numerous market outlets for fresh vegetables.
Power of Suppliers	• Suppliers have low-moderate 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.
Basis for Competition	• 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.
Barriers to Entry	• 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.
Substitution Effects	• There are minimal substitution effects, although "artificial" food grown in laboratories may pose a threat in the next 5-10 years.
Overall	• Competition in the indoor farming industry is low-moderate according our primary data and the application of Porter's Competitive Strategy model. Return on investment is steady moderate not of unicorn status.

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Analysis of Kennett Area as Site for the COE

Criteria	Evaluation of Kennett Area
Existing infrastructure for packaging, distribution	Has extensive "crop-agnostic" infrastructure for cold storage, packaging, and distribution
Existing Indoor Ag industry and potential for growth and diversification	One hundred year old industry. Grows half of the US production of mushrooms indoors. Growers interested in ways to diversify and benefit from higher margin crops. Outside investors interested in area to site indoor ag facilities.
Transportation network and proximity to rail and ports	Extensive network work of roads and rail in area. Close proximity to major ports including Wilmington, Philadelphia and Baltimore. Proximate to international airports in Philadelphia and Baltimore.
Fit in terms of culture, history of area	Indoor farming has been a mainstay of southern Chester County for over 100 years. Strong agricultural roots.
Local and state government support	Local governments such as Kennett Township, Kennett Square, and New Garden have taken the lead in exploring the COE and the potential for diversification of the mushroom industry.
Greentech workforce	Indoor farming combines agriculture and technology. Region boasts strong presence in technology as well as agriculture, evidenced by school programs and jobs.
Local universities and schools	Greater Philadelphia area boasts one of the highest concentrations of colleges and universities in the country. There is also a strong presence of land grant institutions such as Penn State as well as schools that specialize in farming such as DeVill University.
Proximity to consumer markets	Products from Kennett region can reach a consumer market of over 250 million people within a 24-hour trucking radius.
Availability of land, IP, capital and other resources	Ample amounts of land in region for the COE. Strong investor community in area, including Philadelphia and New York. Expertise in indoor farming available tri-state region.

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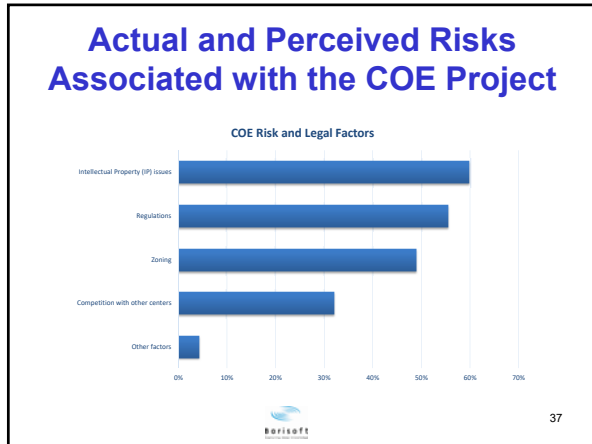


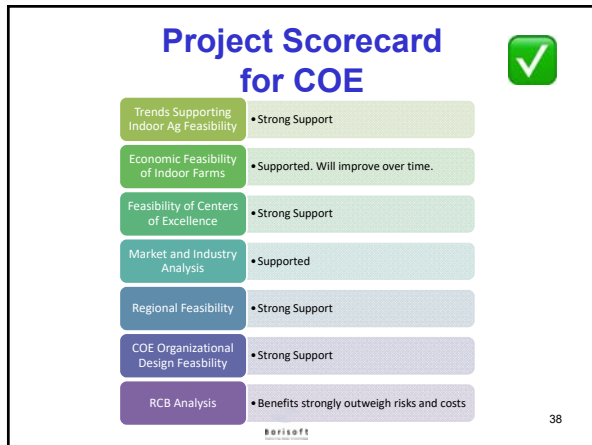
8. COE Organizational Feasibility

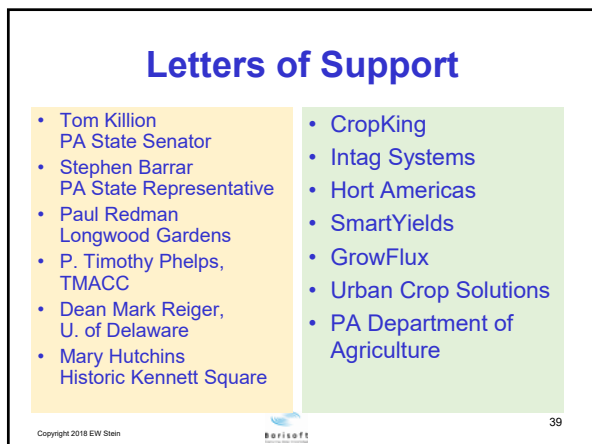
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Preliminary Design of COE Based on Survey and Interviews

Design Parameters of COE	Top Value(s)
Functions	<ul style="list-style-type: none"> Workforce training Applied research Services to Indoor Ag industry Lead regional economic development
Services	<ul style="list-style-type: none"> Best practices Leadership and advocacy Knowledge base for indoor agriculture
Location	<ul style="list-style-type: none"> Philadelphia region including Chester County (Mushroom Capital)
Clients	<ul style="list-style-type: none"> Indoor farms Local community Universities CEA suppliers, service companies and investors
Structure	<ul style="list-style-type: none"> Public/Private partnership
Revenue Sources	<ul style="list-style-type: none"> Grants Contracted research Sponsorship fees
Facilities and Technology	<ul style="list-style-type: none"> Testing Labs Workspaces
Budget	<ul style="list-style-type: none"> \$1-2 million
Potential Partners	<ul style="list-style-type: none"> Netherlands Japan China Canada










10. Summary, Conclusions and Next Steps

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Summary & Conclusions

- COE project is feasible across all dimensions
- Potential to transform and introduce innovation into local mushroom farms
- Potential to transform the green indoor ag industry and to accelerate its growth
- Great potential that COE can support sustainable economic development in region



Plan or be planned for.....

Russell L. Ackoff

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Scope of Current Project

Project Identification	• Pre-Feasibility, Planning of COE
Project Preparation	• Feasibility Study of COE
Project Design	• Design of COE
Project Execution	• Construction of COE
Project Sustainability	• On-going Management of COE

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Next Steps for COE




Communications Strategy

- To create awareness and engagement re the feasibility study and next steps




Design and Implementation Strategy


- Initiate a Design Study of the COE
- Attract COE sponsors and investors
- Prepare for COE project implementation




Economic Development Strategy

- Engage with potential investors and industry partners for demo sites, prototype development, etc.
- Attract companies interested in building full-scale indoor farming facilities
- Attract investors to the region for other projects related to indoor farming
- Match potential partners with mushroom farmers and other related companies


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Discussion



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