

Ensuring an Agbioscience Workforce for Indiana's Future

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AgriNovus Indiana

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Table of Contents

Executive Summary.....	iii
Section I. Introduction	1
Agbioscience Innovations Are Key to Solving Global Grand Challenges.....	1
The National Supply of Human Capital is Not Keeping Up with Demand.....	2
Agbioscience—A Critical Economic Driver for Indiana	3
Is Indiana’s Workforce Positioned to Drive Economic Growth of the Agbioscience Industry?	5
Section II. Assessment Approach—Framework and Methods	7
Occupational Framework.....	7
Analytical Methodology and Approach	8
Section III. Indiana’s Core Agbioscience Workers: Demand, Supply, and Alignment.....	11
Demand for Core Agbioscience Talent in Indiana.....	11
Current Occupational Demand	11
Projected Occupational Demand	14
Key Findings from Employer Surveys and Interviews	17
Demand Summary for Core Agbioscience Occupations	20
The Supply of Indiana’s Core Agbioscience Workforce	22
Current Supply of Core Agbioscience Degrees	22
Industry and Academic Viewpoints Regarding Supply from Surveys and Interviews.....	26
Aligning the Demand and Supply of Core Agbioscience Occupations.....	29
Section IV. Indiana’s Allied Agbioscience Workers: Demand, Supply, and Alignment	33
Demand for Allied Agbioscience Talent.....	33
Current Occupational Demand	33
Projected Occupational Demand	36
Key Findings from Employer Surveys and Interviews	37
Demand Summary for Allied Agbioscience Occupations.....	40
The Supply of Indiana’s Allied Agbioscience Workforce	40
Current Supply of Allied Agbioscience Degrees	41
Industry and Academic Viewpoints from Surveys and Interviews	43
Aligning the Demand and Supply of Allied Agbioscience Occupations	44

Indiana's Agbioscience Workforce

Section V. Strategic Recommendations 47

 Strategy 1: Create a Greater Pipeline of Students Interested in Agbioscience Careers. 48

 Strategy 2: Develop Industry-Relevant Skill Sets for Core Occupation Talent..... 54

 Strategy 3: Increase Agbioscience Career Engagement for Allied Occupation Fields. 62

 Strategy 4: Catalyze Continued Career Advancement for Rising Professionals and Foster Linkages
 between Post-Retirement Professionals and Start-Up Opportunities 67

VI. Conclusion..... 71

Appendix 73

Executive Summary

Many of the most pressing challenges facing humankind have their solutions rooted in modern agriculture and its related value-added industrial supply chain (herein termed the agbioscience industry). The current global population is projected to increase from 7.3 billion to 9.7 billion by 2050.¹ In order to feed the world, it is anticipated that global food production will have to double by 2050 despite most cultivatable land already being in production.² This significant increase in demand for agricultural products is occurring at the same time that industrial demand for plant-based fibers, fuels, and materials is experiencing a significant increase as well. These developments are made all the more challenging by the pressing need to increase agricultural production while reducing environmental impacts associated with human economic activity. As a result, agbioscience innovation holds great promise for significant economic growth for the food and agricultural economy moving forward.

In today's innovation-driven economy, where businesses need to keep up with the fast pace of technological change, the ultimate competitive factor for economic growth is human talent. Despite the overwhelming need for innovation in agriculture, the United States faces a predicted agricultural workforce shortfall over the next five years. According to a recent report from the U.S. Department of Agriculture (USDA) supported by analysis from Purdue University, there will be nearly 58,000 job openings in the U.S. food and agriculture industry each year (from 2015 to 2020) for college graduates from across the country.³ Over this same period, an average of 35,400 new U.S. graduates with degrees in food, agriculture, and natural resources will step in to fill these positions, potentially leaving almost 40 percent of the available jobs open. The grand global challenges that can effectively be solved through advancements in agbioscience innovation are thus occurring at a time when there are not enough skilled individuals entering the workforce.

"The face of American agriculture is changing. Nearly 10 percent of U.S. jobs are related to agriculture and the increasingly complex nature of production requires more training and education in science, technology, engineering and mathematics—the STEM fields—to stay competitive and meet the needs of a growing world for food, fuel and fiber. This is a great opportunity for smart, young people to start careers in a field that addresses some of the world's most pressing challenges."

Agriculture Secretary Tom Vilsack

Indiana's Agbioscience Imperative—Developing and Attracting Human Capital

The agbioscience industry is a significant economic driver of Indiana's economy, employing just over 75,000 individuals, not including primary production workers (farming). As a result, the agbioscience industry represents more than 3 percent of Indiana's total private sector employment. Furthermore, the agbioscience industry has seen robust growth over the past decade. From 2003 to 2014, Indiana experienced a 22 percent increase in agbioscience employment compared with a 3 percent growth rate for Indiana's total private sector.

¹ United Nations Department of Economic and Social Affairs. July 2015.

² Bruce M. Chassey, Wayne A. Parrott and Richard Roush. "Crop Biotechnology and the Future of Food: A Scientific Assessment." CAST Commentary, QTA 2005-2, October 2005. <http://www.cast-science.org/>.

³ Purdue University and USDA, *Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment, United States, 2015–2020*. See: <https://www.purdue.edu/usda/employment/>.

The Agbioscience Talent Mix

Core Occupations—those jobs that have a distinct, direct role in the agbioscience industry via their job function or expertise in agriculture, food, or related areas.

Allied Occupations—those jobs, such as business, IT, and skilled production, that have key roles and functions yet transcend multiple industry sectors.

To keep up with this strong demand for talent requires the right blend of skilled, educated, and engaged individuals fostering new ideas and working toward common goals. At the heart of this activity in the agbioscience industry are highly skilled scientists, engineers, technicians, and others with agbioscience-specific backgrounds and expertise, termed **Core Occupations**. Equally critical to competing in a knowledge and innovation-driven sector are key personnel in business, information technology (IT), and skilled production functions—areas of talent for which agbioscience companies must compete with other advanced industries—termed **Allied Occupations**.

As previously noted, national studies indicate a predicted shortfall of agbioscience workers over the next five years. By comparison, **Indiana's workforce development and talent generation in core agbioscience occupations is well aligned with industrial demand**. Overall, Indiana's agbioscience industry expressed satisfaction with the technical skills acquired through ag-specific postsecondary degree programs; however, there was concern that many of these programs lacked industrial relevancy/professional skill development as part of the curriculum.

The national studies also find the agbioscience industry needs professionals with broader training that integrates agricultural sciences with other STEM disciplines as well as enhancing business acumen. When Indiana is compared with the nation, it is discovered that **Indiana's agbioscience industry sector is unable to attract the number and quality of individuals to serve in allied occupations**. Nearly every industry representative interviewed voiced concern regarding the industry's ability to attract allied occupations to the agbioscience industry sector. The quantitative data also point to concerning shortfalls within allied occupational groups in Indiana. These pressing and immediate concerns require that programs and initiatives be developed to help ensure that allied occupational groups are aware of and better linked to the opportunities that Indiana's agbioscience industry affords.

These challenges call for strategic interventions that can help to ensure a predictable, robust supply of qualified individuals with the right skill sets to meet the needs of this innovative sector into the future.

Strategic Recommendations to Meet Indiana's Talent Needs

To maintain its position as a 21st century agbioscience leader, Indiana must have a 21st century agbioscience workforce equipped to apply and develop leading technologies. This workforce must bring not only strong technical skills, but also an ability to communicate, problem-solve, work effectively in teams, and, perhaps most importantly, apply agbioscience technologies to solving today's global challenges. To do this, Indiana must develop a workforce that is applications-focused, experiential-based, entrepreneurial, well-rounded, engaged, and appropriately skilled.

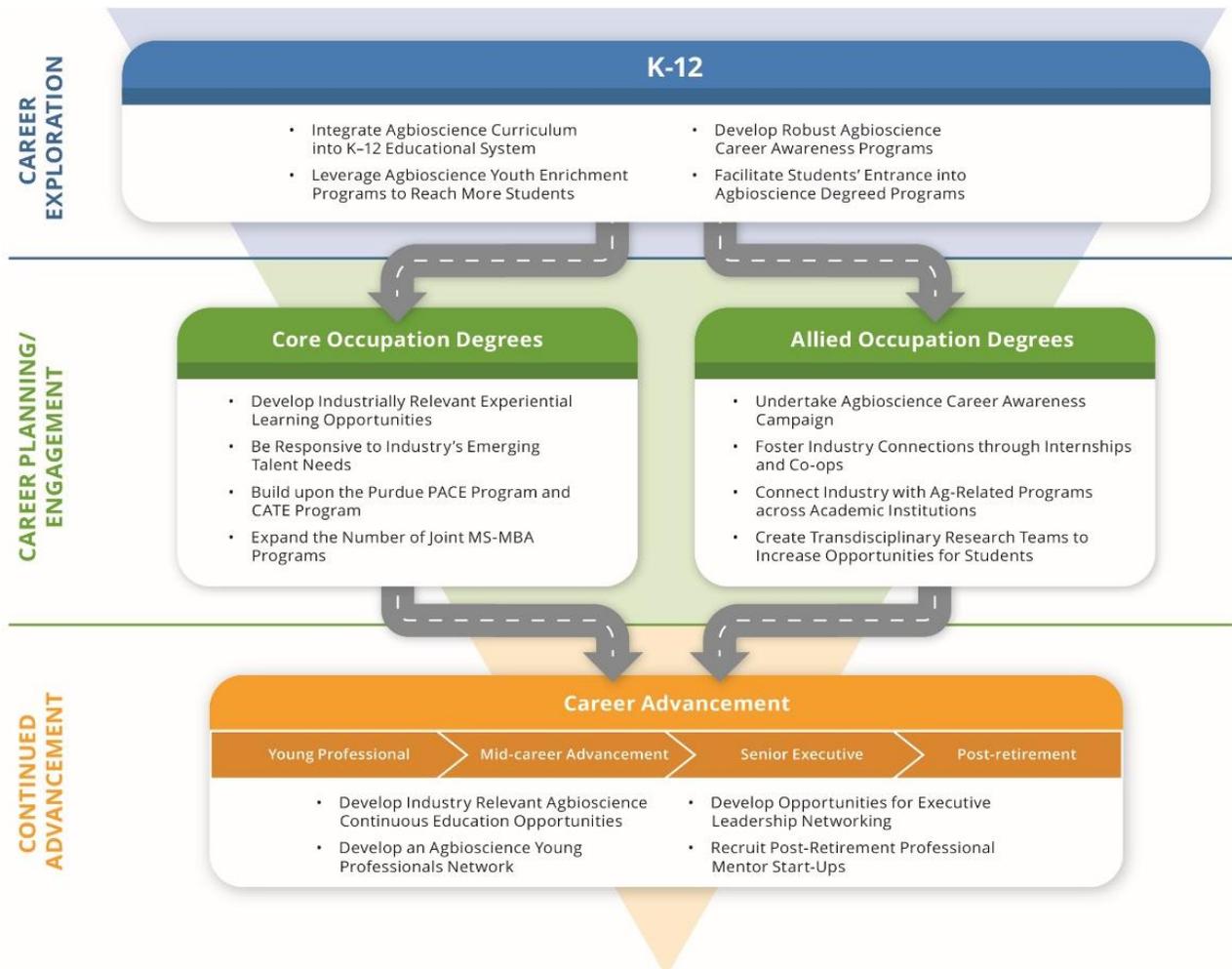
The challenge for Indiana is to go beyond traditional paradigms of education by practically integrating agbioscience skills development across the full talent pipeline composed of K–12, colleges and universities, and continued professional development. To achieve this leading position in agbioscience talent development requires a multiplicity of partnerships (private, public, trade organizations and associations) to create the pipeline of workers needed in the short- and long-term.

For Indiana to be a leader in generating and sustaining a highly skilled agbioscience workforce, it must work concurrently on implementing four critical strategies:

1. Create a greater pipeline of students interested in agbioscience careers.
2. Develop industry-relevant skill sets for core occupation talent.
3. Increase agbioscience career engagement for allied occupation fields.
4. Catalyze continued career advancement for rising professionals and foster linkages between post-retirement professionals and start-up opportunities.

These four strategies are best understood as interrelated efforts that reinforce each other and create a progression as depicted in Figure ES-1. No one single action or strategy will fully address Indiana's agbioscience talent demands and gaps. Instead, a multidimensional approach is needed that reflects the variety of opportunities and needs that Indiana's agbioscience industry faces.

Figure ES-1: Indiana's Agbioscience Talent Pipeline



Source: TEconomy Partners, LLC

The agbioscience industry's ability to develop, cultivate, and acquire specialized human talent with specific and unique skill sets throughout the entire talent pipeline is paramount to its ability to continue to grow and prosper in the State of Indiana.

Section I. Introduction

Agbioscience Innovations Are Key to Solving Global Grand Challenges

Many of the most pressing challenges facing humankind have their solutions rooted in modern agriculture and its related value-added industrial supply chain (herein termed the agbioscience industry). No other arena of economic activity, or field of science and innovation, so directly addresses human survival and quality of life, global economic development, and prospects for an environmentally sustainable future.

On a global scale, humankind's needs and challenges are daunting. The current global population is projected to increase from 7.3 billion to 9.7 billion by 2050.⁴ Yields of staple crops such as corn, rice, wheat, and soybeans must increase at a higher rate than current trends portend in order to feed a more affluent, more urban, and more populated world. To meet this growing demand (driven both by rising population and increasing income levels), it is anticipated that global food production will have to double by 2050 despite most cultivatable land already being in production.⁵ The inequity of global income levels and access to food across the planet already leads to debilitating levels of malnutrition, undernutrition, and associated poor health for over 1 billion people.⁶ This significant increase in demand for agricultural products to feed a growing population is occurring at the same time that industrial demand for plant-based fibers, fuels, and materials is experiencing a significant increase as well. All of these developments are made all the more challenging by the pressing need to increase agricultural production while reducing environmental impacts and global climate change associated with human economic activity.

Against this backdrop of global needs and challenges, it becomes clear that the role of agriculture, and associated agbioscience advancements, is a critical driver of humankind's future. This reality should not come as a surprise. Agriculture has a long-standing history of contributions to science, technology, and innovation-based development in the United States—indeed, it represented the first great industry for the country as national frontiers expanded. Agriculture was the foundational industry for almost every state and, to this day, stands as a central component of the nation's and many individual state economies. The need for a scientific approach to agricultural production and the diffusion of innovation ultimately led to the foundation of the U.S. Land-Grant University System, underpinning the research and technological advancements and expansion of knowledge powered by the U.S. higher education system.

Today, agbioscience innovation continues to have significant global impact. Rapid advancements in areas of modern agbioscience are solving major global issues and needs. By addressing large-scale challenges, agriculture has an assured market for the solutions it produces. Whether addressing food security for an expanding global population, providing advanced nutrition products to improve human health, or providing environmentally sensitive feedstocks for fuels and industrial materials applications—great promise exists for the food and agricultural economy moving forward.

⁴ United Nations Department of Economic and Social Affairs. July 2015.

⁵ Bruce M. Chassey, Wayne A. Parrott and Richard Roush. "Crop Biotechnology and the Future of Food: A Scientific Assessment." CAST Commentary, QTA 2005-2, October 2005. <http://www.cast-science.org/>.

⁶ United Nations Food and Agriculture Organization (FAO). "The State of Food Insecurity in the World." Accessed online at www.fao.org/publications/sofi/en/.

The National Supply of Human Capital is Not Keeping Up with Demand

In today's innovation-driven economy, where businesses need to keep up with the fast pace of technological change, the ultimate competitive factor for economic growth is talent. In other words, the common thread that runs through almost all scientific, technological, and practice advancements is the skilled human capital required to undertake industrial advancements.

Industry executives consistently emphasize that their ability to operate effectively in a global economy with ever-increasing competition depends upon the quality and availability of a wide range of skills across the workforce. Talent is essential to all stages in the creation and deployment of innovation, including the following:

- The world-class researchers who drive new discoveries;
- The applied scientists and engineers who help develop new products and processes;
- The entrepreneurs, marketing and finance staff, and business consultants who drive the business side of commercialization and new venture formation that bring innovation to the global marketplace; and
- The technical skills of the workforce to produce and deliver quality products and services.

Despite the overwhelming need for innovation in agriculture in the face of climate change, pests, pathogens, soil loss, and availability of land and water, the United States faces a predicted agricultural workforce shortfall over the next five years. According to a recent report from the U.S. Department of Agriculture (USDA) supported by analysis from Purdue University, there will be nearly 58,000 job openings in the U.S. food and agriculture industry each year (from 2015 to 2020) for college graduates from across the country.⁷ Over this same period, an average of 35,400 new U.S. graduates with degrees in food, agriculture, and natural resources will step in to fill these positions, potentially leaving almost 40 percent of the available jobs open.

In addition to needing more agriculture professionals, the United States also needs professionals with broader training that integrates agricultural sciences and other science, technology, engineering, and mathematics (STEM) disciplines. Agriculture is a fundamentally interdisciplinary endeavor, and agriculture professionals rely on a range of specialties that necessitates a broad education. Plant breeders, for example, draw upon entomology, plant pathology, agronomy, soil science, and microbiology, and need to integrate the tools of genetics, bioinformatics, statistical modeling, and robotics. Without an interdisciplinary

“College graduates with expertise in food, agriculture, renewable natural resources, and the environment are essential to our ability to address the U.S. priorities of food security, sustainable energy, and environmental quality. Graduates in these professional specialties not only are expected to provide answers and leadership to meet these growing challenges in the United States, but they also must exert global leadership in providing sustainable food systems, adequate water resources, and renewable energy in a world of population growth and climate change.”

—Purdue University and USDA

Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment, United States, 2015–2020

⁷ Purdue University and USDA, *Employment Opportunities for College Graduates in Food, Agriculture, Renewable Natural Resources, and the Environment, United States, 2015–2020*. See: <https://www.purdue.edu/usda/employment/>.

workforce, the pace of technological innovation in agriculture may slow, and critical global challenges may not be addressed. The USDA-Purdue University study found that during the five-year period to 2020, 27 percent of the projected job openings in the agbiosciences will be in STEM-related fields.⁸

What is most concerning is that the grand global challenges that can effectively be solved through advancements in agbioscience innovation are occurring at a time when more and more individuals are further and further removed from agriculture in general. Agriculture once formed the foundation of human civilization. It allowed our early ancestors to build stable communities, while improvements in agricultural productivity moved us from subsistence farming, to a position whereby farmers generated a surplus of food for sale in the market—freeing others to specialize in trades and forming the foundation for commercial economies. Today, most consumers are distanced from the source of products used in our daily lives. According to a recent survey conducted on behalf of the U.S. Farmers & Ranchers Alliance, 72 percent of consumers know nothing or very little about farming or ranching.⁹ As a result, consumers do not know, and often do not care, where food comes from, where the lumber to build homes originated, nor the source of the fibers in clothes and furnishings. This distancing from a food and agricultural heritage is in part contributing to this predicted workforce shortage.

Agbioscience—A Critical Economic Driver for Indiana

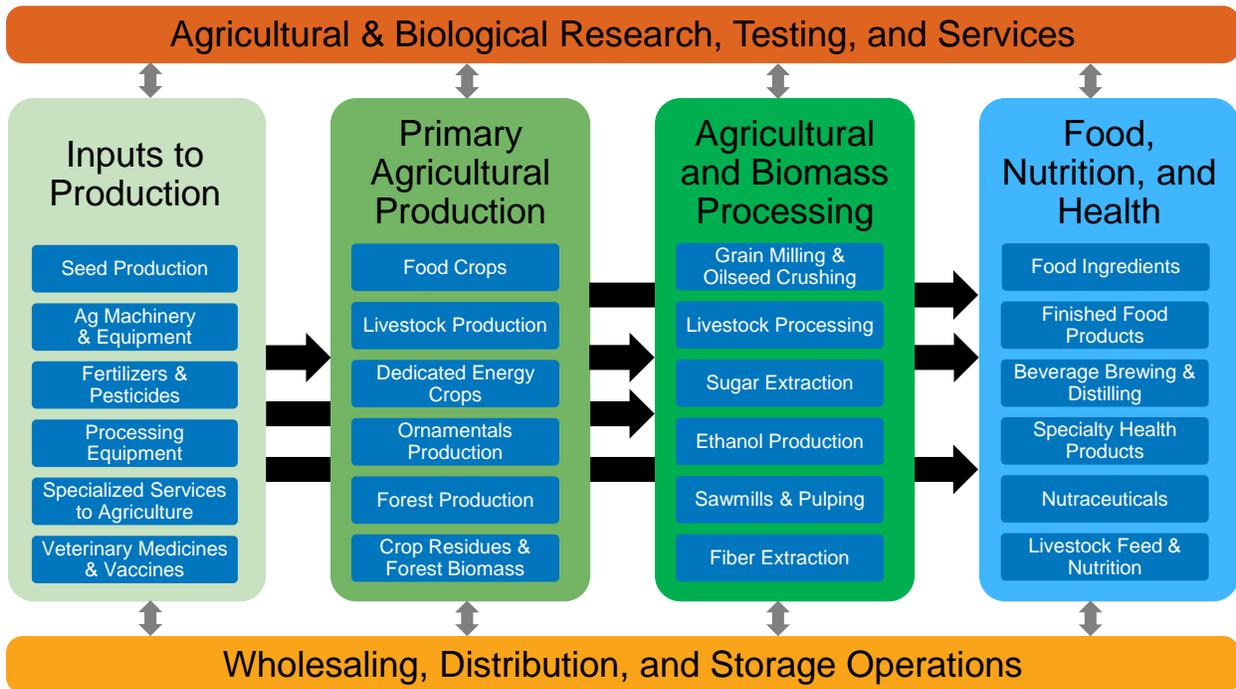
While agbioscience innovation will continue to play a role globally in the future, it is also important to recognize the significant economic impact the industry sector has on the State of Indiana. The agbioscience industry represents an applied area of life science knowledge and innovation—a life science subsector engaging research and development (R&D) to improve, protect, and expand primary agricultural production and the production of value-added products based on agricultural outputs.

The agbioscience sector is an interconnected value chain of agricultural-related economic activity, generally structured as illustrated in Figure 1.

⁸ Ibid.

⁹ See <http://www.fooddialogues.com/press-release/antibiotics/nationwide-surveys-reveal-disconnect-between-americans-and-their-food>, Retrieved October 17, 2016.

Figure 1: The Agbioscience Value Chain and its Major Components



Source: TEconomy Partners LLC.

The agbioscience industry includes not only inputs to primary agricultural production—for example, advanced crop varieties and seeds, crop and livestock protection products, soil amendments, precision agricultural equipment, and other information technologies—but also downstream value-added products that use the output of primary agricultural production as feedstock inputs for the creation of higher-value products for application to food, nutrition, health, materials, chemicals, polymers, textiles, and other specialized industrial and consumer markets.

The total agbioscience industry (including farm production) in Indiana employed 140,949 personnel across the full value chain in 2014 (Table 1), representing nearly 6 percent of Indiana’s total private sector employment. Not including primary production (farming), the remaining segments of the agbioscience industry employed just over 75,000 (53 percent of total value-chain employment, a slight increase since 2012 when it represented 51 percent of the total value-chain employment).

Table 1: Indiana Agbioscience Industry Employment, 2014

Innovative Agbioscience Sector & Major Subsectors	IN Employment, 2014	Employment Change, 2003–14	Employment Change, 2009–14
Total Private Sector	2,499,827	3%	9%
Total Agbiosciences	140,949	11%	8%
Total Agbiosciences—Without Primary Production (Farming)	75,150	22%	14%
Ag & Biological Research, Testing, & Services	8,125	23%	9%
Agricultural & Biomass Processing	4,709	7%	2%
Food, Nutrition, & Health	40,924	26%	17%
Inputs to Production	14,282	17%	12%
Primary Production—Incorporated	14,563	22%	17%
Primary Production—Farm Proprietors	51,236	-5%	-2%
Wholesaling, Distribution, & Storage Operations	7,110	18%	10%

Source: TEconomy's analysis of Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) data, enhanced file from IMPLAN; farm proprietor employment data from the Bureau of Economic Analysis (BEA).

An important finding is that, in all cases (other than primary production), Indiana has seen employment grow between 2003 and 2014. Post-recession (2009–2014), the agbioscience subsectors (again, other than primary production and agricultural and biomass processing) have either met or exceeded Indiana's total private-sector growth rate of 9 percent.

In addition, Indiana is undeniably a national leader in agricultural production of both commodity and specialty crops and also livestock. The state's 57,700 farms cover 14.7 million acres of land and generated \$11.2 billion in farm gate sales in 2012—ranking the state 10th in the nation in agricultural production value, even though it ranks only 18th in total farmland. That same year, Indiana agriculture exports reached a record \$4.7 billion. The broader food and agriculture sector contributes \$16 billion to Indiana's gross state product and employs 19 percent of the Hoosier workforce.

As a result, the total agbioscience industry in Indiana clearly represents a high-performance economic sector. Indiana's research and innovation assets are driving productivity gains in primary production as well as advancements in the broader agbioscience value-chain leading to significant economic impacts for the state.

Is Indiana's Workforce Positioned to Drive Economic Growth of the Agbioscience Industry?

Understanding the ramifications of the estimated workforce shortage at the national level, AgriNovus Indiana (AgriNovus) set forth to better understand if Indiana is being impacted by the same trends, or if this critical statewide industry sector is faring better than the country as a whole. Further, if it is determined that Indiana is also falling behind, AgriNovus recognizes that putting forward an action-oriented set of recommendations that addresses the workforce misalignment will be critical.

To this end, AgriNovus engaged TEconomy Partners, LLC (TEconomy) to develop a data-driven, fact-based understanding of the demand and supply of agbioscience workers in Indiana, and the factors shaping how demand and supply can be more closely linked. TEconomy is a global leader in research, analysis, and strategy for innovation-based economic development. In 2014, the Central Indiana

Indiana's Agbioscience Workforce

Corporate Partnership (CICP) engaged the principals of TEconomy to research and publish a report on Indiana's innovative food and agriculture industry, which served to inform the formation of AgriNovus and help guide some initial activities. In 2015, the principals were reengaged to develop more detailed reports on the four key agbioscience innovation sectors identified by AgriNovus as priority areas for Indiana—plant sciences; animal health and nutrition; human food and nutrition; and high tech agriculture.

Building from this previous work, this study seeks to develop a better understanding of the current and projected demand and supply of agbioscience workers in Indiana. Specifically, the study seeks to answer the following questions:

- **What types of skilled workers will be needed?** TEconomy examines Indiana's situation and emerging trends based on quantitative analysis of state occupational trends and forecast data along with surveys of and discussions with key Indiana agbioscience companies, academic institutions, and other industry organizations.
- **What capacity does Indiana have now?** TEconomy synthesizes information regarding existing higher-education, training, career pathway, and other program offerings via state and regional providers.
- **Where are the major gaps in the workforce system relative to key demands for the agbioscience workforce?** TEconomy analyzes what the cross-cutting skill needs are as well as those specific to individual subsectors of the industry that are and will be in high demand and may require new programmatic approaches to meet the needs of Indiana's agbioscience industry.
- **What solutions must be implemented to ensure that agbioscience industrial workforce needs are aligned with the higher education delivery system?** TEconomy puts forward strategic recommendations and specific actions focused on improving the alignment between Indiana's agbioscience workforce demands and the current ability to supply those workers to ensure a robust talent pipeline is in place for Indiana's agbioscience industry into the future.

To answer these questions, this report is organized into the following sections:

- Section II discusses the methodology and analytical approach undertaken for this study.
- Section III outlines the current and projected demand and supply of **core** agbioscience workers in Indiana.
- Section IV outlines the current and projected demand and supply of **allied** agbioscience workers in Indiana.
- Section V provides a set of strategic recommendations and proposed actions for improving the supply of agbioscience talent in Indiana to ensure it meets industrial demands.

Section II. Assessment Approach—Framework and Methods

Occupational Framework

To advance and execute agbioscience industry innovation, the right blend of talented, skilled, educated and engaged individuals fostering new ideas and working toward common goals is required. At the heart of this activity in the agbioscience industry are highly skilled scientists, engineers, technicians, and others with agbioscience-specific backgrounds and expertise. Equally critical to competing in a knowledge and innovation-driven sector are key personnel in business, information technology (IT), and skilled production functions such as assemblers, computer-controlled machine tool operators, chemical plant operators, machinists, and industrial production managers—areas of talent for which agbioscience companies must compete with other advanced industries.

In structuring this assessment, the TEconomy project team has made a key delineation between the “core” agbioscience workers who can clearly be identified as having a distinct, direct role in the industry via their job functions or expertise in agriculture, food, or related areas along the industry value chain, and their “allied” counterparts, those who have key roles and functions that transcend multiple industries. This is both a matter of substance—being able to distinguish those in the sector who have a background and expertise in agricultural and other highly related fields, but also of necessity—to effectively work within the structure of state and federal occupational data that often limit the ability to see the deep occupational detail that underlies industries within a state industry cluster.

TEconomy conducted a detailed assessment to develop a working definition of both the core and allied occupational structure for the agbioscience-related workforce in Indiana (See the Appendix for U.S. Department of Labor, BLS Standard Occupational Classification [SOC] information on specific occupational codes that fall into the two definitions).

Core agbioscience occupations were identified as those jobs where the primary function is directly and clearly related to the agbioscience industry value chain. These core occupations stand out in their key roles played within agbioscience industry subsectors spanning agricultural production, inputs to production, food manufacturing, and R&D activities. These occupations were grouped along common roles, education, and skill requirements and were presented, vetted, and refined in discussions with AgriNovus and its Board of Directors. The five major core occupational groups¹⁰ include the following:

- Agbio Scientists and Agricultural Engineers
 - Examples include: animal, food, and soil scientists; agricultural engineers.
- Agbioscience Technicians

¹⁰ While critically important to the agbioscience industry, the majority of agricultural production workers on farms and other ag-related operations across the state were not a primary focus of this assessment. AgriNovus recognizes the importance of this agricultural production workforce, but given federal and state data limitations, has instead decided to focus this project on those agbioscience workforce and talent needs requiring postsecondary and advanced degrees in an effort to better understand Indiana’s ability to maintain a competitive advantage in agbioscience innovation. While it is recognized that many primary production workers obtain postsecondary degrees, this specific occupational group was not the focus of this analysis.

Indiana's Agbioscience Workforce

- Examples include: agricultural and food science technicians.
- Agricultural Support
 - Examples include: agricultural inspectors; animal breeders.
- Food Production and Processing Workers
 - Examples include: bakers; butchers and meat cutters; food batchmakers.
- Veterinarians and Vet Techs.
 - Examples include: veterinary technologists and technicians; veterinary assistants.

To identify key allied agbioscience occupations, TEconomy utilized national “Staffing Patterns” data that break down occupational employment by industry and analyzed the composition of detailed occupations within key agbioscience component subsectors. Unfortunately, state-level staffing patterns data for detailed industries are often less than complete in order to protect the confidentiality of individual employers that make up a large share of the sector, or where employment totals are relatively small and are not statistically reliable. Therefore, the approach here utilized the national staffing patterns data for these sectors.

Specifically, the project team identified “allied” occupations that meet both of the following requirements:

1. These occupations make up at least 1 percent of employment in agbioscience industry segments (where available). Segments include agricultural chemicals, agricultural machinery manufacturing, agricultural support, forestry, food and beverage manufacturing, farm and grocery distribution, veterinary services, and R&D.
2. Agbioscience industry segments’ share of employment exceeds the share of employment in the broader industry classification (e.g., all of manufacturing) indicating that these occupations play an especially important role in the production of goods and delivery of services in the agbioscience industry.

In a few specific cases, allied occupations have been added that drive innovation in the agbiosciences but did not quite meet the requirements above. For example, IT occupations focused in software and applications development that are crucial for precision agriculture were added to the allied occupational analysis.

The seven major allied occupational groups include the following:

- Engineers and Engineering Management
- General Management and Business Operations
- IT—Software and Applications Development
- Life Scientists and Science Technicians
- Sales Representatives
- Skilled Production and Maintenance Workers
- Transportation, Distribution, and Logistics.

Analytical Methodology and Approach

Developing a fact-based assessment that answers the key questions posed in this study requires both a quantitative and qualitative assessment of the situation for agbioscience-related talent specific to Indiana, its industry structure, and unique dynamics.

Indiana's Agbioscience Workforce

The approach to assessing the *demand* for agbioscience-related talent incorporates the following:

- Quantitative approach:
 - **Occupational Employment Statistics (OES)** data, to assess employment levels and recent trends (Sources: BLS and Indiana Department of Workforce Development [DWD])
 - **Occupational Employment Projections**, to assess projected annual demand for employment including both new job openings and replacement needs (Source: Indiana DWD)
 - **Industry “Staffing Patterns” data**, to identify key occupations that are not clearly agbioscience related, e.g., skilled production workers (Source: BLS)
- Qualitative approach:
 - **Industry Employer Survey** administered by TEconomy to Indiana agbioscience companies to assess their occupational mix, emerging skill needs, and technology areas critical to remaining competitive into the future
 - **Interviews** across industry, academia, and other key Indiana agbioscience stakeholders

The approach to assessing the *supply* of agbioscience-related talent in Indiana incorporates the following:

- Quantitative approach:
 - **Postsecondary Graduates across key degree fields**, to assess the supply of agbioscience-related talent generated by Indiana institutions (Source: National Center for Education Statistics)
 - **Graduate Retention data**, to assess levels and shares of recent Indiana graduates that remain in state (Source: Indiana Network of Knowledge [INK])
- Survey Research and Interviews:
 - **Industry Employer Survey** to assess recruitment dynamics, education, and experience requirements of candidates
 - **Interviews** across industry, academia, and other key Indiana agbioscience stakeholders
 - **Review of more detailed educational program offerings**, career awareness, and guidance activities and engagement with industry on meeting skill needs

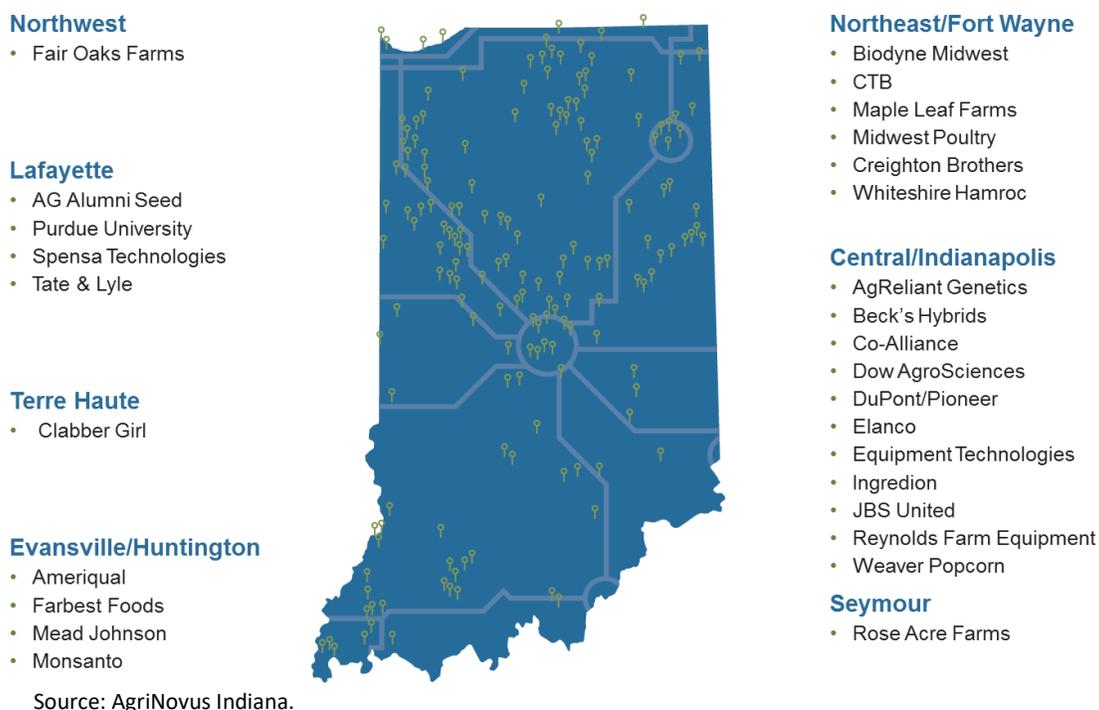
Combining what is learned from both the demand and supply analyses, the assessment determines the degree to which demand and supply align in Indiana across each occupational group. Areas of occupational “misalignment” are brought forth later in this report as key areas for potential strategic interventions by AgriNovus and other key stakeholders.

Section III. Indiana's Core Agbioscience Workers: Demand, Supply, and Alignment

Demand for Core Agbioscience Talent in Indiana

While rooted in primary agricultural production, the emergence and continued development of the agbioscience value chain in Indiana depend upon the growth and global position of industry leaders such as those shown in Figure 2. Today, Indiana boasts a robust industrial agbioscience base ranging from inputs to agricultural production to agricultural and biomass processing to food, health, and nutrition products, along with a diverse and growing base of agbiotech companies. The agbioscience industry's ability to acquire specialized human talent with specific and unique skill sets is paramount to its ability to continue to grow and prosper in the State.

Figure 2: Agbioscience Companies Are Located Throughout Indiana



Current Occupational Demand

Recent industrial growth in Indiana's agbioscience sector has yielded a strong demand for expertise in core occupations. The economic expansion that began in mid-2009 has seen the industry grow jobs at a double-digit pace and propelled corresponding demand for innovation-driving occupations in Indiana.

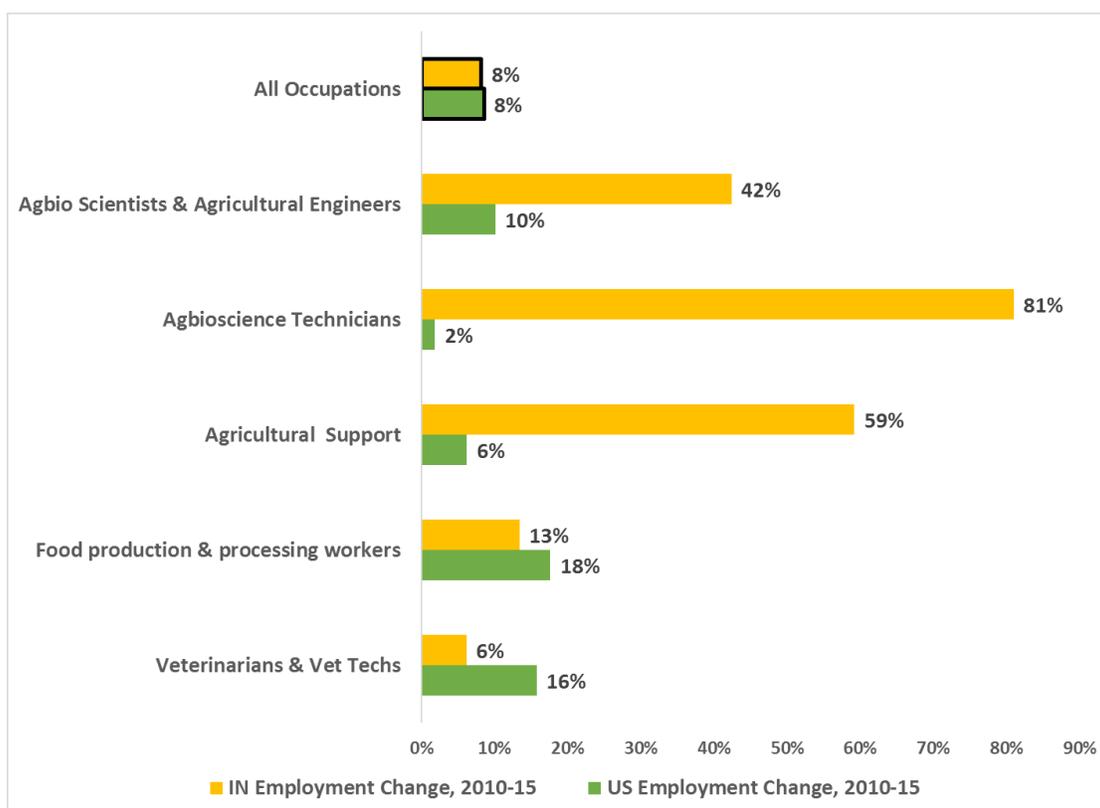
Each of the core agbioscience occupational groups that was analyzed has grown during the economic expansion, with most experiencing double-digit job gains, and three of the five groups outpacing national growth (Figure 3).

- The highly educated and skilled group of **agbioscientists and agricultural engineers** has grown its employment base by 42 percent in Indiana over the 2010–15 period, which represents a net

job gain of 360 over the five-year period. Job gains have been driven by increased hiring of food scientists and technologists and soil and plant scientists. The strong gains in the scientific workforce show a commitment to innovation in these areas.

- **Agbioscience technicians** have similarly demonstrated strong hiring, outpacing the country, with Indiana firms ramping up hiring of agricultural and food science technicians since 2010.
- **Agricultural support** jobs, which span farm-specific roles in purchasing, inspection, breeding, grading/sorting, and mechanics, have grown by 59 percent since 2010 with particularly strong jobs added among farm equipment mechanics and graders and sorters of agricultural products.
- While not outpacing the country, **food production and processing** workers have seen 13 percent growth since 2010 with large job gains in meat cutters and trimmers; food batchmakers; and food cooking machine operators.
- Since 2010, **veterinarians and vet techs** have seen more modest job gains with job growth contributed in both of these occupational areas.

Figure 3: Employment Trends in Core Agbioscience Occupational Groups, 2010–15



Source: TEconomy’s analysis of BLS, OES data.

The size and relative concentration of Indiana’s core agbioscience occupational groups are presented in Table 2. Location quotients (LQs) are utilized to gauge the relative concentration and strength of each occupation in Indiana. Location quotients measure the degree of job concentration within a state or region relative to the nation.¹¹ A state LQ above 1.0 represents a greater concentration than the

¹¹ Location quotients (LQs) are a standard measure of the concentration of a particular industry in a region relative to the nation. The LQ is the share of total state or regional employment in the particular industry divided by the share of total industry employment in the nation. An LQ greater than 1.0 for a particular industry indicates that the region has a greater relative

Indiana's Agbioscience Workforce

national average. When the LQ is significantly above average, 1.20 or greater, the state is said to have a “specialization” in the occupation.

While at the highest level the core occupational groups do not meet this “specialized” threshold, there are several occupations within these groups that have a specialized concentration in Indiana (see Table 2). The concentration of jobs in agricultural support is very strong relative to the country, with a LQ for this group signaling a 9 percent greater concentration in Indiana.¹² The emergence of these groups in recent years, however, is increasing the state’s “market share” of talent across the board and is improving these location quotients.

Table 2: Employment Metrics for Core Agbioscience Occupations, 2015

Core Agbioscience Occupational Groups	Indiana Empl., 2015	IN Empl.% Change, 2010–15	US % Change, 2010–15	Indiana LQ, 2015	Specialized Occupations Within Each Group (LQ≥1.20)
All Occupations	2,947,380	8%	8%	1.00	n/a
Agbio Scientists & Agricultural Engineers	1,210	42%	10%	0.70	Food Scientists & Technologists
Agbioscience Technicians	760	81%	2%	0.71	Agricultural & Food Science Technicians
Agricultural Support	2,340	59%	6%	1.09	Farm Equip. Mechanics/Service Techs; Buyers & Purchasing Agents
Food Production & Processing Workers	15,440	13%	18%	0.92	Meat, Poultry, Fish Cutters/Trimmers; Food Cooking Machine Operators
Veterinarians & Vet Techs	4,350	6%	16%	0.86	None

Source: TEconomy’s analysis of BLS, OES data.

Note: LQ = Location Quotient.

Indiana is emerging in its core agbioscience occupational groups with its widespread job growth.

Figure 4 represents an effective way to summarize the performance and recent demand dynamics of the core occupations. The figure presents three key characteristics for assessing the state’s current position and recent trends—employment size (relative size of bubble), employment growth (represented on horizontal axis), and employment concentration (LQ on vertical axis). With each core agbioscience group firmly to the right of the vertical axis, Indiana can be seen as having an “emerging” workforce with strong demand in recent years.

concentration, whereas an LQ less than 1.0 signifies a relative underrepresentation. An LQ greater than 1.20 denotes employment concentration significantly above the national average. In this analysis, regional specializations are defined by LQs of 1.20 or greater.

¹² It is important to note that the scope for the BLS Occupational Employment Survey (both nationally and across states) includes only “non-farm” business establishments so there is likely an under-representation of job totals in agricultural support in the OES data to the extent these workers are employed at farming establishments as opposed to industrial agbioscience sites or firms.

Indiana's Agbioscience Workforce

While these occupational groups are not considered to be specialized in their overall employment concentration, each does include detailed components with specialized concentrations in Indiana. These include the following:

- Agbio Scientists and Agricultural Engineers: *Food Scientists and Technologists* (LQ is 1.63)
- Agbioscience Technicians: *Agricultural and Food Science Technicians* (LQ is 1.55)
- Agricultural Support: *Farm Equipment Mechanics and Service Technicians* (LQ is 1.55); *Buyers and Purchasing Agents of Farm Products* (LQ is 1.27)
- Food Production and Processing Workers: *Meat, Poultry, and Fish Cutters/Trimmers* (LQ is 1.33); *Food Cooking Machine Operators and Tenders* (LQ is 1.23).

Figure 4: Indiana Core Agbioscience Occupations: Employment Size, Concentration, and Change, 2010–15



Source: TEconomy's analysis of BLS, OES data.

Note: Size of bubble corresponds to employment level.

Projected Occupational Demand

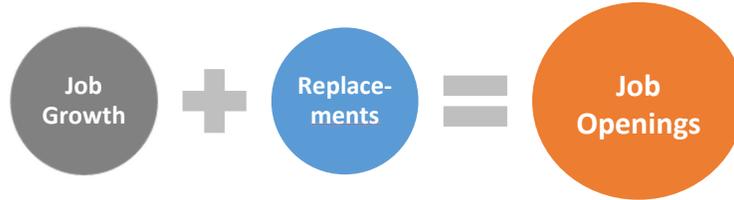
A complete analysis and assessment of occupational demand looks not only to the recent past but also to expectations for future workforce needs. The state's DWD develops 10-year projections of occupational demand specific to Indiana, and these projections are further broken down into annual job openings projected into two distinct categories—"replacements" and "new" jobs.

Labor demand includes not only the growth of new jobs as an economy or individual sector expands, but also job openings due to replacements. Many workers leave their jobs because of retirement or a change in occupation; consequently, employers need replacement workers in addition to those for any

new jobs that are created. In many cases, the demand for workers due to the need for job replacements within an occupation far outpaces the change in total number of workers due solely to growth.

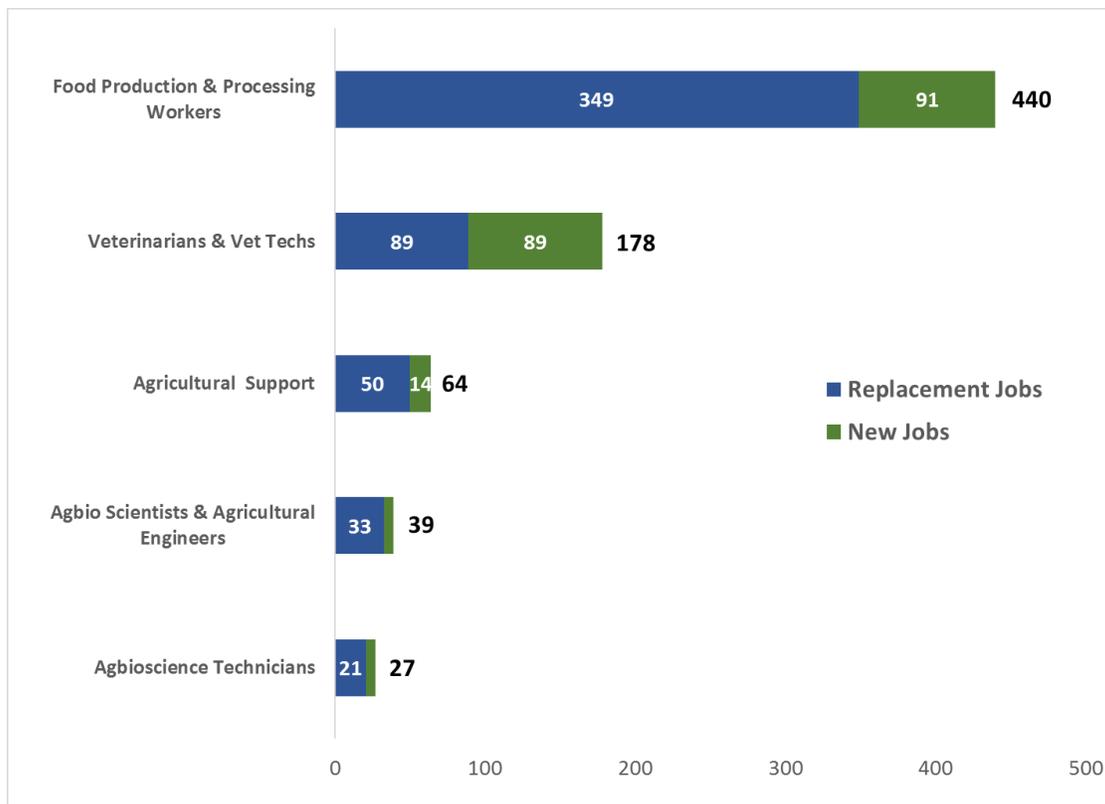
Therefore, the full measure of labor demand is expressed most completely by adding expected job growth and the need for replacement workers, equaling total job openings. Figure 5 presents a simple graphic for fully considering job openings.

Figure 5: How Job Growth and Job Replacements Relate to Total Job Openings



The DWD projections reveal an annual demand for 748 workers in Indiana in the core agbioscience occupations to fill overall job openings expected due to both growth and replacement needs (Figure 6). For Indiana's overall economy, the Department is forecasting a breakdown of annual job openings that show 66 percent for replacements and 34 percent for new job openings. **The situation for core agbioscience occupational needs is expected to tilt much more toward replacements—in fact, for four of the five groups, replacement needs are close to or above 80 percent of annual openings.** The exception is among veterinarians and vet techs, where the split is even at 50 percent each.

Figure 6: Projected Annual Employment Needs in Core Agbioscience Occupations, 2012–22



Source: TEconomy's analysis of Occupational Employment Projections, Indiana DWD.

Indiana's Agbioscience Workforce

Looking ahead, the overall growth projections for core agbioscience workers over the 2012–22 period are generally lower than those for the overall workforce in Indiana. Across the state's economy, in both public and private sectors, DWD is forecasting overall growth of 12 percent. Table 3 provides the growth projections for each group, with all but one lagging this economy-wide growth projection (veterinarians and vet techs each have projected annual job growth well above the statewide average).

The expected high need for replacements reflects the aging of the agbioscience workforce as well as modest projected growth in the sector by DWD. And, while projecting 10 years into the future is difficult, it is important to note the pace at which this economic expansion has generated net new jobs for these workers beyond the replacements that have occurred. These net new job totals exceed those projected for both new and replacement openings for three of the five occupational groups reflecting higher needs (Table 4). Over the 5-year period to 2015, job gains in the core occupational areas averaged more than 700 per year or more than 3,600 growth jobs in total.

Table 3: Employment Growth Projections in Core Agbioscience Occupations, 2012–22

Occupational Group	Projected Empl. Growth, 2012–22
All Occupations	12%
Agbio Scientists & Agricultural Engineers	6%
Agbioscience Technicians	10%
Agricultural Support	7%
Food Production & Processing Workers	7%
Veterinarians & Vet Techs	20%

Source: TEconomy's analysis of Occupational Employment Projections, Indiana DWD.

Table 4: Annual Net Job Growth in Core Agbioscience Occupations, 2010–15

	Annual Net Job Growth, 2010–15	Greater or Less than Projected Annual Job Openings?
Food Production & Processing Workers	364	<
Agricultural Support	174	>
Agbioscience Technicians	72	>
Agbio Scientists & Agricultural Engineers	68	>
Veterinarians & Vet Techs	50	<

Source: TEconomy's analysis of BLS, OES data.

Both the recent past and future projections represent key information to consider for the demand for talent, and both will be used to assess the alignment of demand and supply for core agbioscience occupations later in this section.

Key Findings from Employer Surveys and Interviews

The quantitative data-driven assessment provides a valuable baseline for understanding the demand for these occupations and their corresponding skill sets. But, this must be balanced and complemented by information gleaned from Indiana agbioscience employers about the dynamics for talent they face today. The project approach has therefore included both a survey of employers as well as one-on-one interviews to better understand the demand for talent.

The following is an overview of the web-based survey administered to companies across the agbioscience value chain in Indiana.

- The employer survey is designed to gauge the demand for workers in key agbio-related occupations with respect to the following:
 - Existing employees
 - Recent hires (over last year)
 - Current vacancies
 - Expected new hires (next two years)
- Key Occupations largely reflect those defined in state/federal data sources, but also allow questions concerning occupations outside standard classifications such as Quality Assurance/Control and Regulatory Affairs.
- Questions asked focused on the following:
 - Degree of difficulty/ease finding qualified candidates
 - Recruitment geography
 - Education and work experience requirements
 - Emerging technology areas important for educational curriculum, incumbent worker training
 - Major workforce-related challenges for employers

Twenty-three of Indiana's agbioscience companies completed the survey, along with a handful of partial survey responses, providing insights into the demand dynamics for talent. Taken together, these companies employ nearly 9,000 in the state's agbioscience sector and generally reflect the breadth of its varied segments, such as agricultural chemicals, plant sciences/seed development, agricultural production, ag-biotech, food manufacturing, ag machinery, human and animal nutrition, biofuels, and other areas. These companies reported hiring just over 800 individuals in Indiana over the last year.

Indiana Agbioscience Employer Survey Response Overview

97 Indiana companies sent online survey via e-mail.

23 companies completed the survey.

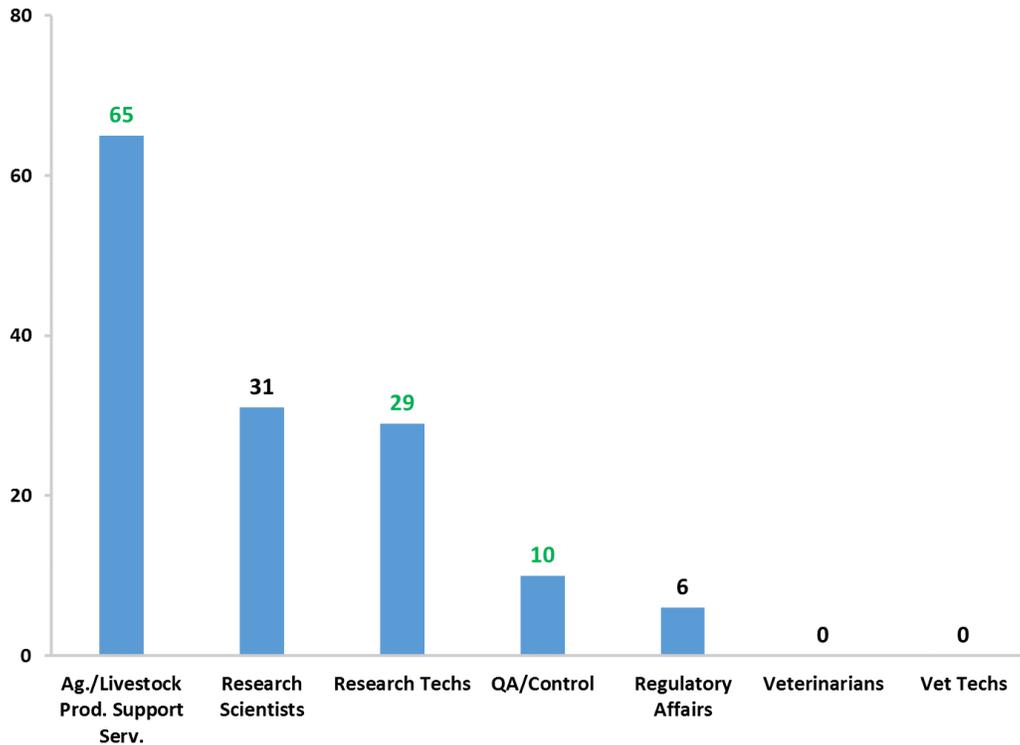
= 24% response rate

The 23 responding companies employ **8,978** currently and have hired **809** over the last year.

Indiana's Agbioscience Workforce

In the occupational groups considered to be “core” in nature, including additional skill sets that are not part of the federal statistical classification structure utilized in the data analysis—specifically quality assurance/control and regulatory affairs—the recent hiring totals are shown in Figure 7.

Figure 7: Recent Hires of Indiana Agbioscience Companies in Core Occupational Areas During the Last Year (Green data labels indicate above-average hiring levels relative to base employment)



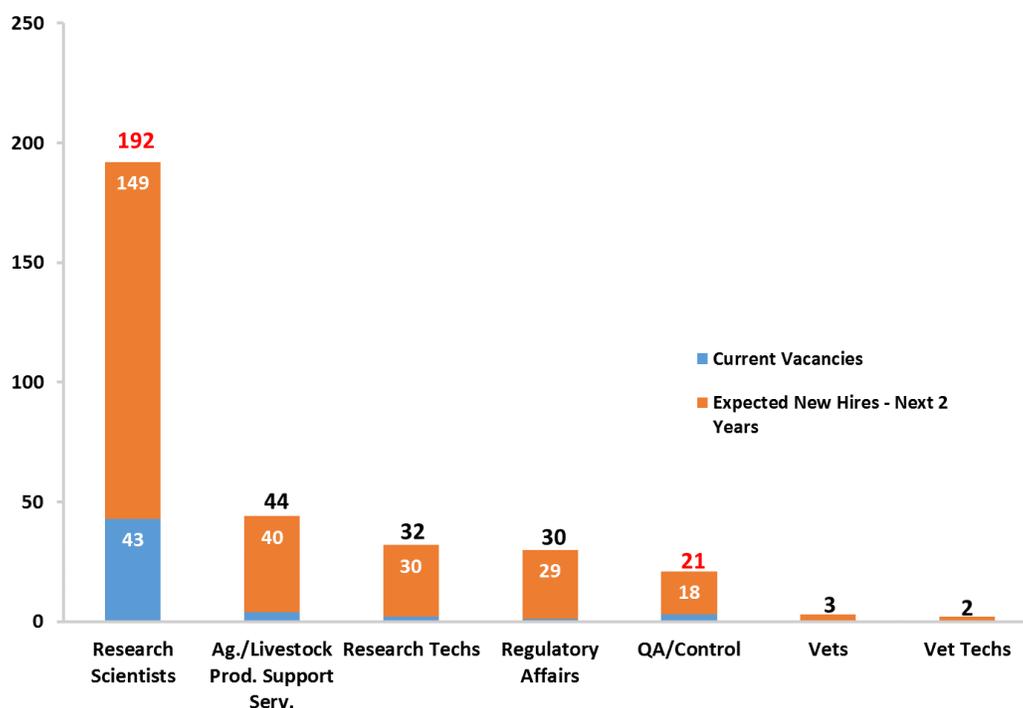
Recent hiring levels were compared with the base level of occupational employment reported by the responding companies to determine whether certain areas could be considered “high demand.” This comparison revealed three occupational groups with above-average demand indicated by recent hires:

- Agricultural/Livestock Production Support Services
- Research Technicians
- Quality Assurance/Quality Control

In addition to actual hires, companies were asked to report indicators of current and future demand, including current vacancies in these areas as well as expectations for future hiring. Figure 8 presents these totals for core occupations with the following occupational groups expected to see above-average hiring into the future:

- Research Scientists
- Quality Assurance/Quality Control

Figure 8: Current Vacancies and Expected New Hires for Indiana Agbioscience Companies in Core Occupational Areas During the Next Two Years (Red data labels indicate above-average hiring levels relative to base employment)



When asked about the degree of difficulty (or ease) in finding qualified workers, very few survey responses indicated that it was “very difficult” to find workers in the core agbioscience fields. Only three occupational areas received these ratings at all, and in these cases, each was noted by just one or two companies. These three “very difficult” occupational areas include the following:

- Research Scientists
- Regulatory Affairs
- Quality Assurance/Quality Control.

Beyond the survey, 24 one-on-one interviews were conducted in order to speak directly with leadership at agbioscience companies as well as nonprofits and governmental organizations that represent the agbioscience industry to further ascertain specific concerns or issues with obtaining the key skilled talent required to grow their specific companies or the industry as a whole. In conducting these interviews, agbioscience employers did indicate three occupational groups that are in high demand and difficult to find and/or retain:

- **Food Production and Processing Workers**—These are difficult to hire, are characterized by high turnover, and, according to employers, often leave for other production-type jobs when available. Employees in this field are often working in difficult conditions and generally earn lower wages than some other advanced manufacturing environments.
- **Quality Assurance/Quality Control and Regulatory Affairs**—This workforce has particular expertise, and, in highly regulated industries such as the agbiosciences, plays key roles in assuring compliance. Employers indicate that they often recruit these individuals from outside

of Indiana, either regionally or nationally, and have a consistent need for this expertise. They also noted that, with the advent of the Food Safety Modernization Act (as an example of new and complex regulation), finding individuals with the regulatory affairs expertise/knowledge to keep up with the changes in legislation is increasingly difficult. A further complication is the fact that this field does not have a formal degree program; therefore, employees must learn on the job, within the company and the regulatory environment in which they operate.

- **Transdisciplinary Research Talent**—These individuals who are able to think and perform outside of “silos” and approach problems through the viewpoint of multiple lenses are needed by companies with highly technical products in emerging markets.

When the few companies that had indicated that research scientists can be difficult to hire were asked for additional information, it was learned that often these are agbioscientists and researchers in extremely niche areas being located to very rural parts of Indiana. As a result, factors such as quality of life must certainly be assumed to be contributors to this issue. The ability to attract agbioscientists and researchers to the larger population centers around the state does not appear to be an issue.

While most interviewees indicated that it was not difficult to find core agbioscience workers, many interviewees did suggest that, while these employees were technically skilled individuals in their respective fields, they often lacked the business acumen desired for the position—skills such as project management, managerial/supervisory oversight, leadership, etc. Employers further indicated that hiring professionals with so-called “soft” skills, including the ability to be punctual, to communicate effectively, and to work in teams that span corporate departments and functions to solve problems and innovate new ideas, is growing increasingly difficult. A few companies also noted a lack of international experience/cultural knowledge that is needed to help drive new products and markets.

Some interviewees suggested that many of their job candidates lack some base-level knowledge in agricultural production, whether from personal experience on a family farm or from professional experience in the industry. While the candidates had the requisite core skill set required, they often lack the broader agricultural background and knowledge to make them a well-rounded employee. This was attributed to the number of individuals who are further and further removed from agricultural production backgrounds. Numerous employers cite this as critical to sourcing and retaining talent in the agbiosciences and find that often employees who do not understand the basics or the seasonal requirements of ag-related work do not remain with the company or industry.

A few other companies indicated that hiring lab technicians can be difficult, and they too have developed their own training programs and are promoting from within.

Demand Summary for Core Agbioscience Occupations

Taken together, the quantitative and qualitative analyses can be summarized to categorize those occupational groups that could be considered in “high demand” now and into the future. Table 5 presents such a summary across the measures discussed in this section and finds only three of the core occupational groups meet a high demand threshold—food production and processing workers; quality assurance/control; and regulatory affairs.

While the demand context is clearly quite strong among core agbioscience occupations, Indiana employers generally indicate that they have been able to find, hire, and retain workers in these job functions, which will be further illuminated in the analysis of demand and supply alignment.

Table 5: Summarizing the Demand Assessment for Core Agbioscience Occupations

Major Occupational Groups	High Growth (IN>US)	Projected High Growth (Occ > IN Avg)	Survey: Strong Recent Hiring	Survey: Strong Expected Hiring	Consistently Identified as in-demand in industry discussions	Total Counts of "YES"	High Demand Status (3 or 4 = high demand)
Agbio Scientists & Agricultural Engineers	YES			YES		2	
Agbioscience Technicians	YES		YES			2	
Agricultural Support	YES		YES			2	
Food production & processing workers					YES	1**	High-Demand
Veterinarians & Vet Techs		YES				1	
Quality Assurance/Control	n/a	n/a	YES	YES	YES	3	High-Demand
Regulatory Affairs	n/a	n/a			YES	1**	High-Demand

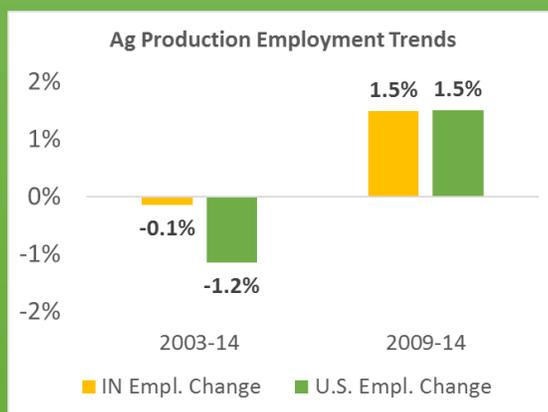
Note: Occupational groups with 3 or 4 “yes” designations are considered to be “high-demand” occupations.

**The project team has designated these production and regulatory jobs and functions as areas to consider as “high demand” for Indiana companies based on the consistent, intense expression of strong demand and difficulty hiring into them. Further, for Regulatory Affairs, the project team is unable to consider these jobs under the occupational data framework as no distinct classification exists for these jobs; so, these “qualitative” interactions are given more weight. For Food Production/Processing occupations, food manufacturers were underrepresented in the survey; but, interviews raised this need at a consistently high level.

Indiana's Agricultural Production Workforce

In addition to the needs of Indiana agbioscience industry employers assessed in this study is the vast agricultural production ("farming") workforce across the state. In 2014, Indiana employed nearly 66,000 in primary agricultural production jobs that span crop and animal production, as well as some jobs in forestry and agricultural support. The majority of these individuals—more than 51,000 in 2014—are unincorporated farm proprietors.* Among these farm proprietors, Indiana ranks 14th among all states.

This chart shows recent employment trends in the full agricultural production context, with Indiana holding employment steady since 2003 and, during the economic recovery, both the United States and Indiana adding 1.5 percent to their respective employment totals.



Source: TEconomy’s analysis of BLS, QCEW data, enhanced file from IMPLAN; BEA data on Farm Proprietors.

These trends and data are from an industry perspective; however, the occupational data that are the focus of this workforce study are essentially nonexistent for the agricultural production workforce as the scope of the OES survey is “non-farm.”

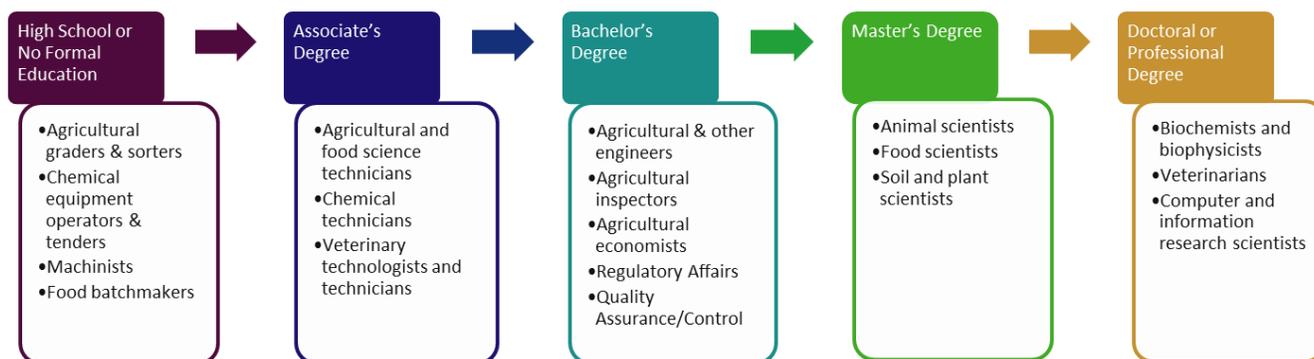
*Note: Employment in agricultural production is measured differently across the federal statistical agencies. The primary industry data set used in this study, the BLS QCEW, captures employment in ag production in incorporated farming operations but excludes many workers on smaller farms that do not pay into the Unemployment Insurance system. Recognizing this limitation in the data, one must look to other data sources to account for this farm-related activity—specifically, farms and farm-related employment estimates from the BEA. The BEA estimates of “farm proprietors” are used here along with data from BLS to present a more complete picture of farm employment in Indiana.

The Supply of Indiana's Core Agbioscience Workforce

Keeping in mind this understanding of demand dynamics, the key question remains as to the supply of talent in Indiana and its capacity to generate the workforce supply needed to meet demand. This section examines the talent generated in Indiana in the areas most aligned with the skills and educational requirements for the core agbioscience occupations.

Part of the value proposition for states and regions that, like Indiana, specialize in the agbiosciences is not only innovation but also the breadth of high-quality jobs generated across the sector. These jobs are not solely for PhD scientists or engineers, but span an impressive range of skill sets, educational requirements, and ultimately job functions. The BLS conducts assessments to identify the education, training, and experience requirements most typically required to enter an occupation. Figure 9 illustrates this for a sampling of key agbioscience occupations across the educational spectrum, highlighting the diversity of jobs and degrees that span the sector.

Figure 9: Entry-Level Degree Requirements for Selected Agbioscience-Related Occupations



Source: U.S. BLS, Occupational Projections Program.

Current Supply of Core Agbioscience Degrees

Indiana's colleges and universities represent a unique and powerful asset to the State. They include world-class research and teaching institutions at all degree levels that span the state. They attract students not only from other states, but also from other nations, and offer degrees across every major field of study.

These institutions and programs represent the primary source of new talent generated in the state with the qualifications necessary to enter core agbioscience occupational fields upon graduation. Of course, the degree levels and experience requirements of these jobs can vary considerably. So, what are the most relevant degree fields and levels required by employers for the core occupations considered in this study? Through federal grants, researchers at the National Crosswalk Service Center have developed a crosswalk from occupations to relevant degree fields.¹³ Combined with the entry-level requirements

¹³ According to the National Crosswalk Service Center website (<http://www.xwalkcenter.org/>): "The National Crosswalk Service Center (NCSC) is a federally-funded national clearinghouse for classification information about occupations, training programs and industries. The NCSC has been operated by the State of Iowa since 1983 under a series of grants from federal agencies. Funding for the Center has been provided by the Employment and Training Administration, U.S. Department of Labor since 1996."

Indiana's Agbioscience Workforce

developed by BLS, the TEconomy project team has mapped degree graduates generated in Indiana that best align with core agbioscience occupational groups.

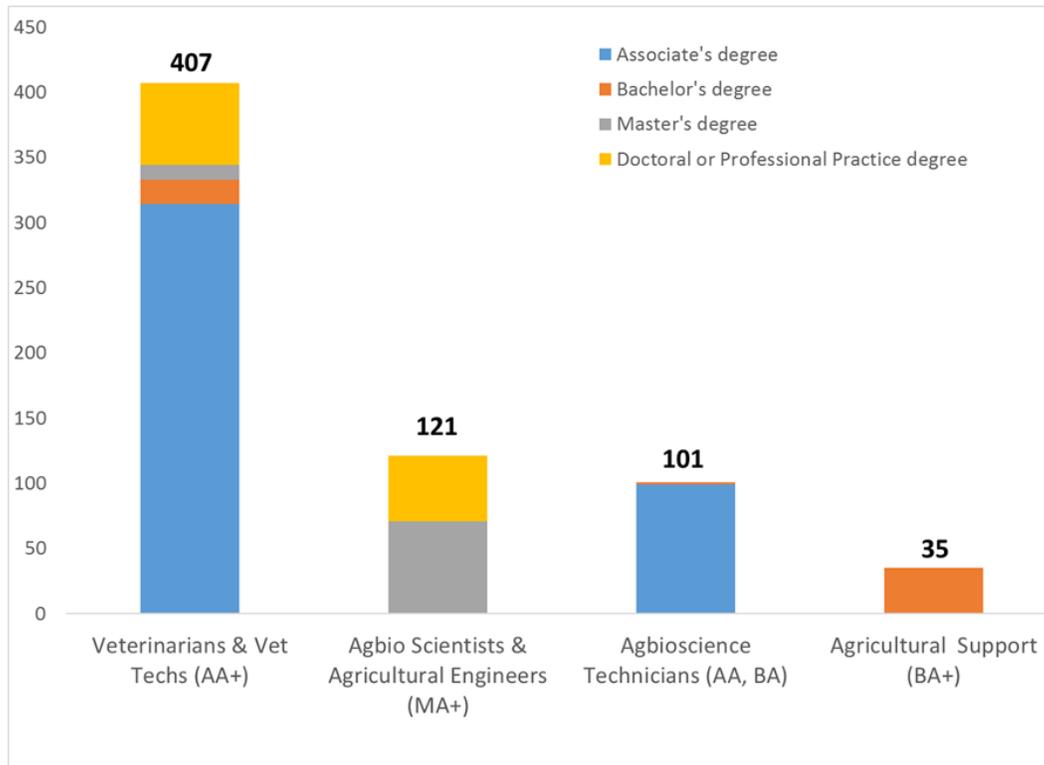
A sampling of the top degree fields and the institutions producing graduates are shown in Table 6, with degree totals by appropriate levels required presented in Figure 10.

Table 6: Leading Indiana Institutions in Core Agbioscience Degree Areas

Agbio Scientists & Ag Engineers	Agbio Technicians	Agricultural Support	Veterinarians & Vet Techs
<p>Purdue University:</p> <ul style="list-style-type: none"> • Ag Engineering • Animal Sciences • Food Science • Soil Science & Agronomy • Forest Sciences & Biology 	<p>Ivy Tech:</p> <ul style="list-style-type: none"> • General Agriculture • Precision Agriculture <p>Vincennes:</p> <ul style="list-style-type: none"> • Applied Horticulture <p>Ancilla College:</p> <ul style="list-style-type: none"> • General Agriculture 	<p>Purdue University:</p> <ul style="list-style-type: none"> • Agricultural Mechanization 	<p>Harrison College, International Business College, Brown Mackie College:</p> <ul style="list-style-type: none"> • Veterinary/Animal Health Technology <p>Purdue University:</p> <ul style="list-style-type: none"> • Veterinary Medicine

Source: TEconomy's analysis of National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS) Database.

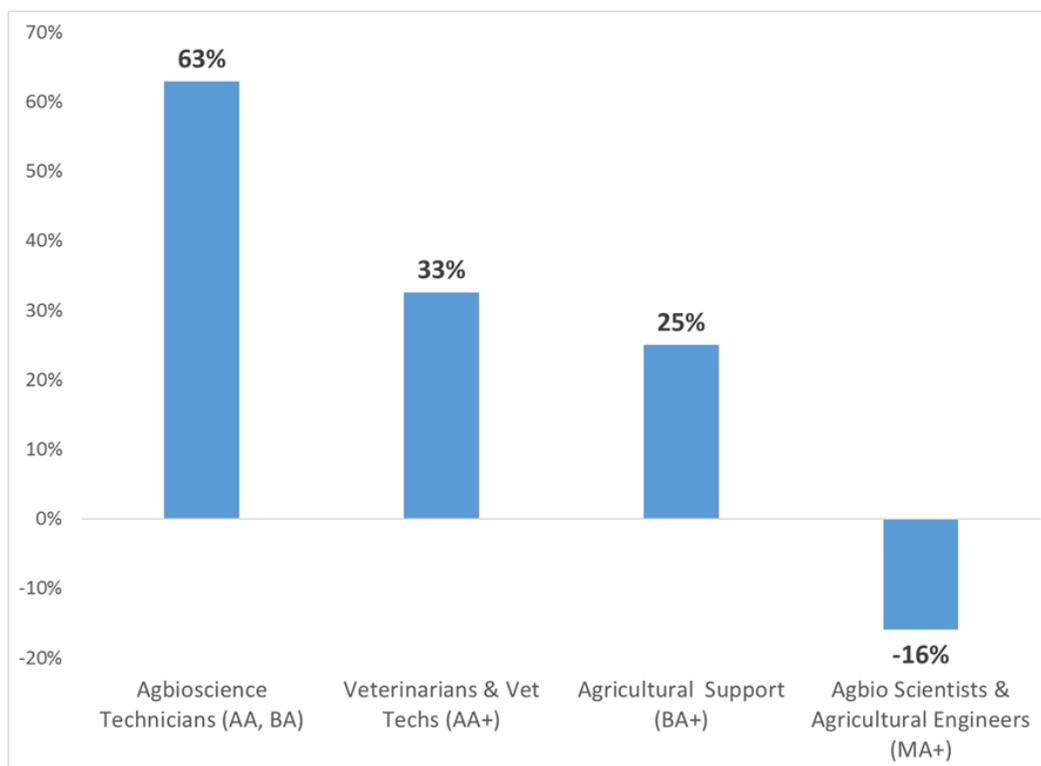
Figure 10: Indiana Graduates in Fields Most Closely Aligned with Core Agbioscience Occupations, 2014



Source: TEconomy's analysis of Postsecondary Degree data from National Center for Education Statistics, IPEDS Database. Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center. Data not shown for: Food Production and Processing workers as majority of jobs do not require postsecondary education for entry.

The recent trend in degree graduates in relevant agbiosciences fields is an important signal of both the capacity of Indiana institutions to generate new talent as well as the trend in student interest in pursuing degrees in these fields. Figure 11 shows these trends since 2010 and finds robust growth across the degrees most relevant to agbioscience technicians; veterinarians and vet techs; and agricultural support. Those degrees most relevant to agbio scientists and agricultural engineers have seen some decline recently at the Master's level and above. This is due to the drop-off in graduate level program offerings in animal physiology at Ball State University and in ecology at Indiana University.

Figure 11: Trend in Indiana Graduates in Fields Most Aligned with Core Agbioscience Occupations, 2010–14



Source: TEconomy’s analysis of Postsecondary Degree data from National Center for Education Statistics, IPEDS Database. Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center. Data not shown for: Food Production and Processing workers as majority of jobs do not require postsecondary education for entry.

In agriculture and related scientific and business fields, the state’s land-grant institution, **Purdue University**, represents a tremendous resource for education and research. The University’s College of Agriculture educates students across a range of fields most relevant to core agbioscience occupations, including agricultural sciences, food sciences, life sciences, and natural resource sciences. Through its role as both an educational and research institution combined with its agricultural extension work across Indiana, Purdue has perhaps the single most important role to play in talent development for this sector.

In addition to Purdue, a number of other institutions are working to advance the postsecondary agbioscience talent base. Most relevant to core agbioscience occupations at the Bachelor’s level are institutions that are developing agriculture-related programs. One such institution is **Huntington University**, which, in the Fall of 2015, established the Haupert Institute for Agricultural Studies that now offers Bachelor’s degrees in agribusiness and agricultural education and connects with industry through outreach and required internships and with youth groups through 4-H and FFA. Though small in size and brand new, this represents a recognition of the importance of agriculture to the state and the excitement of students in pursuing these degrees.

A number of institutions also provide Associate’s degrees in fields related to core agbioscience occupations. **Ivy Tech**, Indiana’s community college system, offers an agriculture program at seven of its campuses that spans animal science, plant and soil science, agricultural equipment, and agricultural

Indiana's Agbioscience Workforce

sales and business. The program offers hands-on field experiences, guest speakers, and industry partnerships with organizations such as Indiana FFA, John Deere, Case IH, and the U.S. Department of Agriculture. Students who desire to transfer into a four-year program can earn an Associate of Science degree and then proceed to another institution. Those who desire to enter the workforce upon completing their studies can earn an Associate of Applied Science degree.

At its Lafayette Campus, *Pathway to Purdue* has been developed as a partnership between the Purdue University College of Agriculture and Ivy Tech Community College-Lafayette. The program allows Ivy Tech students to co-enroll at Purdue in preparation for an undergraduate degree in the College of Agriculture. Pathway students take courses simultaneously at both institutions with the goal of earning a Bachelor of Science degree in agriculture from Purdue.

At its Terre Haute Campus, Ivy Tech has recently launched a new program in Precision Agriculture Equipment Technology. Using state-of-the-art laboratories, students combine computer technology with GPS and mapping software to record and track yield information. Classes focus on a variety of subjects necessary to be successful in this field, including production agriculture, mechanical systems, electronics, and business strategies and global farming issues. The program offers students the opportunity to earn three different precision agriculture related certificates as well as an Associate of Applied Science in Precision Agriculture Equipment Technology.

Vincennes University offers a two-year Associate's program in Natural Resources and Environmental Sciences with a focus in agriculture under a cooperative partnership with Purdue University that gives students the option to either enter a baccalaureate program at Purdue or another four-year institution or begin work. The University also offers degrees in Applied Horticulture.

Ancilla College has recently added a two-year Associate's program in agriculture. The program prepares students to go directly into the workforce or transfer to a four-year program. Ancilla has developed agreements with nearly 20 four-year schools that guarantee qualified applicants placement for those seeking a Bachelor's degree. The program has also developed numerous relationships with local businesses seeking trained individuals.

Finally, a number of Indiana's academic institutions are becoming engaged in areas of relevance to the agbioscience industry. For example, the College of Technology at **Indiana State University** has developed a program in Unmanned Systems, with significant relevance to precision agriculture, including participation in the program by several Indiana companies in the precision agriculture space. Because of the level of interest in the program, Indiana State has plans to also develop a Master's degree program in data informatics that will have an agricultural component.

Industry and Academic Viewpoints Regarding Supply from Surveys and Interviews

As with the demand analysis, the quantitative data-driven assessment provides a valuable baseline for understanding the supply of degreed individuals in core agbioscience skill sets. But, this must be balanced and complemented by information gleaned from Indiana agbioscience employers and the dynamics for talent they face today as well as issues being faced by the academic institutions providing the training. Therefore, the project approach included both a survey of employers (described earlier) as well as one-on-one interviews with both employers and representatives of academic institutions to better understand the supply of talent.

A range of more general, and often less technical, and even "soft" skill sets are cited by employers in the survey as critical "emerging" areas of importance in developing their *incumbent workforce*. These areas for potential training needs include the following, quoting directly from employers:

- "Technology orientation, including embracing new technologies"
- "Problem solving and critical thinking"
- "Team orientation"
- "Effective communication skills - both internally and externally"
 - "Customer service as a top priority"
 - "Media skills/public speaking skills"
 - "Public opinion influencers"
- "Management training/leadership"
- "Savvy with digital and social media; implementing new media technologies to interact with customers"
- "Use of data analytics to make informed decisions; managing 'Big Data'"
- "Entrepreneurial skills and orientation"
- "Global understanding of agricultural production and how to commercialize products internationally"
- "Precision agriculture trends (moving fast, need to keep up)"
- "Staying on top of regulatory changes"
- "Teaching skilled people who are not from the farm about agriculture"
- "Strategic planning"
- "Patience in the job and learning to earn promotions"
- "Process orientation, working in teams/collaboration, leadership orientation, accountability."

When asked a similar question regarding emerging technology and knowledge areas critical for *new hires*, employers emphasized many of the same responses as for incumbents, but further included the following:

- "Project management skills"
- In manufacturing/production:
 - "Lean manufacturing (continuous improvement) focusing on bringing the customer value"
 - "Computer Numerical Control (CNC) setup/operating"
 - "Brake press/roll former operators"
- "Strategic business acumen and emotional intelligence to complement their technical training"
- "Use of data science and computing skills in production agriculture."

Employers were asked about **emerging technologies** in the agbiosciences that they felt needed to be reflected and/or increasingly emphasized in educational curriculum. The frequency of areas identified are shown in Table 7.

Table 7: Emerging Technology Areas Identified by Indiana Agbioscience Employers

Technology Area	# of Companies Identifying
Precision Agriculture	14
Food Safety Technologies	11
Value-Added Food & Health Products	10
Bioinformatics	9
Molecular Plant Improvement Including Tissue Culture, Genetic Engineering, and Transgenics	7
Animal Genetics/Genomics	7
Pathogen Biosecurity	5
Biofuels & Other Bioenergy Technologies	5
Biomaterials, Renewable Materials	4
Synthetic Biology	3
Industrial Microbiology*	3
Advanced Food Packaging	3
Other areas reported:	
Crop Protection Chemistry; Computational Chemistry; Protein Chemistry	1
Livestock Infrastructure: Improved livestock production facilities that incorporate more technology, green energy, controlled emissions technology	1
Human Microbiome	1
Hazard Analysis Critical Control Point (HACCP) QA/QC**	1

*Industrial Microbiology includes the manipulation of microbes and meta-genomic microbial populations for application to food and biomass production, energy and green chemicals production, and bioremediation of environmental contaminants.

**According to the U.S. Food and Drug Administration: HACCP is a management system in which food safety is addressed through the analysis and control of biological, chemical, and physical hazards from raw material production, procurement, and handling to manufacturing, distribution, and consumption of the finished product.

The supply of talent can be affected by factors well beyond specific degrees, experience, and areas of expertise. Indiana agbioscience employers indicate other factors affecting workforce supply as follows:

- Many operate in rural, small towns and in small company environments, and employee match-making can be limited and difficult in these settings with a limited pool of available talent;
- Competing for low- and middle-skilled talent for lower-paid jobs against other industries can be difficult given the nature of agbioscience-related work (often physically challenging in difficult work environments);
- Finding employees who fit into the “culture” of an agbioscience organization is challenging, typically with respect to a familiarity or experience with agriculture;
- Having a strong work ethic; and
- Increasingly, agbioscience companies operate in global markets; it is difficult to find multilingual individuals as well as those with appropriate cultural skills.

The feedback from Indiana agbioscience employers indicates that key worker characteristics are evolving to require not only experts in scientific and technical disciplines in agriculture and related fields, but also workers who bring key competencies around softer skills as well. This evolution and corresponding workforce challenges are not completely unique to the agbiosciences, but rather are

increasing in importance in other advanced industries, requiring workforce development and educational programming designed to address more well-rounded characteristics.

Aligning the Demand and Supply of Core Agbioscience Occupations

The growth and continued success of Indiana's agbioscience industry require an alignment on talent that ensures a predictable and robust supply of qualified workers across the sector. Considering lessons learned from both sides of the demand-supply equation—both quantitatively and qualitatively—provides a picture on potential areas of misalignment.

One approach to determining the alignment on specific occupational groups is to compare, on an annual basis, the levels of graduates from Indiana postsecondary institutions in degree fields most relevant to these occupations with the annual demand projected. Several caveats of this approach must be acknowledged:

- Specifically, that not everyone who graduates from a degree program will enter into an occupational field that directly aligns with it;
- New graduates are certainly not a substitute for experienced workers in skilled occupations; and
- Certainly, not all graduates remain in state following graduation.

With those caveats in mind, the approach does allow for an assessment of the broad contours of alignment within Indiana and highlights key areas where there may well be a misalignment now and/or into the future.

In Indiana, a key adjustment can be made to this approach, however, with respect to the last caveat noted above, that of assessing graduate "retention." Of course, not all graduates of any state's postsecondary institutions are going to remain in state to begin (or even continue) their careers. Indiana, in its position as a significant importer of students to attend its colleges and universities, will tend to see a loss of graduates to other places if for no other reason than many of these students are returning to the states or countries from which they originally came.¹⁴ But, some assessment and calculation of career prospects or continuing education are considered by virtually all graduates, including consideration of wages/salary. Coming to Indiana to study for a number of years exposes out-of-state students to the experience of living in the state, as well as gives them the opportunity to evaluate career opportunities in Indiana companies and across industries.

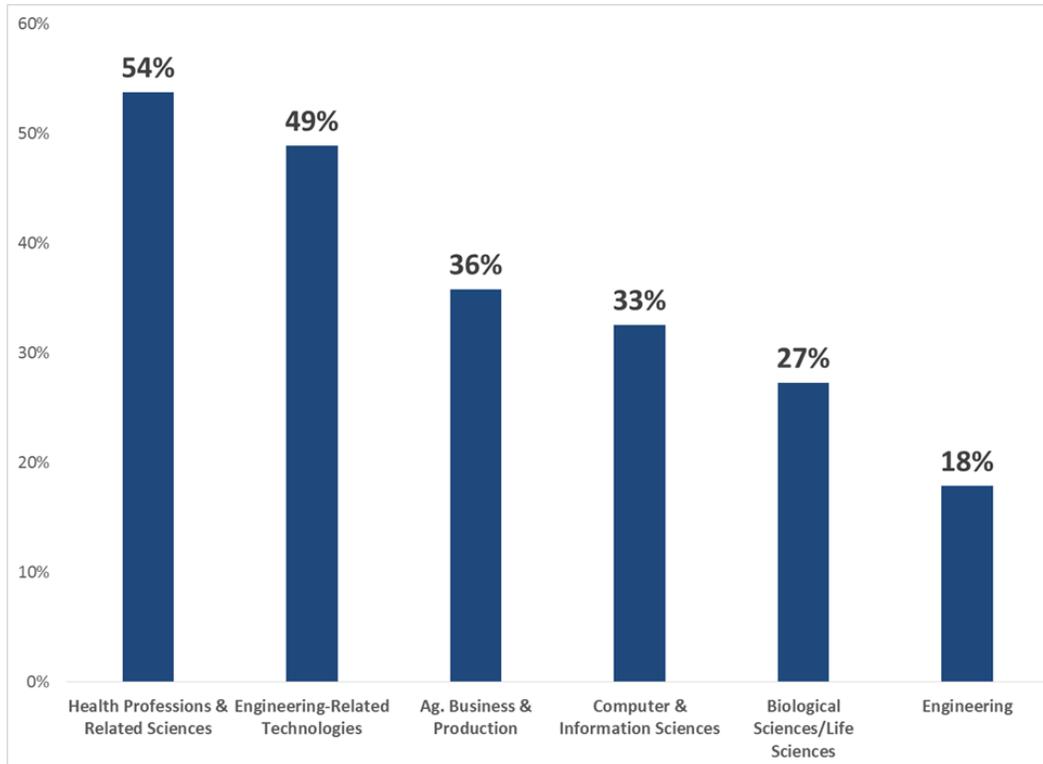
Indiana, like some other states, has been innovative in its linkages of state-level education and workforce databases to enable some tracking of students attending its public colleges and universities to determine whether or not they are employed in the state following graduation, based on personal

¹⁴ Indiana is in the middle among states in terms of its percentage of all undergraduate students who come to school from out of state—24 percent in 2014 were from out of state, ranking 22nd among all states. However, if one ranks states by the sheer size of this out-of-state cohort, Indiana ranks 11th, with the migration of undergraduate students into Indiana totaling 16,583 in the Fall of 2014. Source: U.S. Department of Education, National Center for Education Statistics, IPEDS, Spring 2015, Fall Enrollment component. Accessed via the Digest of Education Statistics. Data represent residence and migration of all first-time degree/certificate-seeking undergraduates in degree-granting postsecondary institutions in Fall 2014. Student in-migrant totals include foreign students.

identifying information such as social security numbers and/or driver's license numbers. These data are maintained under the Indiana Network of Knowledge (INK) program.¹⁵

Data from INK were provided to understand the retention context for graduate cohorts across high-level degree programs. Figure 12 shows the shares of public institution graduates employed in the state in 2014.

Figure 12: Share of 2009–13 Graduates at the Bachelor's Level and Above from Indiana Public Institutions Employed in Indiana in 2014



Source: TEconomy's analysis of data provided by INK via the Indiana DWD.

Note: Some graduate and employment totals are suppressed by INK due to limited sample sizes and to maintain confidentiality.

The INK data highlight the realities and significant challenges around graduate retention in Indiana, though these challenges are not unique to Indiana and other states that have an especially large out-of-state student population. Insights from INK data allow for the following two distinct approaches to the assessment around supply:

- A first approach (Table 8) that compares annual demand with the supply of graduates in relevant fields
- A second approach (Table 9) that compares annual demand with *the supply of graduates adjusted for average retention rates applied across the relevant major degree fields.*

¹⁵ For more information on the Indiana Network of Knowledge see: <http://www.in.gov/ink/>.

Indiana's Agbioscience Workforce

For core agbioscience occupations, the demand side of the talent equation is also presented in two ways—as discussed earlier, to include the perspective on demand from projections as well as from recent annual net job changes.

Table 8: Approach #1, Indiana Core Agbioscience Occupations: Comparison of Annual Projected Job Openings and Annual Net Employment Increases with “Supply” of Total New Higher-Education Degrees Generated

Key Life Science-related Occupational Groups	Indiana Projected Annual Job Openings, 2012-22	Indiana Annual Net Employment Increase, 2010-15	Indiana Degree Graduates, 2014	Degree Levels Generally Required
Agbio Scientists & Agricultural Engineers	39	72	121	Master's & higher
Agbioscience Technicians	27	68	101	Associate's & higher
Agricultural Support	64	174	35	Mixed - Bachelor's & higher; no credential
Food production & processing workers	440	364	n/a	No Postsecondary requirement
Veterinarians & Vet Techs	178	50	407	Mixed - Associate's; Professional degree

Source: TEconomy’s analysis of OES and Occupational Projections data from Indiana DWD; Postsecondary Degree data from National Center for Education Statistics, IPEDS Database; graduate retention data from INK.

Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center.

Table 9: Approach #2, Indiana Core Agbioscience Occupations: Comparison of Annual Projected Job Openings and Annual Net Employment Increases with. “Supply” of New Higher-Education Degrees Generated, Adjusted for Graduate Retention Rates

Key Life Science-related Occupational Groups	Indiana Projected Annual Job Openings, 2012-22	Indiana Annual Net Employment Increase, 2010-15	Indiana Degree Graduates Adjusted for Avg. In-State Retention, 2014	Degree Levels Generally Required
Agbio Scientists & Agricultural Engineers	39	72	43	Master's & higher
Agbioscience Technicians	27	68	36	Associate's & higher
Agricultural Support	64	174	13	Mixed - Bachelor's & higher; no credential
Food production & processing workers	440	364	n/a	No Postsecondary requirement
Veterinarians & Vet Techs	178	50	219	Mixed - Associate's; Professional degree

Source: TEconomy’s analysis of OES and Occupational Projections data from Indiana DWD; Postsecondary Degree data from National Center for Education Statistics, IPEDS Database; graduate retention data from INK.

Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center.

Under the first approach, generally close alignment is seen between annual graduates and the demand scenarios, though some concerns emerge about the supply of graduates for agricultural support jobs relative to their annual demand. That said, all agricultural support positions do not require postsecondary credentials, and this potential gap could be overstated. Agricultural support positions were not identified as “high demand” across the full demand analysis and were not identified to the project team as an area of intense need by employers; however, given the strong recent hiring and potential for a mismatch in demand versus supply, these core occupations should be considered as an area for potential misalignment to be considered for strategic intervention.

Unfortunately, this postsecondary supply analysis does not apply to the vast majority of the food production and processing workforce as these jobs generally do not require a college degree. With that

Indiana's Agbioscience Workforce

acknowledged, discussions with food manufacturers indicate a very strong, current, and consistent need for production workers due to high turnover in this workforce. Because of this, the project team has designated this core occupational group as a “high demand” area with a current misalignment for potential strategic intervention.

A more realistic scenario in the second approach considers that all Indiana graduates do not remain in state following completion of their degree. Some misalignment is evident in the data on retained graduates compared with annual need, particularly in view of the demand scenario under recent job gains. This misalignment continues to apply to agricultural support positions and skill sets as it did under the first approach. Further, one sees the alignment gap narrow for occupational groups like agbio scientists and agricultural engineers and for agbioscience technicians where there has been strong recent hiring but overall this has not been identified as high demand across each of the measures and factors considered. In general, these positions are not a current challenge or misaligned area for employers to fill but if the economy and this industry continues to generate strong gains, that dynamic could change.

Shifting toward necessary areas for intervention, the findings from this approach must be combined with the areas identified as “high demand” that consider the input from not only a data perspective, but also via employer surveys and interviews. Those areas identified as both high demand and with potential misalignment are the primary candidates for necessary strategic intervention and will be revisited in the final section of the report.

The Key Role of Indiana's Postsecondary Faculty in the Agbioscience Talent Pipeline

In addition to the skilled, specialized talent required by the Indiana agbioscience industry, highly skilled and educated teachers, professors, and instructors for the state's colleges and universities are necessary to continue to advance the talent pipeline in Indiana. These professionals represent one of the most important roles in talent generation.

In academic disciplines most directly related to the agbiosciences, 1,490 postsecondary teachers were employed in Indiana in 2015, with a breakdown as follows:

- **Agricultural science teachers, postsecondary: 470 employed**
- **Biological science teachers, postsecondary: 1,020 employed.**

Indiana's concentration of agricultural science professors is highly specialized with a statewide LQ of 2.27, representing 127 percent more than the national average and highlighting Indiana's key role in state, regional, and national agricultural education. Unfortunately, data are not published to assess the demand for agricultural science professors either over the recovery or with respect to projections.

In the biological sciences, Indiana has seen strong growth in recent years—the base of Indiana professors has grown by nearly 31 percent since 2010, while nationally there has been a 5 percent decline. Projected annual openings through 2022 for these professions total 19 in Indiana.

In the context of this report and its focus on ensuring a robust talent pipeline for the agbiosciences into the future, the role that postsecondary faculty play in generating high-quality talent is critical and must be considered alongside the needs of private industry.

Section IV. Indiana's Allied Agbioscience Workers: Demand, Supply, and Alignment

Demand for Allied Agbioscience Talent

In addition to those occupations most clearly in core agbioscience job functions and areas of expertise, a broad range of occupations are critical for the industry to function effectively and efficiently and to innovate. **These jobs span areas of science and engineering, management and business operations, IT, sales and marketing, skilled production and maintenance, and transportation and logistics functions, among others.**¹⁶

These occupations are closely “allied” with their core agbioscience peers. This designation has a specific context under the occupational structure within which the project team is working (see text box) and the critical consideration that the agbioscience industry competes for talent among this workforce in ways that it does not for “core” talent. Specifically, Indiana’s agbioscience companies are constantly competing for talent in these areas with all advanced manufacturing in Indiana and with other technology-driven industries. These occupations have been identified as playing a disproportionately important role in the agbiosciences.

This section will consider the talent and workforce dynamics at play for Indiana’s agbioscience companies under the framework of allied agbioscience jobs and will utilize the approach and methodology applied in the previous section to assess demand and supply in Indiana.

Current Occupational Demand

The economic expansion and broad-based job growth across Indiana in recent years (including in the agbiosciences) have driven strong demand for allied agbioscience occupational groups, with each of these areas growing and five of the following seven groups outpacing national growth trends (Figure 13):

- **The skilled production and support workforce**, which includes a wide range of occupations from assemblers to Computer Numerical Control (CNC) machine operators, maintenance, welding, and inspectors, is very large in Indiana, spanning the state’s leading advanced manufacturing sector, and has been growing rapidly in this economic expansion. Its 23 percent growth rate has outpaced national growth (18 percent) with particularly strong job growth in

Identifying “Allied” Agbioscience Occupations

To identify these key “allied” agbioscience occupations, TEconomy utilized national “Staffing Patterns” data that break down occupational employment by industry. Note these two characteristics:

1. These occupations make up at least 1 percent of employment in Agbioscience Industry Segments (where available). Segments include Ag Chemical Mfg, Machinery Mfg, Ag Support, Forestry, Food and Beverage Mfg, Farm and Grocery Distribution, Vet Services, and R&D.
2. Agbioscience Industry Segments share of employment exceeds share of employment in the broader industry classification (e.g., all of manufacturing), indicating that these occupations play a key role in the production of goods and delivery of services in the agbioscience industry.

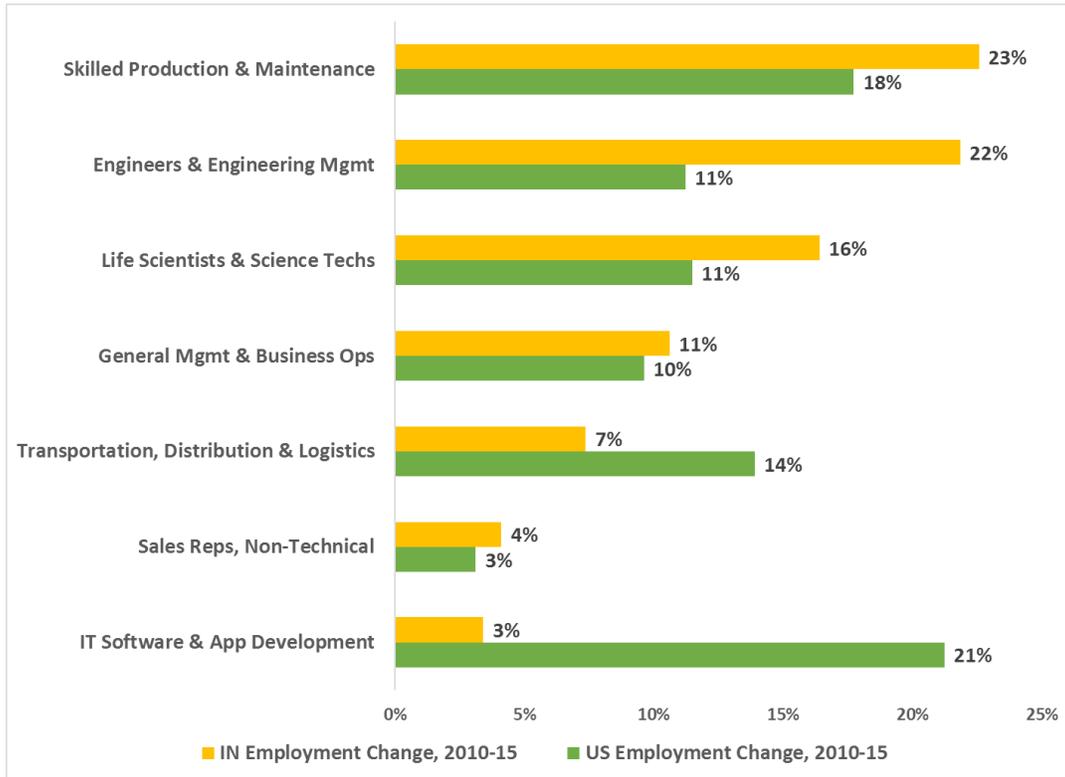
In some specific and limited cases, occupations have been added that drive innovation in the agbiosciences but did not meet the requirements above; i.e., IT.

¹⁶ For a complete listing of the detailed occupations that make up these occupational groups, see the Appendix.

occupations such as industrial machinery mechanics, team assemblers, welders, inspectors, and testers.

- **Engineering and engineering management.** Beyond agricultural engineers, the agbiosciences require expertise in allied fields such as chemical, industrial, mechanical, and electronics engineering, as well as engineering management more broadly. These occupations in Indiana have grown at twice the national rate during the expansion with strong growth overall, but outpacing the nation in growth of electrical and electronics and mechanical specializations, as well as among industrial and mechanical engineering technicians.
- **Life scientists and technicians** play an integral role in the agbiosciences' innovation and value chain in areas of expertise that include biochemistry, microbiology, and chemistry. These occupations have also seen strong growth in Indiana, outpacing the nation, led by growth in the technician workforce, as well as biochemists and biological scientists.
- **General management and business operations** fields have outpaced the nation since 2010 in high-growth areas such as general and operations management, natural sciences management, compliance officers, and business operations specialists.
- Employment among **sales representatives** (non-technical) has outpaced national growth.
- While **transportation, distribution, and logistics** has not outpaced the nation, it has grown since 2010 led by growth in management and drivers.
- **IT areas focused on software and applications development**, which play key roles in precision agriculture, informatics and other more traditional IT functions within the agbiosciences and other sectors, have seen lagging job growth in Indiana during the economic expansion well behind the rapid growth across the country.

Figure 13: Employment Trends in Allied Agbioscience Occupational Groups, 2010–15



Source: TEconomy’s analysis of BLS, OES data.

Indiana has a sizable, growing, and, in several areas, “specialized” base of talent in the allied agbioscience occupational groups. While these job numbers reflect the employment in industry sectors well beyond the agbiosciences, Indiana’s economic growth and concentrations in advanced manufacturing, logistics, and life sciences clearly stand out (Table 10). **Among the groups, Indiana has a specialized concentration of talent in skilled production and maintenance (LQ is 1.87), engineering and engineering management (LQ is 1.30), and in transportation, distribution, and logistics jobs (LQ is 1.27).**

Table 10: Employment Metrics for Allied Agbioscience Occupations, 2015

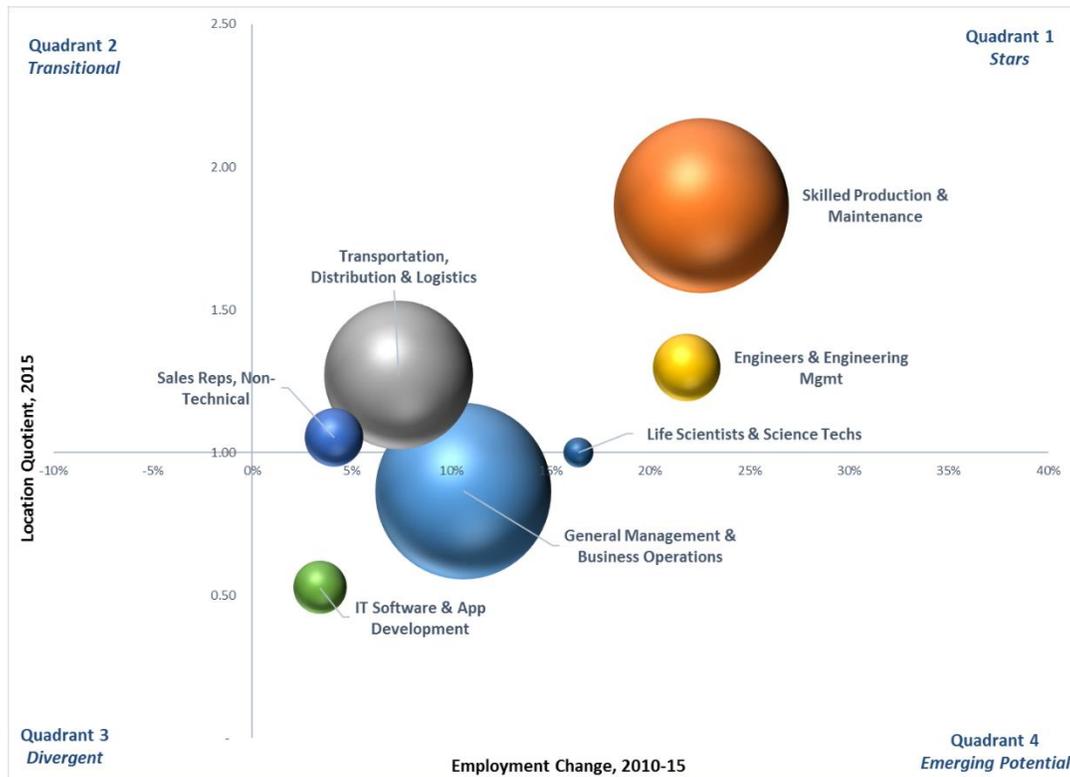
Core Agbioscience Occupational Groups	Indiana Empl., 2015	IN Empl.% Change, 2010–15	US % Change, 2010–15	Indiana LQ, 2015
All Occupations	2,947,380	8%	8%	1.00
Engineers & Engineering Management	42,500	22%	11%	1.30
General Management & Business Operations	291,220	11%	10%	0.87
IT Software & App Development	26,150	3%	21%	0.53
Life Scientists & Science Techs	8,090	16%	11%	1.00
Sales Reps, Non-Technical	31,740	4%	3%	1.05
Skilled Production & Maintenance	287,560	23%	18%	1.87
Transportation, Distribution & Logistics	207,970	7%	14%	1.27

Source: TEconomy’s analysis of BLS, OES data. Note: LQ = Location Quotient.

Indiana's Agbioscience Workforce

These statewide competencies and Indiana's pervasive recent job growth stand out with all of the allied occupational groups positioned in Figure 14 in the growth quadrants and several firmly in the "stars" designation, featuring occupations that are both growing and with a concentration that exceeds the national average. The analysis of recent experience clearly demonstrates strong demand during the economic expansion in Indiana for these workforce areas; and, as Indiana agbioscience companies are reporting via the survey and interviews, this demand has sparked a highly competitive market for talent.

Figure 14: Indiana Allied Agbioscience Occupations: Employment Size, Concentration, and Change, 2010–15

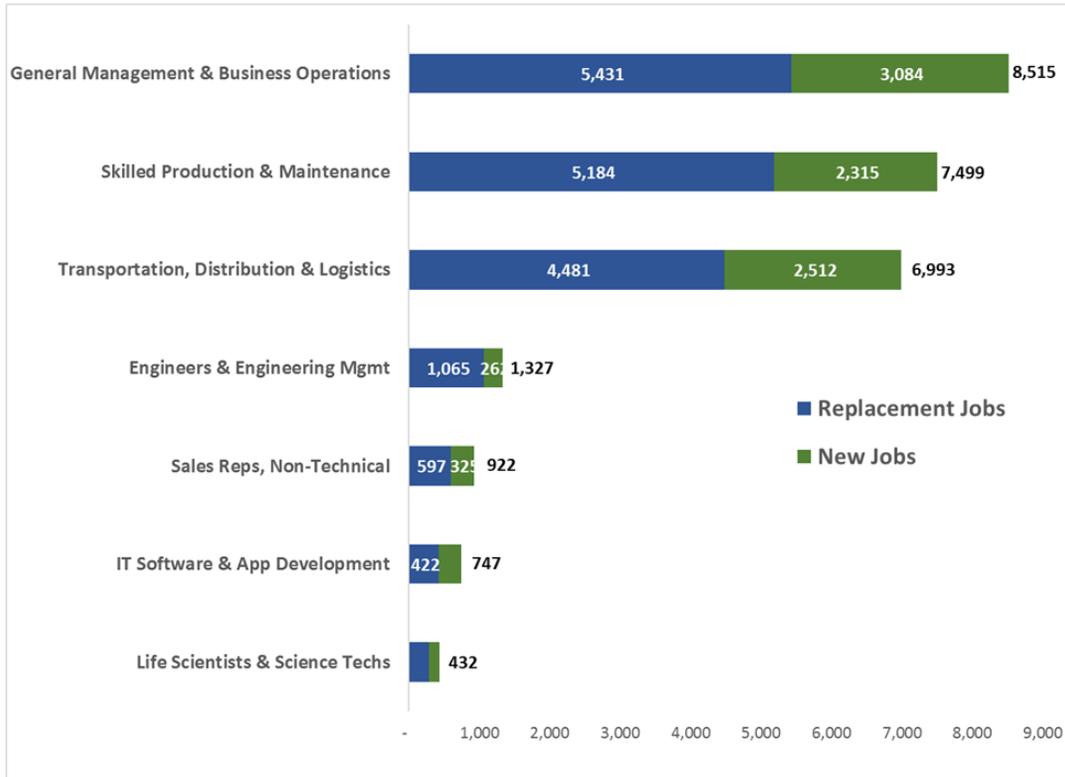


Source: TEconomy's analysis of BLS, OES data.

Projected Occupational Demand

Looking toward the future, the expected demand across the allied agbioscience occupations is large and generally reflective of the overall breakdown in Indiana of two-thirds of demand coming from replacement needs and the remainder expected from growth (Figure 15). Two occupational groups tilt in other directions, however, where engineering and engineering management is expected to see a much greater share (80 percent) of annual job openings due to replacements, a signal of an aging engineering workforce that must be closely monitored and considered by state institutions that generate engineering talent and expertise. The second area is in IT where software-related talent is expected to see a somewhat above-average tilt toward new growth generating annual openings—56 percent replacements to 44 percent growth.

Figure 15: Projected Annual Employment Needs in Allied Agbioscience Occupations, 2012–22



Source: TEconomy’s analysis of Occupational Employment Projections, Indiana DWD.

Overall employment growth projections for life scientists and technicians; IT; and transportation, distribution, and logistics occupations are expected to exceed the overall average (Table 11).

Table 11: Employment Growth Projections in Allied Agbioscience Occupations, 2012–22

Occupational Group	Projected Empl. Growth, 2012–22
All Occupations	12%
Engineers & Engineering Management	6%
General Management & Business Operations	11%
IT Software & App Development	13%
Life Scientists & Science Techs	15%
Sales Reps, Non-Technical	11%
Skilled Production & Maintenance	9%
Transportation, Distribution & Logistics	13%

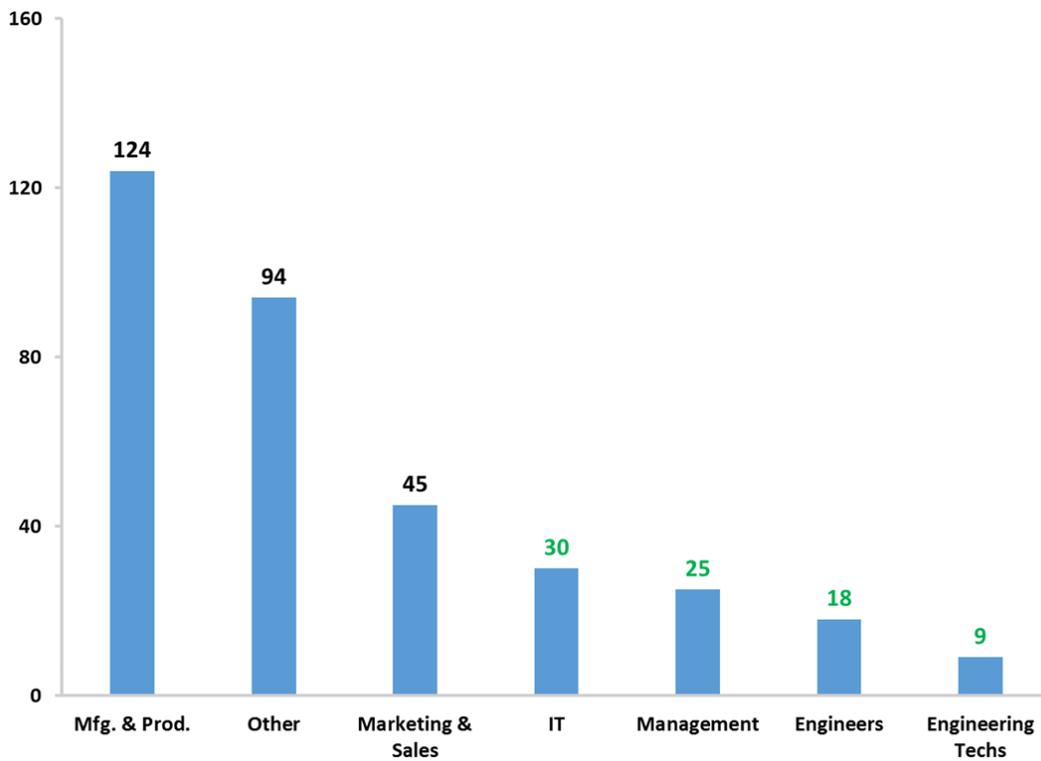
Source: TEconomy’s analysis of Occupational Employment Projections, Indiana DWD.

Key Findings from Employer Surveys and Interviews

Indiana agbioscience employers reporting in the survey indicate that the following four allied occupational areas had above-average hiring relative to their employment base over the last year (Figure 16):

- IT
- Management
- Engineers
- Engineering Technicians.

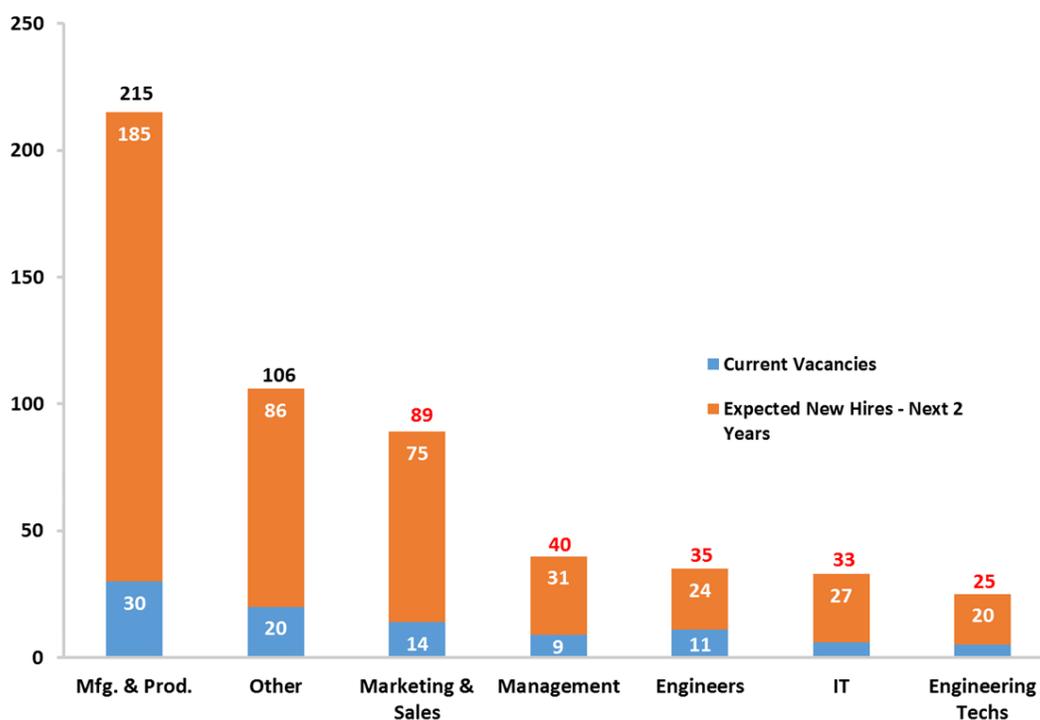
Figure 16: Recent Hires of Indiana Agbioscience Companies in Allied Occupational Areas During the Last Year (Green data labels indicate above-average hiring levels relative to base employment)



In addition to recent hires, companies were asked to report indicators of current and future demand including current vacancies in these areas as well as expectations for future hiring. Figure 17 presents these totals for allied occupations, with the same four occupational groups expected to see stronger demand in the future, as well as marketing and sales:

- Marketing and Sales
- IT
- Management
- Engineers
- Engineering Technicians.

Figure 17: Current Vacancies and Expected New Hires for Indiana Agbioscience Companies in Allied Occupational Areas During the Next Two Years (Red data labels indicate above-average hiring levels relative to base employment)



Interviews and discussions with Indiana agbioscience employers reinforce the strong demand and challenges faced in identifying and hiring a broad cross section of this allied workforce. In almost every interview conducted across the broad and varied agbioscience subsectors, interviewees suggested that it was difficult to find the following:

- Professional staff, including in marketing, management, sales, and human resources
- IT/Software developers and those with expertise in Big Data analytics
- Engineers and technicians
- Process manufacturing experts
- Production technicians with computer skills
- C-level executive talent.

Similar to core occupations, employers indicated that hiring professionals with so-called “soft” skills, including the ability to be punctual, communicate effectively, and work in teams, was growing increasingly difficult. Employers also expressed a growing need for transdisciplinary research talent, including engineering talent who understand agbioscience issues and concerns.

Finally, it was recognized that agbioscience companies are competing against almost every other industrial sector for these individuals with the allied occupational skill sets. Individuals in nonspecific ag fields are needed by the agbioscience cluster but can work in numerous other industry sectors. Many hold the opinion that the overall lack of career awareness in these allied occupations about the

opportunities that the agbioscience industry sector afforded was a major stumbling block in being able to attract the skilled talent required.

Demand Summary for Allied Agbioscience Occupations

The assessment by the project team finds pervasive “high demand” across nearly all of the allied agbioscience occupational groups (Table 12). Across the quantitative analysis and employer surveys and interview discussions, these occupational groups are clearly experiencing strong demand and agbioscience employers are competing for talent in these areas, typically against other industries and regions across the state. The strong demand for allied occupations is likely a function of the current strength of the economy and labor market broadly in Indiana, and as seen when the supply side is included, further challenges exist for Indiana’s agbioscience sector in competing for a limited talent base across most of these occupational areas.

Table 12: Summarizing the Demand Assessment for Allied Agbioscience Occupations

Major Occupational Groups	High Growth (IN>US)	Projected High Growth (Occ > IN Avg)	Survey: Strong Recent Hiring	Survey: Strong Expected Hiring	Consistently Identified as in-demand in industry discussions	Total Counts of "YES"	High Demand Status (3 or 4 = high demand)
Engineers & Engineering Mgmt	YES		YES	YES	YES	4	High-Demand
General Management & Business Operations	YES		YES	YES	YES	4	High-Demand
IT Software & App Development		YES	YES	YES	YES	4	High-Demand
Life Scientists & Science Techs	YES	YES		YES		3	High-Demand
Sales Reps/Marketing	YES			YES	YES	3	High-Demand
Skilled Production & Maintenance	YES				YES	2**	High-Demand
Transportation, Distribution & Logistics		YES	n/a	n/a		1	

Note: Occupational groups with 3 or 4 “yes” designations are considered to be “high-demand” occupations.

**The project team has designated these production jobs and functions as areas to consider as “high demand” for Indiana companies based on the consistent, intense expression of strong demand and difficulty hiring into them.

The Supply of Indiana’s Allied Agbioscience Workforce

Indiana’s academic institutions represent a diverse and valuable resource for generating talent across the broad range of skills and expertise required for allied agbioscience occupations. Table 13 highlights the varied range of degree fields and institutions engaged in educating and training the future Indiana workforce.

This range spans the state’s larger institutions including the following:

- Indiana University where strengths in business, computer science, the life sciences, and informatics play a key role;
- Purdue University has leading strengths in engineering, computer science, and life sciences;
- University of Notre Dame has key degree programs and academic excellence in areas such as chemical engineering, business, IT, and the natural sciences;
- Smaller institutions play key roles as well, including Rose-Hulman (engineering) and Indiana Wesleyan (accounting and management information systems [MIS]).

Many other Indiana colleges and universities are graduating students at various levels in these key areas as well, and it is important to recognize that talent generation requires a broad and deep postsecondary ecosystem throughout the state.

Table 13: Leading Indiana Institutions in Allied Agbioscience Degree Areas

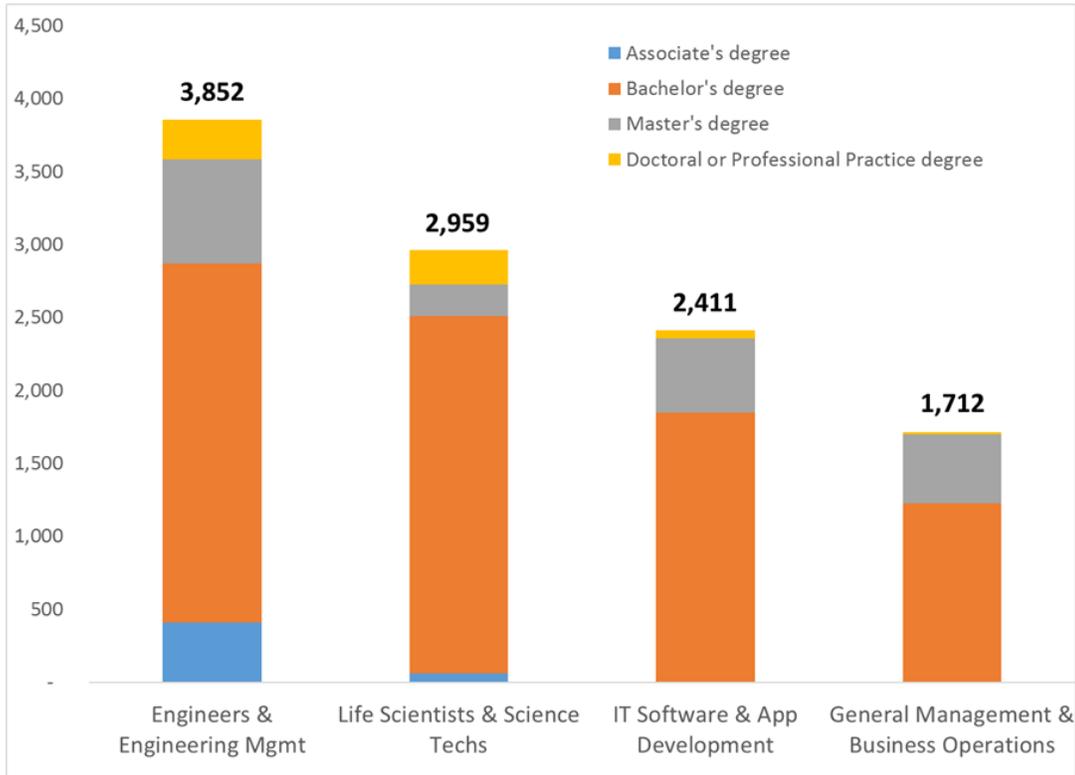
Engineers & Engineering Mgmt	General Mgmt & Business Operations	IT Software & App Development	Life Scientists & Science Techs
Purdue University: <ul style="list-style-type: none"> Mechanical Eng Electrical & Electronics Eng Chemical Eng Industrial Eng Rose-Hulman: <ul style="list-style-type: none"> Mechanical Eng Chemical Eng Univ. of Notre Dame: <ul style="list-style-type: none"> Chemical Eng 	Accounting: <ul style="list-style-type: none"> Purdue University Indiana Wesleyan Univ. of Notre Dame Ball State Univ. Butler University Agricultural Economics & Agribusiness: <ul style="list-style-type: none"> Purdue University Huntington University 	Computer Science: <ul style="list-style-type: none"> Purdue University IU-Bloomington Rose-Hulman Indiana University–Purdue University Indianapolis (IUPUI) Informatics: <ul style="list-style-type: none"> IU-Bloomington MIS: <ul style="list-style-type: none"> Indiana Wesleyan Univ. of Notre Dame Computer Engineering: <ul style="list-style-type: none"> Purdue University Unmanned Systems: <ul style="list-style-type: none"> Indiana State Univ. 	Biology: <ul style="list-style-type: none"> IU-Bloomington IUPUI Purdue University Univ. of Notre Dame Chemistry & Biochemistry: <ul style="list-style-type: none"> Purdue University Univ. of Notre Dame IU-Bloomington

Source: TEconomy’s analysis of Postsecondary Degree data from National Center for Education Statistics, IPEDS Database.

Current Supply of Allied Agbioscience Degrees

The degree fields highlighted in Table 13 are but some of the leading areas that map to the array of allied occupations that play critical roles in the agbiosciences. Taken together, and considering the degree levels most typically required to enter into these occupational areas, graduate totals for 2014 are shown in Figure 18.

Figure 18: Indiana Graduates in Fields Most Closely Aligned with Allied Agbioscience Occupations, 2014

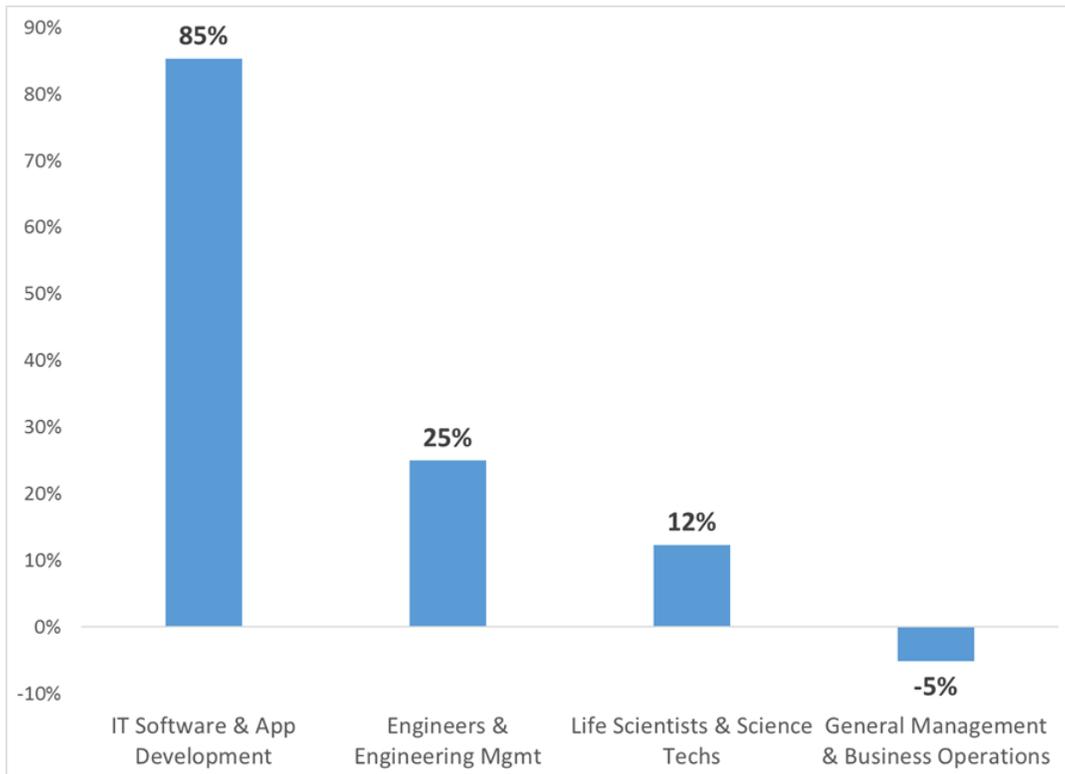


Source: TEconomy’s analysis of Postsecondary Degree data from National Center for Education Statistics, IPEDS Database.

Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center. Data not shown for: Sales Reps; Skilled Production & Maintenance; and Transportation/Distribution as majority of these jobs do not require postsecondary education for entry. Management occupations are not included due to inability of crosswalk to effectively map degrees to “managers.”

Degree graduates in three of four allied occupational areas have grown, with especially strong growth in IT-related degrees in recent years in Indiana (Figure 19). Engineering and life science-related degrees have also increased since 2010, a positive sign for areas with strong workforce needs. In general management and business operations, there has been a relatively small decline in graduates at the Bachelor’s level and above, primarily due to a modest decline in accounting degrees.

Figure 19: Trend in Indiana Graduates in Fields Most Aligned with Allied Agbioscience Occupations, 2010–14



Source: TEconomy’s analysis of Postsecondary Degree data from National Center for Education Statistics, IPEDS Database.

Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center. Data not shown for: Sales Reps; Skilled Production & Maintenance; and Transportation/Distribution as majority of these jobs do not require postsecondary education for entry. Management occupations are not included due to inability of crosswalk to effectively map degrees to “managers.”

Industry and Academic Viewpoints from Surveys and Interviews

The previous section on the core agbioscience workforce presented the broad-based reporting by companies related to the supply of workers across the full agbioscience sector. In those qualitative findings reported earlier, a detailed listing of “soft” skill requirements were emphasized by employers. It should not be lost in this discussion of the allied occupations that employers are emphasizing a need not only for technical skills but also for the following:

- Strong communication skills (both internal and externally facing)
- Ability to work effectively in team settings, particularly across functions and departments
- Problem solving and critical thinking

The project team heard consistently a concern that business, IT, and other professionals did not have an orientation toward, or awareness of, the agbiosciences as a career path or viable option for pursuing a career, despite the strength of the industry in Indiana and its recent record on job creation. This is a major area of concern for agbioscience employers and stakeholders across Indiana, and “career awareness” is a critical need in the state.

Indiana's Agbioscience Workforce

- Entrepreneurial skills and orientation
- Strategic planning.

In addition to these soft skills, the previous section also presented highly relevant technical and background qualifications that relate closely to allied occupations, including the following:

- Project management skills
- In manufacturing/production environments:
 - Lean manufacturing (continuous improvement)
 - CNC setup/operating
 - Brake press/roll forming operators
- Data analytics capabilities to drive decisions; managing “Big Data”
- IT workforce well-versed and up to date in precision agriculture
- Increasing need for multi- and transdisciplinary talent in many areas, including for engineering talent.

An overarching context and key theme throughout discussions with Indiana’s agbioscience employers is the importance of having some background and familiarity with agricultural production and operations. In allied occupations, the workforce is not preparing for a specific ag- or food- or natural resource-focused job function or industry. The project team heard consistently a concern that business, IT, and other professionals did not have an orientation toward, or awareness of, the agbiosciences as a career path or viable option for pursuing a career, despite the strength of the industry in Indiana and its recent record on job creation. This is a major area of concern for agbioscience employers and stakeholders across Indiana, and “*career awareness*” is a critical need in the state.

Aligning the Demand and Supply of Allied Agbioscience Occupations

Using the same quantitative approach applied to the core occupations, the annual demand for workers (via employment projections) can be compared with the most recent annual “supply” of new graduates from Indiana postsecondary institutions for an assessment of general alignment across the allied occupational groups. Utilizing Indiana’s unique INK dataset and the powerful insights it can provide related to the retention of graduates in Indiana jobs following graduation, the following approaches can be developed:

- A first approach (Table 14) that compares annual demand with the total supply of graduates in relevant fields;
- A second approach (Table 15) that compares annual demand with *the supply of graduates adjusted for average retention rates applied across the relevant major degree fields.*

Table 14: Approach #1, Indiana Allied Agbioscience Occupations: Comparison of Annual Projected Job Openings and Annual Net Employment Increases with “Supply” of Total New Higher-Education Degrees Generated

Key Life Science-related Occupational Groups	Indiana Projected Annual Job Openings, 2012-22	Indiana Degree Graduates, 2014	Difference ["+" = More Degr Grads; "-" = Fewer Grads than Openings]	Degree Levels Generally Required
Engineers & Engineering Mgmt*:				
Engineers	916	3,445	2,529	Bachelor's & higher
Engineering Technicians	97	407	310	Associate's
General Management & Business Operations*:				
Business Operations	1,272	1,712	440	Bachelor's & higher
Clerks & Administrative Assistants	6,049	n/a	n/a	No Postsecondary requirement
IT Software & App Development	747	2,411	1,664	Bachelor's & higher
Life Scientists & Science Techs:				
Scientists	152	448	296	Master's & higher
Science Technicians	280	2,511	2,231	Associate's & Bachelor's
Sales Reps, Non-Technical	922	n/a	n/a	No Postsecondary requirement
Skilled Production & Maintenance	7,499	n/a	n/a	No Postsecondary requirement
Transportation, Distribution & Logistics*	6,901	n/a	n/a	No Postsecondary requirement

Source: TEconomy’s analysis of OES and Occupational Projections data from Indiana DWD; Postsecondary Degree data from National Center for Education Statistics, IPEDS Database.

Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center.

*Data not included for Management occupations due to inability of crosswalk to effectively map degrees to “managers.”

Table 15: Approach #2, Indiana Allied Agbioscience Occupations: Comparison of Annual Projected Job Openings and Annual Net Employment Increases with “Supply” of New Higher-Education Degrees Generated, Adjusted for Graduate Retention Rates

Key Life Science-related Occupational Groups	Indiana Projected Annual Job Openings, 2012-22	Indiana Degree Graduates Adjusted for Avg. In-State Retention, 2014	Difference ["+" = More Degr Grads; "-" = Fewer Grads than Openings]	Degree Levels Generally Required
Engineers & Engineering Mgmt*:				
Engineers	916	616	-300	Bachelor's & higher
Engineering Technicians	97	199	102	Associate's
General Management & Business Operations*:				
Business Operations	1,272	627	-645	Bachelor's & higher
Clerks & Administrative Assistants	6,049	n/a	n/a	No Postsecondary requirement
IT Software & App Development	747	785	38	Bachelor's & higher
Life Scientists & Science Techs:				
Scientists	152	122	-30	Master's & higher
Science Technicians	280	685	405	Associate's & Bachelor's
Sales Reps, Non-Technical	922	n/a	n/a	No Postsecondary requirement
Skilled Production & Maintenance	7,499	n/a	n/a	No Postsecondary requirement
Transportation, Distribution & Logistics*	6,901	n/a	n/a	No Postsecondary requirement

Source: TEconomy’s analysis of OES and Occupational Projections data from Indiana DWD; Postsecondary Degree data from National Center for Education Statistics, IPEDS Database; graduate retention data from INK.

Notes: Degree graduate totals align with levels of degree generally required. Occupation to Degrees crosswalk developed by the National Crosswalk Service Center.

*Data not included for Management occupations due to inability of crosswalk to effectively map degrees to “managers.”

Under the first scenario (Approach #1), Indiana is producing a large surplus of graduates in key fields most relevant to the allied agbioscience occupations. And, while agbioscience employers must compete with a number of other advanced industries for this talent pool, for those occupations that require

postsecondary degrees, the “supply” of graduates in 2014 is well above the projected annual demand. Also, while one must acknowledge that newly minted graduates are not a perfect substitute for experienced workers who need to be replaced, this approach shows little concern for the demand-supply alignment in these fields going forward. This approach does not, however, account for the attrition that Indiana faces among graduates who leave the state.

Applying an average retention rate of graduates by degree field using the data from INK yields a scenario that more accurately reflects the market and competition for talent in Indiana and aligns with the situation faced by employers in these high-demand occupations. In Approach #2, talent deficits are revealed for occupational areas such as business operations, engineers, and life scientists, and little to no graduate surplus is shown in areas such as IT and engineering technicians. Add to this the reality that agbioscience employers are competing fiercely for this talent among other industries and in an increasingly tight labor market where the unemployment rate is under 5 percent,¹⁷ and one can better understand why employers are facing challenges in finding and hiring qualified allied workers.

Taken with the assessment of “high-demand” allied occupations, and the relative misalignment of demand and supply seen across key occupations, the project team finds widespread challenges for Indiana’s agbioscience employers across most allied occupational groups, including the following:

- Engineers and Engineering Management
- General Management and Business Operations
- IT—Software and Applications Development
- Life Scientists
- Sales Representatives and Marketing Professionals
- Skilled Production and Maintenance Workers.

These challenges, and those identified in the assessment of core occupations, call for strategic interventions in Indiana that can help to ensure a predictable, robust supply of qualified individuals with the right skill sets to meet the needs of this innovative sector into the future.

¹⁷ According to the U.S. BLS, Local Area Unemployment Statistics program, the seasonally adjusted unemployment rate in Indiana in June 2016 was 4.8 percent.

Section V. Strategic Recommendations to Align Indiana's Agbioscience Workforce Demand with Supply

Today, the agbiosciences represent a significant economic engine for the State of Indiana. Driven by global population and wealth increases, the demand for agricultural inputs and outputs is well assured, and states such as Indiana that sustain and grow an innovative industry base in the agbiosciences will be well positioned for economic growth. This growth will come not only through the development and production of technologies used in agriculture and in the downstream processing of agricultural commodities into value-added products, but also through new products and processes that will be found at the intersection of agbiosciences with other disciplines, such as IT and life sciences.

However, to maintain its position as a 21st century agbioscience leader, Indiana must have a 21st century agbioscience workforce equipped to apply and develop leading technologies. This workforce must bring not only strong technical skills, but also an ability to communicate, problem-solve, work effectively in teams, and, perhaps most importantly, apply agbioscience technologies to solving today's global challenges. To do this, Indiana must develop a workforce that is applications-focused, experiential-based, entrepreneurial, well-rounded, engaged, and appropriately skilled.

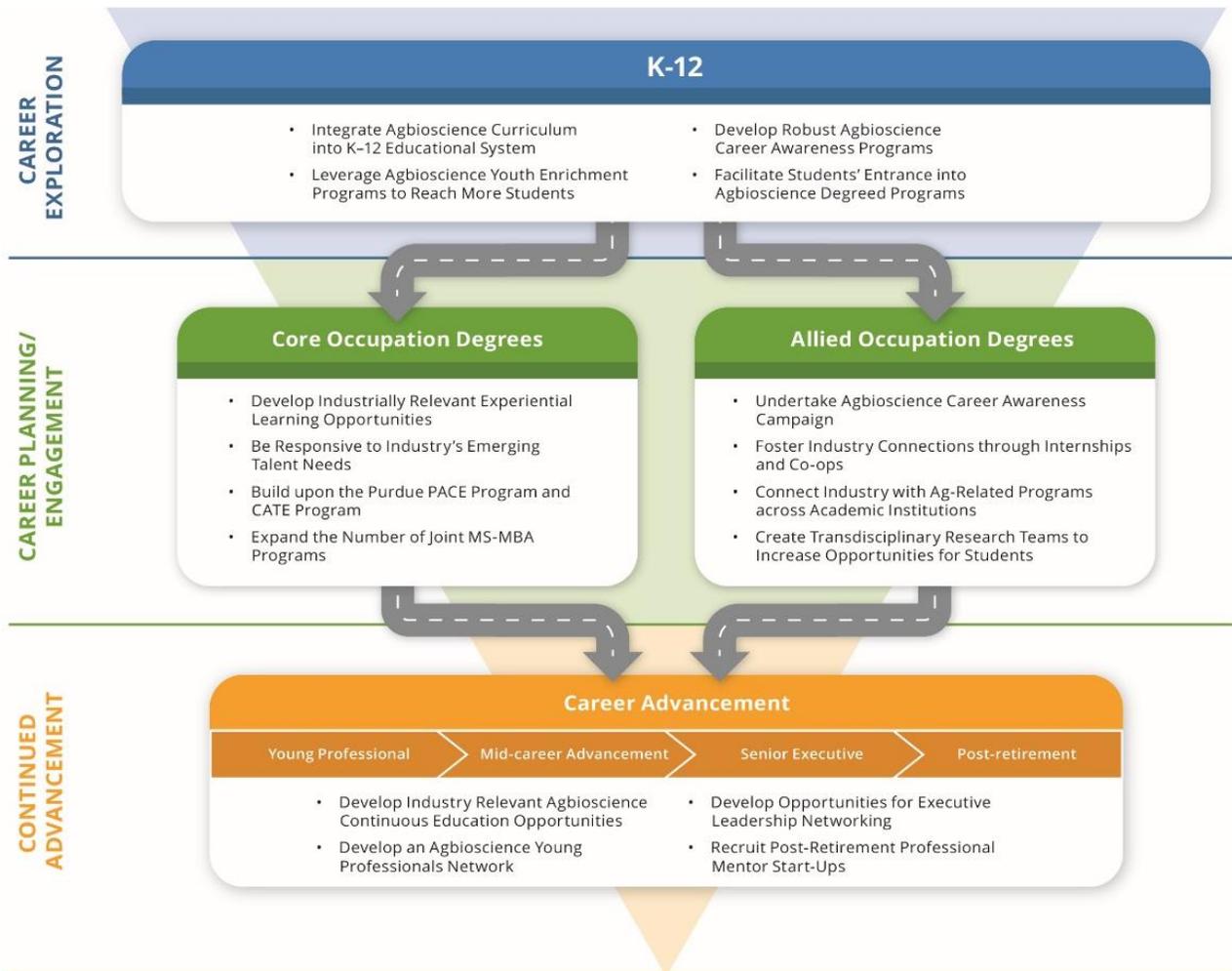
The challenge for Indiana is to go beyond traditional paradigms of education by practically integrating agbioscience skills development across the full knowledge supply chain composed of K–12, colleges and universities, and continued professional development. To achieve this leading position in agbioscience talent development requires a multiplicity of partnerships (private, public, trade organizations and associations) to create the pipeline of workers needed in the short- and long-term.

For Indiana to be a leader in generating and sustaining a highly skilled agbioscience workforce, it must work concurrently on implementing four critical strategies:

1. Create a greater pipeline of students interested in the agbioscience careers.
2. Develop industry-relevant skill sets for core occupation talent.
3. Increase agbioscience career engagement for allied occupation fields.
4. Catalyze continued career advancement for rising professionals and foster linkages between post-retirement professionals and start-up opportunities.

These four strategies are best understood as interrelated efforts that reinforce each other and create a progression as depicted in Figure 20. No one single action or strategy will fully address Indiana's agbioscience talent demands and gaps. Instead, a multidimensional approach that engages students, educators, professionals, and industry leadership at all stages of the talent pipeline is required that reflects the variety of opportunities and needs that Indiana's agbioscience industry faces.

Figure 20: Indiana's Agbioscience Talent Pipeline



Source: TEconomy Partners, LLC

A description of each strategy is provided below along with a series of concrete action items that Indiana should pursue to help ensure that the talent required by the agbioscience industry is available in the state, ultimately helping the industry grow and prosper.

Strategy 1: Create a Greater Pipeline of Students Interested in Agbioscience Careers.

One of the challenges facing the agbioscience sector in the context of career development is that, in many ways, these careers are “invisible”. The careers are not identified with or organized by a single occupation; they are not careers often portrayed in the media; and they are not careers that people have daily contact with, as they do with many retail or service professions. Furthermore, the need to increase the pipeline of students interested in the agbiosciences is occurring at a time when more and more individuals are further and further removed from agriculture in general. This distancing from our agricultural heritage is in part causing the predicted workforce shortage.

Indiana's Agbioscience Workforce

One of the underlying tasks, therefore, of a statewide agbioscience talent effort is to make the industry sector's careers significantly more visible on many levels and to multiple audiences: to students; to educators and career counselors; to public and private sector leaders; and to the general public as a whole. As a result, it is critical that the recommendations address actions that can be undertaken to help ensure a level of career awareness that generates a pipeline of students interested in pursuing careers in the agbiosciences.

The first step in creating a greater pipeline of students interested in agbioscience careers is to overcome the overall industry sector's image problem. Simply put, for the majority of youth, agriculture is simply not "cool." A recent survey conducted by the Land O'Lakes Foundation found that only 3 percent of college graduates surveyed and 9 percent of millennials (born between 1982 and 2000) had thought about an ag career or would consider one.

"People still think you have to wear boots and overalls to work in ag. Most don't realize that modern agriculture has become a technologically advanced field with a wide spectrum of careers from seed geneticists and soil conservationists to supply chain analysts and economists."

Lydia Botham
Executive Director
Land O'Lakes Foundation

While the public perception of agriculture is a challenge beyond the scope of this report, it is a factor that influences the perspective of future undergraduate students. As a result, the strategic recommendations and proposed actions found in this report cannot focus solely on programs and initiatives aimed at institutions of higher education. Undergraduate agbioscience students enter college after graduating from a K–12 education system. Therefore, one strategy for increasing the number and quality of students pursuing agbiosciences is to encourage more students to pursue careers before they even reach college.

However, the lack of understanding of the exciting career opportunities that are available within the agbioscience industry sector is a problem with respect to developing a robust pipeline of students interested in pursuing agbioscience careers. To help overcome this issue, Indiana must initiate a multifaceted educational campaign to inform the populace of the career opportunities that exist within the agbiosciences and how these careers will help change the world in the coming decades. This educational campaign must be targeted not only at educational providers, such as teachers throughout the K–12 system, administrators, and guidance counselors, but also the students, parents, regional leadership, and community and statewide thought leaders.

The need to create a greater pipeline of students interested in agbioscience careers requires that programs and initiatives be developed to help ensure that students, parents, and teachers within the primary and secondary educational system are aware of and linked to the opportunities that Indiana's agbioscience industry offers. The following four actions are recommended as opportunities to pursue to help ensure that Indiana is developing a robust pipeline of talent into the future.

Actions to Pursue to Create a Greater Pipeline of Students Interested in Agbioscience Careers:

Action 1: Consistently Integrate Agbioscience Curriculum into Indiana's K–12 Educational System

Action 2: Leverage Indiana's Agbioscience Youth Enrichment Programs to Reach More Students

Action 3: Leverage and Develop Robust Agbioscience Career Awareness Programs

Action 4: Help Facilitate Students' Entrance into Agbioscience Degreed Programs

Action 1: Consistently Integrate Agbioscience Curriculum into Indiana's K–12 Educational System.

Numerous individuals interviewed for the study expressed concern over the lack of agbioscience awareness both within student bodies as well as with their trusted advisors (parents, teachers, guidance counselors, etc.). As communities are becoming further removed from primary agriculture production, this trend is increasing, causing an even greater gap of knowledge. The following recommendations seek to address this problem by providing consistent, integrated agbioscience curriculum into Indiana's K–12 educational system.

Expand Indiana's Agriculture in the Classroom. Agriculture in the Classroom (AIRC) is a grassroots program coordinated by the USDA. Its goal is to help students gain a greater awareness of the role of agriculture in the economy and society so that they may become citizens who support wise agricultural policies. The program is carried out in each state, according to state needs and interests, by individuals representing farm organizations, agribusiness, education, and government.

In Indiana, AIRC is coordinated by the Indiana Farm Bureau. Members of the organization who are interested in becoming volunteers are provided program materials and standards-based lessons for use in their counties. There are more than 130 active volunteers across the state of Indiana. In 2012, more than 60,000 students learned about agriculture through more than 100,000 lessons, activities, and field trips about a variety of agriculture topics.

It is recommended that AgriNovus work with the Indiana Farm Bureau, the Indiana State Department of Agriculture, the Indiana Department of Education, and the agbioscience industry sector to expand the scope and reach of the AIRC program to help ensure that students within every school district have access to the supplemental curriculum and that it is being used by teachers to expose students to exciting agbioscience career opportunities.

Agriculture in the Classroom (AIRC) is a flexible educational program designed to supplement and enhance teachers' existing curriculum by providing teaching materials, strategies, interactive exercises, helpful links, and awards for excellence in teaching about agriculture. AIRC is carried out in each state, according to state needs and interest, by people who represent farm organizations, agribusiness, education, and government. USDA supports each state organization by helping to develop AIRC programs, acting as a central clearinghouse for materials and information, encouraging USDA agencies to assist in the state programs, and coordinating with national organizations to increase awareness of agriculture in the nation's students.

Better link STEM education to agbioscience career opportunities. Indiana is already doing much that is in line with national best practices around K–12 STEM education. The private and philanthropic sector in Indiana has prioritized advancing STEM-related education and skills across its K–12 (and in some cases

Indiana's Agbioscience Workforce

K–16) system for both students and teachers. These initiatives are aimed at providing a strong foundation to prepare students for college, careers, and lifelong learning.

However, agbioscience stakeholders expressed a desire to make a more explicit connection between the numerous STEM education initiatives that are ongoing in Indiana and the opportunities afforded by the agbioscience industry. This can be done in various ways. One is to establish more integrated high school–college career academies (see the description of the Pennsylvania Governor's School for Agricultural Sciences in Action 10).

Another approach is to complement high school STEM education with more hands-on, application-oriented career courses. This is the approach taken by the Connecticut Career Choices (CCC) program for the bioscience industry. The CCC program built off the basic courses in STEM (such as biology, math, and other sciences) and demonstrated their relevancy to students, linking to mastering critical thinking, problem-solving, and experiential learning. CCC incorporates innovative curriculum, online learning tools, professional development for teachers, experiential learning, and complementary extracurricular programs. CCC's signature event is the Governor's High School Innovation Challenge, in which student teams are "challenged" to incorporate advanced technologies to develop a "mock" company and author a white paper that describes innovative applications of technologies and services.

Place an Agricultural Educator in Every High School. If Indiana truly desires to differentiate itself from other states in terms of developing a pipeline of talent excited and prepared to enter the agbioscience workforce, it is recommended that a statewide program be developed that helps fund the placement of an agricultural educator in every high school across the state. It is important to note, however, that the traditional model for agricultural education is not necessarily being recommended for every school system. The traditional agricultural education model has been one of a stand-alone curriculum in which students are taught concepts related to agriculture, natural resources, and land management through hands-on experience. While this model has been successfully incorporated in school systems in the past, and still stands as a model that is successful today in many rural communities, it is not necessarily a model that will work in more urban and suburban settings. Yet, it is in these settings that students are in the greatest need of exposure to agbioscience opportunities. It is being recommended that alternative models to agricultural education be explored, including having educators serving as building-wide resources for integration of agbioscience concepts into existing curriculum as well as serving as a resource for primary educators within the school system.

[Action 2: Leverage Indiana's Agbioscience Youth Enrichment Programs to Reach More Students.](#)

In addition to integrating agbioscience concepts and experiences into formal K–12 curricula and academic programs, other opportunities exist for providing K–12 students with exposure to the agbiosciences and related-fields through extracurricular youth enrichment programs. Such programs can complement coursework and allow students to have a long-term engagement in learning about agbioscience concepts.

4-H is delivered in Indiana by Purdue Extension. Through 4-H programs and initiatives, kids complete hands-on projects in areas such as health, science, agriculture and citizenship, in a positive environment where they receive guidance from adult mentors and are encouraged to take on proactive leadership roles. Kids experience 4-H in every county in the state through in-school and after-school programs, school and community clubs, and 4-H camps.

The National FFA Organization is the largest student-run organization in the country. Formerly known as Future Farmers of America, today FFA is a widespread and diverse organization providing programming and educational opportunities for students with an interest in farming, as well as serving students interested in opportunities related to a wide array of allied fields, including research, technology, the environment, business, communications, and leadership.

Two of the most prominent relevant youth enrichment programs are 4-H and FFA, both of which provide opportunities for young people across the country to be involved with an agriculture-focused national organization; to gain leadership skills; and to connect with scientists, practitioners, and other agbioscience professionals. Indiana has very strong 4-H and FFA programs (including the Indiana FFA and also the headquarters of the National FFA) that should be better leveraged. It is recommended that AgriNovus work with these two statewide programs, in concert with National FFA, and the local school systems to help ensure that K–12 students throughout the state, including those in urban and suburban settings as well as minority and ethnic groups, are being exposed to programmatic offerings.

In addition, it is recommended that Indiana consider developing an Agbioscience Academy, a summer high-school enrichment program. Such programs are offered already in a number of states, including Pennsylvania, Tennessee, and Virginia, and typically follow the format of a week-long summer academic experience for high-

achieving students on the campuses of state public academic institutions. In part because they are on college campuses, such summer residential programs provide some of the clearest connections between K–12 students and four-year institutions. For example, the Pennsylvania Governor's School for Agricultural Sciences involves about 70–100 faculty and staff from Pennsylvania State University's College of Agricultural Sciences each year. It is not uncommon for academy participants to choose to attend their state's college of agriculture, and attracting students seems to be a common goal of such programs.

Action 3: Leverage and Develop Robust Agbioscience Career Awareness Programs.

As previously noted, the lack of agbioscience career awareness at the primary and secondary levels is a problem with respect to developing a robust pipeline of students interested in pursuing agbioscience careers. Children will not become interested in pursuing careers for which they have no knowledge or their perceptions are negative. To help overcome this issue, Indiana must begin a multifaceted educational campaign to inform the public of the tremendous career potential, in terms of advancement and success, that exist within the agbiosciences and how these careers will help change the world in the coming decades. This educational campaign must be targeted not only at educational providers, such as teachers throughout the K–12 system, administrators, and guidance counselors, but also the students, parents, regional leadership, and community thought leaders.

Indiana should focus its efforts in three primary areas. First, it is recommended that Indiana's FFA chapters, in partnership with AgriNovus, **promote the National FFA's website AgExplorer.com** to children, teachers, parents, and other youth influencers as a resource that can be utilized to better

understand agbioscience career options. AgExplorer.com is a new career exploration website developed by National FAA and Discovery Education that provides comprehensive career resources to help students explore approximately 235 unique careers within the agbiosciences. Through the website, students can learn more about why such careers are exciting and attractive by watching videos, exploring the career pages, and completing the Career Finder interactive.

It is also recommended that AgriNovus work with industry partners to create an **Agbioscience Career Day** modeled after the existing, nationally led Manufacturing DaySM. AgriNovus should work with a group of industry sponsors and co-producers to create an Agbioscience Career Day designed to amplify the voice of individual companies and coordinate a collective voice of agbioscience companies to share with youth and their parents the exciting nature of the agbioscience industry and the career opportunities it affords.

Manufacturing DaySM is a celebration of modern manufacturing meant to inspire the next generation of manufacturers. Manufacturing DaySM seeks to address common misperceptions about manufacturing by giving manufacturers an opportunity to open their doors and show, in a coordinated effort, what manufacturing is—and what it isn't. By working together through this initiative, manufacturers are seeking to address the skilled labor shortage they face, connect with future generations, take charge of the public image of manufacturing, and ensure the ongoing prosperity of the whole industry.

Action 4: Help Facilitate Students' Entrance into Agbioscience Degreed Programs.

Indiana has already put in place a number of innovative programs to help support students who are interested in the agbiosciences transition from secondary education to higher education. The following are examples.

Ivy Tech's Pathway to Purdue is a partnership between the Purdue University College of Agriculture and Ivy Tech Community College—Lafayette designed to allow Ivy Tech students to co-enroll at Purdue in preparation for an undergraduate degree in the College of Agriculture. Pathway students take courses simultaneously at both institutions with the goal of earning a Bachelor of Science degree in agriculture from Purdue. The program is currently available only through the Ivy Tech—Lafayette Campus. It is recommended that the opportunity to incorporate this program onto other Ivy Tech campuses that offer an Associate's Degree in Agriculture be explored. While distance to Purdue might be an issue at some locations, the opportunity to take online classes could potentially overcome that barrier.

Ivy Tech's College Connection Coach Program is designed to provide support to high school students by helping them explore career and college opportunities. The coaches are Ivy Tech employees who work on-site at the high schools to serve that school's students. Students who visit a College Connection Coach receive assistance with college applications, dual credit programs, and scholarship and financial aid applications as well as guidance on options available after high school. The coaches' overall goal is to help students decide on the best path to achieve their life and educational goals. Plans are in place to expand this initiative across the entire state. The program was created with the goal of enabling more Indiana high school students to earn a college degree. It is recommended that the Coaches be provided with the same career awareness information provided to teachers and guidance counselors as discussed in Action 11 to ensure that they are able to accurately and proactively discuss agbioscience-related opportunities with the students whom they counsel.

Purdue Summer Start is a five-week, credit-bearing summer session that is scheduled before the start of a student's freshman year at Purdue. This program is designed to give students a jumpstart on their college career. Students join a community, participate in activities, explore campus, and take classes to earn credit toward their degree. This more relaxed and intimate environment provides students a chance to adjust to college living and to the rigor of college-level classes. Students also develop strong connections through the Summer Start community of support and activities on campus. It is recommended that College of Agriculture students who are identified as potentially "at-risk" be encouraged to participate in the program to help ensure a more seamless entry into college.

North Carolina State University's Life Sciences First Year (LSFY) Program is designed for students who enter NC State with an interest in any aspect of the life sciences. The LSFY curriculum provides exposure to all areas of life science study through specially designed courses as well as specific career counseling. After learning more about degree requirements and exploring their own interests and aptitudes (both in and out of class), LSFY students apply by the end of their first year to transfer into a degree program. NC State credits the program as the driver for the increased enrollment in a number of its agbioscience programs.

Finally, it is recognized that even if the recommended actions of this strategy are implemented successfully, there will be students who will express interest as an incoming freshman in biological sciences who have never been exposed to agbioscience opportunities. For this reason, it is recommended that Purdue, including its regional campuses, develop a program similar to North Carolina State University's Life Sciences First Year (LSFY) Program (see textbox) in order to expose these students to opportunities within the agbiosciences.

Strategy 2: Develop Industry-Relevant Skill Sets (i.e., management talent, professional development, soft skills, etc.) for Core Occupation Talent.

The quantitative and qualitative analyses put forth in Section III provide interesting insight into the existing strengths of Indiana's agbioscience workforce that can be leveraged to create further comparative advantage for Indiana's agbioscience industry. However, they also highlight some significant concerns that, if not addressed, could prove to be significant deterrents to the ability of Indiana's agbioscience industry to continue to grow in the future.

As previously noted, national studies indicate a predicted shortfall of agbioscience workers over the next five years. When Indiana is compared with the nation, it is discovered that **in terms of core agbioscience occupations, Indiana compares quite favorably with the nation, with strong workforce production in most core occupational groups.** However, the quantitative data do indicate a few shortfalls related to agricultural support positions as well as food production and processing workers. Furthermore, the qualitative interviews highlighted concerns regarding access to individuals with quality assurance/control and regulatory affairs experience and/or educational backgrounds. These concerns represent opportunities to further develop existing ag-specific degreed programs as well as create new programs to meet the ever-changing needs of the agbioscience industry. Table 16 provides a summary of the current demand-supply dynamics across key core occupations and suggests potential intervention levels required to address these current skill gaps.

Table 16. Summary of Demand-Supply Dynamics across Key Occupations

Occupational Group	Identified as "High-Demand"	Potential Misalignments	Potential Intervention Level
Agbio Scientists & Agricultural Engineers			
Agbioscience Technicians			
Agricultural Support		★	
Food production & processing workers	★	★	Secondary/Cert./Associates
Veterinarians & Vet Techs			
Quality Assurance/Control	★	★	Undergrad/Graduate
Regulatory Affairs	★	★	Certification/Undergrad

Source: TEconomy Partners, LLC

However, more important than simply the analysis of the alignment between supply and demand, the skill sets being developed versus what is needed must be analyzed. While most individuals interviewed expressed satisfaction with the technical skills acquired through ag-specific degree programs, there was concern that many of these programs lacked industrial relevancy/professional skill development as part of the curriculum. Indiana agbioscience employers have made it clear that a technically focused core agbioscience college degree alone does not provide the sufficient skills needed for its workforce.

Currently, many ag-specific degree programs are viewed as lacking industrial relevancy due to the lack of professional skill development. Some experience and understanding of the world of work is necessary to help college graduates translate their education into practical workplace skills. This demand for college graduates with workplace skills and experience represents a shift in the demands of the external world, demonstrating the pressures a global knowledge-based economy places on talent to be relevant to work.

The National Research Council, in its study *Transforming Agricultural Education for a Changing World*, found the following:

...students should master a variety of transferable skills in addition to content knowledge. Employers value those skills at least as much as book learning. Providing students the opportunity to engage in a variety of experiences ... helps to make content knowledge come alive while strengthening the so-called soft skills important in the workplace.¹⁸

Higher education must ensure that agbioscience curriculum offers students a strong orientation toward career opportunities and practical applications of their skills in a non-academic setting. The National Research Council proposes that this includes integrating work experience into the curriculum and exposing students to professional development skills, including the following:

¹⁸ National Research Council. *Transforming Agricultural Education for a Changing World*. Washington, DC: The National Academies Press, 2009. doi:10.17226/12602.

- **Teamwork and Working in Diverse Communities**—provide students with opportunities to work together both in and outside the classroom, to interact with and depend on people with different backgrounds, and to work on projects that will lead to better results than any student could have obtained alone.
- **Working across Disciplines**—prepare students to be able to work not only with experts in their own field but more broadly with those in other fields to solve common problems.
- **Communication**—provide students with numerous opportunities to write and speak about a variety of topics to audiences that extend beyond their classmates.
- **Critical Thinking and Analysis**—provide students with the opportunity to engage with real-world systems and to be required to evaluate disparate data, make decisions on the basis of these data, and explain and defend their choices.
- **Ethical Decision-Making**—provide opportunities to weigh contradictory aspects of disparate data and balance competing interests, such as assess the risks and benefits associated with various practices to balance concerns coming from scientific, economic, environmental, and other arenas.
- **Leadership, Management, and Business**—provide students opportunities to motivate others and manage complex tasks, teams, and budgets, as well as develop facilitation and conflict resolution skills and basic business and financial skills.
- **Research**—provide students with the opportunity to contribute to original research, to gain first-hand experience in conducting research, and to participate in laboratory communities.
- **International Experiences**—expose students to global perspectives, issues and cultures through learning-abroad programs and by increasing the international content in coursework.

In addition to identifying the need for integrating professional development skill sets into ag-specific degree programs, industry also identified the need to ensure that higher education is more responsive to industry's emerging talent needs, including the current identified need for more quality assurance/control and regulatory affairs talent. Also identified was the shortage of skilled talent that can work in various production environments as those positions are either highly competitive with other advanced manufacturing industry sectors or include skills that in the past were introduced earlier in a student's life, but today an increasing percentage of agbioscience students are not arriving on campus with the prerequisite knowledge.

The following four actions are recommended as opportunities to pursue to help ensure that Indiana is developing the industry-relevant skill sets for its core occupation talent base.

Actions to Pursue to Develop Industry-Relevant Skill Sets for Core Occupation Talent:

Action 5: Develop Industrially Relevant Experiential Learning Opportunities, including Internships and Co-op Programs

Action 6: Be Responsive to Industry's Emerging Talent Needs, Including the Current Identified Need for More Quality Assurance/Control and Regulatory Affairs Talent

Action 7: Build upon the Purdue Agricultural Centers Experience (PACE) Program and Other Components of the College of Agriculture Transformational Experiences Program

Action 8: Expand the Number of Academic Concentrations Offered by Leveraging the Existing Joint Purdue University/Indiana University MS-MBA Program

Action 5: Develop Industrially Relevant Experiential Learning Opportunities, including Internships and Co-op Programs.

Within professional degree programs, there is a long tradition of including field experiences as a way to build practitioner skills and facilitate the move from theory to practice. Two of the most common forms of workplace learning are cooperative education (co-op programs) and internships. In co-op programs, students alternate periods of paid work with campus study or split their time between the workplace and the campus. An internship provides students with relevant work experience over a shorter, set period of time.

Both co-op programs and internships are structured and supervised experiential learning opportunities that provide students with practical experience in their chosen fields. Co-op programs and internships illustrate classroom relevance in the professional world. Beneficial for both students and employers, they offer career exploration and skills application for students and provide employers with workers who are creative, enthusiastic, are able to assist with projects, and are open for mentorship. Transitioning students into full-time employees is also a proven time- and cost-saving recruiting method.

While prevalent in both professional degree programs and engineering programs, co-op programs and internships are not as widespread in ag-specific degreed programs. However, experiential education can certainly help students gain the following:

- a deeper understanding of subject matter than is possible through classroom study alone;
- the capacity for critical thinking and application of knowledge in complex or ambiguous situations; and
- the ability to engage in lifelong learning, including learning in the workplace.

The hardest part of developing co-op programs and internships is gaining the participation of employers. Indiana needs a coordinated outreach effort and consistent platform across higher education institutions granting ag-specific degrees to stimulate and implement employer involvement with co-op programs, internships, job shadowing, and other work experience activities for students.

To overcome this barrier, Oregon State's College of Agricultural Sciences has created the Experiential Learning Coordinator position, who works in close partnership with industry, agencies, and the Career Development Center on establishing and enhancing partnerships relating to internships and careers. The

position works to place students in a wide range of experiential learning opportunities through the office's connections with industry and other agbioscience stakeholders.

It is recommended that Purdue's College of Agriculture offer both undergraduate majors and terminal ag-specific master's students at least two independent work experience activities as part of each degree granted. These work experiences can range widely and include co-op programs, internships, capstone projects, work studies, job shadowing, and career mentors, among other activities. Due to the size of the envisioned program, it is recommended that Purdue's College of Agriculture dedicate a specific position to oversee and coordinate these efforts with industry. In addition, it is recommended that other academic institutions that are providing ag-specific degrees also require independent work experience activities as part of each degree granted. Depending on the number of students involved, this effort could be coordinated through the institution's Career Development Center.

Indiana needs a coordinated outreach effort and consistent platform across higher education institutions granting ag-specific degrees to stimulate and implement employer involvement with co-op programs, internships, job shadowing, and other work experience activities for students.

Action 6: Be Responsive to Industry's Emerging Talent Needs, Including the Current Identified Need for More Quality Assurance/Control and Regulatory Affairs Talent.

In 2011, the Food Safety Modernization Act (FSMA) was signed into law and heralded as the most significant reform to U.S. food safety standards in over 70 years. In interviews with industry stakeholders, significant concern was expressed regarding their ability to find employees who understand and then have the capabilities to ensure compliance with the vast regulations of the industry. The implementation of FSMA is only continuing to put a strain on the time, resources, and knowledge required to ensure that a company remains compliant with both the federal and state regulations. In particular, due to the roll-out nature of FSMA, companies are finding it difficult to stay abreast of changes that are being implemented.

Quality assurance/control and regulatory affairs are two core occupations that Indiana industry identified as in high demand, but for which there is no ag-specific degree available. Based on the ever-changing regulatory environment, it is critical that training is available so that employees can obtain the requisite skill sets. It is recommended that Purdue's College of Agriculture, in partnership with other relevant programs across the University, develop a certificate in Quality Assurance/Control and a Certificate in Regulatory Affairs to address this specific industry need.

While quality assurance/control and regulatory affairs are two core occupations in high demand, there will always be emerging occupational fields in demand by industry for which academic institutions must respond in a flexible and nimble fashion. One example of a statewide initiative in response to a specific industry cluster's talent needs is the effort in North Carolina, known as NCBioImpact, to establish an avenue for life science professionals to raise skill levels by leveraging broader postsecondary educational institution assets. This is a joint undertaking of the state's dedicated biosciences development organization, NCBiotech; the North Carolina Biosciences Organization; the North Carolina Community College System; and the University of North Carolina System. Its objective is to work to ensure that North Carolina can meet the talent needs of the biopharmaceutical sector. NCBioImpact was created in 2003 with a grant from the Golden LEAF Foundation, which invests North Carolina's tobacco settlement

Indiana's Agbioscience Workforce

funds in economic development initiatives. For existing workforce skill upgrading, NCBioImpact offers both short courses as well as certificate programs that can lead to future degrees, through three specific components:

- Biomanufacturing Training and Education Center (BTEC) is a specialized biomanufacturing training and education facility at North Carolina State University. The pilot-scale production plant provides advanced, hands-on training and education for students and current workers. BTEC is well regarded in its professional certificate programs involving a wide range of skills in upstream, downstream, and analytical technologies used in biomanufacturing, including GMP and specific skills in advanced techniques, such as cell culture engineering, chromatography, and assay development and validation.
- Biomanufacturing Research Institute and Technology Enterprise (BRITE), located at North Carolina Central University, provides short courses designed for job seekers or current employees in the biotechnology sector who wish to enhance their skills through continuing education. BRITE's short courses with hands-on experience in instrumentation and equipment found in the workplace provide an efficient, cost-effective avenue for companies to retool existing employees to meet evolving product goals, or for job seekers to prepare themselves.
- NC BioNetwork seeks to fill employment gaps in North Carolina's growing biotechnology industry. These professional development short courses are offered upon request with a minimum of six participants. Upon completing a short course, including a competency exam, participants receive continuing education units from North Carolina Central University, Division of Continuing Education.

It is recommended that AgriNovus work with the agbioscience industry to determine current or emerging skill sets that are in high-demand but not currently possessed by the existing talent base, and then work with academic institutions to develop specific programs to deliver this specialized training to ensure the necessary skill sets can be found in Indiana. For example, the study has identified food processing and production talent (see Table 16) as a high-demand occupation that is experiencing a shortage of skilled talent, in part driven by the high demand for skilled workers in Indiana to support the advanced manufacturing environment. Indiana already has a successful initiative underway between OrthoWorx and Grace College to service the orthopedics sector that can serve as a model in developing incumbent worker education and training programs (see textbox).

Industry-University Partnering to Enhance Worker Education & Training at Grace College

Examples of effective, applied programs with industry partners are those recently established at Grace College to serve the regulatory and quality control needs in Indiana's leading Orthopedics sector. The programs fill a need for skill upgrading among incumbent workers in high-demand areas. These customized education programs, developed in partnership with OrthoWorx, a non-profit organization working to maintain and grow the Greater Warsaw orthopedics cluster, include:

- **Medical Device Quality Management.** Grace College has a five-course sequence focused in quality management that can be applied at the certificate, bachelor's, or master's levels. The courses utilize industry professionals with extensive experience and focus on critical components of quality management, including quality systems, postmarket surveillance, design control and assurance, manufacturing quality and supply chain management, and statistical processes.
- **Orthopedic Regulatory and Clinical Affairs (ORCA).** Grace College offers "the nation's only graduate program designed specifically by and for orthopedic regulatory and clinical affairs professionals." The college offers both a graduate certificate and master's level program with an accelerated design to complete in 1 year. The program is focused on developing a strong foundation and understanding in laws and regulations, particularly of the FDA related to orthopedic products. Specific courses are offered in introductory orthopedics, medical device law, writing for regulatory affairs, managing clinical data, good clinical practices, compliance, and clinical trial management and monitoring.

Action 7: Build upon the Purdue Agricultural Centers Experience (PACE) Program and Other Components of the College of Agriculture Transformational Experiences Program.

The other core occupational group that is experiencing potential misalignment between demand and supply is in the area of agricultural support occupations. In discussions with industry, this misalignment is being driven by more and more students being further removed from production agricultural experiences in their youth, and therefore entering their formal education with much less foundational agricultural knowledge and experience.

Purdue's College of Agriculture has recognized this issue and has created the Purdue Agricultural Centers Experience (PACE) Program, which is designed to expose undergraduate students who have little or no farm experience to primary agricultural production operations at one of the eight Purdue Agricultural Centers. Under the leadership of a faculty member, undergraduates spend a summer working at a Center and engaging in research as well as gaining farm experience.

PACE is one of the College of Agriculture Transformational Experiences, or CATE for short, whose goal is to provide experiences, primarily outside the classroom, that are designed to improve graduation and retention rates, improve student engagement and satisfaction, and prepare students for life after college. These experiences help students to not only realize their potential and foster personal development, but help them determine their place in a global environment. Transformational experiences are also commonly known as co-curricular activities or high-impact practices. Specific programs and initiatives geared toward developing

Indiana must work to overcome a growing trend in which more and more students are further removed from production agricultural experiences in their youth, and therefore entering their formal education with much less foundational agricultural knowledge and experience.

professional skill sets that are currently available to students include the following:

- Leadership Development Certificate Program (LDCP), which is structured to provide students with experience and growth in leadership.
- Issues-360, which provides educational experiences for students to help them become more skilled in issues engagement.
- PotashCorp Executive i2i Pathway to Excellence Program, a partnership between Purdue, Southern Illinois University, and PotashCorp, which is aimed at developing highly trained executive talent with research, leadership, critical thinking, and problem-solving skills. The year-long program provides an on-campus undergraduate research experience with a cross-institutional collaborative environment through which students, faculty mentors, and industry representatives develop and refine their communication, networking, and leadership skills. Participants also receive training in executive leadership through Washington University.

It is recommended that Purdue continue to expand and increase the number of students who participate in its PACE program as well as other CATE initiatives.

Action 8: Expand the Number of Academic Concentrations Offered by Leveraging the Existing Joint Purdue University/Indiana University MS-MBA Program.

The majority of industry stakeholders interviewed expressed a desire for Purdue's ag-specific graduate programs to incorporate a greater degree of business/professional development training. Purdue has already successfully developed one such graduate program in partnership with Indiana University—the MS-MBA in Food and Agribusiness Management. Recognizing the need for both general business management expertise and industry-specific knowledge to successfully lead in today's complex food and agribusiness marketplaces, the MS-MBA in Food and Agribusiness Management is a joint program of the Agricultural Economics Department at Purdue University's College of Agriculture and the Kelley School of Business at Indiana University. While the MS-MBA in Food and Agribusiness Management has a strong reputation, it is offered only to graduate students pursuing an agricultural economics degree.

It is recommended that Purdue's College of Agriculture consider expanding the diversity of MS-MBA offerings available to include programs relevant to other core occupational codes. The MS-MBA programs could be in partnership with the Kelley School of Business at Indiana University, the Krannert School of Management at Purdue, or other relevant Masters programs at other Indiana institutions of higher education.

Master of Business and Science (MBS) degree at Rutgers University is a hybrid degree combining master's level coursework in science or engineering with courses in business and policy. The science courses are taken within a specific concentration in areas such as the life sciences, engineering, mathematics, information technologies, and sustainability. Agbioscience-specific related programs include Food Science, Global Agriculture, Global Food Technology and Innovation, Horticulture and Turfgrass Science, Sustainability, and Biotechnology and Genomics. All students take a common business core including finance and accounting, marketing, communication, leadership, and project management. In place of a thesis, students work in teams and develop a business plan around a technology in their field.

Strategy 3: Increase Agbioscience Career Engagement for Allied Occupation Fields.

While certainly implementing the actions recommended in Strategy 2 will provide an even more robust talent base for Indiana’s core occupations and help overcome a few of the identified gaps, the findings from this study point to a much larger issue of significant concern—Indiana’s ability to align and to attract allied occupations to serve the agbioscience industry.

The national studies highlight that the agbioscience industry needs professionals with broader training that integrates agricultural sciences with other STEM disciplines as well as business acumen programs. However, the quantitative and qualitative analyses put forth in Section IV indicate Indiana’s agbioscience industry sector is unable to attract the number and quality of individuals to serve in allied occupations. It is well understood that, due to the fundamentally interdisciplinary nature of the field, without a more broadly skilled agbioscience workforce, the pace of technological innovation may slow and the critical challenges facing the industry may not be able to be addressed. Nearly every industry representative interviewed for this study voiced concern regarding the industry’s ability to attract allied occupations to the agbioscience industry sector. The quantitative data also point to disturbing shortfalls within allied occupational groups in Indiana. These pressing concerns require that programs and initiatives be developed to help ensure that allied occupational groups are aware of and linked to the opportunities that Indiana’s agbioscience industry affords.

Table 17 provides a summary of the current demand-supply dynamics across key allied occupations and suggests potential intervention levels required to address these current skill gaps.

Table 17. Summary of Demand-Supply Dynamics across Key Occupations

Occupational Group	Identified as “High-Demand”	Potential Misalignments	Potential Intervention Level
Engineers & Engineering Mgmt.	★	★ (Engineers)	Undergrad/Graduate
General Management & Business Operations	★	★	Undergrad/Graduate
IT Software & App Development	★	★	Certification/ Associates/Undergrad/Grad
Life Scientists & Science Techs	★	★ (Scientists)	Graduate
Sales Reps/Marketing	★	★	Associates/Undergrad
Skilled Production & Maintenance	★	★	Secondary/Cert./Associates
Transportation, Distribution & Logistics			

Source: TEconomy Partners, LLC

As Table 17 highlights, based on the high demand for allied occupations, it is extremely difficult for Indiana’s agbioscience industry to find the skilled talent that it requires. Industry executives cite the

Indiana's Agbioscience Workforce

overall lack of agbioscience career awareness among the general populace as a significant driver of these labor shortfalls.

The first step in attracting allied occupational talent to the agbioscience industry is to increase the general interest in the sector. Today, the vast majority of individuals never even consider a career in the agbiosciences. As long as talented individuals remain ignorant of the opportunities that the agbioscience industry sector affords, they will not seek information about the career prospects this field can offer. It is important to increase interest in the agbioscience sector in general in order to improve the supply of allied occupational talent.

However, this will not be easy. Currently, the general perception of the agbioscience industry is one that often involves difficult working environments, is located in very rural communities, and overall is considered by many as "uncool." The agbioscience image lacks the following: understanding of the high-tech, cutting-edge nature of the industry; awareness of the global relevance of its markets; and knowledge regarding the influence the industry will have in solving many of the world's greatest challenges in the 21st Century.

The overall lack of agbioscience career awareness for allied occupations requires that programs and initiatives be developed to help ensure that allied occupational groups are aware of and linked to the opportunities that Indiana's agbioscience industry offers. The following four actions are recommended as opportunities to pursue to help ensure that Indiana is attracting talent from its allied occupational base.

Actions to Pursue to Increase Agbioscience Career Engagement for Allied Occupation Fields:

Action 9: Undertake Significant Outreach through an Agbioscience Career Awareness Campaign at the Undergraduate and Graduate Levels within Allied Occupation Degree Fields Utilizing a Variety of Tools to Help Demystify the Agbioscience Industry and Debunk Its "Uncool" Perception

Action 10: Foster Connections with Agbioscience Companies through Internships and Co-ops across Indiana's Institutions of Higher Education

Action 11: Connect Indiana's Agbioscience Industry with Newer Ag-Related Programs across Indiana's Academic Institutions

Action 12: Engage Purdue's College of Engineering, School of Management, and Data Science Efforts in Agbioscience Research Opportunities to Create Transdisciplinary Research Teams that Generate Increased Opportunities for Students

Action 9: Undertake Significant Outreach through an Agbioscience Career Awareness Campaign at the Undergraduate and Graduate Levels within Allied Occupation Degree Fields Utilizing a Variety of Tools to Help Demystify the Agbioscience Industry and Debunk Its "Uncool" Perception.

Undergraduate and graduate students pursuing degrees in allied occupations do not know enough about the agbioscience sector, its achievements, and its importance to solving the world's greatest challenges. Promoting the fact that agriculture has a major role in everyone's daily life is a way to

improve the current image around agriculture and agricultural sciences. Making students aware of the significant and highly challenging issues the agbioscience sector is seeking to solve is an important component in the effort to improve the image of agriculture.

Undergraduate- and graduate-level curriculum within allied occupation degree fields can work to educate and inform students with regards to the opportunities found within the agbioscience sector in a number of ways.

Provide Agbioscience Professional Development Opportunities for Faculty/Staff within Engineering, Business, IT, and Other Life Science-Related Degree Programs. Faculty and staff can share in their classrooms only knowledge that they themselves have garnered. Curriculum development and modification are largely the prerogative of the faculty. Yet, there is little investment in professional development for faculty to learn about the demands of the agbioscience workplace and to be involved in externships around agbioscience industry functions relating to their fields. It is suggested that faculty be able to apply for professional development sabbaticals and summer externships with agbioscience companies during which they can develop case studies, course materials, and student career development programs. Programs could be piloted at Purdue and Ivy Tech, focusing on developing agbioscience industrial partnerships for faculty outside the College of Agriculture. Once a model has been developed, it could be expanded to other higher education institutions across Indiana.

Integrate Agbioscience Case Studies and Problem-Based Learning into Allied Degree Curriculum. The agbiosciences provide numerous real-world examples that can be brought into the classroom and used to enhance student learning, providing opportunities for students to practice their allied skills within an agbioscience context. Problems taken from, or at least based on, actual agbioscience industrial experiences provide context and relevance to students. These types of cases and problems also provide opportunities for students to learn by doing. They may even be able to contribute to solutions to the real-world problems that they are given. However, at the moment, very few case studies and problem-based learning assignments within engineering, business, IT, and other allied degree fields have any relevancy to the agbioscience industry. This lack of exposure to the sector limits students' understanding and interest in the field. It is recommended that a series of case studies and problem-based learning exercises be developed for curriculum within allied occupation degree fields and integrated into the curriculum. AgriNovus could oversee programs being piloted at a select number of institutions and, once developed, could be expanded to all higher education institutions across Indiana.

Create Agbioscience Business Case Study Competitions at the MBA Level and Senior Capstone Projects at the Undergraduate Level. Agbioscience-specific MBA business case competitions and senior capstone projects provide the opportunity to reach graduate and undergraduate students and expose them to an in-depth look at a component of the agbioscience industry sector. In terms of an MBA business case study competition, events typically bring together dozens or even hundreds of very bright, connected people, and highly engaged company representatives on the lookout for new talent. While the focus and formats of case competitions can vary quite widely, they all share a dual purpose: (1) to advance students' business skills and (2) to help students build connections that will aid in their career development through interacting with peers from other

Agbioscience-specific MBA business case competitions and senior capstone projects provide the opportunity to reach graduate and undergraduate students and expose them to an in-depth look at a component of the agbioscience industry sector.

Indiana's Agbioscience Workforce

schools and networking with representatives from sponsoring companies who often use their participation for recruiting. While a senior capstone project is typically more internally facing than an MBA business case competition, the opportunity to explore a component of the agbioscience industry still exists. It is also possible to develop relationships with at least a few agbioscience companies through the course of the project. AgriNovus could oversee programs being piloted at Purdue and, once developed, could be expanded to other higher education institutions across Indiana.

Develop a Young Champions/Mentorship Program. Numerous institutions of higher education have instituted an alumni mentorship program that enables alumni to share their professional and personal experience and expertise with current students. Typically, these programs are tied to the degrees pursued with little focus on the industry sector served. In addition, most programs do not attempt to develop mentorship programs with twentysomethings early in their careers. To help communicate the variety of career options available in Indiana for graduate and undergraduate students pursuing allied occupation degree fields, it is recommended that AgriNovus work with the various Alumni Offices and Career Development Offices at a select number of institutions of higher education to establish Young Champions/Mentorship Programs focused on the agbioscience sector. Alumni could be utilized to speak before classes and student organizations, help direct case studies, and participate in capstone projects. By focusing on building relationships with younger alumni, the perception that the agbioscience industry is “uncool” could also be debunked.

Action 10: Foster Connections with Agbioscience Companies through Internships and Co-ops across Indiana's Institutions of Higher Education.

Action 5 discusses the importance of internships and co-ops in helping to develop professional skill sets within Indiana's ag-specific degree programs. However, internships and co-ops can serve an equally important role in non-ag-specific degree programs in helping to expose students pursuing allied

INTERNnet: Since 2001, the Lilly Endowment has supported this web-based internship-matching program linking employers, students, and schools. It was initially launched by the Greater Indianapolis Chamber of Commerce in partnership with the University of Indianapolis and now operates as a nonprofit organization, Indiana INTERNnet. It offers a dynamic, searchable database, matching, and reporting system coupled with personal assistance—including a toll-free hotline to answer questions and provide internship guidance and resource materials. The goal is to help create or expand high-quality experiential opportunities within Indiana.

occupation degree fields to Indiana's agbioscience sector. It is proposed that AgriNovus work to gain the full participation of the agbioscience sector in Indiana's INTERNnet.

Through active participation by the agbioscience sector in INTERNnet, AgriNovus can then work with Career Development Offices and the programs created and implemented under Action 5 to ensure that students are placed. This in turn will develop greater career awareness of the agbioscience industry in Indiana within allied occupations.

Action 11: Connect Indiana's Agbioscience Industry with Newer Ag-Related Programs across Indiana's Academic Institutions.

Most industry stakeholders interviewed for this study had a relatively deep understanding of Purdue as the Land-Grant University for the State and its agbioscience programs and often hired Purdue graduates.

Indiana's Agbioscience Workforce

However, there was less awareness of a number of newer ag-related programs that are being developed across Indiana's academic institutions in support of the agbioscience industry.

For example, a number of Indiana's two-year institutions of higher education are expanding their agriculture and agbioscience-related offerings, including Ivy Tech, Vincennes, and Ancilla College. Ivy Tech is not only expanding its agriculture degree offerings to more campuses, but it has also recently created a new precision agriculture program with agbioscience applicability. Huntington University has created a new four-year agribusiness degree to meet the needs of agribusiness professionals. Indiana State University (ISU) has developed under its College of Technology a minor in Unmanned Systems, which represents new and growing opportunities in precision agriculture. ISU has already forged industrial partnerships with Indiana precision agriculture companies. In addition, Indiana State has recently developed a Master's of Science in Data Analytics, which also has significant relevancy to the agbioscience industry.

Indiana State University, in response to the emerging precision agriculture industry sector, recently created two new programs to train students—a minor in unmanned systems and a Master's of Science in Data Analytics, both of which have strong precision agriculture components as part of the curriculum.

It is difficult for Indiana's agbioscience companies to be aware of all of the programs and degrees that are provided in the state, and as a result, industry is not always aware of the various sources of talent available as well as programs in which they can participate to develop internships and other career development opportunities. It is recommended that AgriNovus develop a comprehensive clearinghouse of information related to the various programs and initiatives that can be found within Indiana's higher education institutions and disseminate the information as well as points of contact broadly to Indiana's agbioscience industry sector working to connect Indiana's agbioscience industry to the numerous relevant programs in allied degree areas.

Action 12: Engage Purdue's College of Engineering, School of Management, and Data Science Efforts in Agbioscience Research Opportunities to Create Transdisciplinary Research Teams that Generate Increased Opportunities for Students.

Recognition of the benefits associated with transdisciplinary science in addressing major scientific and technological challenges is growing. Indeed, it is widely understood that some of the biggest questions in science demand solutions that are beyond the capabilities of any single discipline. The facilitation of transdisciplinary teams of faculty is thus key to advancing progress and innovation in a complex area such as agbioscience.

As one of the nation's premier Land-Grant Universities, Purdue has demonstrated a large-scale, sustained commitment to applying research and knowledge in science, social sciences, economics and business studies, engineering, and other disciplinary fields to advance agbioscience research and sustain agbioscience-based economic, technological, and social development. Through its renewed commitment to agbiosciences through the Purdue Moves initiatives, Purdue recognizes that the combined strengths of its College of Agriculture and College of Engineering are unparalleled, and together, can make ground-breaking strides in advancing the agbioscience field.

Disciplines in the College of Agriculture also have strong intellectual connections with those in departments in many other parts of Purdue as well as with other research institutions across the state

with boundless possibilities for collaboration. Purdue should be encouraged to continue to develop transdisciplinary research teams that provide both graduate and undergraduate students the opportunities to work in team environments that most closely mirror the work of its industrial counterparts. If possible, seed grants should be made available to transdisciplinary teams in order to allow them to pursue joint research funding. Through such research teams, students will be exposed to the types of research environments that will best prepare them for entering the workforce.

The biggest questions in science demand solutions that are beyond the capabilities of any single discipline. The facilitation of transdisciplinary teams of faculty is thus key to advancing progress and innovation in a complex area such as agbioscience.

Strategy 4: Catalyze Continued Career Advancement for Rising Professionals and Foster Linkages between Post-Retirement Professionals and Start-Up Opportunities.

Given the fast pace at which innovations in agbioscience are emerging, it is critical that existing agbioscience professionals are able to effectively and efficiently shift with the development of new skills within emerging fields. A state that provides the environment for this to happen seamlessly while pursuing career advancements will benefit from an industry base that is more competitive and better positioned within ever-increasing global markets.

In addition, as innovation- and knowledge-driven organizations, agbioscience firms tend to attract leadership and management who need to keep abreast of trends in their industry and constantly monitor changes and opportunities that occur in the fast-changing world of the agbiosciences. Networking opportunities provide introductions to potential mentors, business partners, capital sources, service providers, and other important contacts. ***States trying to support industry clusters have found that the scale and intensity of networking must be substantial to help spur value-added relationships.***

Finally, individuals who have successfully completed one career and retired are often ready to explore new opportunities and to lend their expertise in new ways. Capitalizing on the cadre of retired talent can provide a significant talent base upon which to further develop the industry cluster.

The following four actions are recommended as opportunities to pursue to help ensure that Indiana continues to develop its talent base beyond formal postsecondary offerings.

Actions to Pursue to Catalyze Continued Career Advancement for Rising Professionals and Foster Linkages between Post-Retirement Professionals and Start-Up Opportunities:

Action 13: Develop Easily Accessible and Industry-Relevant Agbioscience Continuous Education Opportunities

Action 14: Develop an Agbioscience Young Professionals Network

Action 15: Develop Opportunities for Executive Leadership Networking

Action 16: Recruit Post-Retirement Professionals to either become Agbioscience Entrepreneurs-in-Residence or Mentors

Action 13: Develop Easily Accessible and Industry-Relevant Agbioscience Continuous Education Opportunities.

Simply having a diploma in hand does not mean that the pursuit of knowledge can come to an end. Agbioscience professionals require access to educational offerings and specialized training that continue to expand their knowledge and introduce them to new areas of inquiry and skill sets. As Action 6 discusses, the need to develop certification programs to meet industry needs in emerging and high-demand areas is critical. Making these certification and other forms of advanced training accessible to the extremely busy career professional is critical to Indiana's success in staying on the cutting edge of agbioscience innovation. Even formal graduate education courses, as envisioned in Action 8, need to meet the needs of professionals seeking to advance their careers by offering evening, weekend, and online course instruction.

It is recommended that AgriNovus work with the agbioscience industry to determine emerging skill sets that will be required for professionals for career advancement, and then work with academic institutions to develop specific programs to deliver this specialized training to ensure the necessary skill sets can be easily accessed in Indiana.

Simply having a diploma in hand does not mean that the pursuit of knowledge can come to an end. Agbioscience professionals require access to educational offerings and specialized training that continue to expand their knowledge and introduce them to new areas of inquiry and skill sets.

Action 14: Develop an Agbioscience Young Professionals Network.

Even in this day and age of being constantly electronically connected, face-to-face peer interaction still has significant benefit. The importance of a young professionals network for the agbioscience industry includes the following:

- **Development of social capital:** Professional organizations allow for a congregation of intelligent, like-minded professionals who are immersed in the inner workings of the industry to gather and provide participants with access to a variety of opinions and ideas.
- **Access to industry knowledge:** Members of young professionals networks often gain access to educational resources like industry research, newsletters, seminars, courses, and events where leading industry thought-leaders share insight into the latest trends, innovations, technology, and best practices. Members further their careers by staying ahead of their competitors.
- **Notice of job opportunities:** Most young professionals networks share job listings that are exclusive to members, working to connect individuals with companies searching for someone with specific talents.
- **Development of leadership skills:** Membership provides opportunities to develop leadership skills speaking at industry events, answering questions on forums, or contributing content to the group's newsletter or website.
- **Opportunity to give back:** Through activities such as the Young Champions/Mentorship Program discussed in Action 9, young professionals are provided ways to give back to students coming up behind them by sharing their experiences and knowledge about the field from a "real-time" perspective.

Indiana's Agbioscience Workforce

It is recommended that AgriNovus work to develop a Statewide Agbioscience Young Professionals Network with regional branches to reach out to and engage with agbioscience talent across the state.

Action 15: Develop Opportunities for Executive Leadership Networking.

As careers advance, the need for networking does not diminish, but in fact can become even more important. In many ways, AgriNovus is already serving as this convener; but, adding additional networking opportunities around particular themes or topics or developing specific programs or initiatives would be helpful. For instance, in Action 9 a faculty externship program was discussed. Depending on the caliber of faculty, this could develop into a value-added opportunity for both industry and academia to jointly review problems/issues and collectively work on solutions, providing both parties with invaluable experiences.

AgriNovus is already creating networking opportunities through its events, innovation councils, board meetings, and similar activities. It is recommended that AgriNovus poll its membership and other industry leaders to determine what type of value-added networking activities would be viewed as beneficial to industry and then seek to develop those programs.

Action 16: Recruit Post-Retirement Professionals to either become Agbioscience Entrepreneurs-in-Residence or Mentors.

A factor in Indiana's ability to realize the full growth potential of the agbioscience industry will be the entrepreneurs who can turn innovation into successful businesses. Catalyzing entrepreneurial activity, however, can be challenging. One of the most significant obstacles to creating and growing entrepreneurial companies is the lack of experienced management talent. For many states, there simply is no cadre of experienced, serial entrepreneurs who know how to turn an idea or a product into a successful venture. Such serial entrepreneurs are needed not only to lead new ventures but also to serve as mentors to help fledgling entrepreneurs develop their skills and increase their chances of success. They have contacts in the investor community, can recognize quality deals, and help to generate deal flow that helps firms access capital markets.

The overall consensus among the agbioscience community is that there is not currently enough entrepreneurial talent to support the innovation and commercialization opportunities that exist within Indiana. In recent years, a number of initiatives have been developed to begin to address this lack of entrepreneurial talent including the Purdue Foundry and, more recently, the Purdue Ag-celerator.

The Purdue Foundry utilizes

Entrepreneurs-in-Residence to help start-ups in commercializing their innovations, including financial modeling, creating business plans, and securing investments.

The Ag-celerator investment is currently supporting two entrepreneur-in-residence positions that will work directly with innovators to help commercialize plant science technologies.

It will be important that, as part of these initiatives, there is a focus on developing agbioscience-specific entrepreneurial training for incorporation into curriculum as well as stand-alone programs. This will help to begin to address the entrepreneurial talent shortage. In addition, more agbioscience entrepreneurs-in-residence may need to be brought into the program to meet the broader agbioscience innovation demand. One pool of potential candidates are retirees who obtained significant executive experience during their career and are now willing to give back by

Indiana's Agbioscience Workforce

serving as mentors, on boards of directors, or as consultants through an entrepreneur-in-residence program. These retirees bring diverse backgrounds across a myriad of fields, including management, sales, business development, and research. It is this diversity of talent and experience that will bring value to the entrepreneur and start-up.

It is important to note that these agbioscience-specific entrepreneurial initiatives are quite new, and as such, it is too early to tell how these resources can best be supported and leveraged. What is important to note is that the energy and momentum for agbioscience innovation and entrepreneurship needs to be further catalyzed and supported as the programs mature and additional needs are recognized.

VI. Conclusion

In today's innovation-driven economy, where businesses need to keep up with the fast pace of technological change, the ultimate competitive factor for economic growth is human talent. To maintain its position as a 21st century agbioscience leader, Indiana must have a 21st century agbioscience workforce equipped to apply and develop leading technologies. This workforce must bring not only strong technical skills, but also an ability to communicate, problem-solve, work effectively in teams, and, perhaps most importantly, apply agbioscience technologies to solving today's global challenges. To do this, Indiana must develop a workforce that is applications-focused, experiential-based, entrepreneurial, well-rounded, engaged, and appropriately skilled.

Despite the overwhelming need for innovation in agriculture to solve many of the 21st century's greatest challenges, national studies indicate a predicted shortfall of agbioscience workers over the next five years, potentially hampering the growth of the industry sector. By comparison, agbioscience companies in Indiana have a comparative advantage when it comes to access to human capital. Unlike many other regions, **Indiana's workforce development and talent generation in core agbioscience occupations is well aligned with industrial demand.** Overall, Indiana's agbioscience industry expressed satisfaction with the technical skills acquired through ag-specific postsecondary degree programs. That being said, this industry also noted that some of these programs lacked industrial relevancy/professional skill development as part of the curriculum, and could be enhanced by providing greater connections between academic curriculum and real-world experiences.

The national studies also find the agbioscience industry needs professionals with broader training that integrates agricultural sciences with other STEM disciplines as well as enhancing business acumen. When Indiana is compared with the nation, it is discovered that, for these types of workers, Indiana mirrors the same problems as the nation—**Indiana's agbioscience industry sector is unable to attract the number and quality of individuals to serve in allied occupations.** Nearly every industry representative interviewed voiced concern regarding the industry's ability to attract allied occupations to the agbioscience industry sector. The quantitative data also point to concerning shortfalls within allied occupational groups in Indiana. These pressing and immediate concerns require that programs and initiatives be developed to help ensure that allied occupational groups are aware of and better linked to the opportunities that Indiana's agbioscience industry affords.

The challenge for Indiana is to go beyond traditional paradigms of education by practically integrating agbioscience skills development across the full talent pipeline composed of K–12, colleges and universities, and continued professional development. For Indiana to be a leader in generating and sustaining a highly skilled agbioscience workforce, it must work concurrently on implementing four critical strategies:

1. Create a greater pipeline of students interested in agbioscience careers.
2. Develop industry-relevant skill sets for core occupation talent.
3. Increase agbioscience career engagement for allied occupation fields.
4. Catalyze continued career advancement for rising professionals and foster linkages between post-retirement professionals and start-up opportunities.

Indiana's Agbioscience Workforce

These four strategies are best understood as interrelated efforts that reinforce each other and create a progression of focus and actions across the talent pipeline. No one single action or strategy will fully address Indiana's agbioscience talent demands and gaps. Instead, a multidimensional approach is needed that reflects the variety of opportunities and needs that Indiana's agbioscience industry faces.

The agbioscience industry's ability to develop, cultivate, and acquire specialized human talent with specific and unique skill sets throughout the entire talent pipeline is paramount to its ability to continue to grow and prosper in the State of Indiana.

Appendix

The following includes the detailed occupational definitions utilized in this report.

Table A-1: Core Agbioscience Occupational Groups

Agbio Scientists and Agricultural Engineers	
SOC Code	SOC Title
17-2021	Agricultural Engineers
19-1011	Animal Scientists
19-1012	Food Scientists and Technologists
19-1013	Soil and Plant Scientists
19-1023	Zoologists and Wildlife Biologists
19-1031	Conservation Scientists
19-1032	Foresters
Agbioscience Technicians	
19-4011	Agricultural and Food Science Technicians
19-4093	Forest and Conservation Technicians
Agricultural Support	
SOC Code	SOC Title
13-1021	Buyers and Purchasing Agents, Farm Products
45-2011	Agricultural Inspectors
45-2021	Animal Breeders
45-2041	Graders and Sorters, Agricultural Products
49-3041	Farm Equipment Mechanics and Service Technicians
Food Production and Processing Workers	
51-3011	Bakers
51-3021	Butchers and Meat Cutters
51-3022	Meat, Poultry, and Fish Cutters and Trimmers
51-3023	Slaughterers and Meat Packers
51-3091	Food and Tobacco Roasting, Baking, and Drying Machine Operators and Tenders
51-3092	Food Batchmakers
51-3093	Food Cooking Machine Operators and Tenders
51-3099	Food Processing Workers, All Other
Veterinarians and Vet Techs	
29-1131	Veterinarians
29-2056	Veterinary Technologists and Technicians
31-9096	Veterinary Assistants and Laboratory Animal Caretakers

Table A-2: Allied Agbioscience Occupations

Engineers and Engineering Management	
SOC Code	SOC Title
11-3051	Industrial Production Managers
11-9041	Architectural and Engineering Managers
17-2041	Chemical Engineers
17-2061	Computer Hardware Engineers
17-2071	Electrical Engineers
17-2072	Electronics Engineers, Except Computer
17-2112	Industrial Engineers
17-2141	Mechanical Engineers
17-2199	Engineers, All Other
17-3026	Industrial Engineering Technicians
17-3027	Mechanical Engineering Technicians
General Management and Business Operations	
11-1021	General and Operations Managers
11-9121	Natural Sciences Managers
11-9199	Managers, All Other
13-1023	Purchasing Agents, Except Wholesale, Retail, and Farm Products
13-1041	Compliance Officers
13-1199	Business Operations Specialists, All Other
13-2011	Accountants and Auditors
43-1011	First-Line Supervisors of Office and Administrative Support Workers
43-3031	Bookkeeping, Accounting, and Auditing Clerks
43-5061	Production, Planning, and Expediting Clerks
43-5081	Stock Clerks and Order Fillers
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive
43-9061	Office Clerks, General
IT Software and App Development	
SOC Code	SOC Title
15-1111	Computer and Information Research Scientists
15-1121	Computer Systems Analysts
15-1122	Information Security Analysts
15-1131	Computer Programmers
15-1132	Software Developers, Applications
15-1133	Software Developers, Systems Software
15-1199	Computer Occupations, All Other

Life Scientists and Science Techs	
19-1021	Biochemists and Biophysicists
19-1022	Microbiologists
19-1029	Biological Scientists, All Other
19-2031	Chemists
19-4021	Biological Technicians
19-4031	Chemical Technicians
19-4099	Life, Physical, and Social Science Technicians, All Other
Sales Reps, Non-Technical	
41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Scientific Products
Skilled Production and Maintenance	
SOC Code	SOC Title
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers
49-9041	Industrial Machinery Mechanics
49-9071	Maintenance and Repair Workers, General
51-1011	First-Line Supervisors of Production and Operating Workers
51-2031	Engine and Other Machine Assemblers
51-2041	Structural Metal Fabricators and Fitters
51-2092	Team Assemblers
51-4011	Computer-Controlled Machine Tool Operators, Metal and Plastic
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic
51-4041	Machinists
51-4081	Multiple Machine Tool Setters, Operators, and Tenders, Metal and Plastic
51-4121	Welders, Cutters, Solderers, and Brazers
51-4122	Welding, Soldering, and Brazing Machine Setters, Operators, and Tenders
51-8091	Chemical Plant and System Operators
51-9011	Chemical Equipment Operators and Tenders
51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders
51-9023	Mixing and Blending Machine Setters, Operators, and Tenders
51-9041	Extruding, Forming, Pressing, and Compacting Machine Setters, Operators, and Tenders
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers
51-9111	Packaging and Filling Machine Operators and Tenders
51-9121	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders
51-9198	Helpers—Production Workers

Indiana's Agbioscience Workforce

51-9199	Production Workers, All Other
Transportation, Distribution, and Logistics	
SOC Code	SOC Title
11-3071	Transportation, Storage, and Distribution Managers
13-1081	Logisticians
53-1021	First-Line Supervisors of Helpers, Laborers, and Material Movers, Hand
53-1031	First-Line Supervisors of Transportation and Material-Moving Machine and Vehicle Operators
53-3031	Driver/Sales Workers
53-3032	Heavy and Tractor-Trailer Truck Drivers
53-3033	Light Truck or Delivery Services Drivers
53-7011	Conveyor Operators and Tenders
53-7051	Industrial Truck and Tractor Operators
53-7061	Cleaners of Vehicles and Equipment
53-7062	Laborers and Freight, Stock, and Material Movers, Hand
53-7064	Packers and Packagers, Hand