

Food and Agricultural Innovation

21st Century Opportunities for Indiana

2012



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EXECUTIVE SUMMARY

In 2004, BioCrossroads embarked on a year-long review of Indiana's agricultural economy and opportunities for growth. The mission of the study, titled *A Strategic Plan for Indiana's Agricultural Economy*, was to examine agriculture-related technologies that could be developed into economic development activities. This narrow focus soon became much wider, at the urging of industry stakeholders and by the absence of an existing statewide agricultural strategy. Before strategic recommendations could be rendered on specific segments of the agricultural economy that had potential for further development and growth, it was clear that a deeper understanding of the entire sector was needed.

The end result of this comprehensive overview was a focus on identifying those industry segments with highest economic potential based primarily on jobs and wage factors. This would allow stakeholders and state officials to select and emphasize those sectors in which Indiana had significant strengths to leverage. BioCrossroads found that five clusters – Wood, Grains, Canning, Pork and Beef, and Baking – accounted for 84 percent of the state's agricultural economy. The report's recommendations, therefore, focused not only on overall industry importance but also specific strategies for these top clusters.

Specifically, the report offered two broad recommendations to defend and benefit the state's entire agricultural economy. These were:

- ◆ Indiana should establish a central authority to drive economic development in the agriculture and agribusiness sectors. This authority should be charged with prioritizing strategies to defend and expand top-supporting clusters and position Indiana to attract investment in future food and agricultural technologies and businesses; and
- ◆ Indiana should designate the top five agricultural clusters (Wood, Grains, Canning, Pork and Beef, and Baking) as immediate priorities for defense and expansion into domestic and global markets.

Almost immediately upon the report's release, the Administration of Governor Mitch Daniels and Lieutenant Governor Becky Skillman made one of their early legislative priorities the establishment of the first ever cabinet-level Indiana State Department of Agriculture (ISDA). This elevated agriculture's placement in the state's economic development dialogue and strategy to a level not held by the industry in decades.

ISDA's responsibilities are to advance Indiana's agricultural economy and be an advocate for the state's farmers and agricultural industry. Recognizing the value and timeliness of the BioCrossroads report, the new ISDA quickly released its own strategic plan for Indiana Agriculture, *Possibilities Unbound: The Plan for 2025*. This involved further comprehensive

research into the industry's past and current market trends and forces. ISDA identified seven strategies to achieve an aggressive vision to make Indiana a "global center for food and agriculture innovation and commercialization."

The strategic priorities included:

- ◆ Increasing the competitiveness of Indiana's high-quality hardwood products;
- ◆ Maximizing Indiana's competitive advantage in bioenergy;
- ◆ Revitalizing pork production (with a goal of doubling it over a 20-year period);
- ◆ Participating in national and global policy issues;
- ◆ Improving regulatory issues involving agriculture;
- ◆ Identifying diversified production models for all Indiana farmers; and
- ◆ Incubating innovative food products that use Indiana agricultural commodities to support nutritious and healthy diets.

While not highlighted in 2004 by BioCrossroads or identified as a broader pursuit of ISDA outside of the food products area, agricultural technology and innovation has a role to play in the successful achievement of all of the earlier identified strategies and the long-term growth of Indiana's food and agricultural industry. Today, perhaps more than ever, agricultural science and technology hold significant potential to solve critical societal challenges and also to generate new business and industry growth. The burgeoning global population and commensurate food demands will tax the agricultural production system in the decades to come. This creates significant demand for new technology applications and further heightens the potential for the sector in Indiana.

Indiana's agricultural production base provides a clear competitive advantage if a strategic emphasis on innovation and technology is pursued. The diverse crop and livestock production base provides inputs for further processing and value added development, resources for research and technology translation, and ultimately a market for the technologies themselves. However, to create an environment conducive for development and commercialization of food and agricultural innovation and technologies, additional elements are also required. This report begins to identify these elements and provides an introduction into a multi-stakeholder conversation about how to advance and grow Indiana's agricultural sector through technology and innovation.

Indiana has a strong foundation of assets and capabilities in the agricultural science and technology sector. Food and agricultural innovation today is as diverse as the industry itself and includes biotechnology, plant science, bioinformatics, information technologies, food science and food safety systems, animal health and nutrition, cropping systems, and satellite technologies, among many others. Companies such as Dow AgroSciences and Elanco, as well as Purdue University, clearly are leaders in agricultural innovation development and research in the state and are well known nationally and around the

world. However, many other businesses and institutions across the state also generate, use, and depend upon new developments, products and services in agricultural technology. The question then remains whether Indiana has all the necessary ingredients to further support, enable and significantly advance Indiana's agricultural economy; and, is it within Indiana's grasp to become a nationally recognized location for technology development and commercialization in the agricultural sector?

BioCrossroads has produced this second study of Indiana's food and agricultural industry to consider these very questions. This effort builds upon the foundation provided in the 2004 study that focused on the leading production and processing clusters in the agricultural economy. Yet, this study goes a step further to explore the industry's science and technology assets and identify opportunities and focus areas that are primed to support and advance Indiana's position as a national leader in agriculture and agricultural innovation.

This study is intended to foster a better understanding of agricultural science and technology as well as further define Indiana's innovation assets that will likely be the basis for growing Indiana's agricultural sector. The study also explores how these assets potentially could be brought together through collaboration or otherwise leveraged collectively or individually to advance the sector and capitalize on emerging opportunities and/or foster areas of technological or scientific strength.

Summary Findings

Indiana is undeniably a national leader in agricultural production of both crops (corn, soybeans, and wheat) and livestock (pork, poultry, and dairy). Agriculture is also an important part of the state economy given that Indiana's diverse production base contributes \$16 billion to the Gross State Product, accounts for over 19 percent of the statewide workforce, and exports \$3.4 billion in product from 62,000 farms and 14.8 million acres. This production base needs to continue to be supported and nurtured, but importantly already offers a strong base of assets and capability from which Indiana's agricultural sector can further build and grow.

A Snapshot of Indiana Food and Agriculture

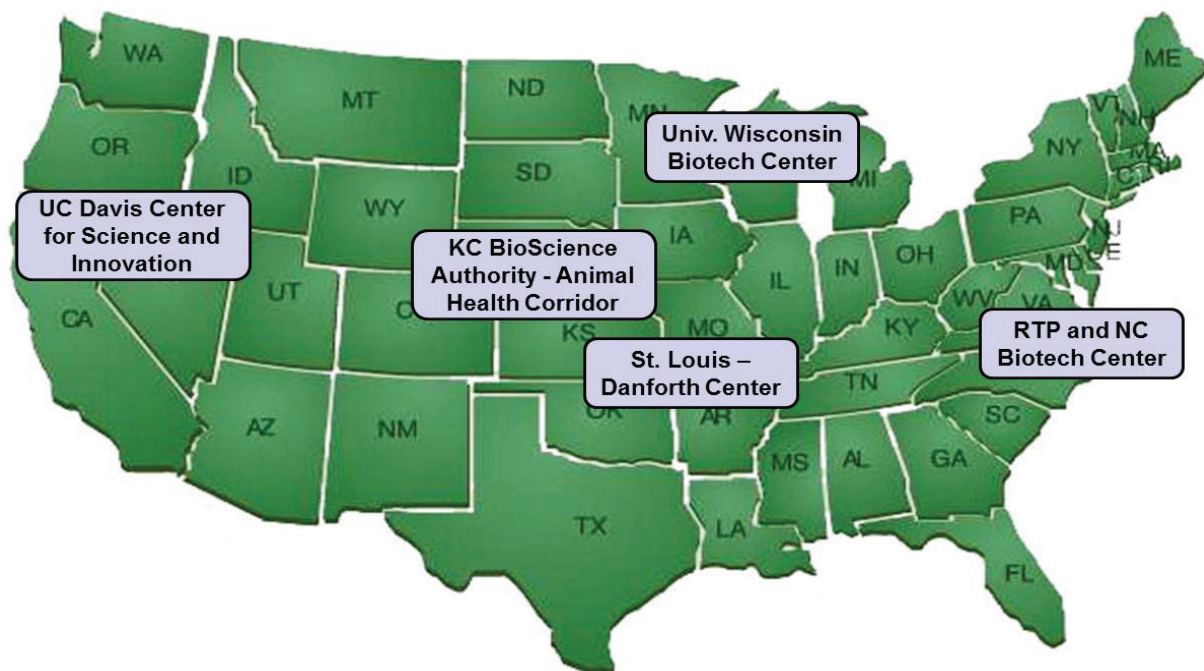
- ◆ \$16 billion of Gross State Product
- ◆ 19% of Hoosier workforce
- ◆ 62,000 farms
- ◆ 14.8 million acres
- ◆ \$3.4 billion in exports

A number of critical macro-level societal issues and challenges exist today. Several global trends have emerged that will challenge Indiana's future success yet also provide great opportunity for increased agricultural production and economic activity. Over the next several decades, agriculture will be challenged to provide food, feed, fiber and fuel to a growing world population. The production increases that are needed also will

have to occur on a limited natural resource base with minimal environmental impact. Changing consumer demands and societal attitudes towards agriculture along with the need to address growing human health and nutrition issues all will require new products, technologies and systems. What is common to each of these trends is the clear role that food and agricultural science and technology research and innovation will play in reshaping the agricultural sector both globally and in the state of Indiana. Indiana is well positioned to capitalize on these global trends, but it will require an expanded focus beyond Indiana's traditional agricultural production base that includes efforts likely aimed at facilitating science and technology investment, collaboration, commercialization, and greater emphasis on workforce development and supportive public policy.

Lessons can be learned from the history, evolution and strategic priorities of each of the regional food and agricultural centers or hubs of innovation around the country, including North Carolina's Research Triangle Park and Biotechnology Center, the Kansas City Animal Health Corridor, and others.

Prominent Agricultural Innovation/Biotechnology Clusters and Centers



These examples provide insight on how other regions with similar food and agricultural innovation assets have analyzed, planned and executed strategies to further expand their research and commercialization activities to spur economic development in their state or region. One common theme in all of the models discussed is the **pursuit of economic activity through a focus on promoting and facilitating science and technology research and commercialization**. Other key observations include:

- ◆ **Existing Basic Science and Research Assets** – Basic science and research helps

spur on scientific innovation that is the essential building block of an increasingly knowledge-based economy like agriculture. The funding models for basic agricultural research have been evolving, and there is increasing pressure for basic research dollars to be spent more productively. As a result, while having basic scientific assets is critical, so is the ability to productively foster collaboration – a key lever for improving the efficiency or yield of the research activity.

- ◆ **Capital and Entrepreneurship** – Having access to capital to drive innovation is critical as is having people with the requisite knowledge, experience, and risk tolerance. Successful models have a strong focus on programs and initiatives that lower financial and personal risk and increase access to capital and promote entrepreneurship.
- ◆ **Technology Translation and Application** – It is often in the marketplace that scientific application continues to occur and is continuously refined leading to additional innovation and competitive advantage. Successful models include programs that better link the marketplace to basic and translational research as well as foster market driven innovation.
- ◆ **Workforce Education and Training** – As agriculture becomes increasingly science- and knowledge-based, agricultural innovation companies require increasingly sophisticated human capital and capacity. As a result, successful models have a strong focus on workforce education and training as well as external talent attraction.
- ◆ **Long Term, Focused Community Engagement** – Community engagement encompasses political leadership, corporate leadership and general community and societal support. Stakeholder engagement is critical, and long-term engagement can typically only be achieved if the efforts are focused around issues and activities that, although perhaps far-reaching in nature, create meaningful long-term value for the stakeholders involved.

The presence of global leaders like Dow AgroSciences, Elanco and Purdue University is critically important to the development of food and agricultural research and innovation in Indiana. The plant biotechnology/biosciences expertise of Dow AgroSciences and the animal health and emerging food safety emphasis of Elanco are recognized around the world. The broad R&D expertise across a number of different Colleges and Centers at Purdue University also is notable. When the state's additional research institutions, research and production agricultural businesses and supporting associations and agencies are layered in, Indiana has perhaps an unparalleled set of resources and capabilities that can be drawn upon to solve the emerging global challenges and drive growth in Indiana's agricultural sector.

It should be noted that there are many other companies not profiled in this report that represent significant capacities in agricultural input (seed, chemical, fertilizer, equipment) suppliers including agricultural cooperatives, production and agronomic technology developers, crop and livestock operations, grain processing and logistics firms, feed mills, livestock integrators, food processing companies, and many others. The question becomes how can all of Indiana's agriculturally related assets be better coordinated and leveraged for mutual and statewide benefit that advances Indiana's position as a global leader in agricultural production and innovation.

Indiana's Food and Agricultural Research and Agribusiness Landscape

PRIMARY STAKEHOLDERS



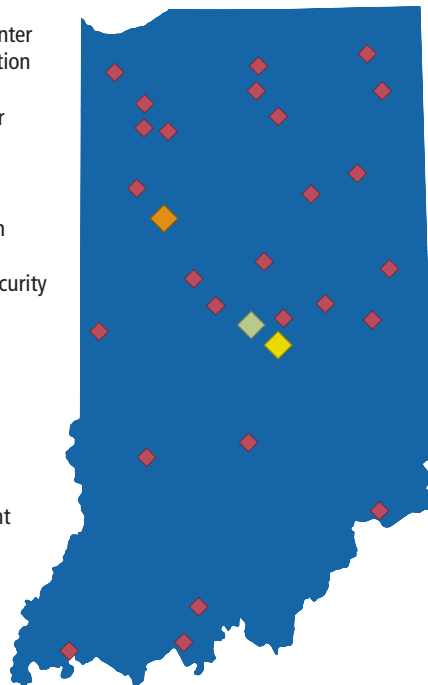
- Crop Diagnostic/Training and Research Center
- Agronomy Center for Research and Education
- Purdue Agricultural Centers
- Animal Science Research/Education Center
- Center for Food & Agricultural Business
- Center for Food Safety and Engineering
- Birk Nanotechnology Center
- Whistler Center for Carbohydrate Research
- Bindley Bioscience Center
- Global Policy Research Institute - Food Security
- Discovery Park
- Innovation and Commercialization Center
- Purdue Research Park System



- Food Animal Research
- Companion Animal Research
- Entrepreneurial, New Product Development



- Crop Protection
- Seed, Traits, Oils
- Pest Management
- Turf/Ornamentals
- Vegetation Management
- Post-harvest Protection



OTHER IMPORTANT AGRIBUSINESS STAKEHOLDERS

- Beck's
- JBS United
- Fair Oaks
- AgReliant Genetics
- Whiteshire Hamroc
- Maple Leaf
- Farbest Foods
- CountryMark
- Remington Seeds
- Weaver Popcorn
- AquaSpy
- Rose Acre Farms
- Bell Aquaculture
- Cook Animal Health
- Red Gold
- Nestlé

OTHER ACADEMIC/RESEARCH INSTITUTIONS



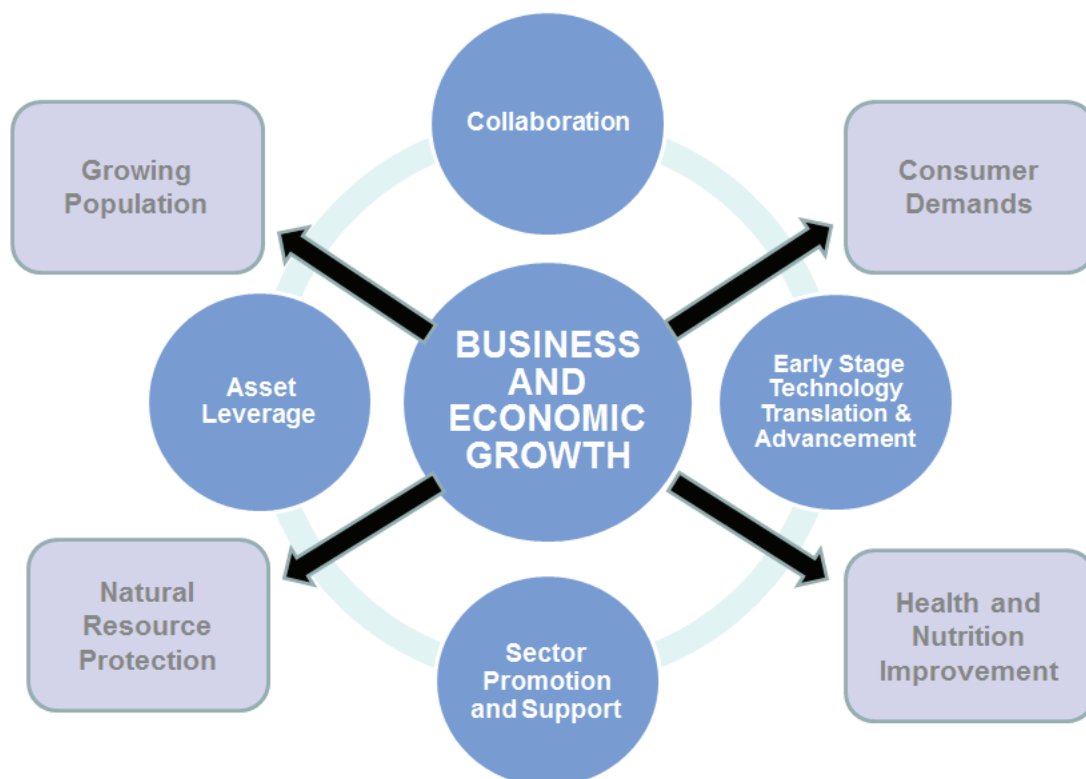
INDUSTRY SUPPORTERS

- IN State Dept. of Agriculture
- IN Agricultural Organizations
- AgriInstitute
- Cultivian - Other Capital Providers
- National FFA

Discussions with stakeholders have helped to identify a roadmap for advancing the food and agricultural sector. To better understand the areas of interest and opportunity for possible broad based stakeholder engagement for further industry collaboration and growth, direct conversations and extensive discussions were conducted with many key agricultural stakeholders. During these conversations, a number of key themes of interest began to emerge, including:

- ◆ **Collaboration** – There was significant interest in business-to-business and public-private engagement leading to potentially collaborative efforts. How can local, regional and even global collaboration be supported and facilitated with Indiana-based organizations?
- ◆ **Early Stage Technology Translation and Advancement** – Innovation occurs globally and is a key driver of economic activity. What can be done to help identify and attract technology and facilitate its commercialization in Indiana?
- ◆ **Sector Promotion and Support** – Collaborations and technology advancement can be encouraged or discouraged based on a number of factors such as public policy, sector branding and promotion, and workforce capability and capacity. How can these factors be promoted, supported, facilitated and/or coordinated to provide the most fertile environment possible for collaboration and technology advancement?
- ◆ **Asset Leverage** – In a number of the stakeholder conversations, a handful of specific potential platforms were identified for further consideration and exploration. Two areas identified for initial exploration are big data analytics and food for health. The attractiveness and potential of these initial platform areas are driven by stakeholder interest, but importantly represent areas of significant existing capabilities.

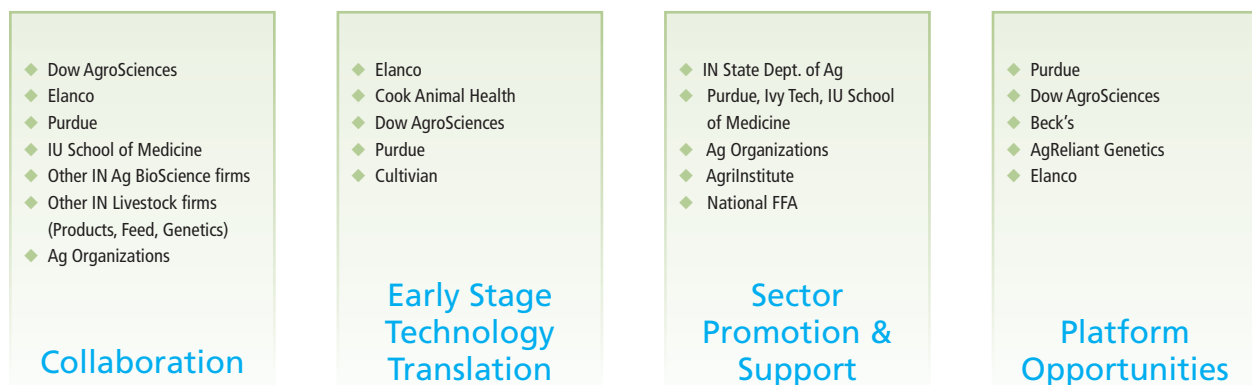
A Roadmap - Collaboration Key to Business and Economic Growth



It is clear the economic vitality of Indiana depends on the continued strength and advancement of the food and agricultural industry. Because of the industry's existing base of innovation and technology and the need for greater productivity improvements to meet increasing global challenges, there are significant opportunities for Indiana to reposition itself as a global leader in agricultural production and technology and science driven innovation through efforts aimed at fostering collaboration, facilitating technology commercialization, promoting the sector, and leveraging assets.

RECOMMENDATIONS

Indiana food and agricultural innovation stakeholders are well positioned for their own business growth and expansion; however, greater coordination and collaboration among the various agricultural leaders could foster more economic development and help to reshape Indiana's agricultural landscape, but it will require greater collective attention and engagement. Already there is considerable engagement by stakeholders in the areas identified on the Roadmap for continued business and economic growth as depicted below, but much of this occurs either independently or with a small number of partners rather than with collective or strategic coordination.



Bringing together key stakeholders from the food and agricultural sector, university and education leaders, and government officials to continue the collective dialogue focused on the prosperity of the industry and state, would be a highly positive development for Indiana. It is critical that this dialogue continue. A forum for facilitating and continuing this collective dialogue is essential and could serve as a platform from which to engage, promote, support, and even advance specific longer-term opportunities for the sector. If properly structured and deployed, an organizing forum could take the lead on further defining the best opportunities for collaboration and continued growth, ultimately leading to greater economic development across the state and for stakeholders individually.

As has been learned from the profiles of other regional food and agricultural innovation centers, these collaborative efforts only work if all stakeholders are actively engaged. Equally important will be energetic participation from a wide range of stakeholders and the recruitment of strong leadership. Financial support and a sustained operating and funding plan must also be developed. This plan would likely require a mix of funding streams including membership support, grants or endowment gifts, and state financial support. Other similar state innovation cluster or center initiatives (including North Carolina and Ohio) receive committed and sustained operating support from state funds because of the critical importance of these efforts to growing the states' economies.

Greater coordination and collaboration among Indiana's agricultural stakeholders is needed in order to capitalize on future business growth and economic development opportunities across the industry. The food and agricultural innovation assets in Indiana (and in the broader Midwestern region) are significant and hold great potential for growing the sector as well as finding solutions to global and societal challenges. An organizing and coordinating vehicle for the state's food and agricultural innovation stakeholders would bring the critical collective attention and engagement needed to leverage existing assets and capabilities and strategically plan for future growth opportunities.

INDIANA'S AGRICULTURAL PRODUCTION BASE – A REVIEW AND UPDATE

In BioCrossroads' first review of Indiana agriculture in 2004, titled *A Strategic Plan for Indiana's Agricultural Economy*, a holistic approach to examine the entire value chain was used rather than separating primary agricultural production from food and agribusiness. BioCrossroads found that five clusters – Wood, Grains, Canning, Pork and Beef, and Baking – accounted for 84 percent of the agricultural economy (represented by the value-added segments of the industry and not including primary farm production) as measured by wages paid (Table I).

TABLE I. INDIANA AGRICULTURAL CLUSTERS

Cluster	Actual Wages Paid – 2003 (mil \$)	% of Total
Wood	1,357	31.4
Grain	795	18.4
Canning	655	15.1
Pork and Beef	441	10.2
Baking	405	9.3
Beverages	234	5.4
Misc.	173	4.0
Dairy	148	3.4
Poultry	119	2.7
TOTAL	4,329	100.0

** These numbers do not include approximately \$1 billion in primary farm production (owner-operator income).*

Major highlights from the report included the identification and examination of several key clusters. For example, the report is broadly credited for recognizing the market size and opportunities of Indiana's hardwood industry. The study noted that 47,000 full-time jobs were in the hardwood products industry and that the hardwood production base was 4.3 million acres (as compared to 1.5 million acres in the early 1900s). Despite competition from China, Indiana has been able to successfully promote many of its unique and highly demanded hardwood species and products in overseas markets.

The identification of the hardwood industry for potential growth even prompted three specific recommendations for further sector development, including the creation of a global branding and marketing strategy, the introduction of advanced manufacturing techniques, and improvements in the production and distribution of quality plant seedlings.

A major weakness cited in the report was the decline of Indiana's food processing industry. In a five year period in the late 1990s, Indiana went from processing and adding value to 80 percent of its food products to just 46 percent. Indiana was still a leader in producing the raw products and agricultural commodities, but these were being shipped to other states, processed and then sold back to Indiana consumers.

Food processing typically takes place either at the point of agriculture production or at the place of food consumption. Therefore, it is not surprising to see most food processing capacity in states like California, Texas, Illinois, Ohio and Pennsylvania (consumption by population) or Georgia, Iowa and Wisconsin (agriculture production). The BioCrossroads report strongly made the case that Indiana could expand its food processing capacity not only because of its agricultural production base but also because one of the nation's most prominent food science departments is housed at Purdue University and the overall business and investment climate in the state is positive.

An examination of these same clusters today – seven years later – would reveal similar findings. While this study does not revisit the original clusters and analytical methodology from the earlier report, it does examine current productivity and income trends for the major agricultural segments and finds that the grain/oilseed and livestock sectors continue to be leading segments in Indiana's agricultural economy. What also has not changed is the recognition that Indiana is a leading agricultural state due to its land base, rich soils, logistics to markets and export terminals, and its research and manufacturing base. Indiana continues to rank high nationally in a wide variety of areas including crop and livestock production but also vegetables, dairy products and other specialty crops. Indiana has sustained its existing agricultural base due in part to strong national and global demand for commodities and to the research and educational capabilities of Purdue University.

Agriculture's Impact on the Economy Today

The remainder of this section reviews the contributions the agricultural economy makes today to the state's overall economy and workforce. It also details some of the prominent production segments or clusters that position Indiana as a national agricultural leader.

Contribution to State Economy. Production agriculture and forestry and fishing services accounted for \$3.8 billion of Indiana's \$267 billion Gross State Product (GSP) in 2010.¹ However, the addition of other related value-added sectors such as lumber and wood products, furniture and fixtures, food and beverage products, textile mill products, paper and related products, grain processing, chemical and equipment manufacturing, etc. contribute an additional \$12 billion to the GSP. While Indiana's GSP is concentrated in manufacturing, retail and service industries, the food and agriculture sector's share is an important and dynamic component of the state economy.

A Snapshot of Indiana Food and Agriculture

- ◆ **\$16 billion of Gross State Product**
- ◆ **19% of Hoosier workforce**
- ◆ **62,000 farms**
- ◆ **14.8 million acres**
- ◆ **\$3.4 billion in exports**

Employment. Farming and other related food and agricultural services also support a large number of jobs throughout the State. In 2010, 679,796 jobs were tied to farm and farm-related businesses in rural communities – over 19 percent of the total 3.5 million workforce.²

Over the last 30 years, the number of farms in Indiana had declined from 87,915 in 1974 to 62,000 farms today. Over this same period, the average size of farms increased from 191 acres to 240 acres over the same period.³ Most recently, the declining trend in farm numbers has begun to reverse with the first modest increases in farm numbers occurring in just the last few years. These farms tend to be small in size with diversified or specialty crop product production, and many are owned and operated by women.

Total cropland (devoted to the major field crops) has held relatively steady at 14.8 million acres. This represents 64 percent of Indiana's total land area of 23.2 million acres.⁴

¹ Gross State Product (GSP) is a measurement of the economic output of a state. It is the sum of all value added by industries within the state and serves as a counterpart to the gross domestic product (GDP). In agriculture, GSP subtracts the amount of production expenses from the total value of production. Gross State Product by Industry for Indiana. Bureau of Economic Analysis, Department of Commerce at <http://www.bea.gov/bea/regional/gsp>. There are a number of different estimates of the food and agricultural industry's contribution to GSP ranging from \$10 to \$25 billion. These differ based on which segments of the sector are included, i.e. wholesale and retail trade, food and beverage service (restaurant sales), etc.

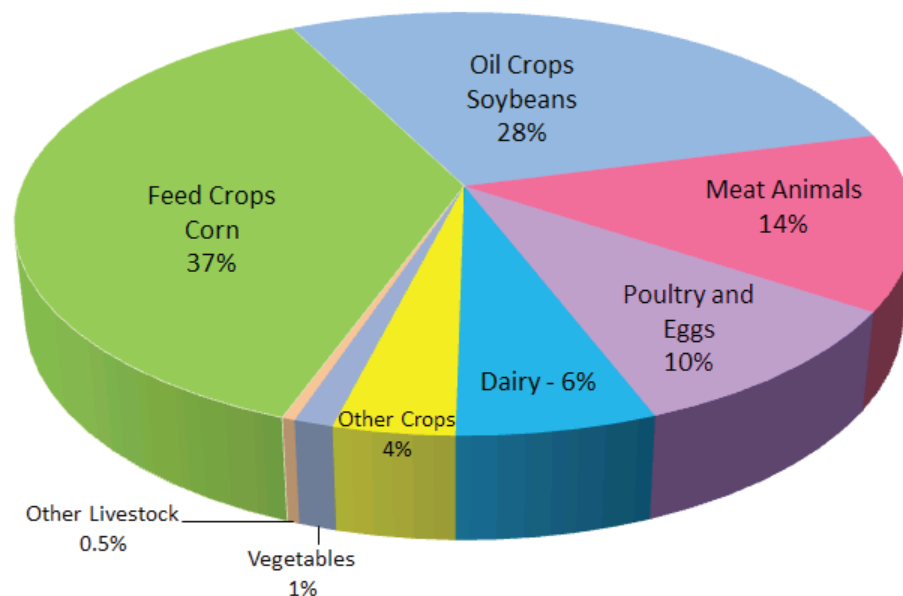
² Indiana FACT SHEET released May 2012. Economic Research Service (ERS)/US Department of Agriculture (USDA).

³ Ibid.

⁴ Ibid.

Financial Health - Cash Receipts and Exports. Indiana's farm sector cash receipts (and resulting income) are variable from year to year depending on current market and price conditions.⁵ Indiana farmers received \$9.59 billion in cash receipts in 2010 putting the state ninth in national rankings for cash receipts from all types of agriculture. Crops accounted for \$6.7 billion (of which \$3.5 billion comes from corn and \$2.7 billion from soybeans) of this total while livestock receipts were \$2.9 billion (Figure II). Meat animals accounted for \$1.3 billion, poultry and eggs for \$938 million, and dairy follows with \$590 million. These five commodity groups accounted for 94 percent of the total 2010 cash receipts.

Figure II – 2010 Indiana Cash Receipts (% of Total – All Crops and Livestock)



An analysis of 2007 figures found that Indiana agriculture has a dramatic ripple effect on local economies. The Indiana State Department of Agriculture reported that for every dollar in direct wages and income from farm, food and forest workers, more than 2.5 times that amount flows into a local economy.⁶

The amount of federal government benefits (in the form of direct production subsidies, conservation funding and crop insurance subsidies) that flow to the sector also varies each year, but has been a diminishing component of income over the last several years as commodity prices have increased. In 1999, government payments accounted for 87% of Indiana agriculture's total net cash income. In 2010, that percentage declined to 13 percent.⁷

⁵ Cash receipts are simply a measure of monthly commodity sales quantities multiplied by USDA published commodity prices.

⁶ "Indiana State Department of Agriculture," National Association of State Departments of Agriculture, www.nasda.org/cms/8769.aspx.

⁷ Farm Income and Costs Briefing Room, ERS/USDA.

In 2010, the nation exported nearly \$108.7 billion of agricultural goods. Indiana alone exported a little more than \$3.4 billion of agricultural goods, or 3.1 percent of the national total. Agricultural products comprise approximately 11 percent of the value of goods that Indiana exports. Since 2000, the value of Indiana's agricultural exports has grown 127.5 percent, exceeding the national growth of 114.1 percent.⁸

Indiana's farmland produces an abundance of corn and soybeans. The Hoosier state is also known for its livestock production, particularly poultry and hogs. The state has several milling facilities that convert crops into more-processed products. More than 90 percent of Indiana's agricultural exports come from just four commodities: soybeans and related products (50 percent), feed grains (23 percent), live animals and meat (11 percent), and poultry and its related products (8 percent).⁹

Segmentation of Indiana's Agricultural Sector

Indiana's food and agriculture sector is highly diverse. Table III below illustrates some of the 2010 national production rankings for the State's leading agricultural sectors.

Table III. Indiana's National Rankings in Key Agricultural Sectors

Ducks	1
Tomatoes for Processing	2
Ice Cream	2
Chickens	3
Spearmint	3
Peppermint	4
Eggs	4
Corn	5
Soybeans	5
Hogs	5
Fresh Market Cantaloupe	5
Fresh Market Watermelon	5
Turkeys	6
Cucumbers for Processing	7
Snap Beans for Processing	8
Blueberries	10

⁸ "Cultivating Trade: The Economic Impacts of Indiana's Agricultural Exports," Indiana Business Research Center, Indiana University, April 2012. <http://www.ibrc.indiana.edu/studies/CultivatingTrade2012.pdf>.

⁹ Ibid.

The following sections provide additional background on several of these segments and their importance to Indiana's food and agricultural sector.

Grains and Oilseeds. Indiana is traditionally known for being among the nation's leading producers of grains (corn, soybeans and wheat). These sectors were identified in the original BioCrossroads report as a significant production sector with an equally critical processing, handling and value added agribusiness sector. Today, the crop production and related industries remain a top agricultural segment.

Indiana farmers planted 5.9 million acres of corn in 2010 with a harvest of 898 million bushels and a market value of \$4.9 billion. An increase in yields over the last decade from 147 bushels/acre to 157 bushels/acre has raised production on a relatively stable acreage base (Table IV).

Table IV. Indiana's Primary Grains Performance

	2000	2010
Corn		
Yield (bu/acre)	147	157
Production (mil bushels)	815.9	898
Soybeans		
Yield (bu/acre)	46	48.5
Production (mil bushels)	259	259

Indiana has significantly increased its production of soybeans over the last few decades. In 1990, planted acreage was 4 million acres and in 2010 it was 5.35 million. Yields, however, have been somewhat volatile in the last ten years which has resulted in relatively unchanged production levels when comparing 2000 and 2010.

Indiana's corn and soybean producers greatly benefit from the State's strong livestock industry and processing plants. Both commodity segments, however, are poised for even greater market growth as continued research and technology development in the areas of biotechnology, alternative energy, food products and nutrition, and bio-based industrial applications occur.

Animal Agriculture. Animal production in Indiana is another strong component of the overall agricultural sector. The value of livestock sales has grown significantly since the 1960s, but has remained relatively flat in recent decades with sales consistently in the range of \$1.7 to \$2.0 billion. The last three years and higher commodity prices, however, have brought significant increases in livestock receipts, reaching \$2.9 billion in 2010. This trend virtually mirrors the growth in the U.S. livestock sector which has increased from

\$20 billion in 1960 to a record \$148 billion in 2010¹⁰. In 2010, Indiana ranked 23rd in the nation based on the value of livestock and poultry products.¹¹

- ◆ **Pork.** Indiana has a long tradition of hog production supported by skilled producers and a strong industry infrastructure. The State's surplus corn and soybean meal production, abundant cropland for distribution of organic animal nutrients and sufficient processing capacity all make Indiana ideally suited for pork industry growth. In 2010, cash receipts from hogs (\$1.02 billion) accounted for 78 percent of total livestock receipts and 11 percent of the total agricultural receipts.¹²

Since 2005, when the Indiana State Department of Agriculture strategically proposed a long-term doubling of Indiana's hog production, there has been quantifiable growth in the industry. In the period between 2005 and 2010, the total number of hogs and pigs on Indiana farms grew from 3.25 million head to 3.65 million. Commercial hog slaughter over that same period also increased from 7.1 million head to 8.6 million.¹³

- ◆ **Poultry.** Although positioned at the bottom of the clusters identified in the 2004 BioCrossroads report, poultry is undeniably an important livestock and product industry to the Indiana agricultural economy. Indiana leads the nation in duck production and also ranks high in chicken and egg production.

About 22 million ducks are raised each year in the United States, and Indiana accounts for nearly three-quarters of that production with over 17 million birds (2010). Indiana poultry farms raised 30.6 million chickens in 2010 (excluding broilers), placing the State third in U.S. production. The hatchery business is another area where Indiana leads the nation. The State ranks 2nd in the production of egg-type chicks. There were 6 billion eggs produced by 23 million laying hens in 2010, placing Indiana fourth nationally (accounting for 7 percent of total U.S. production). Indiana's turkey industry also is growing and had a record production year in 2009 raising 16 million birds, valued at \$349 million.¹⁴

- ◆ **Dairy.** Dairy production is another growth segment in Indiana's livestock complex. In 2000, the state had 145,000 milk cows that produced about 2.2 million pounds of milk. Today, Indiana has about 2,400 milk cow operations with approximately 169,000 milk cows (nearly 16% of the nation's total herd as of January 2010). The State ranks 14th in the United States for milk production with 3.4 billion pounds produced in 2010 valued at \$590 million.¹⁵

¹⁰ ERS/USDA, <http://www.ers.usda.gov/Data/FarmIncome/finfidmu.htm>.

¹¹ National Agricultural Statistics Service/USDA, 2002 Census of Agriculture. Texas ranked 1st with \$10.4 billion in livestock and poultry product sales. Ohio was 21st with \$1.8 billion and Illinois 22nd with \$1.79 billion.

¹² Indiana Agricultural Statistics – 2010-11 Bulletin. U.S. Department of Agriculture, National Agricultural

¹³ Ibid.

¹⁴ Ibid.

¹⁵ Ibid.

Other Specialty Crops. Fruit, vegetable and other specialty crop production in Indiana is very diverse. Some operations specialize in intensive production of high-value crops under cover and some produce large fields of vegetables for processing.

Indiana is home to a productive tomato processing industry – tomatoes rank first in acreage (9,600 acres) and value (\$22 million) among Indiana vegetable crops. Watermelon and cantaloupe production, concentrated in the southwestern part of the State, also are important to the agricultural economy – Indiana ranks fifth nationally for both.

Summary Observations

Indiana is undeniably a national leader in agricultural production of both crops (corn, soybeans, and wheat) and livestock (pork, poultry, and dairy). Agriculture is also an important part of the state economy given that Indiana's diverse production base contributes \$16 billion to the Gross State Product, accounts for over 19 percent of the statewide workforce, and exports \$3.4 billion in product from 62,000 farms and 14.8 million acres. This production base needs to continue to be supported and nurtured, but importantly offers a strong base of assets and capability from which Indiana's agricultural sector can further build and grow.

21st CENTURY GLOBAL CHALLENGES FOR FOOD AND AGRICULTURE

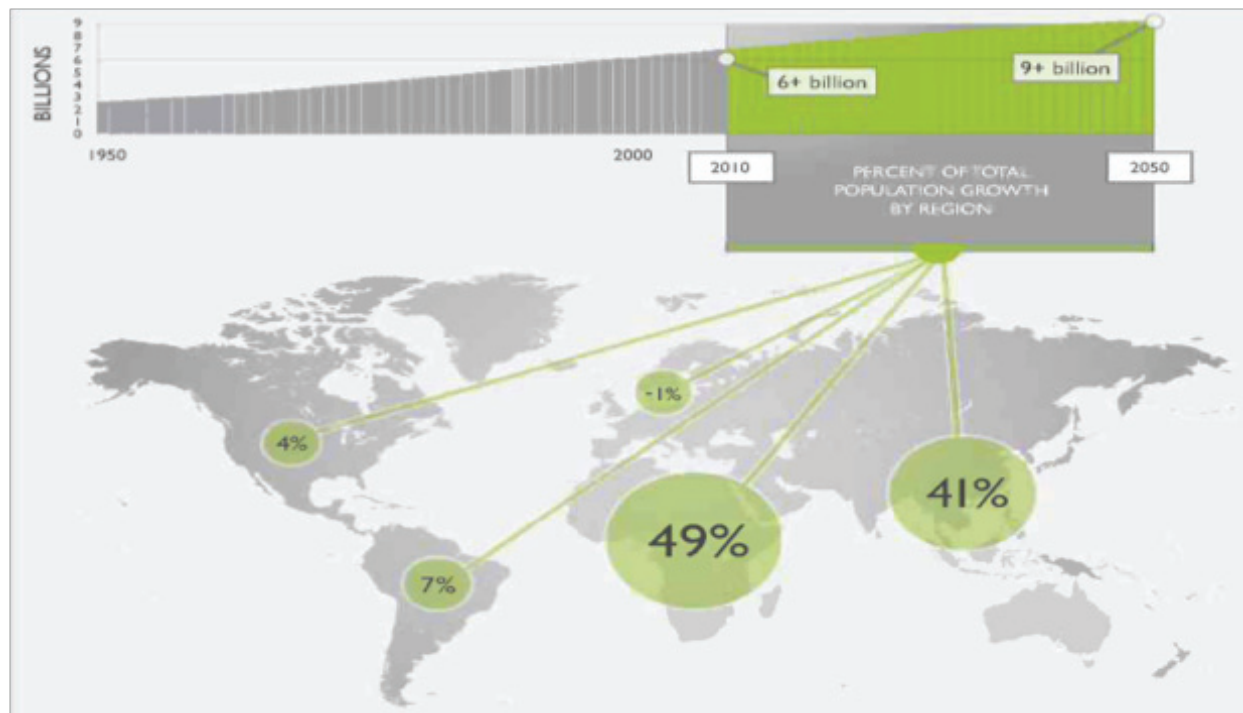
Several global trends have emerged that will challenge Indiana's future success yet also provide great opportunity for increased agricultural production and economic activity. These trends originate far beyond our state, but nevertheless will determine the future of the agricultural industry in the coming decades and as a consequence shape or reshape Indiana's agricultural sector. Over the next several decades, agriculture will be challenged to provide food, feed, fiber and fuel to a growing world population. World population is forecast to increase by nearly 30 percent to 9 billion people by 2050. As a result, science, technology, and innovation, and the application of this research, primarily through commercialization, will dramatically reshape global agriculture.

Improvements in technology and sound public policies will be needed to meet this challenge. In the United States, both public policies and private sector investments have been shaped by decades of abundance and declining real food prices. The challenge today is to adjust to an era in which the agricultural sector must meet competing and growing demand with limited natural and financial resources. The United States will play a leading role in determining whether the world is able to meet these challenges, and therefore, major agricultural states like Indiana are well positioned to capitalize on these opportunities through advancement and investment in science and technology in the agricultural space.

Feeding a Growing World

Today there are nearly one billion people who do not have access to a safe and adequate food supply. In fact, around 20 percent of the world's population lives on less than \$1.25 per day and many of them are children who suffer from long-term health problems. Between now and 2050, the global population is projected to grow by nearly 30 percent, resulting in an estimated 2.3 billion more people to feed. In May 2011, the United Nations projected world population would grow from about seven billion to more than nine billion by 2050 (Figure V).

Figure V. Global Population Growth and Percent of Growth by Region



Source: United Nations/Global Harvest Initiative 2011 GAP Report

Most of the population growth is expected in Sub-Saharan Africa (49 percent or one billion by 2050) and Asia (41 percent or 900 million), both of which are low-income areas with relatively low levels of agricultural productivity.

Up to 3 billion more middle-class consumers will emerge as this global population increases, spurred especially by the rapid economic development in emerging markets such as China and India. The growth of these two countries is historically unprecedented and is happening at about ten times the speed at which the United Kingdom improved average incomes during the Industrial Revolution. These citizens will escalate demand for cars, computers, furniture and other luxury items. They will also be able to afford higher levels of nutrition. In India, caloric intake per person could rise by 20 percent over the next two decades, and China's per capita meat consumption could increase by 40 percent to 165 pounds per year (still well below U.S. consumption levels).¹⁶

The growing population, increasing incomes, and changing consumption patterns will mean substantial growth in the demand for food. At a 2009 international conference on food security, United Nations Food and Agriculture Organization (FAO) Director General Jacques Diouf declared that global agricultural output needed to double by 2050. Food and feed are not the only sources of increasing demand for agricultural output. Agriculture

¹⁶ 2010 Global Agricultural Productivity Report, Global Harvest Initiative.

is an important source of fiber, energy, and industrial raw materials, and the demand for these non-food uses of agriculture commodities is also likely to grow in the future. But rising demand is only half of the picture faced by world agriculture in the 21st century. The challenge is whether agricultural supply can rise sufficiently to meet these demands without forcing food prices up or seriously degrading the environment.

Concerns about a returning Malthusian crisis in food supply are not new. In the two centuries since Malthus published *An Essay on the Principle of Population*, agriculture has kept pace with the growing population and rising incomes by increasing its use of natural resources (land and water) and other inputs (energy, fertilizer, and chemicals). During the 1960s there was widespread anxiety that in the face of rapid population growth, serious food shortages and famines were practically inevitable. Yet aided by “Green Revolution” high-yielding varieties, greater use of fertilizers, investments in irrigation, and expansion of cropland, agricultural production not only kept up with population growth, but also increased available food calories per capita.

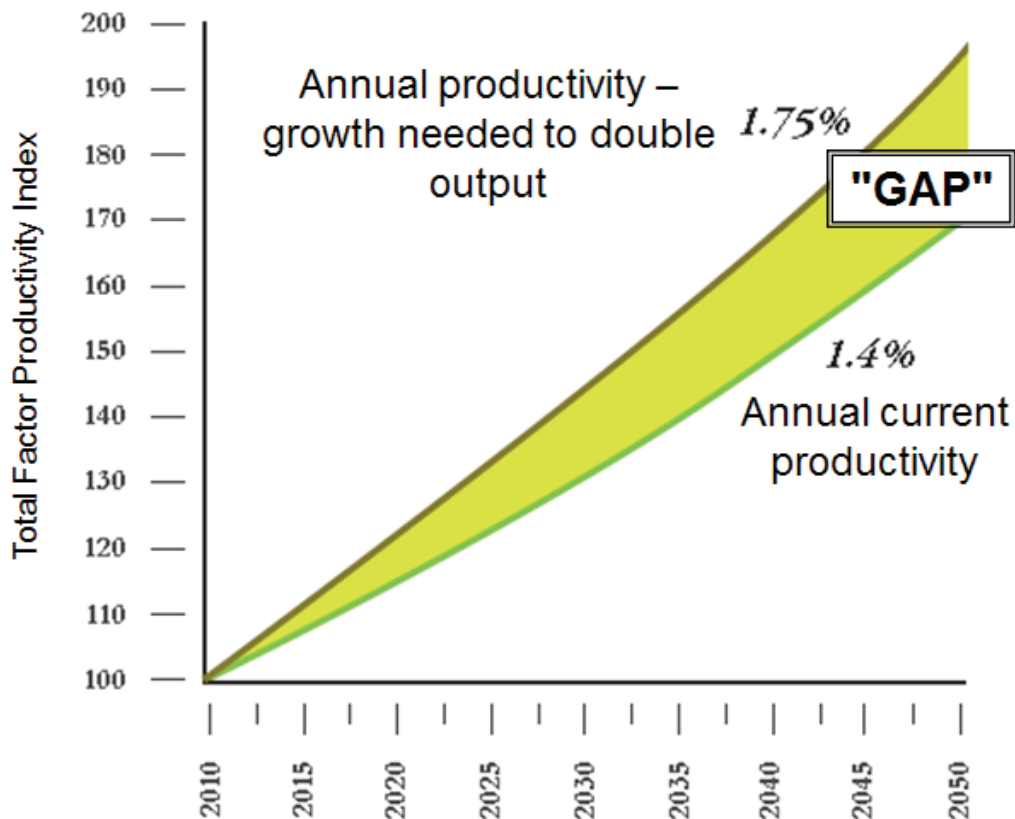
Doubling agricultural output by 2050, while freezing agriculture’s environmental footprint, will require growing the annual productivity rates to at least 1.75 percent annually from the current 1.4 percent (Figure VI).¹⁷ Not only will it be necessary to raise the average rate of total factor productivity growth by one-fourth above its present rate to close the gap, but also productivity will need to grow even more rapidly during the next two decades, when demand will be increasing faster.¹⁸

The primary lever for raising productivity growth is by increasing investments in science and technology, but it takes years to reap the benefits of such investments. Moreover, public sector investments in agricultural research and training in developed and many developing countries have been declining in recent years. Not only must this trend be reversed, but policies that impede the dissemination of new technologies and reduce incentives to farmers to increase their productivity should be reformed.

¹⁷ Ibid.

¹⁸ 2010 Global Agricultural Productivity Report, Global Harvest Initiative. Total Factor Productivity (TFP) is a measure that reflects the amounts of total inputs used per unit of output, including comparisons of the growth of output to growth of input use. A one percent increase in TFP, for example, means that one percent fewer agricultural resources are required to produce a given bundle of crop and livestock outputs so that, if prices were unchanged, the average cost of production would decline by one percent.

Figure VI. Agricultural Productivity Gap Exists



Resiliency of Natural Resource Base

Increased food supply and lower food prices, however, have not come without costs to the global environment. Today it is clear that agriculture not only needs to meet rising demand, but also needs to freeze or shrink its environmental footprint. Put simply, the challenge for 21st century agriculture is to do more with less. The world's growing demand for agricultural production must be met not by bringing more land into production, with more gallons of water, or with more intensive use of inputs that impact the environment, but by being better stewards of existing resources through the use of technological innovation combined with policy reforms.

Despite this acknowledgment, predictions today still point to coming decades characterized by dwindling water supplies, diminished water quality, vanishing topsoil, deforestation, declining fish stocks, and other possible outcomes of over- or misuse of natural resources. At the same time, competition for use of natural resources is expected to increase.

Since the 1960s, the traditional way of growing more food – by plowing more land – has been out of favor. This is partly for environmental reasons and partly because many countries have used up all their available farmland. The World Bank says the world has 1.2 billion acres of land available with fewer than 11 people per hectare living on them (this excludes land on which farming would be impossible, such as deserts, rainforests or the Antarctic.) The area currently under cultivation is 3.7 billion acres, so if all that extra land could be used it would represent an increase of one-third.

Different types of agriculture require different land intensity, yet the use of land puts them on a common basis. A number of factors are driving demand for cropland higher including greater demand for food and feed, further productivity losses due to land degradation, water scarcity, and the loss of arable land due to the expansion of urban areas. Just as there are constraints on available land, constraints also exist on the availability of water. Globally, agriculture accounts for nearly 70 percent of all water withdrawals.

In order to reduce the environmental footprint of agriculture, the challenges of meeting the diverse needs of a growing world population must be accomplished sustainably, primarily by utilizing existing land and natural resources to increase production and continuing to develop and adopt technologies – both traditional and cutting-edge – to enhance productivity.

Changing Consumer Demands and Societal Attitudes

Consumers deserve the widest possible variety of safe and affordable food choices. In general, consumers trust food producers to keep the food supply safe, and they are more concerned about food contamination than about technology used on the farm. Additionally, consumers cite affordability as one their most pressing concerns.¹⁹ For this reason, consumers from all classes and geographies — from those who can afford organic foods to those who struggle to maintain a diet that sustains them — must be allowed to choose from an abundance of safe, nutritious and, most importantly, inexpensive food options.

A large international research project was undertaken as part of a white paper drafted by Jeff Simmons, CEO of Elanco, to determine how and why people around the world make the food choices they make—and, more specifically, how they regard food production technologies.²⁰ The International Consumer Attitudes Study (ICAS) reviewed more than 70 reports and studies about consumer attitudes and behaviors in 26 countries (mostly developed) around the world. This was followed by a validation study by The Nielsen Company.²¹

¹⁹ International Food Information Council's "Consumer Perceptions of Food Technology Survey" – 2010.

²⁰ Simmons, Jeff. "Technology's Role in the 21st Century: Making Safe, Affordable and Abundant Food a Global Reality." 2011.

²¹ These studies represent the opinions of more than 97,000 people in the 26 countries.

The project segmented consumer respondents into two categories: 95 percent were designated as “Food Buyers” and 4 percent were “Lifestyle Buyers”.²² Food Buyers choose foods produced by modern agriculture and are either neutral about or supportive of using efficiency-enhancing technologies to grow food. In general, these buyers make purchases based on taste, cost and nutrition (in that order). These consumers also have the “default” view that the foods they buy are safe. The majority of these consumers do not make everyday purchase decisions based on food safety concerns or how they feel about policy and political issues such as animal rights. The Lifestyle Buyers purchase food based largely on lifestyle factors: ethnicity and vegetarianism, or support for organic, local and Fair Trade food suppliers, etc. For this group, price is not a factor in their purchasing decision.

Research also shows that the two consumer groups tend to overlap in many areas, depending on personal tastes and preferences. In other words, these are not distinct market segments. In 2010, 75 percent of traditional food buyers in the United States also routinely bought organic foods, even if they cost more.

There also is a fringe consumer group (1.7 percent of U.S. consumers, according to research commissioned from The Nielsen Company)²³ that participates in protests, picketing and rallies to “protect” consumers from modern food-production “threats.” Although these groups are sometimes little more than a few like-minded people skilled at gaining access to the media, they can be effective at influencing local, regional and even national media—and legislation. The results of their efforts, including bans on safe, efficient food production technologies, tend to have far-reaching and often negative consequences, no matter how unintended.

Consumers want taste, cost, nutrition and some lifestyle choices. Consumers want the right to make their own food-buying choices rather than having those choices made for them. The traditional and the new and changing tastes and preferences of consumers all will require the development and advancement of a variety of food product, processing, and safety technologies and systems.

Consumers’ attitudes towards food and agriculture are changing as well. Consumers (or the general society) tend to view agriculture today as a corporate business, yet society still has an idyllic feeling towards small, rural farms and pastoral settings. It is the scale of much of modern production agriculture that makes it an “industry” in the eyes of the average consumer and is subjecting it today to “industrial” coverage by the news media.

²² Simmons, 2011

²³ Simmons, 2011.

Organic farming provides an example of this divergent consumer view towards the role and function of agriculture. It still commands a small market share because of its price, but consumer research shows many would buy organic if it were less expensive. The research also illustrates that consumers would prefer buying quality, affordable food with less chemicals and thus environmental impact. Yet, consumers tend not to consider or think about the question of whether organic agriculture could feed the world's growing population.

Agriculture has long had a "contract" with society to provide a safe, affordable and abundant food supply. Today, the "contract" and consumers' expectations and values are changing and are having an effect on agricultural practices, systems and policies. Whether it is attitudes towards the size of farming, its impact or footprint on the environment, or animal care, the consumer and society at-large are having a significant impact on how the industry makes future contributions.

Human Health and Nutrition

Most U.S. households have consistent, dependable access to enough food for active, healthy living—they are food secure. There is a minority, though, of American households that experience food insecurity at times during the year, meaning that their access to adequate food is limited by a lack of money and other resources. The U.S. Department of Agriculture (USDA) monitors the extent and severity of food insecurity in U.S. households through an annual, nationally representative survey. In 2010, 85.5 percent of U.S. households were food secure throughout the year.²⁴ The remaining 14.5 percent (17.2 million households) were food insecure. Food-insecure households (those with low and very low food security) had difficulty at some time during the year providing enough food for all their members due to a lack of resources.

Children were food insecure at times during the year (2010) in 9.8 percent of households (3.9 million households), down from 10.6 percent in 2009. These households were unable at times during the year to provide adequate, nutritious meals for their children. Good nutrition, especially for children, is important in establishing and maintaining a good foundation for a child's future physical and mental health, academic achievement, and economic productivity. Unfortunately, food insecurity is an obstacle that threatens that critical foundation.

At the same time that hunger threatens these same fundamental capacities, more than one-third of U.S. adults (35.7 percent) are obese.^{25,26} Approximately 17 percent (or 12.5

²⁴ USDA/ERS Food Security Survey and Report, 2010.

²⁵ Data from the National Health and Nutrition Examination Survey (NHANES), FDA/Centers for Disease Control and Prevention.

²⁶ The most common method of body-fat measurement for classification purposes uses weight in pounds and height in inches to calculate a person's body mass index, or BMI, score. A score of 30 or above on the BMI chart results in being categorized as "obese."

million) of children and adolescents aged 2—19 years are obese. During the past 20 years, there has been a dramatic increase in obesity in the United States and rates remain high. In 2010, no state had a prevalence of obesity less than 20 percent. Thirty-six states had a prevalence of 25 percent or more; 12 of these states (Alabama, Arkansas, Kentucky, Louisiana, Michigan, Mississippi, Missouri, Oklahoma, South Carolina, Tennessee, Texas, and West Virginia) had a prevalence of 30 percent or more. Washington, D.C., and the state of Colorado are the only two regions of the United States where obesity's prevalence is less than 20 percent of the population.

The Centers for Disease Control and Prevention (CDC) calls America an “obesogenic” society, characterized by a culture that promotes overeating, poor nutrition and total lack of physical activity. Without exception, the underlying cause of obesity is overconsumption of calories relative to an individual's needs. Even though a calorie is a calorie, it is easier to become obese on a steady diet of high-calorie, high-fat foods that are devoid of nutrients than it is while eating a diet of fruits, vegetables, lean proteins and whole grains.

New innovation in the food industry and the continued development of “functional foods” may make a difference in this battle. A functional food is one in which a new ingredient(s) (or more of an existing ingredient) has been added to a food, and the new product has a new function (often one related to health-promotion or disease prevention). The general category of functional foods includes processed food or foods fortified with health-promoting additives, like “vitamin-enriched” products. An example of this type of fortification would be the historic addition of iodine to table salt, or Vitamin D to milk, done to resolve public health problems such as rickets.

Functional foods are an emerging field in food science due to their increasing popularity with health-conscious consumers, the ability of marketers to create new interest in existing products, and the still-to-be-determined broad health benefits to consumers.

The functional food industry, consisting of food, beverage and supplement sectors, is one of several areas in the food industry that is experiencing rapid market growth. It is estimated that the global market for the functional food industry will reach \$176.7

Golden Rice – A Functional Food Prevented from Making A Difference.

Golden rice is a variety of *Oryza sativa* rice produced through genetic engineering to biosynthesize beta-carotene, a precursor of pro-vitamin A in the edible parts of rice. The scientific details of the rice were first published in *Science* in 2000. Golden rice was developed as a fortified food to be grown in developing countries where there is a shortage of dietary vitamin A. In 2005, a new variety called Golden Rice 2 was announced which produces up to 23 times more beta-carotene than the original variety of golden rice. Neither variety is currently available for human consumption. Although golden rice was developed as a humanitarian tool, it has met with significant opposition from environmental and anti-biotechnology and anti-globalization activists.

billion in 2013 with a compounded annual growth rate of 7.4 percent. This kind of growth is fueled not only by industrial innovation and development of new products that satisfy the demand of health conscious consumers but also by health claims covering a wide range of health issues. Yet, consumer skepticism persists mainly due to the fact that benefits associated with consuming the products may be difficult to be detected.

Public policy changes may also have a dramatic impact on future obesity trends and therefore on the food and agricultural industry. The U.S. Surgeon General's office and the CDC have both publicly lined up behind behavioral approaches as the main weapon in what is becoming a "war" on obesity. First Lady Michelle Obama's high-profile Let's Move campaign against childhood obesity consists almost entirely of behavioral weight-loss wisdom—that is, find ways to encourage children to eat less-calorie-dense foods, to become more active, and to enjoy doing it. The recent proposed bans of toys in Happy Meals in San Francisco and mega-sized sugary drinks in New York City suggest that more officials may be getting ready to apply pressure on the food industry. To make it easier and more tempting to buy healthier food in poorer, disproportionately overweight communities, the White House has proposed subsidizing the costs of fruits and vegetables. Approaching the problem from the other direction, New York City Mayor Michael Bloomberg is among those who have advocated modifying food-assistance programs to restrict the purchase of high-sugar beverages, and last year Washington, D.C., enacted a 6 percent tax on sugary drinks. New York City has also offered vouchers for buying produce at farmers' markets to low-income families and incentives to stores to offer healthier fare.

Research Priorities and Structure

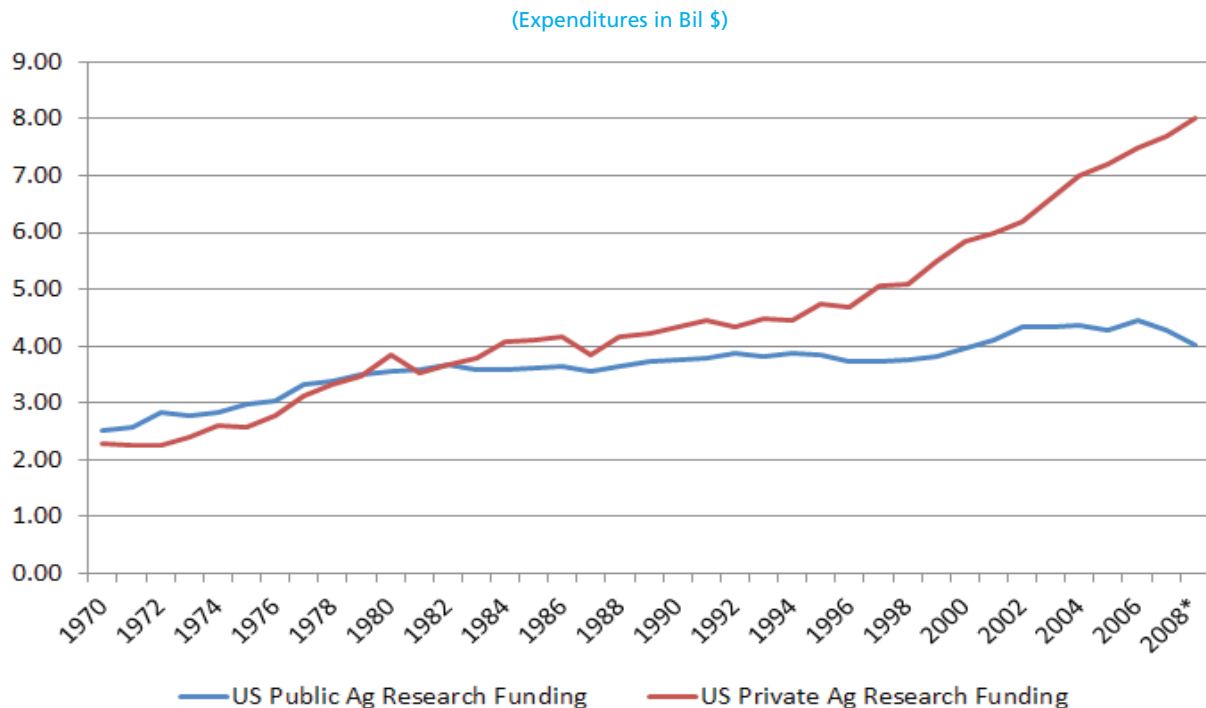
Advances in agricultural productivity have led to abundant and affordable food and fiber throughout most of the developed world. More efficient agricultural machinery, agricultural chemicals and fertilizers, genetic improvements in crops, and changes in farm management techniques have transformed U.S. agriculture since the Great Depression and set the stage for continued productivity growth. Agricultural research funded by both public agencies and private-sector firms has been the most important source of these advances.

Studies consistently find high social rates of return from public agricultural research, with median rates exceeding 40 percent.²⁷ Even when adjustments are made for such factors as private-sector research, losses from tax collection, and errors in research lag estimates, rates of return to public research remain positive.

²⁷ Alston, J.M., C. Chan-Kang, M.C. Marra, P.G. Pardey, and T.J. Wyatt. 2000. A Meta-Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem, IFPRI Research Report 113. Washington, DC: International Food Policy Research Institute.

The environment for U.S. public agricultural research has changed dramatically over the past 30 to 40 years. Private-sector investment in agricultural research and development (R&D) in the United States grew rapidly from the middle 1970s to the present, and surpassed public-sector investment by the early 1980s. The rate of increase in total public-sector agricultural research expenditures slowed during the same time period (Figure VII).

Figure VII. U.S. Private Sector Agricultural Research Surpasses Public Research More Than 30 Years Ago



Meanwhile, government and private-foundation reports note that both public-sector agricultural research and mission-oriented government agencies have become more focused on applied research rather than on basic research.²⁸ These reports also contemplate new funding mechanisms including competitive allocations as alternatives to more traditional formula funding.

Debates over the direction of public agricultural research and the nature of its funding mechanisms have continued. Over the last few decades, changes have occurred in constant-dollar funding levels for various other disciplines supported by the Federal Government. Biomedical research increased the most; but research in the other life sciences, such as agricultural sciences and biology, as well as engineering, environmental sciences, and computer sciences, also increased over most of the period since 1980, except recently between 2003 and 2005.

²⁸ National Research Council. 1996. Colleges of Agriculture at the Land Grant Universities: Public Service and Public Policy. Washington, DC: National Academy Press.

Growth in the productivity of the global food and agricultural system will be largely determined by today's investments in research and development. In recent decades, the private sector has become a major player in developing innovations for food and agriculture. Factors spurring private companies to invest in food and agricultural research include the emergence of biotechnology and other new scientific developments, the strengthening of intellectual property rights over agricultural innovations, new regulatory requirements, the expansion of markets for improved agricultural inputs and food products, and rising consumer demand for more diverse foods. More recently, rapid growth in the market for biofuels has pushed companies to expand their R&D investments in this area as well.

Formal institutional linkages between the public and private sectors in agricultural research continue to evolve. Such arrangements serve to more closely link together science-oriented public research with technology-oriented private research. Nevertheless, public-private cooperation in research raises new issues that have important social and economic consequences, such as the ownership of intellectual property and the content of the public research agenda. Nevertheless, the combined public private spending on agricultural research is approximately \$12 billion annually, and the global drivers of agriculture are going to require significantly greater public private leverage through new and different collaborative models.

New Public/Private Ag Research Partnership Proposed to Meet Global Food Demand

U.S. Senators Debbie Stabenow and Pat Roberts – leaders of the Senate Agriculture Committee – introduced legislation on March 30, 2012 to establish a foundation to solicit private donations to enhance research for the most pressing challenge facing U.S. agriculture - meeting exploding global demand.

“Agriculture research must remain a priority for our nation, especially given the role food plays in national security and stability,” Senator Roberts has said. “Establishing this foundation is an innovative way to generate new sources of funding for agricultural research by leveraging our public investment in agricultural research with private donations during a time of federal budgetary constraints.”

The bill, The Foundation for Food and Agriculture Research (FFAR), authorizes the establishment of a 501(c) 3, a non-profit organization, and includes provisions outlining the duties and structure of the foundation, including an appointed Board of Directors representing the diverse sectors of agriculture. This model serves as a tool to foster new public-private partnerships among the agricultural research community, including USDA research agencies, academia, private corporations, and non-profit organizations.

There are precedents for congressionally mandated foundations across the federal government, including entities devoted to medical research, public health and safety and natural resource conservation. Some examples include: Foundation for the National Institutes of Health, Foundation for the Centers for Disease Control and Prevention, National Fish and Wildlife Foundation, and the National Forest Foundation.

Summary Observations

A number of critical macro-level societal issues and challenges exist today. Some are uniquely independent of one another but others are inextricably linked together. What is common to each of them is the clear role that food and agricultural oriented science and technology research and innovation will play in reshaping the agricultural sector both globally and in the state of Indiana. Indiana is well positioned to capitalize on these global trends, but it will require an expanded focus beyond Indiana's traditional agricultural production base that includes efforts likely aimed at facilitating science and technology investment, collaboration, commercialization, and greater emphasis on workforce development and supportive public policy.

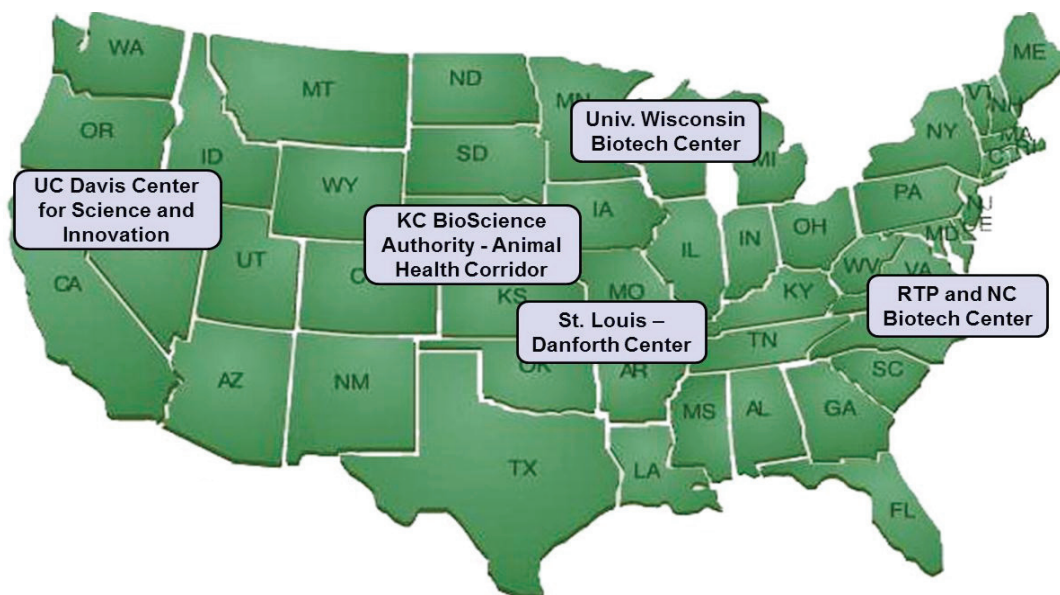
ECONOMIC GROWTH THROUGH AGRICULTURAL INNOVATION AND COMMERCIALIZATION – AN OVERVIEW OF EXISTING COLLABORATIVE MODELS

Innovation is the creation of something new...better or more effective products, processes, services, technologies, or ideas. However, innovation in and of itself is not enough. The value of innovation can only be captured by society when innovation is accepted, i.e., adopted and used, by markets, governments, and society. This section will profile several collaborative models that have leveraged the agricultural and life sciences innovation of a region to develop clusters, hubs or centers to strategically advance further technology research and commercialization and ultimately generate local, state and regional economic development opportunities. In addition, this section will also begin to identify themes that represent the likely foundational elements for fostering and nurturing agricultural economic growth through science and technology.

Innovation Environments Around the Country

Collaborative models and research clusters focused specifically on plant and animal technologies have emerged in several locations around the country (Figure VIII). One of the premier clusters in the country is North Carolina's Research Triangle Park (also known as RTP). RTP is the largest and arguably best-known research park in the United States. At more than 7,000 acres, RTP has strong university connections to Duke University, North Carolina State University, Wake Forest, and UNC-Chapel Hill. Today, it is home to more than 170 world-class firms that employ 42,000 full time workers.

Figure VIII. Prominent Agricultural Innovation/Biotechnology Clusters and Centers



By these measures and several others, RTP has been a resounding success. Yet that success was far from certain when RTP was envisioned over 50 years ago. In fact, at the time of RTP's founding, few people would have expected it to achieve the impressive size and activity level it enjoys today. Although RTP is a model for regional economic development, its lessons do not translate easily or seamlessly to other regions.

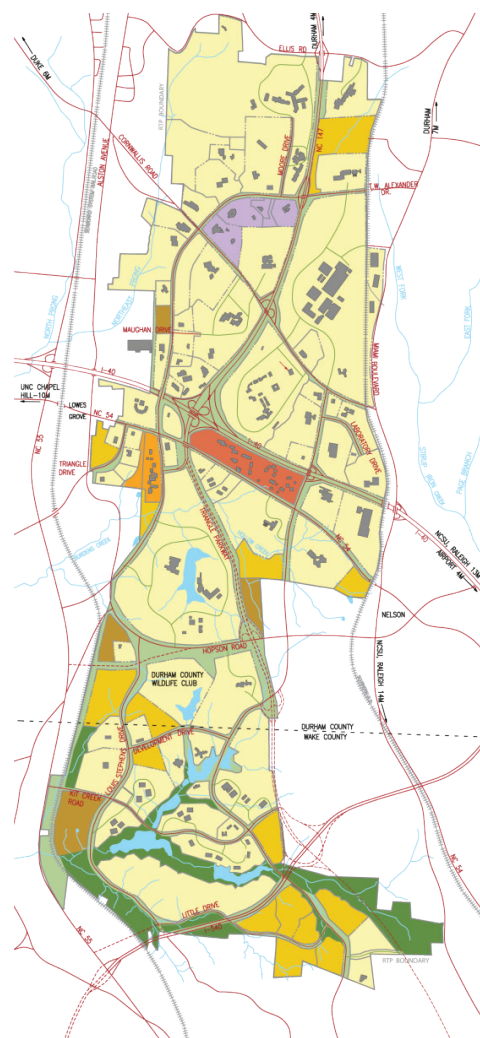
RTP Genesis and Early Years

In the mid-1950s, North Carolina's economy found itself heavily concentrated in just three industries – tobacco, textiles and furniture – each of which employed primarily low-skill workers. Each of the industries was also on the decline, and North Carolina's per capita income was virtually the lowest in the nation, ranking 48th in 1952. By the mid-20th century, North Carolina, despite having strong research universities, was seeing many of its college graduates moving to other states.

A group of the state's education, business and government leaders advocated that the universities act as a magnet to attract business. In 1954, Governor Luther Hodges formed a committee to perform an assessment. The small group produced a 10-page report that said, "... specific plans should be made for the development of an area between Raleigh, Durham and Chapel Hill and near the Raleigh-Durham Airport, as a center for industrial research."

In 1959, they had raised \$1.425 million from more than 850 donors. This was used to acquire the initial land for the park, establish the Research Triangle Institute to do contract research, and to construct a new building to house the Institute (Figure IX). Four months later, Chemstrand Corporation became the first major private tenant of the park, but there was little additional growth over the next six years. In 1965, RTP was selected for the Department of Health and Human Services first \$70 million Environmental Health Sciences Center (now called the National Institute

Figure IX. Research Triangle Park



of Environmental Health Sciences). Only a few months later, IBM located a 184,000 square foot research facility on 395 acres in RTP. Then Governor Terry Sanford had courted the government center for three years and IBM for seven years. These two “wins” validated the mission of RTP. Overall, in the more than 40 years since 1965, the Park has averaged six new companies and approximately 1,800 new employees each year.

North Carolina Biotechnology Center

In the early 1980s, the leaders in North Carolina established a structure and a long-term commitment for biotechnology innovation and commercialization that would build upon the established and growing success of RTP. Many had recognized early on that the science and applications of biotechnology fit remarkably well with its natural resources and economic foundations. To ensure a coordinated and innovative approach to biotechnology development, the State established the North Carolina Biotechnology Center (NC Biotech Center) in 1984 to stimulate the biotechnology economy and to create jobs. It was the first state-sponsored biotechnology initiative in the United States.

The mission of the NC Biotech Center is to provide long-term economic and societal benefits to North Carolina by supporting biotechnology research, business, and education statewide. The main areas of focus are science and technology development, business development, education and training and economic development. The Center accomplishes this mission via its six statewide offices. Over \$200 million has been invested in grant, loan and other programs over more than 20 years to further solidify the state’s biotechnology foundation and to leverage even more investment.

Since its inception, the Center has carefully targeted its funding to the requirements of biotechnology development; science and research; education and workforce training; and company establishment and growth. Programs and activities have assisted but not duplicated the efforts of various public and private entities involved in biotechnology, from universities and entrepreneurs to investors and start-up companies. The strategic investments have paid off handsomely. North Carolina has deliberately and successfully stimulated one of the most envied, interactive and productive biotechnology communities or clusters in the world.

The Center promotes North Carolina’s competitive advantages in the agricultural biotechnology industry and strategically develops efforts to maintain the state’s prominence in this sector. How does the Center “sell” the state’s assets? The Center highlights the following advantages:

- ◆ **A Global Hub (commercial assets).** The state is home to world class research parks and innovation incubators. It also has more than 58,000 employees at 538 biotech-related companies. The NC Biotech Center also has six offices strategically located throughout the state to provide expertise and support.
- ◆ **Human Capital (people).** There are a number of hands-on worker training programs (some of which are state supported). There is also close collaboration between industry and educational institutions to create tailored training programs for life sciences workers.
- ◆ **World Class Research and Discovery (academic assets).** More than \$1.3 billion is invested annually in sponsored life science research at North Carolina's universities. Centers of Innovation for Nanobiotechnology, Medical Devices and Drug Discovery coordinate research in emerging sectors and speed products to the marketplace.
- ◆ **Funding and Support (capital).** Loan amounts provided by the Center range from \$30,000 for company start-up costs to \$250,000 for research and growth funding. There has also been \$1.5 billion in venture capital funding invested in North Carolina companies over the last five years with fully one-quarter of the funding going to start-ups.
- ◆ **Thriving Community (long-term support).** There has been 27 years of state government investments and commitments to continued biotechnology growth in the state. There are numerous conferences and networking events hosted around science and business topics.
- ◆ **A Place to Call Home (geography).** The Center also highlights the quality of life in the state, including affordable and diverse housing options, recreational opportunities, rich history and culture, and top educational institutions.

The NC Biotech Center has been successful in a number of areas. Much of this is tied directly to the \$200 million in grants, loans and education and networking opportunities the Center has provided to grow the state's biotechnology sector and leverage further investment. These funds have been distributed through grants to North Carolina Universities and loans to North Carolina companies. The Center makes grant awards in agriculturally related research to universities through its Science and Technology Development program and finds that for every dollar invested, an additional \$7.70 in funding is spurred. The Center also funds early stage research projects that are considered pivotal for future innovation in agricultural biotechnology through its Business and Technology Development Program. Companies receiving this support have, on average, secured follow-on funding from other sources of \$144 for each dollar invested by the Center.

In addition to funding new research, the Center also brings scientists together to share ideas. The Plant Molecular Biology Consortium brings together academic and industrial scientists to discuss research. This forum has thrived for almost 20 years with participation from hundreds of scientists.

The Center also reaches across the state every year to teachers who want to learn more about biotechnology topics. The Center hosts Summer Workshops for educators and has already reached more than 1,450 teachers who in turn teach hundreds of thousands of North Carolina students. These workshops have included: Introductory Biotechnology, Biotechnology for Plants, Animals and the Environments, among others. The Center has also funded the development of high school and middle school courses focused on career and technical education.

The NC Biotech Center is committed to maintaining a forward looking strategy to keep biotechnology development a key focus of North Carolina. In fact, in 2009, a strategic report, “30 in 10 – Growing North Carolina’s AgBiotech Landscape” was compiled by a number of agencies, institutions and other entities. The NC Biotech Center was perfectly positioned to convene all the relevant parties and facilitate the conversations, strategies and activities critical to future success. The leaders involved set a goal of “30 in 10” – adding \$30 billion to North Carolina’s economy over the next ten years by combining traditional agriculture and new technology strengths, especially in agricultural biotechnology.

Arguably, RTP is the most notable and successful of all science parks in the United States. Yet it is the combined collaborative strength of RTP’s innovation environment and infrastructure along with the strategic vision and partner coordination of the NC Biotech Center that is especially noteworthy.

The RTP story could lead one to believe that success was inevitable. In actuality, several factors were stacked against it. For example, at the time of RTP’s founding, the region was not a large metropolitan area, it lacked a strong base of high-tech manufacturing, it had a low-skilled workforce, and it had little tradition of entrepreneurial activity. However, it did have several “assets” or factors that when coordinated and leveraged appear to be core to the longer-term success of RTP.

- ◆ **University Strength and Collaboration.** The region’s strongest asset was its world-class research universities. Few places have a conglomeration of faculty and facilities comparable to that found in the Raleigh-Durham-Chapel Hill region. Today, there are nine research universities and five medical or veterinary schools in the region with \$1.5 billion in annual research funding across them. The universities also recognized early on that they had to act as a unified research community, cooperating for the common good.
- ◆ **State Political Leadership and Support.** The leadership of at least two of the state’s Governors in the Park’s early years played a critical role. Not only did these State executives help set the strategic agenda and convene common interests and stakeholders, they also engaged directly in recruiting initial organizations and also committed state financial support to the overall effort.

- ◆ **Community Engagement.** The people of North Carolina have a strong tradition of commitment and cooperation for the common good of the state. Representatives from relevant sectors such as government, industry and academia all met in facilitated discussions to provide the vision and support needed to maximize the common good. A forum for stakeholder engagement helped to organize stakeholders around a common set of issues and ensure stakeholder support around broader themes of economic development, education and workforce issues, and science and technology innovation.
- ◆ **Patience and Continuity.** If the experience of RTP is a guide, the process of growing collaboration and successfully building a regional economic development cluster can take decades – not just years. The RTP process involved numerous steps, each requiring considerable time: developing the region's assets; inventorying and appraising those assets; identifying the region's opportunities; constructing strategies for pursuing those opportunities; finding resources for executing those strategies; engaging stakeholders; attracting the interest of researchers and companies; and catering to researchers and companies once attracted. In the case of RTP, it took more than 20 years to develop a large corporate R&D presence, and it took another 20 years to reach its maximum level of growth. A key factor in RTP's success was the sustained community and financial support to the strategic vision over such a long period of time through various political administrations.
- ◆ **Financial Support.** Tangible financial investments from corporate stakeholders and the State were needed to launch and support the RTP effort. The State of North Carolina invested \$100 million last year (2011) in biotechnology programs and over \$1 billion in the last ten years. This is evidence of the state's quarter-century financial commitment to biotechnology innovation and was a fundamental requirement for creation of the NC Biotech Center.

"Looking back now, it seems so obvious that all these groups had a lot to gain by working together. But back then, it wasn't so obvious...What it took was the willingness of public-spirited leaders from various segments of the community to downplay their differences. There was a great generosity of spirit that dominated from the beginning, and this was what enabled people to look beyond their own narrow interest for the benefit of the entire project. From this generosity came first a basic agreement to work together. Once that was reached, the positive aspects of working together... took over and we were on our way."

– George Simpson, *Founding Director of the Research Triangle Committee*

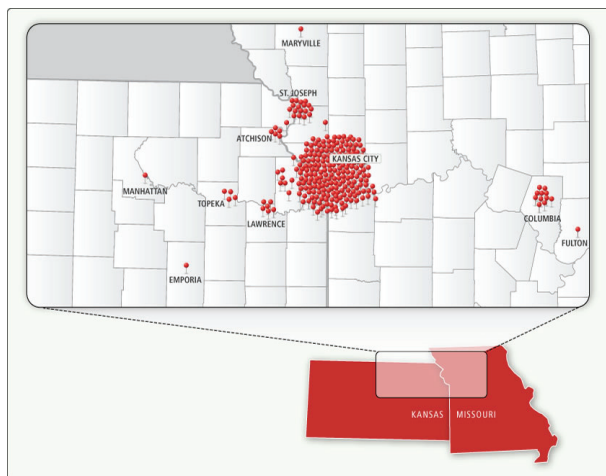
The results have been unquestionably successful – RTP today has 170+ world-class firms that employ 42,000 full time workers in developed space of 22.5 million sq. feet. The RTP impact on the North Carolina economy is impressive with \$2.8 billion in capital investment and a \$2.7 billion annual payroll.

Kansas City Animal Health Corridor

Missouri and Kansas share the Animal Health Corridor in the Kansas City (KC) region which is home to a significant concentration of animal health and nutrition companies. The region was branded as the Kansas City Animal Health Corridor (KC Corridor) just five years ago to capitalize on the cluster of animal health companies already located in both states for the mutual benefit of the region, the companies, and animal health.

In the animal health industry, it is common knowledge that the KC area is a global leader and hub for animal health related economic development and research. In fact, KC area companies account for nearly 32 percent of the total sales of the \$19 billion global animal health industry.²⁹ There are 220+ animal health companies with 13,000+ employees in the corridor, including five of the ten largest global animal health companies and three of the ten largest animal nutrition companies (Figure X).³⁰

Figure X. Kansas City Animal Health Corridor



The KC region has seen sustained growth in the presence of animal health companies, especially in the number of companies providing supportive services and technology to the major animal health/pharmaceutical firms. Similar to North Carolina and RTP, companies have located in the KC region because of the academic and research and veterinary expertise of local universities as well as the business success that has come from clustering near other similar businesses or service providers. But, unlike North Carolina and RTP, there is not a regional park where these companies collectively locate.

²⁹ Brakke Consulting, 2008.

³⁰ Among the major companies in the area are Hill's Pet Nutrition, with headquarters in Topeka, Kansas; Boehringer Ingelheim Vetmedica, with U.S. headquarters in St. Joseph, Missouri; and Bayer Animal Health, with North American headquarters in Shawnee, Kansas.



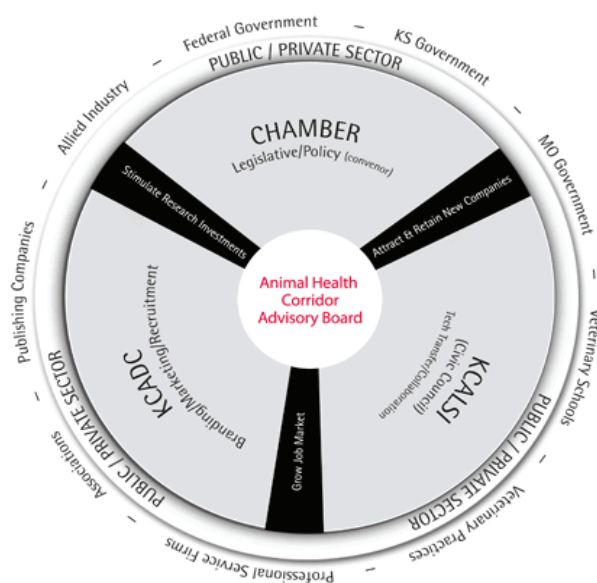
Another key difference between the KC Corridor and RTP is the way in which the strategic emphasis on regional opportunities has emerged. In North Carolina, there was a clear vision to build the biotechnology sector and RTP. In the KC region, much of the clustering of animal health and nutrition companies occurred organically over time, and it has only been in the last several years that the KC Corridor's stakeholders have actively focused on more economic development growth and job creation.

The first step to achieve that was creating the KC Corridor "brand" and marketing and promotion of the region.

The key players in the Kansas City region's business, educational, scientific and government communities have now joined together to more strategically create a climate of opportunity for companies competing in and supporting the animal health and nutrition industry. The organizations which are taking leadership roles in this initiative are the Greater Kansas City Chamber of Commerce, the Kansas City Area Life Sciences Institute (coordinating body for the Greater Kansas City region's life sciences research initiatives), and the Kansas City Area Development Council (Figure XI). These groups work closely together to ensure that "Kansas City is the global leader for animal health and nutrition research, innovation and production."

The KC Animal Health Corridor Advisory Board is at the center of these organizations to help develop and guide the strategic direction and future work plans to further promote and grow the KC Corridor. The Advisory Board is made up of leaders from animal health businesses and academic institutions including Kansas State University and the University of Missouri – Columbia.

Figure XI. KC Animal Health Corridor Structure



The KC Corridor, while continuing its marketing and promotional efforts, is now more actively focused on a multi-pronged, longer term strategic plan for growth. It includes:

- ◆ **Leveraging Signature Assets.** The KC Corridor is working with other regional partners to leverage existing capabilities and engage the National Bio- and Agro-Defense Facility (NBAF) with KC Corridor companies and resources. In 2008, Manhattan, Kansas was selected by the Department of Homeland Security (DHS) as home to the \$650M National Bio- and Agro-Defense Facility. This facility is expected to have a \$3.5 billion economic impact on the broad region over the first 20 years of operation and generate additional life science industry growth. Site preparation is now underway, with construction expected to be completed in 2016. After certification and transfer of personnel and programs, it is anticipated to be fully operational in 2018.
- ◆ **Early Stage Technology Translation.** The KC Corridor has recently established the Center for Animal Health Innovation. This Center, similar to the NC Biotech Center, is focused on longer-term strategic opportunities for animal health companies in the corridor and region, specifically in the area of technology commercialization. The new Center opened in April 2011 at the Kansas State University Olathe campus after receiving a \$1 million seed grant from the Kansas BioScience Authority (KBA).

The mission of the Center for Animal Health Innovation is to connect innovation to industry with the express goal of producing breakthrough products and services that can have a major impact on the animal health industry. At the core of the Center is its Proof of Concept Program that is devoted to identifying, evaluating, funding and helping to commercialize the most promising technologies. The fundamental principle of the Proof of Concept program is that by connecting innovators to industry early in the development process, breakthrough products and services are more likely to be created quickly and have greater value. In addition, the Proof of Concept program maintains that connection until the project reaches commercial ready status through a strong mentoring program that strives to increase the number of projects that move from idea to market.

- ◆ **Workforce Education and Training.** The KC Corridor develops strategies that leverage training resources to produce a workforce skilled in key competencies meeting the needs of KC Corridor companies and entities. Specifically, the University of Kansas has developed a master's of business administration with a focus on animal health. Kansas State opened the International Animal Health and Food Safety Institute in 2011 at a new campus just outside Kansas City where students pursuing graduate degrees in biological sciences and technology collaborate with scientists conducting research on the campus. The campus also provides professional development for employees of area companies.
- ◆ **Community Engagement.** The KC Corridor serves as a conduit for interaction and engagement within the animal health industry. It also coordinates efforts with Federal and State lawmakers to ensure the necessary financial and public policy support is in place to advance and promote the KC Corridor assets and resources.

Other Regional or Specialized Initiatives

A number of other areas have strategic centers or clusters focused on agricultural innovation. These are spread throughout the country and many are located at a major university (University of Wisconsin, University of California Davis) or a metropolitan area with significant business assets (St. Louis).

The University of Wisconsin Biotechnology Center (UWBC) does not have the same economic development objectives as the NC Biotech Center or the Center for Animal Health Innovation. It is committed to being a quality, comprehensive, multidisciplinary biotechnology center that supports, coordinates, disseminates and advances biotechnology. The UWBC focuses first on the development of research tools and capabilities and participation in cross-disciplinary research programs across the University and with industry. It also works to increase public awareness and understanding of biotechnology and coordinates and participates in various training activities for students and visiting scientists. Public policy development and evaluation is another priority of the UWBC. Although successful at achieving its primary aims, the university centric approach of the UWBC limits its ability to drive economic impact as successfully as RTP or the KC Corridor.

Ohio's Approach for Funding Economic Growth

A decade ago, Ohio launched the Ohio Third Frontier to create new technology-based products, companies, industries and jobs and to build an "innovation economy" in the state. The \$2.3 billion initiative supported by state bond financing provides funding for open innovation, entrepreneurial support, value chain development, and expansion of a skilled talent pool that can support technology-based economic growth. Although perhaps not directly applicable for Indiana, it is an interesting model for fostering innovation and commercialization because its success has come as a result of both Ohio's state budget funding commitment and its public policy position to incentivize further innovation and commercialization activities.

The Donald Danforth Plant Science Center in St. Louis was founded in 1998 through a \$60 million gift from the Danforth Foundation, a \$50 million gift from the Monsanto Fund, the donation of 40 acres of land from Monsanto Company, and \$25 million in tax credits from the State of Missouri. The mission of the Danforth Center is to "improve the human condition through plant science." It seeks through its research to feed the hungry and improve human health; preserve and renew the environment; and enhance the St. Louis region as a world center for plant science. The Danforth Center is involved in many different plant-based research areas. Some of the most prominent fields include: biofuels; biofortification; disease resistance; drought tolerance; pesticide and fertilizer reduction; and biosafety and regulation.

The Danforth Center has an interesting funding model that relies much less on state funding than RTP or the KC Corridor. The Center, today, maintains close research and funding ties with Monsanto and a smaller number of key partners. While there are some academic alliances with the University of Illinois at Urbana-Champaign, the University of Missouri in Columbia, Missouri, Purdue University, and Washington University in St. Louis, research collaboration is tied more directly to specific projects rather than industry or economic development growth. The Danforth Center has made significant contributions to plant science research, however, as compared to RTP and the KC Corridor, the Center's collaborative efforts are more narrowly captured by Monsanto and a small number of other partners rather than by a broader industry or the larger region.

Summary Observations

Lessons can be learned from the history, evolution and strategic priorities of each of the regional food and agricultural centers or hubs of innovation around the country, including North Carolina's Research Triangle Park and Biotechnology Center, the Kansas City Animal Health Corridor, and others. These examples provide insight on how other regions with similar food and agricultural innovation assets have analyzed, planned and executed strategies to further expand their research and commercialization activities to spur economic development in their state or region. One common theme in all of the models discussed is the pursuit of economic activity through a focus on promoting and facilitating science and technology research and commercialization. Other key observations from these profiles include:

- ◆ **Existing Basic Science and Research Assets** – Innovation begins with formal basic science and research for both “breakthrough innovations” and improvements to existing technological products and processes. These assets are incredibly important and extraordinarily expensive to build from scratch and are housed at universities, research institutes and private companies. Basic science and research helps spur on scientific innovation that is the essential building block of an increasingly knowledge-based economy like agriculture. The funding models for basic agricultural research have been evolving, and there is increasing pressure for basic research dollars to be spent more productively. As a result, while having basic scientific assets is critical, so is the ability to productively foster collaboration – a key lever for improving the efficiency or yield of the research activity.
- ◆ **Capital and Entrepreneurship** – In order for innovation to achieve its societal benefit, it requires commercialization (capital and people). Having access to capital to drive this activity is critical as is having people with the requisite knowledge, experience, and risk tolerance. Successful models have a strong focus on programs and initiatives that lower financial and personal risk and increase access to capital and promote entrepreneurship.

- ◆ **Technology Translation and Application** – It is often in the marketplace that scientific application occurs and is continuously refined leading to additional innovation and competitive advantage, and it is this market-driven innovation that often leads to significant economic growth within markets and regions. As a result, the existing market is an important source of meaningful, continuing innovation. Successful models include programs that better link the marketplace to basic and translational research as well as foster market-driven innovation.
- ◆ **Workforce Education and Training** – As agriculture becomes increasingly science- and knowledge-based, agricultural innovation companies require increasingly sophisticated human capital and capacity. In addition, as innovation and technology continues to migrate ever increasingly into agricultural production, the education and training requirements in the production sector are going to continue to increase. As a result, successful models have a strong focus on workforce education and training as well as external talent attraction.
- ◆ **Long Term, Focused Community Engagement** – Community engagement encompasses political leadership, corporate leadership and general community and societal support. Stakeholder engagement is critical, and long-term engagement can typically only be achieved if the efforts are focused around issues and activities that, although perhaps far-reaching in nature, create meaningful long-term value for the stakeholders involved.³¹

³¹ The North Carolina Biotechnology Center, housed in RTP, is just such an example. It develops the strategic direction for North Carolina's biotechnology positioning through collaborative public-private partnerships and also supports innovation economic development initiatives and strengthens the industry-university partnerships in the state.

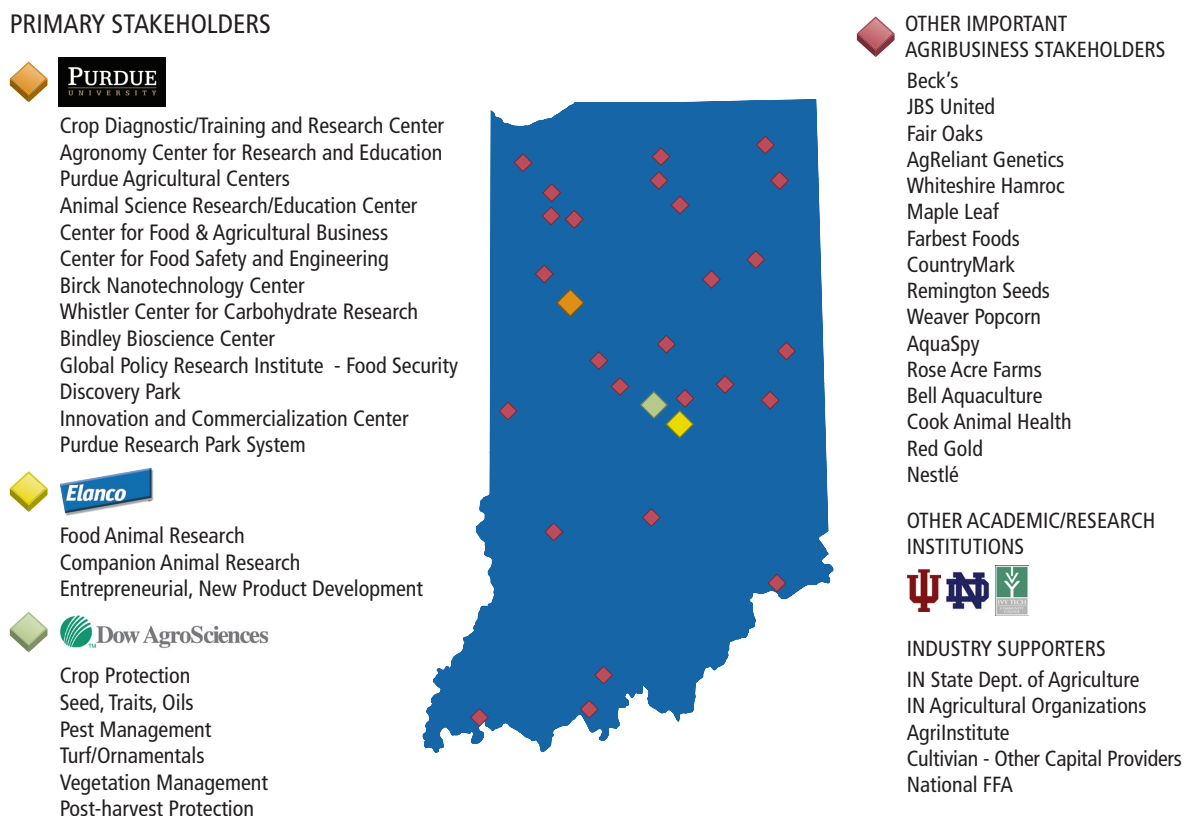
AN OVERVIEW OF INDIANA'S FOOD AND AGRICULTURAL RESEARCH AND AGRIBUSINESS SECTOR

Indiana is recognized as a leader in production agriculture. However, it is the combination of traditional agricultural production capacity and the agricultural related science and technology assets Indiana possesses that make it uniquely positioned to address and capitalize on the larger global trends that are going to reshape the agricultural industry over the next several decades.

Indiana's Food and Agricultural Innovation

Of central importance to food and agricultural research and innovation development in Indiana is the presence of global leaders Dow AgroSciences, Elanco and Purdue University. The plant biotechnology/biosciences expertise of Dow AgroSciences and the animal health and emerging food safety emphasis of Elanco are recognized around the world. The broad R&D expertise across a number of different Colleges and Centers at Purdue University also is notable. When the state's additional research institutions and other research and production agricultural businesses are layered in, Indiana has perhaps an unparalleled set of resources and capabilities that can be drawn upon to solve the emerging global challenges and drive growth in Indiana's agricultural sector (Exhibit XII).

Exhibit XII. Indiana's Food and Agricultural Research and Agribusiness Landscape



Dow AgroSciences is a global leader in providing agricultural crop protection and plant biotechnology products, pest management solutions and healthy oils. Dow AgroSciences invents, develops, manufactures and markets products for use in agriculture, industrial and commercial pest management, and food service. Dow AgroSciences is a wholly owned subsidiary of The Dow Chemical Company and had record annual global sales of \$5.7 billion in 2011 and has approximately 6,700 employees worldwide.

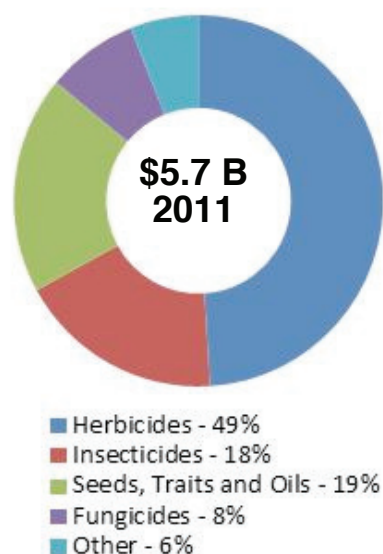
The company was originally known as DowElanco and began in 1989 as a joint venture between the Agricultural Products business unit of The Dow Chemical Company and the Elanco Plant Sciences business of Eli Lilly and Company. The company was renamed in 1997 when Dow acquired 100 percent ownership of the business.

Innovation is foundational to all of Dow AgroSciences' major divisions (Seeds, Traits and Oils; Crop Protection; and Pest and Vegetation Management), and their technologies contribute to meeting the societal challenges discussed earlier. The company uses breeding and agricultural biotechnology in the discovery and development of traits for insect resistance, herbicide tolerance, oil quality, enhanced meal quality, drought tolerance, and nitrogen utilization. Dow AgroSciences has also led in the development of healthier oils for food production and human consumption. In fact, since 2005, more than 100 restaurants and restaurant chains in North America, like Taco Bell, have converted to Dow AgroSciences' Omega-9 Oils. As a result, nearly one billion pounds of "bad" fats have been removed from the diets of North American consumers.

Discovery and Commercialization. Dow AgroSciences employs a multi-phase development process to discover, develop, and introduce new products in the marketplace. The process begins with the Discovery Stage and starting with the basic scientific disciplines (biology, chemistry, molecular biology and genetics), researchers first explore, design and identify potential candidates for insecticides, herbicides, fungicides, crop traits and plant-cell produced proteins.

In Pre-Development, Dow AgroSciences scientists challenge the new product candidates against business targets and fully characterize their behavior in a wide spectrum of environments. Product candidates then proceed to be engineered for optimal and reduced risk performance through formulation and delivery systems prior to launch into the marketplace, where R&D continues to support them. R&D support is ongoing throughout the product's lifespan, including expansion into new markets or crops and re-registration activities.

Dow AgroSciences Sales - 2011



To complete the process, it will take an agricultural chemical compound approximately nine to ten years from the time it enters Phase I of the Discovery Stage until Commercial Launch. This costs an average of \$256 million, according to industry figures. From gene discovery to commercial launch, development and registration of a new trait or stack of traits takes an average of ten years and in excess of \$130 million - and that figure is growing as Dow AgroSciences and its industry partners and competitors focus on increasingly more complex traits.

Collaboration. Dow AgroSciences makes collaboration a key priority and recognizes that it can benefit from others' expertise and technologies. The company collaborates with global industry, academia, and government entities for licensing, partnerships and acquisitions. In fact, Dow AgroSciences leads the industry in the proportion of R&D spending done with outside collaborators. Since January 2010, Dow AgroSciences has entered into a number of important collaborative agreements. These include:

- ◆ June 29, 2012 – Dow AgroSciences, The Royal Barenbrug Group Announce Relationship to Develop Advanced Germplasm in Forage Seeds;
- ◆ May 24, 2012 – Dow AgroSciences, Agdia Announce License Agreement to Develop Automated Reader for Immunoassay Strips;
- ◆ March 21, 2012 – Dow AgroSciences, Dualsystems Biotech Announce Profiling Agreement to Identify Molecular Targets for Dow AgroSciences' Agrochemical Discovery Program;
- ◆ January 10, 2012 – Dow AgroSciences, Fraunhofer IME Announce Multi-year Research Agreement to Develop Novel Biotechnology Approaches to Improve and Enhance Crops;
- ◆ January 11, 2011 - Dow AgroSciences Identifies Lead Molecule in Collaboration with GVK Biosciences;
- ◆ November 02, 2010 - Viamet Pharmaceuticals, Dow AgroSciences to Collaborate on Development of Improved Crop Protection Products;

Enlist™ - A Dow AgroSciences Commercialized Product Innovation

Dow AgroSciences develops innovation based on customer needs. This is true of the Enlist™ Weed Control System, a combination of chemistry and herbicide-tolerant technology in corn, soybean and cotton germplasm. The new technology leverages the strengths of proven 2,4-D products to manage resistant and hard-to-control weeds. Genes were discovered through a rapid, genomics-based research effort, enabling biotechnology breakthroughs that impart crop tolerance to 2,4-D-containing herbicides, allowing the effective use of new 2,4-D products over crop plants to address accelerating weed control challenges. Dow AgroSciences has also developed Colex-D™ Technology, featured in the Enlist herbicide solutions, which will provide the benefits of ultra-low volatility, minimized potential for drift, decreased odor and improved handling characteristics.

- ◆ September 20, 2010 - Dow AgroSciences, Wageningen UR Enter into Agreement to Use EXZACT™ Precision Technology;
- ◆ September 09, 2010 - Dow AgroSciences, KWS Enter Into Agreement for Research & Product Development;
- ◆ April 16, 2010 - Dow AgroSciences, Iowa State University Enter into Research Agreement Using EXZACT™ Precision Technology in Algae;
- ◆ February 18, 2010 - Dow AgroSciences, Victorian Government Expand Research Alliance;
- ◆ January 12, 2010 - Danforth Center to Collaborate With Dow AgroSciences to Employ EXZACT™ Precision Technology; and
- ◆ January 11, 2010 - Dow AgroSciences, KeyGene Enter Into a Trait Development Agreement.

Dow AgroSciences has also actively engaged in a number of acquisitions, mostly of regional or specialty seed companies around the world. Between 2007-2011, the company acquired 12 other companies based in the United States, Germany, Canada, Brazil, the Netherlands, and Austria.

Dow AgroSciences has made significant R&D investments, acquired strategic companies and developed critical collaborative agreements that should result in significant technology-driven growth. The company's agricultural chemical pipeline is filled with high-value solutions and proprietary formulations for the next ten years, and its acquisitions have strengthened its channel access and technology penetration.

Elanco

Eli Lilly and Company's venture into the animal health field began in the early 1950s. At that time, it was believed that certain findings of the company's scientific research for human medicines would be useful in the plant and animal fields. Lilly introduced its first antibiotic for veterinary use only in 1953. A year later, Lilly formed the Agriculture & Industrial (A&I) Division to handle its non-human marketing.

In 1960, the A&I Division which developed both agricultural chemicals and animal health products was reorganized as Elanco Products Company, and by 1973, Elanco had grown to the point that it supplied nearly one-third of Lilly's sales. Lilly split off its agricultural chemicals in 1989, forming DowElanco, a joint venture owned by Dow Chemical Company and Eli Lilly and Company. Elanco continued to concentrate on its core business of animal science.

Today, Elanco's product line concentrates on livestock for the food animal industry and companion animals. The products encompass four therapeutic classes: antibacterials, parasiticides, anticoccidials, and productivity enhancers. The company conducts research on products and target species and benefits from the research programs of Lilly Research Laboratories. Elanco's primary focus has been on feed additives and other products for the food animal segment of the livestock industry. However, in 2007, Elanco launched Elanco Companion Animal Health, focused on pet medicines.

Elanco is focused on five key objectives as it strives to help feed the world through increased food animal production, and to help companion animals live longer and healthier lives. It does all of this with some amount of its own R&D, but relies heavily on licensing agreements and partnerships with other technology and contract providers.

Food Animal Health and Productivity. Elanco has made it a priority to use proven technologies to sustainably deliver more food with fewer resources. Elanco antibacterials, anticoccidials, vaccines and parasiticides make food safer by preventing and controlling disease and reducing threats to animal health such as enteric or respiratory disease. Productivity enhancers make food affordable and abundant by increasing the amount of meat, milk or eggs from each animal, and safety tools ensure the integrity of the food supply.

Companion Animal Health. Elanco is now recognized as a companion animal pharmaceutical company that has quickly established itself as a trusted source for delivering innovative products.

World Hunger. Elanco has recognized that the availability of animal-sourced protein in the diet is becoming an increasingly important global issue. The company believes in the use of its technology and innovation to ensure a safe, affordable and abundant supply of food. Elanco also helps in the fight against hunger through local and global feeding initiatives.

Food Safety. Elanco has launched a new business platform focused on food safety that develops and markets food-safety products and services to the food-animal industry through Elanco Food Solutions. Elanco Food Solutions offers a new integrated systems approach to food safety and was a natural extension of its services that improve the health and productivity of food animals. As food-production systems around the world evolve, the meat and poultry industries must move toward total-management systems where addressing food safety is imperative.

Technology, Innovation and Science Translation for Animal Health. Elanco has built a disciplined R&D process that has generated a portfolio of products that increase productivity and prevent and control diseases and parasites. Elanco also has forged partnerships with its parent company and biotechnology firms worldwide to meet unmet or under-served needs in animal health. Elanco pursues and builds partnerships with a wide variety of companies and organizations and especially seeks collaborative opportunities with companies developing new:

- ◆ Therapeutic agents that control infectious diseases;
- ◆ Therapeutic agents that enhance food animal production (cattle, swine and poultry);
- ◆ Pet medicines and therapeutic agents for managing acute and chronic diseases in pets (dogs and cats);
- ◆ Technologies to control internal and external parasites affecting livestock and pets; and
- ◆ Food safety technologies.

Purdue University

Within Purdue, there are hundreds of projects related to agricultural innovation and it would be impossible to illustrate the impacts of each and every one. Purdue's land-grant university (LGU) heritage along with its experiment stations and extension service make it a natural leader in basic and applied research that leads to food and agricultural innovation. Some of the most notable areas of research include: agribusiness, agronomy, animal science, biochemistry, food science, food safety, entomology, and horticulture. The distinctive research in these and other areas has brought an international reputation to Purdue. Extensive discipline-based research that involves faculty from multiple colleges and schools has been a critical element of the University's research platform. More recently, Purdue has pooled its research strengths by creating interdisciplinary centers that address challenging societal problems.

Purdue also provides support services to industry in a wide number of R&D areas and in process improvement. The University often provides the testing, piloting and scale-up infrastructure and expertise to propel new innovations and technologies to market. Through the extension service, Purdue translates new knowledge, techniques and tools into production agriculture and other industry segments. Purdue also educates the scientists, engineers, business leaders, producers, and other skilled human capital required to sustain Indiana, U.S. and global leadership in the food and agriculture industries.

Purdue was profiled as a part of a Battelle study focused on all the LGUs in the North Central United States. The areas of major innovation assets that Battelle reviewed fell into the following categories:³²

- ◆ Plant science, crops, agronomy and plant transformation;
- ◆ Animal science, animal health and livestock research;
- ◆ Food product R&D and advanced nutrition and health products development;
- ◆ Biosecurity and food safety;
- ◆ Industrial bioeconomy (fuels, chemicals, materials) research and development; and
- ◆ Environmental sciences and sustainability.

A number of Purdue's centers and other key programs that support the first several of these asset categories deserve specific mention because of their express focus on food and agricultural innovation or because of their unique multidisciplinary approach to research and technology commercialization.

Plant science, crops, agronomy and plant transformation. As would be expected, Purdue has a significant focus on the development, improvement and cultivation of agricultural crops suited to Indiana and the Midwest. Experiment stations perform R&D that leads to crop improvements (i.e., increased yield, improved crop product quality, disease

³² "Power and Promise: AgBioscience in the North Central United States," Battelle, 2011.

and pest resistance). This research comes in the form of both traditional breeding and hybridization techniques and also via the most modern transgenic techniques.

The Purdue University Crop Diagnostic Training and Research Center is known across the Midwest for its work in diagnosing agricultural crop problems. The Center, established in 1985, is designed to assist producers sharpen their crop problem troubleshooting skills and evaluate new and alternative management strategies. At the Center, small plot demonstrations illustrate insect, nematode, weed, disease, soil fertility, and cultural problems associated with corn, soybean, forage, and small grain production. Â

The Purdue Agronomy Center for Research and Education (ACRE), also known as the Agronomy Farm, provides a campus-based field research station for agronomic crops and soils research for departments working on field crops. It is utilized by eight different departments and USDA researchers to conduct studies ranging from basic to applied research including: plant breeding and genetics, crop production and soil tillage management, plant physiology, soil fertility, weed control, disease and insect resistance and control, and variety performance for various crops.

The University also operates eight regional Purdue Agricultural Centers (PACs) across the state to provide opportunities to do research in locations with hundreds of soil types and multiple microclimates. The PACs are used by researchers across the college as they include both animal and plant productions systems as well as a variety of forest land. The regional PACs are designed for applied field, animal and forestry research as well as Extension and outreach efforts that can be applied to the geographic location.

Animal science, animal health and livestock research. Livestock is a major component of the U.S. value-added agriculture system, and Indiana and the Midwest are well-known for their intensive vertically-integrated livestock operations. Purdue provides support to Indiana's livestock industry with work in advanced nutrition for livestock, livestock health products, livestock breeding, meat science, dairy science and other food products development.

Purdue's Animal Science Research and Education Center (ASREC) provides animals, facilities, technical assistance and labor to conduct research, provide instruction, and assist in extension educational activities. Research trials vary from basic to applied and involve many disciplines, including nutrition, physiology, behavior, genetics, reproduction, animal health, and product quality.

ASREC sits on over 1,500 contiguous acres of highly productive land and is located ten miles outside of campus. There are facilities at the center for all species (beef, dairy, poultry, sheep, and swine) plus a feed mill, a farm shop, and business office. In 1996, the USDA-ARS Livestock Behavior Unit constructed a 10,000 square foot facility for scientists to identify how animals perceive and respond to their environment. An aquaculture unit was added in 1997 which further enhances research capabilities.

Food product R&D and advanced nutrition and health products development.

Modern bioscience advancements have allowed Purdue and other LGUs to build active programs specializing in high-value products in the expanding categories of advanced nutrition, functional food and healthcare products such as nutraceuticals and biopharmaceuticals. The emerging marketplace for advanced food and ag-based health products is opening up new opportunities to the development and production of high-value niche food and health products.

Purdue's Whistler Center for Carbohydrate Research is a university-industry research center that conducts fundamental research related to practical applications of carbohydrates. The center works in partnership with companies all across the country to extend uses of carbohydrates, hydrocolloids in general, other biopolymers, and cereals. Private companies become members of the center through a paid fee and benefit from the following services:

- ◆ Generation of fundamental information targeted for new technology development;
- ◆ Access to young scientists trained to understand and work with carbohydrates and related biopolymers via education which stresses application of knowledge of their chemistry, fundamental properties and behaviors, structures, and dynamics; and
- ◆ Collaboration on unique problem-solving capabilities.

Current members include Dow AgroSciences, Cargill, ConAgra, Corn Products International, Genencor, General Mills, GPC, Nestle, Pepsico, Roquette, and Tate and Lyle.

Biosecurity and food safety. Agricultural commodities are primarily produced in open environments, and thus the opportunity exists for natural pathogens or contaminants to reside on harvested production. Livestock, too, face the threat of infectious diseases, and some microorganisms residing in livestock can bring about food-borne illness in humans.

Purdue's Center for Food Safety and Engineering (CFSE) has an important role in developing approaches and technologies to address food safety and biosecurity. There are several food safety research centers nationwide associated with other academic institutions. With few exceptions, these centers are limited to agriculture faculty only, lack recognized multi-disciplinary strengths, and/or are linked to a specific commodity group. Currently, none of the university-based food safety centers include engineering as an essential component. CFSE incorporates engineering to develop physical and chemical mechanisms for detection of microbial and chemical hazards to the food supply. The expertise of engineers is also critical in in process control.

CFSE has a five year cooperative agreement with the U.S. Department of Agriculture's Agricultural Research Service to develop better methods of detection and prevention of biological and chemical food borne contaminants. CFSE positions Purdue as a national leader in food safety research and is grounded in an important multi-disciplinary research approach.

Industrial bioeconomy (fuels, chemicals, materials). The use of biomass as feedstocks for the production of a broad range of industrial products including fuels, chemicals, polymers and materials provides additional growth opportunities for intensive agricultural states like Indiana. The Midwestern region has emerged as a leading producer of biofuels, and Purdue and other universities have made significant investments in developing the faculty and specialized research and infrastructure assets to develop the bioeconomy. Purdue's Center for Energy, the Bindley BioScience Center as well as the Birck Nanotechnology Center are assets that contribute to the development of the industrial bioeconomy.

Beyond Basic Research. Beyond the basic research capabilities of Purdue and the other Midwestern Land grant universities, it is worth noting that over the past decade, Purdue has made significant investments in its infrastructure to promote and facilitate the translation of basic research in to practical application often times in collaboration with the private sector.

- ◆ The **Purdue New Ventures Team in Food and Agriculture** was created in 2002 when it was recognized that the Extension service could provide assistance with economic development opportunities at a more localized level. The interdisciplinary team supports evaluation and development of new business ventures through workshops, conferences, individual consultations, a branded set of publications on effective business planning, and INVenture, a web-based interactive business planning tool. The team is composed of faculty, staff and county-based Extension educators who are specialists in agricultural tourism, entrepreneurship, economics, farm management, agricultural finance, agricultural economics, horticulture, agricultural and biological engineering, food science and aquaculture. The New Ventures team has importantly developed educational materials and tools essential to cultivating successful entrepreneurial ventures.
- ◆ The **Center for Food and Agricultural Business** provides innovative and relevant professional development experiences, advanced degree opportunities and applied research to firms and individuals operating in those industries, which interface with production agriculture through deep linkages with industry, a world-class faculty, and a professional staff with unmatched program development and delivery capabilities. The **Center for Commercial Agriculture** was recently created to serve the professional development and applied research needs of those who make their living farming. Through innovative professional development experiences, supported by creative applied research, and integrated with undergraduate and graduate degree programs, the Center for Commercial Agriculture helps prepare current and future farmers for the challenges of feeding and providing energy for a growing world.
- ◆ **Discovery Park** and its major centers lead Purdue's large-scale interdisciplinary research efforts. The Park was launched in 2001 with a \$5 million commitment from the state of Indiana for a nanotechnology center. Today, it is a \$600 million research and learning complex of eight core centers, where more than 4,000 faculty

members and students are using an interdisciplinary approach to tackle significant research questions using nanotechnology and biotechnology. Purdue has attracted more than \$550 million in sponsored research in the first ten years of Discovery Park's interdisciplinary approach.

Today Discovery Park operates as a self-sustaining entity through the following eight core centers: Bindley Bioscience Center, Birck Nanotechnology Center, Burton D. Morgan Center for Entrepreneurship, Discovery Learning Research Center, Global Sustainability Initiative (Center for the Environment, Energy Center, Purdue Climate Change Research Center and the Center for Global Food Security), Advanced Computational Center for Engineering and Sciences (Cyber Center/Computing Research Institute and the Rosen Center for Advanced Computing in ITaP), Oncological Sciences Center and the Regenstrief Center for Healthcare Engineering. The Park provides an innovative and collaborative environment where major research challenges can be examined objectively and with a view towards generating economic development opportunities in the state and region.

- ◆ The **Innovation and Commercialization Center** supports Purdue's broader and nationally-recognized commercialization activities. The Association of University Technology Managers ranked Purdue sixth nationally for its commercialization successes in the 2010-2011 fiscal year. Purdue, through its research foundation, had 11 startups in the same period. Yet, university leadership recognized that greater flexibility in research and technology translation models and also collaboration with the private sector is needed. Therefore, Purdue announced in January 2012 the launch of a new research commercialization center that will have an impact on food and agricultural innovation discoveries and help move those to the marketplace more quickly. The Innovation and Commercialization Center is a long-term initiative to support core university activities and will increase revenue for the university, and spur economic development in Indiana.

The center, housed in the Burton D. Morgan Center for Entrepreneurship in Discovery Park, will serve as a "one-stop shop" for faculty and staff inventors and offer seed grants and other funding for testing concepts, developing prototypes or participating in joint technology development projects with external partners. The center is expected to attract investors and venture capitalists who are seeking fast-paced innovation development and unique partnerships and collaboration.

The Purdue Research Foundation's Office of Technology Commercialization (OTC) will be part of this new effort. OTC importantly provides Purdue faculty, staff and student entrepreneurs advice and support in establishing intellectual property rights and turning those discoveries into products and services, and the Innovation and Commercialization Center will expand its resources to support the translation of Purdue discoveries.

- ◆ The **Purdue Research Park** also has a critical role in technology commercialization and economic development. The Park system now has four locations across Indiana and 200 companies that employ more than 4,000 people. When established in 1961, the Purdue Research Park was the third such park established in the United States. Stanford Research Park was founded in 1951, and the Research Triangle Park in North Carolina followed in 1959.

“First-rate research, with a goal of creating innovative goods and services, is an indispensable element of any state’s economic success, and the Purdue Research Park is Indiana’s flagship asset in this realm.”

– Governor Mitch Daniels on the Park’s 50th Anniversary Celebration, 2012.

The Purdue Research Park is a prime location for Purdue University faculty researchers who wish to commercialize their discoveries. There are nearly 70 Purdue faculty directly involved in new companies based in the Purdue Research Park.

The Research Park has worked closely with state and local economic development officials to encourage several companies to relocate to Indiana. These and the other companies housed in the Park are from a diverse array of sectors, including life sciences, agrosience, cybersecurity and manufacturing.

Dow AgroSciences Makes Significant Investment at Purdue Research Park –A Successful Collaboration

Dow AgroSciences recently relocated its Seed Quality Control Lab from Iowa to a larger laboratory site at the Purdue Research Park in West Lafayette. The Purdue Research Park lab facility will enable the future capacity and capabilities needed to support the growing Dow AgroSciences Seeds business, as well as serve as a proving ground for its next generation technologies. Additionally, the new lab facility will allow for the implementation of additional testing technology and capabilities, future expansion opportunities, and closer collaboration with student and faculty talent at Purdue and Dow AgroSciences’ own scientists at their Indianapolis headquarters.

The new lab facility is an addition to the current Dow AgroSciences presence at the Purdue Research Park, which includes a 15,000 square foot research and development space and an 11,000 square foot greenhouse complex leased by Dow AgroSciences for life sciences research. To help fund the life sciences research project in 2010, the Indiana Economic Development Corporation provided a \$2.2 million grant to the Purdue Research Foundation to assist in the construction of the greenhouse.

The Purdue Research Park has been recognized by state, national and international organizations. In 2008, the International Economic Development Council presented the Research Park with three first-place awards for excellence in economic development in the areas of entrepreneurship, partnerships with educational institutions and technology-based economic development. In 2010, the National Business Incubation Association honored the Purdue Research Park Entrepreneurship Academy with the Incubator Innovation Award.

Other Agribusiness Research and Innovation Leaders

The following alphabetical inventory is intended to showcase the diversity of Indiana's agribusiness industry spanning the spectrum from research to production. The following companies and organizations, although not at the scale of Dow AgroSciences, Elanco, or Purdue University in terms of their investments in science and technology innovation, are nevertheless, making significant investments in the development and adoption of research and innovation to advance their organizations and in aggregate represent a significant portion of the agricultural based research and development and technology adoption occurring in the state.

AgReliant Genetics (Westfield). AgReliant Genetics is the fastest growing independent seed company in the industry and currently the fourth largest field seeds company in the United States. They focus on offering the best seed products to North American customers through superior research, breeding and production techniques by focusing only on seed. AgReliant Genetics is owned by two of the largest independent seed companies in the world. KWS and Limagrain bring over 200 years of combined seed experience to AgReliant Genetics. Innovation, superior service and exceptional customer value are the center point of their multiple seed brand offering.

AquaSpy (Indianapolis). AquaSpy was founded in 1998 in Adelaide, Australia by agronomists seeking a way to better measure and monitor soil moisture levels. AquaSpy data is analyzed, converted into actionable conclusions, and delivered directly to a web browser, making the service easy, intuitive and affordable. AquaSpy's mission is to take the risk out of growing by providing data and alerts to farmers regarding the health and requirements of their crops, based on measurements of soil-plant interaction. There are 683 million irrigated acres in the world that could benefit from being monitored by this technology, generating an interesting return for farmers if applied correctly. The company has thousands of sensors deployed in Australia, South America and the United States.

Beck's (Atlanta). Beck's is a family-owned seed business celebrating a 75 year (three generation) history. Beck's sources quality seed genetics and technologies from suppliers worldwide to offer a larger selection of traits and genetics to its customers. Beck's also conducts its own extensive breeding and other research trials. The company prides itself on the Beck family's commitment to the seed industry and views its strong relationships with multiple suppliers to access the best performing products, its recruitment and retention of

good employees, and its training of quality dealers as some keys to the company's success and continued growth. Beck's is the sixth-largest seed company in the United States and the only one in the top six that is family-owned.

Bell Aquaculture (Albany). Bell Aquaculture is the nation's largest yellow perch aquaculture facility. Bell utilizes the world's latest genetic, nutritional and production research in producing yellow perch, but also is a leader in sustainable production. Bell has worked with experts, initiated research and development, and employed licensed university technology to grow its fish. The operation is vertically integrated with fish raised directly from broodstock and egg to production size.

Biosafety and environmental innovations are critical to Bell. The fish are grown indoors in re-circulating aquaculture systems so there is no danger of outside contamination of any kind. The fish live in water that is purified on-site and held to the same standards as a municipal water supply. Bell also has a state-of-the-art FDA inspected processing facility.

Cook Animal Health (West Lafayette). Cook Animal Health is a new division of Cook Biotech. Cook Biotech was established in 1995 following a Purdue University biomedical engineering research team's discovery of the unique properties of porcine small intestinal submucosa. Since the company was founded, Cook Biotech has developed and currently manufactures advanced tissue repair products for worldwide distribution. Cook Biotech has over 60 divisions – one now being an Animal Health group - that are generating cutting-edge biotechnology and other applications and looking for ways to cross-pollinate ideas and innovation across divisions.

Cook Animal Health is seeking out well-developed research underway in the animal health industry that may need translation or investment to bring to market. They also are interested in securing animal health products already approved in other countries that could be licensed and brought to the United States for regulatory approval and marketing. The division is focused on animal health products for both large and companion animals. Cook already has been challenged in its search for contract manufacturers that can conduct larger scale product testing for animal-based trials rather than human trials and is actively seeking new partnerships to accomplish this.

Equipment Technologies (Mooresville). Equipment Technologies is the largest independently owned manufacturer of self-propelled sprayers (Apache Sprayers) in North America. The company's Apache Sprayers, designed by Equipment Technologies' innovative engineering and management team, use patented suspension systems and have custom made cabs for maximum driver visibility.

Fair Oaks Farms (Fair Oaks). Fair Oaks Farms is a large, diversified dairy farm, dairy product producer and entertainment destination focused on education of modern agricultural and livestock production practices. Not only does Fair Oaks employ the most modern dairy production, nutrition, health, and biosecurity technologies, but the company

is also a leader in other unique innovations including anerobic digestion and also functional food product development. Fair Oaks Farms has transformed animal waste through anerobic digestion to produce methane gas, which is transformed to gasoline and piped directly to the Farm's own fueling station for compression and use in their truck fleet.

Fair Oaks also provides milk to and collaborates with the cooperative Select Milk Producers on a unique functional food/sports nutrition beverage. The product, known as Athlete's HoneyMilk, is now available nationwide.

Farbest Foods (Huntingburg). Farbest Foods is one of the largest turkey companies in the United States and a respected leader in the industry. Farbest supplies fresh and frozen turkey products to brand-name value added further processors around the world. Farbest is an adopter of the most modern livestock production technologies and standards. The company meets and exceeds USDA requirements and adheres to Hazard Analysis Critical Control Point (HACCP) food safety management guidelines utilizing on-site PCR lab equipment that tests bacteria through DNA technology. In addition, all flocks are tested for Avian Influenza before they are processed.

Farbest Foods processes nearly 40,000 tom turkeys daily under strict food safety and freshness guidelines. Their processing operations are approved by the National Poultry Improvement Plan (NPIP), an agency dedicated to disease-free hatchery products through the use of diagnostic technology.

lotron Industries (Columbia City). lotron Industries Canada Inc. is a Canadian company operating an Electron Beam service center in Vancouver. The company's second facility, lotron Industries USA Inc., just opened early this year. lotron uses patented Electron Beam technology to modify the physical, chemical, molecular and biological properties of materials and products, improving their usefulness and enhancing their value.

The Electron Beam technology has important applications in the food industry through irradiation. Irradiation processing can improve the safety of the food supply by offering several beneficial results including: control and elimination of pathogens, disinfestation and shelf life extension. Numerous agribusiness sectors have also realized cost saving benefits by utilizing Electron Beam processing. Many agribusiness companies require contaminant free materials and products. Electron Beam processing can replace traditional sanitation methods that are often tedious and less cost effective for achieving the control and elimination of pests such as weeds and insects, as well as bacteria, fungus and molds.

JBS United (Sheridan). Founded in 1956 as United Feeds, JBS United is an international leader in the animal nutrition industry providing research-based products worldwide to owners and producers of various animal species. Key divisions of JBS United include: Animal Nutrition, Grain, R&D and Emerging Technologies. JBS United is an employee-owned company with annual sales revenue of \$550 million and nearly 350 employees.

The Emerging Technologies Division of JBS United, Inc. is actively involved in the discovery, development and market introduction of specialty products for the animal industries. This Division includes a team of scientists with decades of experience in a variety of areas related to animal sciences including nutrition, enzyme technologies, reproduction, microbiology, and genetics. The Emerging Technologies program focuses on the following areas of technology and innovation in the animal health and nutrition industry: Agricultural Biotechnology; Digestive Enzymes; Omega 3 Fatty Acids; Animal Probiotics; and Livestock Waste Solutions.

Maple Leaf Farms (Milford). Founded in 1958, Maple Leaf Farms began as a small duck operation producing 280,000 ducks its first year. By 1964, duck production had grown to more than 1 million. Maple Leaf Farms is now North America's leading duck producer, raising 12-15 million ducks annually and accounting for more than half of the North American duck market.

Maple Leaf Farms may come from humble roots, but is always looking to the future in terms of technology and advancements that improve lives. Maple Leaf Farms has become the leader in specialized production due to innovative solutions provided through its subsidiary, MLF Biotech, Inc. MLF Biotech specializes in animal health and nutrition by promoting a healthy digestive tract in the animal through the use of probiotics and by protecting it from ingested toxins through toxicity testing services. MLF Biotech is the exclusive provider of ToxiScreen®, which detects the overall toxicity of ingredients, feed and finished food products with a single test.

Midwest Poultry Services (Mentone). Midwest Poultry Services is a fifth generation, family-owned and operated egg farming business that houses more than two million hens. Midwest Poultry Services is dedicated to the health and welfare of their hens, and goes to great lengths to ensure their hen houses are run with care, high standards of safety and cutting edge process technologies.

Specifically, Midwest Poultry has been a national leader at incorporating innovation and technology to combat salmonella. All of the farm's hens come from hatcheries certified to provide chicks free of salmonella. The young birds are vaccinated to create resistance to the bacteria. Finally, a complex system of stacked conveyor belts and fans move the waste materials from the barns over a three day period so that it is completely dried and available for resale as a commercial-grade fertilizer/nutrient material for crop application.

Nestlé (Anderson). Switzerland-based Nestlé operates its world's largest ready-to-drink beverage production facility. The production and distribution center makes Nesquik and Coffee-Mate and represented at the time of its construction the company's single, largest capital investment (initially \$359 million with subsequent expansion) in the 140 years of the company's history.

Nestlé's Anderson plant produces milk-based beverages using a system of packaging sterilized products in airtight containers so that freshness is preserved for several months.

Nestlé has made other investments in Indiana, including a water bottling operation in Greenwood and an ice cream production plant in Fort Wayne.

Red Gold (Orestes). Red Gold is a family-owned tomato canner and food company that began in 1942 to provide canned food products for the war effort. While the company's peak harvest of fresh tomatoes lasts only 12 weeks, 40,000 hours are devoted to quality testing each summer. This includes over 361,000 quality tests by the company's own food science specialists. Red Gold depends on the creativity and knowledge of their food scientists and technologists to ensure they are responsive to ever-changing consumer tastes and trends. Red Gold's Research and Development Department continuously develops new formulations for a wide variety of tomato products. The company also works to develop suitable genetic strains of tomatoes that are best suited for their production needs.

Remington Seeds (Remington). Remington Seeds is the largest corn and soybean seed contract production, packaging and distribution company in the United States. The company's innovation and use of technology allows it to partner with some of the world's leading seed retailers to provide the highest quality corn, soybean and wheat seed products available.

Remington Seeds bundles a number of cutting-edge technologies in its operations to preserve the genetic integrity of the seed, to perform quality testing of finished products, and to package, label and palletize the finished seed products. Remington Seeds has also developed a proprietary inventory management system that allows real time tracking of the operational and quality status of seed during field, plant and warehouse operations.

Rose Acre Farms (Seymour). Rose Acre Farms is the second largest egg producer in the United States and is a family-owned egg farm with operations across the Midwest. The family's association with eggs and farming dates back at least 125 years. The firm's 16 million chickens supply fresh eggs to customers in most parts of the United States, as well as dried and liquid egg products for use by the foodservice industry.

Rose Acre has been a leader in innovation and patented technology. In early 1993, Rose Acre licensed a patented method of processing liquid eggs with microwaves to extend their shelf life.

In 1998, Rose Acre introduced a new egg called Golden Premium that contained seven times the vitamin E of regular eggs and enhanced levels of Omega-3 fatty acids. The eggs, which were produced by changing the nutritional content of a chicken's diet, cost a third more than standard ones. Rose Acre also has used laser technology for over a decade to print dates on eggs to indicate when they were laid. The company was the first in the country to do so and used a special inkjet printer that could mark 2,400 eggs per minute with food-grade red ink. In addition to the date, the eggs showed a Rose Acre Internet address, www.goodegg.com.

Weaver Popcorn (Noblesville). In 1928, Reverend Ira Weaver founded the Weaver Popcorn Company shucking and bagging his own carefully-grown popcorn, then delivering it to his customers with the assistance of a horse-drawn wagon. Today, Pop Weaver has

become a leading brand of microwave popcorn, distributing products throughout the United States and to more than 90 other countries worldwide.

In 2010, Weaver Popcorn initiated a partnership with Dow AgroSciences to create a healthier popcorn product using Dow AgroSciences Omega-9 canola oil. The new microwave popcorn was not a line extension but rather an entire replacement of their old product formulations to enhance the health profile of the popcorn. The company employs state-of-the-art product formulation and packing technologies and also has made sustainable production a priority, using less packaging material and ink and utilizing natural, unbleached bags.

Whiteshire Hamroc (Albion). Whiteshire Hamroc is a foundation swine genetics company with the most elite Yorkshire, Landrace, and Duroc genetics in the world. According to the registrations at the National Swine Registry, Whiteshire Hamroc is the largest recorder of Yorkshire and Duroc, and the second largest recorder of Landrace swine in the United States.

Whiteshire has devoted extensive resources in three major areas: herd health, genetics, and environment. Stringent health control and bio-security is a high priority research area for Whiteshire. The company also uses a combination of proven technologies (Herdsman, STAGES, and “Real-time” scanning) with phenotypic selection to continually improve their genetics and build more productive, profitable seedstock. Whiteshire also has developed an innovative, patented building and ventilation system, called AIRWORKS, to provide quality air space.

Supporting the Advancement of Indiana’s Agricultural Sector

In addition to the entities involved directly in food and agricultural research and production, there is another important group of contributors and organizations that are critical to the promotion of and economic development activities in the industry.

AgrilInstitute. Established in 1983 as the Indiana Institute for Food and Agriculture with Lilly Endowment support, AgrilInstitute today is a nationally recognized leadership development organization that also facilitates a robust network of agricultural and rural leaders. A cornerstone program of AgrilInstitute is the two-year Indiana Agricultural Leadership program that has a curriculum of leadership learning with agriculture at its foundation.

Cultivian Ventures. Cultivian Ventures, LP, is a venture capital fund focused on high technology opportunities in the food and agricultural sectors. Cultivian operates from Indianapolis and the Midwestern region, which they contend hosts the world’s greatest concentration of public and private R&D spending for food and ag markets. Originally known as the Midpoint Food and Ag Fund LP, Cultivian works closely with the management of emerging technology companies to bring cutting edge technology solutions to market. Other traditional financial firms and venture capital groups in the Midwest (Periculum Capital, Credit Suisse, Open Prairie Ventures, Rural American Fund, and City Securities, among others) also are active in the food and agricultural industry.

Indiana's Commodity and Trade Organizations. Indiana, like other Midwestern states, has an active and well-organized trade association network to represent the specific interests of agricultural producers and businesses. These groups provide valuable education and industry information to their members as well as political engagement on key legislative and regulatory issues. While they operate independently, they will coordinate efforts more broadly around critical policy or industry issues. These include: Indiana Farm Bureau, Indiana Soybean Alliance and Indiana Corn Marketing Council, Indiana Pork Producers, Indiana State Poultry Association, Indiana Beef Cattle Association, Indiana State Dairy Association and Indiana Professional Dairy Producers, and the Agribusiness Council of Indiana.

Indiana State Government – Indiana State Department of Agriculture. This first-ever cabinet level agency focused on agriculture was created by Governor Mitch Daniels in 2005. Unlike most state agricultural government agencies, ISDA has very limited regulatory functions and instead serves as an advocate for the sector, with emphasis on promotion and economic development. ISDA resources are devoted to a number of initiatives under three strategies, including:

- ◆ Advocacy (Outreach, Regulatory Coordination and Policy Development Initiatives) – ISDA serves as an advocate for Indiana agriculture at the local, state and federal level.
- ◆ Environmental Stewardship – the Department works with agricultural stakeholders to enhance the stewardship of natural resources on agricultural land in a manner that creates value-added opportunity for producers and assists agriculture stakeholders with current and future regulatory challenges.
- ◆ Economic Opportunity (Hardwoods, Entrepreneurship, Livestock, International Trade and Bioenergy Initiatives) – ISDA is expected to define and nurture economic opportunity, including technology development, in the food, fuel and fiber sectors.

Ivy Tech Community College. Ivy Tech, as the state's only community college network and largest public post-secondary institution, has enhanced its agricultural curriculum and course offerings in recent years to meet the rapidly changing needs of agriculture employers. Two degree programs in agriculture are offered at multiple campuses to prepare students for careers in crop and livestock production and agribusiness. One of the programs also allows students to transfer to Purdue to continue a full four-year agricultural degree education.

National FFA Organization. The National FFA Organization is headquartered in Indianapolis and is the nation's premier youth agricultural education and leadership development organization. Founded in 1928 as the Future Farmers of America, the organization's name was changed in 1988 to the National FFA Organization, now commonly referred to as simply FFA, to recognize that the organization supports students with diverse interests in the changing food, fiber and natural resource industries, encompassing science, business and technology in addition to production agriculture. Today there are over 540,000 members with nearly 7,500 chapters in all 50 states. FFA

chapters are expanding in urban/suburban areas as career opportunities in food and agriculture continue to expand. Today, FFA chapters are in 18 of the 20 largest U.S. cities, including New York, Chicago and Philadelphia.

“Today, we are still the Future Farmers of America. But, we are the Future Biologists, Future Chemists, Future Veterinarians, Future Engineers and Future Entrepreneurs of America, too.”

– FFA

FFA advisors and agriculture teachers deliver an integrated model of agricultural education providing students with innovative and leading-edge education, enabling them to grow into competent leaders. The leading educational offerings for students include: agri-science, biotechnology, agricultural mechanics, horticulture, animal science and natural resources.

Battelle Study Finds Areas of Common Interest and Research Focus

In May, BioCrossroads released a report conducted by the Battelle Technology Partnership Practice, Advancing Indiana’s Life Sciences Competitiveness and *Strategic Collaborations*, that reviewed the broad research and innovation drivers of our state’s economy. The study highlighted significant innovation and strategic technology platforms for Indiana in the following life science areas:

- ◆ Drug Discovery, Development, Delivery and Diagnostics;
- ◆ Global Health;
- ◆ Health Informatics, Outcomes and Clinical Research;
- ◆ Orthopedic, Surgical and Interventional Therapy Instruments & Devices; and
- ◆ Plant Improvement.

The Battelle study clearly validated the presence of significant agriculture-related innovation assets and identified Plant Improvement as a key strategic technology platform to be further developed. According to the study’s own definition, plant improvement “incorporates plant breeding, hybridization, and plant transgenics for desirable input or output traits. Input traits include attributes in crop protection and yield enhancement, such as disease/pest resistance, nitrogen or water use efficiency, abiotic stress tolerance, etc. Output traits include attributes such as functional nutrient enhancement, downstream processing of food ingredients/biomass, specific chemical/oil composition, etc.”

The study profiled Dow AgroSciences as an industry leader in plant biotechnology focused on gene discovery, mechanisms for manipulating gene expression, discovery of traits, and quantitative mapping to improve varieties. Other ag biotechnology companies are referenced, including AgReliant Genetics, Beck’s, and Remington Seeds, among others. The study also acknowledged Purdue University as one of the nation’s leading universities in agbiosciences with a long-standing traditional strength in plant breeding/hybridization

expertise. Purdue is also heavily involved in the application of genomics, genetics, and modern molecular approaches to plant improvement. Through this process, Battelle was able to identify three specific areas that are particularly well aligned across industry and academia—plant genetics and genomics; entomology, insect pest control and crop protection; and food science, products and safety.

The strong presence of both industry and academia in agricultural biosciences make Indiana highly competitive in this life sciences platform, according to the study. However, the report also observed that existing collaborations are limited and that there may be opportunities to further and more significantly leverage the assets and capabilities in-place through efforts specifically aimed at improving coordination and collaboration.

Some specific recommendations were offered for consideration on how to begin enhancing collaboration among these entities for greater impact. These included:

- ◆ **Developing Multi-institutional Collaborations.** Whether by forming a formal shared institute, or a more ad hoc partnership between institutions, a first step needs to be the bringing together of academic and industry parties to determine joint R&D themes.
- ◆ **Supporting Technology Commercialization and Entrepreneurship.** While there are some smaller and more lifestyle oriented businesses and farm-based businesses in the plant improvement/specialty foods arena, there has not been a concerted effort to facilitate the growth of higher performance, entrepreneurial businesses with the goal of growing them into substantial enterprises. There is a growing base of venture capital entering the agbioscience space, and opportunities may exist to better identify early stage opportunities and work through a formal vetting and assistance process.
- ◆ **Facilitating Cross Industry Engagement.** Building connectivity and business development opportunities between first-tier companies, such as Dow AgroSciences, and second-tier agbioscience businesses in Indiana.
- ◆ **Leveraging Existing Assets.** Leveraging the IT and informatics capabilities of the research universities to assist industry with analytical needs. Modern genomic and post-genomic science techniques generate massive quantities of data—data which lend themselves to the large-scale computing infrastructure and advanced analytical capabilities of the universities. Collaborations between industry and the universities in this area can help advance the methods and tools of plant data analysis, and form the basis for the discovery of new commercial opportunities.

In addition, Battelle identified “foods for health” as another area of promise for greater development. The Battelle authors correctly point to a number of characteristics that well-position Indiana in this “food for health” arena, including the world-class plant genetics and breeding programs at Dow AgroSciences and Purdue, the food science research at Purdue and also the clinical research capacity at the Indiana University School of Medicine. In this area, “basic research can be applied to identify phytochemicals and plant constituents” that can lead to the production of value-added functional foods or

nutraceuticals. Functional foods and nutraceuticals are a particularly exciting area of agricultural research because of the profound impact these products could have on many of the global problems already described – feeding a growing population and improving human health and well-being.

There may also be broader networking and collaborative opportunities in this area than even what the authors suggest. Food for Health can be more broadly defined to also include the agronomic, crop and livestock production, plant biosciences, animal health, food processing and safety fields as well as the basic science and research, capital and educational training needed to support such a comprehensive area of food and agricultural innovation.

Summary Observations

The presence of global leaders like Dow AgroSciences, Elanco and Purdue University is critically important to the development of food and agricultural research and innovation in Indiana. The plant biotechnology/biosciences expertise of Dow AgroSciences and the animal health and emerging food safety emphasis of Elanco are recognized around the world. The broad R&D expertise across a number of different Colleges and Centers at Purdue University also is notable. When the state's additional research institutions, research and production agricultural businesses and supporting associations and agencies are layered in, Indiana has perhaps an unparalleled set of resources and capabilities that can be drawn upon to solve the emerging global challenges and drive growth in Indiana's agricultural sector.

In addition, there are some very clear areas of shared research interest and capabilities that could represent significant opportunities for collaboration and engagement that would further strengthen the position of the organizations involved and help drive agricultural research and innovation from local, global, and even non-agricultural based sources particularly in the areas of plant improvement and functional foods. It is also this type of collaboration and engagement that could begin to provide Indiana a clear foothold and a stronger leadership position in the increasingly knowledge-based global agricultural economy.

It should be noted that there are many other companies not profiled in this report that represent significant capacities in agricultural input (seed, chemical, fertilizer, equipment) suppliers including agricultural cooperatives, production and agronomic technology developers, crop and livestock operations, grain processing and logistics firms, feed mills, livestock integrators, food processing companies, and many others. The question becomes how can all of Indiana's agriculturally related assets be better coordinated and leveraged for mutual and statewide benefit that advances Indiana's position as a global leader in agricultural production and innovation.

THE ROADMAP FOR ADVANCING INDIANA'S FOOD AND AGRICULTURAL SECTOR

A key question that has surfaced in both the Battelle Life Sciences Competitiveness study and discussions with industry leaders is how further engagement and collaboration between and among agricultural and non-agricultural stakeholders in Indiana, regionally and globally, can occur. The Battelle study acknowledged a limited “collaborative environment” and the need to build awareness of capabilities and interests across institutions.

To better understand the areas of interest and opportunity for possible broad based stakeholder engagement for further industry collaboration and growth, direct conversations and extensive discussions were conducted with many key agricultural stakeholders. During these conversations, a number of key themes began to emerge, including:

- ◆ **Collaboration** – There was significant interest in business-to-business and public-private engagement leading to potentially collaborative efforts that could dramatically advance the Indiana agricultural sector. How can local, regional and even global collaboration be supported and facilitated with Indiana-based organizations?
- ◆ **Early Stage Technology Translation and Advancement** – Innovation occurs globally and is a key driver of economic activity. What can be done to help identify and attract technology and facilitate its commercialization in Indiana?
- ◆ **Sector Promotion and Support** – Collaborations and technology advancement can be encouraged or discouraged based on a number of factors such as public policy, sector branding and promotion, and workforce capability and capacity. How can these factors be promoted, supported, facilitated and/or coordinated to provide the most fertile environment possible for collaboration and technology advancement?
- ◆ **Asset Leverage** – In a number of the stakeholder conversations, a handful of specific potential platforms were identified for further consideration and exploration. These platforms, if brought to fruition, would provide the sector non-competitive, but highly specialized capabilities that could benefit individual stakeholders as well as the sector in general. Two areas identified for initial exploration are big data analytics and food for health. The attractiveness and potential of these initial platform areas are driven by stakeholder interest, but importantly represent areas of significant existing capability as identified by the Battelle Life Sciences Competitiveness study.

Indiana's food and agricultural innovation advancements have evolved over time and are found in nearly all parts of the state and in all segments of the traditionally defined agricultural sector. Lengthy investigations and discussions with key leaders at Dow AgroSciences, Elanco, Purdue University and several dozen other entities made it clear

that this sector, while admittedly experiencing growth and recognized for its talent and capacities, has the potential for significantly more innovation and broader statewide economic impact if it can better identify, organize, and engage stakeholders around areas of common interest and concern.

Collaboration

Despite a strong network and familiarity that seem to exist in Indiana's food and agricultural sector, there still is strong interest in seeking and identifying new business partnerships, both public and private and internal and external to food and agriculture. Many businesses are seeking new connections and opportunities for engagement not just in Indiana, but across the region as well as around the world, in order to find novel research and source new technologies.

- ◆ **Value Chain Support.** The typical continuum of technology development and commercialization begins with technology identification, then moves to proof of concept and ends with product development or commercialization. Cutting across the entire "process" is an often complex regulatory environment. One agribusiness leader shared that "partners fill these gaps for us, and we need an array of expertise and capability to successfully complete this technology identification and commercialization process."
- ◆ **Partner and Technology Sourcing.** Many stakeholders agreed that innovation and technology is abundant today. It is the identification and recruitment or application of the technologies that has yet to be effectively facilitated. One stakeholder offered that their business "needs to be able to cast a bigger net" to identify new technologies and partnerships and not just communicate with their long-standing business partners. Another executive was interested in any effort or venue that would help their business "connect more dots" with a wider variety of potential partners in both the private and public sectors.
- ◆ **Beyond the State and Beyond Agriculture.** Private sector relationships also are being redefined today as many traditional food and agricultural companies are seeking new partnerships with technology start-ups, with other food and agricultural companies that are outside their industry segment, and now with non-agricultural firms that provide unique technology services. For example, many food and agricultural technology developers are successfully applying traditional manufacturing, engineering, biotechnology and contract services including clinical laboratories, and safety analysis services to the agricultural sector.
- ◆ **Private Sector/Academic Relationships.** Private/public partnerships have long existed and have been quite successful in the food and agricultural sector. The research platforms of Purdue University and the IU School of Medicine have historically collaborated with industry and are increasingly motivated to participate in novel public/private partnerships that leverage assets and capabilities.

The traditional relationship (or “contract”) between stakeholders and our broader “society” and public academic institutions was long modeled on society’s financial support for the university research that ultimately supported and expanded human knowledge which befitted both the private sector and research. Today, the model is different and society increasingly expects economic value in the form of new businesses, jobs, an improved tax base and increased self-support by the university and its researchers.³³ University researchers have long been expected to publish and contribute to human knowledge and today, more than ever, are strongly encouraged to create, license and collaborate with the private sector. In addition, as agriculture becomes increasingly science and technology driven, industry is under greater pressure to innovate, which is an exceedingly expensive proposition.

Today, in an increasingly competitive landscape and with budget cuts widely applied to state universities, new private/public partnerships are being developed that are more flexible, specific to the private company’s research needs and areas of academic expertise, and provide other cross institutional benefits such as access to faculty and industry scientists through sabbaticals, shared labs or other awareness and engagement models.

This new paradigm calls for changed relationships between universities and business and will require that universities adopt more flexible research, licensing and technology commercialization models with the private sector. A number of business leaders commented that the “traditional university culture makes it difficult for researchers and faculty to engage effectively, which limits the value for both parties.”

Universities also must be open to greater collaboration with other research universities and academic institutions. One agribusiness executive openly supported the creation of a targeted “multi-university consortium” that could leverage the research strengths of multiple institutions while facilitating easier engagement and collaboration. This was also the conclusion of Battelle’s North Central United States Land Grant University study that focused on the twelve states in the North Central United States and their research assets across all the land-grant universities in the region.

Early Stage Technology Translation and Advancement

Stakeholders mentioned frequently the challenge in identifying, evaluating, funding and helping commercialize promising technologies. Connecting innovators to industry early in the development process means products and services can be created more quickly. Yet, there are limitations that stakeholders identified today in terms of access to capital, sourcing of technology and availability of entrepreneurial talent.

- ◆ **Capital Access.** While considerable investments are being made in early-stage technology developments and research in the medical, drug and device and even traditional biotechnology fields, there is minimal financial support for early-stage

³³ Model developed and presented by Cultivian Ventures.

technology translation or commercialization of food and agricultural innovation. This remains a limiting factor for entrepreneurs, private industry and public institutions.

Access to capital is a significant challenge today whether a university researcher or start-up venture. The business development continuum requires financial resources and funding at multiple stages, whether in the form of grants, traditional bank or other financial institution financing, angel investment, venture capital, or strategic partnerships.

The most significant challenge for all parties involved comes during the proof of concept or technology translation stage. It is at this point where the science and technology is the least proven and most risky. It is also the stage at which capital is most limited due in large part to current economic conditions, which have caused investors to look for later stage, less risky opportunities. In addition, much of the early stage capital has been redeployed by investors to reinforce the economic viability of existing venture investments, which has further siphoned capital away from early technology translation.

Venture funding also remains heavily focused on other industries. As recently as 2010, the top industries pursued by the approximately 800 U.S. venture funds included telecommunications, electronics, software, new media and biopharmaceuticals.³⁴ Food and agriculture as an industry is not even tracked as a venture capital category.

Fortunately, venture capital seems to have a growing interest in food and agricultural investments. Today, there are about five to six funds focused solely on food and agriculture, and they are located in Indiana, Illinois, Wisconsin, Massachusetts and Canada. A number of other mainline funds are also expressing interest in co-investing with other funds on food and agriculture innovation. The challenge for many in the venture capital community is their lack of understanding and familiarity with the food and agricultural science and sector. Some of that can be attributed to geography as the venture capital centers are primarily located on the East and West coasts while the food and agricultural industry's core base and assets are more geographically central.

Some specific suggestions that were raised by stakeholders include the establishment of new or further support of existing venture capital and seed funding sources targeted towards food and agricultural innovation advancement as well as expanded industry engagement, which could help to identify co-development partners as an alternative vehicle for advancing early stage technology. In addition, the advancement of grant programs like those at the NC Biotech Center that focus on proof of concept testing could provide significant benefit to university and industry partners by allowing the technology to be further matured prior to commercialization. A proof of concept grant program would also be an attractive vehicle for helping to attract globally sourced technology to the state.

³⁴ Thomson Reuters, 2010.

- ◆ **Technology Sourcing.** In addition to capital formation, technology sourcing is another area of potential interest. Science and technology innovation is a global undertaking, and several stakeholders expressed interest in vehicles or programs that could help to facilitate the awareness and identification of and engagement with agricultural and non-agricultural technologies that could have significant applications in the food and agricultural sector.
- ◆ **Entrepreneurial Talent.** Another often-stated need from business leaders is the development of a larger entrepreneurial talent base, both within the university research community, the youth of the state and innovation and technology developers. More economic development strategies today acknowledge the critical importance of a knowledge-driven workforce and a culture of innovation and creativity, rather than simply focusing on cheap land and labor assets.

Stakeholders acknowledged that creating an environment in Indiana and providing the tools to encourage and support entrepreneurship will ultimately create more new business opportunities that would benefit the food and agricultural sector. Fostering agricultural entrepreneurship is a long-term proposition, but programs that promote entrepreneurship by providing support and/or lowering risk were viewed as highly valuable. The aims of a broad-based entrepreneurial initiative might include several different efforts such as:

- ◆ Education and training for students, researchers, faculty and industry;
- ◆ Building interest in agricultural entrepreneurship through, for example, an entrepreneur in residence program;
- ◆ Facilitating entrepreneurial engagement with academia and industry; and
- ◆ Cultivating an agriculturally focused entrepreneurial community through efforts aimed at talent attraction and retention.

Sector Promotion and Support

A common interest among stakeholders was the general promotion and advancement of the food and agricultural sector as a whole. A number of critical needs were raised in numerous interviews and discussions that if further developed and coordinated could provide benefits to each stakeholder but more importantly elevate the status and success of the state's agricultural industry.

- ◆ **Talent Development and Workforce Recruitment.** The search for more uniquely trained talent has become an increasingly greater priority for food and agricultural businesses as the industry itself has evolved and diversified, especially towards more science, math and engineering based fields.

Advanced Science Education. Increasingly, genetic engineering, molecular biology, biotechnology, informatics, and manufacturing know-how is needed in the food and agricultural industry and requires highly specialized talent with advanced degrees and

experience. Industry leaders commented that there are not enough graduates in the technical fields most needed for advanced research and development. Some even suggested that while the traditional degree for new hires has been in agriculture, the companies can “teach” the new hires themselves about agriculture, but need the technical education to be in the more science based fields such as bioinformatics, genomics, proteomics and chemistry.

STEM Education and Post Secondary Education. Another perspective on education needs was an emphasis on improved problem solving capabilities. More researchers and scientists with these technical skills are being recruited from Asia, underscoring the importance of continued focus on K-12 and STEM education.

A number of specific ideas were presented by stakeholders to more effectively focus on talent and workforce enhancement like promoting a more targeted educational strategy that focuses on food and agricultural science, technology and innovation and entrepreneurship.

Talent Recruitment. Business leaders and human resource officers described talent today as a global commodity – and one that can sometimes be in scarce supply. In order for Indiana’s food and agricultural companies to compete globally, they will need to access talent from around the world. Many stakeholders quickly acknowledged the recruiting they do of undergraduate and graduate students from Purdue, but increasingly they also are looking for talent in specialized or vocational training programs, from other Land Grant Universities, other research institutions and even management and business schools all over the world. Stakeholders were supportive of efforts aimed at community promotion and vitality that could support internal talent attraction and retention efforts.

- ◆ **Education and Policy.** The food and agricultural industry is acutely aware today of the importance of sound policy and education. Most government leaders do not have an in-depth understanding of the scope or unique issues facing the food and agricultural industry. There is an opportunity for the industry to come together and provide education on important agricultural issues. This could include educational roundtables, hosting tours, providing important industry data and analyses and conducting specialized research studies.

Many of the agribusiness firms, associations and entities included in this study pursue their own policy priorities and will, on occasion, coordinate with one another on especially critical policy issues, most of which tend to be legislative. There also is an opportunity to advocate for policies that support an economic development agenda that includes the food and agricultural industry with an emphasis on innovation and technology. One stakeholder highlighted the need for industry to join together and advocate for “incentives and programs that make it easier and less risky for food and agricultural companies to invest in science and technology, people, and agribusiness

operations that are better geared to capitalize on the changing face of agriculture over the next decade.” The combined experience and economic contributions of the stakeholders profiled in this study along with others in the industry well position them to be active contributors to the policy-making process not just in Indiana, but also potentially at the federal level.

- ◆ **Branding.** Many different suggestions have been made for ways to “promote” Indiana’s food and agricultural technologies and innovations. Stakeholders were well aware of the branding and promotion efforts of North Carolina’s biotechnology sector and the KC Animal Health Corridor. North Carolina, for example, described the state as offering the “Complete Life Sciences Package” with a large, diverse biotechnology workforce; collaborative life-science community; and low business costs. The KC Animal Health Corridor was officially “branded” by the passage of legislative resolutions by state legislatures in Kansas, Missouri and even congressional resolutions acknowledging the regional cluster. The KC Corridor fully describes the value of being located in a region that has the world’s largest concentration of the animal health industry on its dedicated web site and even has branded a unique logo to promote the region, their member companies, and the KC Corridor’s programs and initiatives.

Branding would help raise the awareness of Indiana’s agricultural sector nationally and internationally, as well as within the state. Branding would also help to create an awareness of the assets, capabilities and potential that ultimately helps to facilitate collaboration and the attraction of technology, capital and talent.

Asset Leverage

Specific opportunities for either local or even regional platforms have been identified that represent areas of collaborative interest, and importantly, are based on areas in which significant specific assets and capabilities already exist.

- ◆ **Midwestern Based Land Grant University Consortium.** Battelle’s North Central United States Land Grant University study clearly articulates the agricultural asset strengths of the larger Midwestern region and advocated for greater leveraging of this base as well as the private sector and land-grant university research innovation that exists. The areas of the sector with the greatest asset overlap include plant science, crops and agronomy; animal science and animal health; food product research; biosecurity and food safety; industrial bioeconomy research (fuels, chemicals, plastics, etc.); and environmental sciences.
- ◆ **Information Technology/Big Data Analytics.** Stakeholders all commented on the enormity of the data they collect, manage, store and analyze in their businesses. Using a seed company to illustrate, they generate tremendous amounts of data in their own laboratories and from other research partners. At the same time, they also receive equally large amounts of data from the fields and farming equipment of their producers and their farm customers. The amount and types of data are

increasingly complex and additional concerns about privacy continue to mount. There are significant big data management and analytics resources available at Purdue University, Indiana University and the Regenstrief Institute. This presents an opportunity to build a highly specific capability that could have broad applicability across Indiana's agricultural sector.

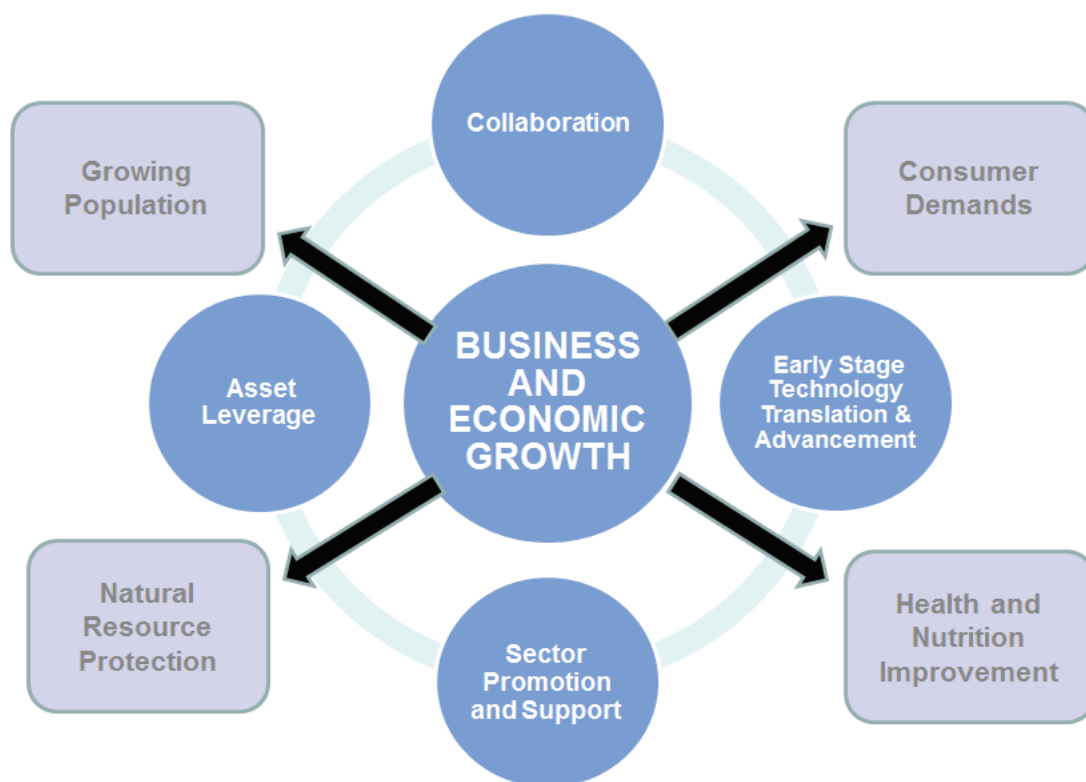
- ◆ **Food for Health.** The Battelle Life Sciences Competitiveness study identified "food for health" as an area of further research and innovation development. Specifically, Battelle described opportunities in the emerging areas of functional food and nutraceutical product development. This focus naturally leverages research and technologies developed by Dow AgroSciences, Elanco, Purdue, and the IU School of Medicine. However, many stakeholders noted the broader networking and collaborative opportunities under this theme than what even Battelle suggested. Food for Health can be defined to include the agronomic, crop and livestock production, plant biosciences, animal health and food processing and safety fields that contribute to the development of new consumer and health-oriented food and agricultural products.

In addition, several additional potential opportunities were also discussed. They included:

- ◆ Biotechnology Analytics – including high resolution spectrometry or Enzyme-linked immunosorbent assay (ELISA) testing;
- ◆ Equipment – food safety testing and delivery devices; and
- ◆ Data Capture – including environmental measurements, imaging, weights, temperature, and bioinformatics.

These four general themes and the specific needs and ideas that support them were repeatedly raised by industry leaders and stakeholders (Figure XII). Importantly, if greater coordination and activity supporting these concepts takes place, there could be both immediate and long-term, sustained business growth in the sector, while at the same time addressing the global changes that are reshaping the sector.

Figure XII. A Roadmap - Collaboration Key to Business and Economic Growth



Not surprisingly, the findings from the local stakeholder interactions turned out to be well aligned with many of the key factors that have been identified previously as important in the RTP and KC Animal Health Corridor profiles. Specifically, stakeholders identified the following areas of emphasis that are exact priorities of these other prominent clusters:

- ◆ Leveraging signature assets;
- ◆ Early stage technology translation and advancement;
- ◆ Workforce education and training;
- ◆ Focused community engagement; and
- ◆ Financial support.

Summary Observations

It is clear the economic vitality of Indiana depends on the continued strength and advancement of the food and agricultural industry. Because of the industry's existing base of innovation and technology and the need for greater productivity improvements to meet increasing global challenges, there are significant opportunities for Indiana to reposition itself as a global leader in agricultural production and technology and science driven innovation through efforts aimed at fostering collaboration, facilitating technology commercialization, promoting the sector, and leveraging assets.

However, if such opportunities are to be pursued, a critical next step is to determine how these efforts should be organized through the continued engagement of the stakeholders themselves. Surprisingly, there is no existing business league or forum for such a dialogue to continue. There are a number of effective agricultural and general business organizations or trade associations that represent specific segments of agriculture or business. However, these groups operate around much more narrowly defined missions. As a result, it is quite possible, that the industry and the state would benefit from a more formal support structure that is focused on the engagement and advancement of these various issues and opportunities.

RECOMMENDATIONS

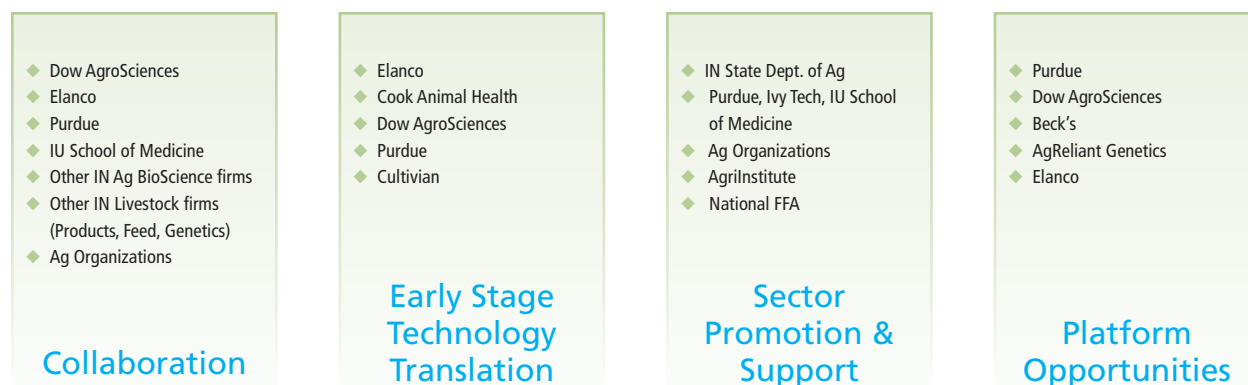
Indiana food and agricultural innovation stakeholders are well positioned for their own business growth and expansion. Greater coordination and collaboration among the various agricultural leaders could, however, foster even more economic development and help to reshape Indiana's agricultural landscape, but it will require greater collective attention and engagement. It is surprising how little strategic deliberation there has been on the challenges and opportunities ahead given the complexities and dynamism of the agricultural sector.

Economic development professionals and elected officials generally underestimate the richness of this industry, seeing it as simply "agriculture". In reality, it represents a wide range of relationships, sophisticated innovation, and knowledge about the needs of a growing and dynamic marketplace – feeding the world, health and nutrition, consumer demand, and environmental resilience.

The absence of a broader dialogue is influenced in part by the competitive and diverse nature of some of the individual companies. Those that are competitive with each other may be reluctant to share information. Conversely, those companies that operate in different market segments or industries may not naturally realize the opportunities for collaboration. Nevertheless, it is clear that there are opportunities of interest that transcend these initial perspectives and enough potential that the leading agricultural stakeholders appear willing to continue the collective dialogue that has been initiated.

Looking Forward

The Roadmap discussed previously provides an outline of the key areas of interest and opportunity for Indiana's 21st century agricultural industry. The diagram below begins to provide an initial perspective on how stakeholders view themselves and their own interests and needs relative to the Roadmap.



Bringing together key stakeholders from the food and agricultural innovation sector, university and education leaders, and government officials to continue the collective dialogue focused on the prosperity of the industry and state would be a highly positive development for Indiana. This report has described a number of areas of potential interest and opportunity and provides several recommendations, some of which were discussed during conversations and meetings with participating stakeholders and others that are new for consideration.

It is critical that this dialogue continue. A forum for facilitating and continuing this collective dialogue is essential and could serve as a platform from which to engage, promote, support, and even advance specific longer-term opportunities for the sector. If properly structured and deployed, an organizing forum could take the lead on further defining the Roadmap and the best opportunities for collaboration and continued growth, ultimately leading to greater economic development across the state and for stakeholders individually. To that end, this organizing forum would be well-positioned to explore and develop the following opportunities:

- ◆ **Collaboration.** The findings and observations from this report suggest that collaboration could be a powerful mechanism for advancing the interest of various stakeholders who share related interests, capabilities, and assets. An organizing forum could play a key role in helping to identify and facilitate engagement around specific collaborative opportunities through a number of different efforts such as:
 1. Identify opportunities and issues shaping the sector;
 2. Mobilize resources to support sector growth needs, such as technology translation financing, sector promotion and marketing, workforce education and training support, etc.;
 3. Further strengthen the brand and reputation of the sector and state;
 4. Offer a platform for enhanced networking and partner identification opportunities;
 5. Offer mentoring for new, innovative food and agricultural firms to connect them to critical market intelligence, funding and other business support services they need to be successful;
 6. Guide a grant program focused on early stage research opportunities, education and training, and economic development and advocacy; and
 7. Explore the potential for expanded regional collaboration.

- ◆ **Sector Promotion and Support - Branding and Awareness.** An organizing forum could create awareness within the industry, with other stakeholders and local and state government officials of the potential for an “ag innovation cluster” or “corridor” in Indiana. The food and agricultural innovation sector will need a strong “brand” to identify the diverse participants and technologies developed, commercialized and used in the state.

Early efforts in branding and awareness should be focused on defining Indiana’s innovation brand and educating broad public audiences about the capabilities and resources of the sector. This definitional stage could include activities such as hosting a food and agricultural innovation educational conference targeted to industry, university, government officials and other stakeholders throughout the state. A web site could also be developed that provides information and profiles of key stakeholders, their products and service capabilities and needs. Following these initial steps, a more focused branding initiative could be pursued to promote specific assets and capabilities identified by organization leaders.

A second stage in generating more awareness would be well defined and organized networking and partnership identification. There was considerable industry interest in identifying potential research and business partners. An innovation entity could serve as a facilitator of regular networking events and targeted seminars focused on key industry issues to bring potential partners together. The web site could also serve as a clearinghouse for this kind of relationship-building, connecting partners seeking unique technologies or other services.

- ◆ **Sector Promotion and Support - Talent and Workforce Development.** A comprehensive educational strategy could also be an initial priority of an organizing forum. This is crucial to talent and workforce development and should be a multi-faceted strategy to enhance current educational offerings and tailor them more to the needs of food and agricultural stakeholders. Stakeholders all acknowledged the outstanding talent development that occurs at Purdue, but they also identified the need to strengthen the current educational curriculum especially in the K-12 system and add programs to introduce future academic and career opportunities in food and agriculture and also better prepare students for an evolving technology and economic landscape.

The workforce requirements of the food and agricultural industry are as diverse as the sector itself. All of Indiana’s academic institutions play a critical role in providing the necessary talent to the industry, whether in the form of PhD researchers, engineers of all types, business managers, laboratory technicians, or others. As businesses work to build more of their own collaborative research and product teams, more collaboration among universities and the educational community in the State could greatly benefit the industry. This would involve not only Purdue, but Indiana University School of Medicine, University of Notre Dame and Ivy Tech Community College. The innovation entity could convene a dialogue across the state with businesses and

these and other educational partners (including Department of Education, Indiana State Department of Agriculture, FFA, among others) in order to better match the workforce requirements of the private sector with the myriad of educational and training offerings.

- ◆ **Early Stage Technology Translation and Advancement – Financing and Access to Capital.** Over the course of conversations with many stakeholders, the lack of consistent and dedicated funding for food and agricultural innovation was viewed as a limiting factor for business and industry growth, especially for start-up firms. The shortage of incubation facilities and seed capital for early stage companies is often cited as a major reason why more food and agricultural breakthrough technologies aren't easily commercialized.

An organizing forum could identify and bring together a larger group of potential investors and explore the potential of a technology incubator specifically focused on food and agricultural innovation. The incubator could connect technical innovations to urgent market needs in Indiana and beyond and would be involved from a very early stage from understanding ideas and opportunities, building teams and channeling partners and also syndicating venture financing. Another funding model that could be explored is the organization of an angel investor network comprised of successful entrepreneurs interested in food and agricultural innovation startups.

The organizing forum could also hold business accelerator programs where advice, mentoring and business connections are offered to startups. Longer term, the entity could also establish a matching grant program that would provide much-needed financial support in the critical technology translation or proof of concept stages of technology commercialization. These could include research grants, education grants, business loans and/or grants to include event support and economic development.

Conclusions

Much as OrthoWorx focuses on the strategic business and regional growth potential of the Warsaw-based orthopedics industry, a new food and agricultural innovation platform could facilitate engagement, foster collaboration when applicable, and help to advance and promote Indiana's agricultural sector. Although industry stakeholders will ultimately need to determine whether a similar formal entity is required or even desired, it could be useful for organizing resources and pursuing a number of key stakeholder interests.

If pursued, it will be critical to have engaged stakeholders delineate what the platform or entity will be and what it should not be. For example, it may not be well suited as a site for laboratory research or company incubation. It could, however, serve as the statewide hub for food and agricultural innovation commercialization, offering access to market research, linking academic, business, civic and policy leaders, supporting workforce development activities, among other functions.

As has been learned from the profiles of RTP and the NC Biotech Center, the KC Animal Health Corridor and other models, these efforts only work if all stakeholders are actively engaged in this strategic industry and state economic development opportunity. Equally important will be energetic participation from a wide range of stakeholders and the recruitment of strong leadership. Financial support and a sustained operating and funding plan must also be developed. This plan could include a variety of funding streams, including membership support, grants or endowment gifts, and state financial support. Other similar state innovation cluster or center initiatives (including North Carolina and Ohio) receive committed and sustained operating support from state funds because of the critical importance of these efforts to growing the states' economies.

Greater coordination and collaboration among Indiana's agricultural stakeholders is needed in order to capitalize on future business growth and economic development opportunities across the industry. The food and agricultural innovation assets in Indiana (and in the broader Midwestern region) are significant and hold great potential for growing the sector as well as finding solutions to global and societal challenges. An organized entity of the state's food and agricultural innovation stakeholders would bring the critical collective attention and engagement needed to leverage existing assets and capabilities and strategically plan for future growth opportunities.

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August 2012

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