

The Intersection of Agbioscience and Tech

AgTech and AgAnalytics as Opportunity Spaces for Indiana

PERFORMED FOR: AGRINOVUS INDIANA

PERFORMED BY: TECONOMY PARTNERS, LLC









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Introduction

Purpose of this Report

This white paper examines the rise of AgTech as a fast emerging advanced industry sector. It examines the forces motivating innovation across the agriculture value-chain, and specifically considers the position of Indiana's large-scale agbioscience sector as a hub, or potential hub, for AgTech R&D, commercial activity, and technology adoption. Indiana is home to a large and productive primary agricultural sector but is equally home to a diverse range of advanced businesses focused on innovating advanced agbioscience inputs, equipment, processing technologies, and more. Furthermore, Indiana also has distinctive capabilities in tech sectors outside of agriculture that have the potential to be increasingly engaged, or drawn into, agricultural and agbioscience applications for their products and services (for example, companies in advanced analytics, software engineering, IoT technology, and communications and networking systems). This report provides a current assessment of the emerging AgTech ecosystem in Indiana and considers opportunities for advancing Indiana's economy using AgTech as a strategic engine for growth.



Disruptive Technologies and Convergence

Agriculture is the original industry in the United States, and it is, and has always been, a sector that constantly seeks to improve its output. Progress first came through the empirical observations of farmers as to what they saw working in their production environments. Large-scale advancements later came through the formation of the land-grant universities, and the application of scientific methods to improving agricultural practices, inputs, and equipment. The formation of Agricultural Extension services provided a formal means to disseminate technological and practice advancements into widespread use, and the U.S. has enjoyed ongoing production advancements and large-scale productivity increases from agriculture rooted in R&D within industry, universities, and federal research institutions.

Indiana has an established track record as a leader in innovation and adoption of technologies to enhance its substantial agricultural production sector – a sector that in 2021 generated \$15.1 billion in cash receipts for all commodities produced¹. The significant scale of Indiana's comparatively large farms (average size is 269 acres)², focused predominantly on producing major row crops (principally corn and soybeans), enables many farmers to invest in high productivity advanced farming equipment and systems. As a result, **agriculture stands as a signature high-productivity industry for Indiana** – evident in 2021 analysis by the Brookings Institution³ (Figure 1).



Figure 1: Productivity in Indiana Relative to the U.S. by Industry Sector, 2019

Source: Brookings analysis of BEA and Emsi data

¹ USDA National Agricultural Statistics Service. "Farm income and wealth statistics. Cash receipts by commodity, state ranking, 2021." https://data.ers.usda.gov/reports.aspx?ID=17844.

² USDA NASS "2021 State Agriculture Overview – Indiana." https://www.nass.usda.gov/Quick_Stats/Ag_Overview/state-Overview.php?state=INDIANA

³ Mark Muro, Robert Maxim, and Jacob Whiton with Yang You, Eli Byerly-Duke, and Monica Essig Aberg. "State of renewal: Charting a new course for Indiana's economic growth and inclusion." Brookings Institution. February 2021.

Today, the environment for agricultural innovation and technological advancement is as dynamic as it has ever been. Long-standing disciplines in agronomy, plant science, soil science, entomology, animal science, agricultural engineering, etc. continue to produce major innovations, but it is increasingly the case that scientific disciplines and fields of technology that have not traditionally been within the domain of agricultural sciences are finding opportunities for novel application to agriculture. What is increasingly occurring is a phenomenon known as "convergence," which has been defined as:⁴

The trend of innovation increasing at the interface between disciplines in science and engineering. Individual discovery is becoming multidisciplinary team discovery. Success comes from integration of multiple cyber, physical, and biological domain elements to derive new products and new solutions to market needs. Companies known for working in one sector partner with or acquire entities in another to develop multicomponent systems and novel combinatorial innovations. Networking, collaboration, adaptability, and nonlinear thinking come to the forefront of drivers of convergence models.

Previous work for AgriNovus colleagues at the Central Indiana Corporate Partnership (CICP) has identified the key domains of technologies driving convergence, disruption, and evolution in existing industries. Three core domains of disruptive technologies were observed, comprising those shown on Table 1:

Table 1: Three Domains of Disruptive Technology

Biological	Physical	Cyber/Digital
 a. Next-Gen Sequencing b. Gene Editing c. Synthetic Biology d. Regenerative Medicine and Tissue Engineering e. Metabolic Engineering f. Bionanotech and Nanomedicine g. Cyber-Biological Systems/ Implantables 	 a. Additive Manufacutring b. Advanced Robotics c. Autonomous Vehicles d. Energy Storage e. Alternative and Renewable Energyw f. Advanced Materials g. Nanontechnology h. Electric Vehicles i. Alternative Mass Transit 	 a. Artificial Intelligence b. Virtual and Augmented Reality c. Cybersecurity d. Cloud e. Big Data Analytics and Associative Intelligence f. Natural Language Processing g. Quantum Computing h. Information Validation i. Edge Computing j. Mobile Internet k. The Internet of Things l. Blockchain Technology

Source: TEConomy Partners

Disruptive technologies are a driver of change, and when reviewing those shown on Table 1 it is not hard to see that the agricultural sector – specifically that of agbioscience that spans the development of value-added food and nutrition, animal health and nutrition, plant science and crop protection and AgTech – has the potential to be a prime application space for almost every one of the listed technologies.

⁴ TEConomy Partners, LLC. 2018. "CLUSTERS & DISRUPTORS: Envisioning Central Indiana's Economic Future in a Time of Change." Produced for the Central Indiana Corporate Partnership.

Agbioscience – On the Frontier of Technological Convergence

Feeding our expanding global population, and doing so in a resilient and sustainable manner, is one of the key defining grand challenges facing humankind. The impetus for applying scientific and technological innovations to address this grand challenge is intense, and it is compelling multiple industries, scientific disciplines, and technological fields to converge around the complex challenge. **This convergence is particularly evident in the broad and expanding domain of AgTech** – an umbrella term that embraces the convergence of biological, physical, and digital technologies as assets for enhancing agricultural production and processing. The 2018 Clusters and Disruptors⁵ report for CICP identified AgTech as being a prime example of the power and promise of convergence, using it as the principal illustration of the phenomenon (Figure 2):



Figure 2: AgTech as an Example of the Phenomenon of Convergence.

Source: TEConomy Partners

What is occurring is a convergence of technologies spanning agricultural equipment, agricultural inputs, informatics, and advanced analytics systems which enabled the emergence of precision and digital agriculture as a dynamic technology-based economic development growth opportunity known as AgTech. The application of these technologies promises to improve agricultural productivity and efficiency and provide solutions to a broad range of global and domestic challenges (Table 2). This convergence of technologies addressing major market needs and challenges across the globe clearly implies a potentially bright future for nations, states, and regions that can establish a robust innovation and industry presence in AgTech.

Table 2: Potential Ag	Tech Solutions to	Agriculture-Related	Challenges
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Challenge	Potential Solutions
Population growth	 Equipment for enhanced, precision application of inputs to increase yield. Real-time field conditions analysis systems to monitor soil conditions, plant health and development, etc. to enhance and protect yield.
Farm incomes	 Precise and metered application of inputs on an "as-needed" basis. Reduced use of expensive inputs provides bottom-line benefits for producers and lessens the impact of input price fluctuations. Yield increases also impact net farm income. Data-driven farm management, using both time-series and real-time data inputs. Development of robotic and autonomous farming systems, enabling cost-effective 24/7 operations and critical farm functions in labor-constrained conditions.
Climate change	 Reduced use of agricultural chemicals and fertilizers (which may be associated with greenhouse gas emissions in their manufacturing and use). More efficient farming operations reduce on-farm energy usage.
Environmental protection	 Precision sensing of localized soil conditions and individual plant needs, enabling prescription application of reduced but optimal amounts of chemicals and fertilizers, and reduced run-off of excess of both. Precision application of water in drought or scarce-water resource conditions.
Evolving and emerging diseases and pests	 Rapid field detection, and early warning, of pests and diseases in soils, crops, livestock, and poultry. Prescription application of crop protection chemicals.
A need for healthier foods	Early and more precise pathogen detection.Optimized production quality and harvesting at peak condition.
Reducing food waste	 Development of harvesting systems to prevent bruising or other damage that may lead to spoilage or wastage of food products post-harvest. Digital supply chain management and real-time product monitoring for product condition.

2018's Clusters and Disruptors report foresaw significant growth opportunity in the AgTech space, and the prediction has largely held true. Data from Pitchbook (Figure 3) illustrates the rising trajectory of venture capital funds flowing into U.S. AgTech deals, increasing from \$2.25 billion in 2018 to \$6.45 billion in 2021. A dip occurred in 2022, and it remains to be seen if this is an anomaly, or if the moving average will begin to rise again in 2023. **Indiana has also experienced a rising moving average in AgTech venture investment**, with the highest levels of investment experienced in 2020 (\$93.1 million) and 2022 (\$117.3 million).





Source: TEConomy analysis of Pitchbook data

It is not just the start-up venture space that is investing in AgTech. Major global agricultural equipment companies (such as John Deere, CNH Industrial, AGCO, Claas, and Mahindra) are furthering their precision and digital AgTech solutions with investments through acquisition and in recruiting digital talent to empower their R&D. Global inputs suppliers (such as Corteva, Syngenta, and Bayer) are also using advanced technology in their discovery and product improvement and providing AgTech software and analytical services to farmers. Perhaps most notably, this is also a space that has attracted the attention of major information technology (IT) and digital solutions companies, with such companies as Microsoft, IBM, Google, and CISCO Systems building business units and capabilities to address market opportunities.

II. Indiana – An Emerging AgTech Hub

Indiana is one of America's leading states in agricultural production. USDA data⁶ show Indiana ranked 8th in the nation in agricultural cash receipts in 2021, and the state enjoys a diverse production profile as a major producer of row crops, specialty crops, livestock, and poultry. Indiana also holds an important position in the agbiosciences industry, being home to a diversity of companies producing agricultural inputs (advanced seed, agricultural chemicals, livestock nutrition, and veterinary health products), equipment for agricultural production and processing, and a fast-emerging footprint in new AgTech ventures (including home-grown ventures and the attraction of emerging businesses from out-of-state and internationally).

Given the rise of AgTech as an engine of economic growth, and Indiana's emergence as a location for AgTech enterprise development, AgriNovus requested that TEConomy provide a current overview of AgTech in the state, and address opportunities for further convergence of state R&D and industry core competencies in biological, physical, and digital domains that may be leveraged or applied to advancing AgTech opportunities. Specifically, TEConomy was tasked with:

- Analyzing the presence of tech and analytics occupations within Indiana's agbioscience sector.
- Assessing the areas of comparative strength in Indiana in technology horizontals that may have relevance to AgTech application.
- Triangulating potential opportunities to leverage Indiana's identified strengths in tech and analytics as cross-cutting supports for further building the AgTech sector in Indiana.
- Outlining evident respective strengths and assets, and opportunities for potential industry collaborations and other activities designed to leverage the capabilities of Indiana's respective agbioscience and tech/analytics sectors.

As the above bullet-points imply, it is important to understand not only the status of the AgTech sector in Indiana, but also to address the potential for Indiana's additional and varied assets in information and digital technologies (hardware, software, networking technologies, data analytics and information technology services) to be engaged in the emerging AgTech opportunity space.



⁶ USDA National Agricultural Statistics Service. "Farm income and wealth statistics. Cash receipts by commodity, state ranking, 2021." https://data.ers.usda.gov/reports.aspx?ID=17844.

Indiana – Current AgTech Operations

Defining AgTech is not easy. As Figure 3 shows, it comprises a diversity of technology- and activitydomains ranging from in field sensors and data gathering systems, through precision guided and finely metered field equipment, farm management software systems, and market access and finance systems for farming operations. There is not a federal government NAICS code that defines AgTech – rather businesses engaged in AgTech are distributed across a range of industry codes that contain companies that may be engaged in AgTech and most which are not yet engaged. Further complicating the equation, is that AgTech comprises only part of the business for many of the large, engaged companies (like Corteva, Elanco, IBM, John Deere, etc.), and it is a distinct challenge to identify the employment or output of these businesses that is AgTech specific.

TEConomy worked with multiple datasets, and collaboratively with AgriNovus, to develop a listing of currently engaged, or likely to be engaged, companies in Indiana AgTech. These are covered in forthcoming work for AgriNovus, but preliminary assessment shows 125 business locations across Indiana with operations in AgTech or with the potential for significant engagement in the space. These companies span: Agricultural Equipment, Technologies, and Systems (50 locations with estimated combined employment of 2,521); Plant Science and Crop Protection (55 locations, 4,383 employees), and Animal Health and Nutrition (20 locations, 1,833 employees).

The employment figure for these three categories of AgTech engaged and potentially engaged companies is total employment and is not specifically personnel involved in developing, producing, or servicing AgTech systems or applications. In addition to the above three categories, Indiana also has an important industry base of food processing companies (including companies in the AgriNovus "Value Added Food and Nutrition" platform). The Value-Added Food and Nutrition platform is larger than the other three categories combined in terms of employment (>17,000 personnel) and advanced tech is certainly being deployed in manufacturing, logistics, and other business operations within this platform (see Table 3). In the case of all four platforms, it would take a program of specific primary research, including individual company interviews (outside of the scope herein), to understand which companies are engaged in deployment of advanced digital technologies versus operating in traditional ways.

Indiana certainly has a diverse agriculture, agbioscience, and tech economy, and AgTech is being developed and deployed at Indiana company locations for a wide variety of agriculture value-chain applications. New, fast growing entrepreneurial ventures and large existing enterprises are engaging in the space and major activity is evident in applications for primary production of crops and animal agricultural production and for agricultural and food processing. Table 3 shows this diversity, providing some examples of AgTech areas of focus and some examples of companies engaged in these respective spaces in Indiana.

Table 3: Types of AgTech Focus Areas and Some Examples of Business Operations in Indiana Engaged in the Space⁷.

Segment	Examples of Companies	Technology Examples
Plant Sciences and Crop Protection	 Corteva Beck's AgReliant Genetics Qmira Advanced Agrilytics Inari 	 Controlled environment and field phenotyping and advanced analytics of seed traits and performance Precision farming strategies and analysis systems Crop protection sensing, diagnostics, and treatment systems Custom farm data analysis and agronomic decision support services
Animal Health and Nutrition	 Elanco United Animal Health BiomEdit Verility Micronutrients 	 Data sciences and applied statistics for product development Precision livestock/poultry feeding and watering systems Livestock/poultry health monitoring systems Precision feed rations
Value Added Food and Nutrition	 Tate and Lyle Red Gold ADM Cargill True Essence Foods 	 Expanding presence of automation in agricultural processing and food processing supply chains Robotics and automation in warehousing and distribution operations Emerging food processing technologies, such as 3-D printed foods Food safety and pathogen detection Food traceability, transparency, cold-chain, and quality monitoring
Agricultural Equipment, Technologies, and Systems	 Intelinair Solinftec RoGo Smart Apply Taranis The Bee Corp InsightTRAC TractionAg MyFarms 	 Drone/aerial remote sensing platforms and sensors Integrated sensor, computer vision, and advanced analytics platforms leveraging AI and Machine Learning Precision inputs application equipment. Connected and smart agricultural systems. Robotic and autonomous systems Advanced sensor systems Farm data analytics Farm management software systems Agribusiness marketing and commodity market analysis

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The table includes some examples only.

Indiana – Broader Technology Competencies

In addition to companies currently concentrating on AgTech as a core component of their business, Indiana also has a substantial tech industry covering the development and manufacturing of digital hardware systems, software systems, custom computer programing services, communications and networking systems, and other areas of tech that have potential relevance to AgTech applications. A forthcoming analysis for AgriNovus' colleagues at TechPoint assesses broader tech competencies and workforce characteristics across the Indiana economy using a four-part classification system which segments the "tech" sector into the ontology shown on Table 4.⁸ The structure is applicable for AgriNovus and agbioscience stakeholders seeking to understand cross-cutting opportunities to engage with tech firms that may have competencies that could find application to AgTech challenges, needs, and market opportunities.

Competency	Definition	Examples of Themes Relevant to Agriculture
Hardware	Tech Hardware , composed of areas such as high- performing computing hardware, IoT devices, sensor, and other physical products that enable large scale data processing and analysis	Connected agricultural equipment or other smart implements and machinery
Software	Tech Software , composed of the software tools and products leveraged by industry in integrating digital technologies into their operations including platforms such as Software-as-a-Service (Saas) products and 3rd party data processing and analytics software tools	Platforms for data management for everything from plant genomics to agribusiness operations
Analytics & Data Sciences Applications	Data Processing & Analytics, including the methods and toolkits usage by companies to gather, manager, analyze, and share insights from large databases. Recognizing that there is some overlap with other tech segments such as software, this segment represents the machine learning and other advanced analytics approaches and tools used to gain insights from large amounts of data including areas such as A.I. and data storage and retrieval	Tools to offer informed decision- making for agricultural production, including Al/ML for analysis of soil, water, weather, etc.
Networking & Connectivity	Networking & Connectivity , including the wired, wireless and distributed infrastructure that supports high speed transfer of data and communications with various connected devices and services, including areas such as cloud and fog computing and low latency data transfer	Connectivity remains the backbone behind AgTech, especially in rural areas where agricultural production occurs.

Table 4: Ontological Structure Used to Classify the Tech Sector

Forthcoming Report. TEConomy Partners. "Innovative Agbioscience in Indiana: 2022 Assessment."

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Hardware systems are a core component of tech in agricultural applications, with sensing systems, IoT systems, and other IT-focused hardware being increasingly integrated into existing agricultural equipment and deployed as stand-alone systems (e.g., in-field sensors, agricultural robots, drone platforms, GPS-enabled guidance systems, etc.). Software is deployed in the operation of hardware systems (either as embedded software within equipment or as connected software controlling features over a communications network) and may also be deployed as purely stand-alone software used for farm (business) management and analysis of data from multiple non-networked sources. Increasingly, data science and advanced analytics represent a core category of "tech" applied to agbioscience applications and information. The huge volumes of data collected in real-time by infield and other sensor and data-collection systems require capabilities in sophisticated analysis up-to and including machine learning and artificial intelligence technologies. Tying the other platforms of tech together are networking and communications technologies, a space that has required significant development attention to be paid to it given the highly geographically distributed nature of agriculture and the rural areas associated with it (that provide coverage challenges for wireless communications providers).

At the present time, the broader tech sector in Indiana (companies that do not identify as being primarily agriculture or food focused in their application) have relatively little engagement with the sector. As illustrated in Figure 4, which examines technology horizontals and industry/application verticals, it is evident that the Agbiosciences vertical sees only limited cross-over in the hardware systems space. IT, software, cyber security, and networking companies are serving quite a broad range of other industry verticals, but their engagement so far with the agbiosciences cluster is quite limited. Given the forces of convergence and the large global market that agbioscience comprises, there is an opportunity to introduce potential agbioscience applications to the wider Indiana tech community and raise awareness levels.



Figure 4: Crosswalk of Employment Totals by Technology Competencies and Markets Served

Source: TEConomy Partners, LLC.

In terms of general trends in the Indiana tech sector, several aspects are worthy of note:

- Overall Indiana's Core IT industry is growing quite rapidly but its growth rate is still lagging that of the sector overall in the U.S. and it does not have a specialized location quotient in Indiana.
- In many ways, Indiana's IT sector exists to serve other industries. Software development and services are key areas of focus for Indiana's IT sector, and critical coverage areas include the application of software development to marketing and sales tech, business support/process tech, data analytics for decision-making support, cloud hosting and digital infrastructure. These are areas of application that could see potential spillover into AgTech applications if companies in these spaces can be attracted to engage.
- Thematic analysis of Indiana tech companies uncovers technology competencies across major clusters, including advanced analytics and data sciences spanning multiple industries, together with integration of digital systems in manufacturing and logistics (IoT, AI/ML and robotics).
- Indiana has experienced a significant rise in Computer Science-related degree completions since 2015 (e.g., IT, Informatics, Computer Engineering, and Computer Graphics), with growth outpacing the U.S. average. The computer science degree pipeline is heavily reliant on Indiana's public R1 universities (Purdue and IU), and, in the case of Purdue, this provides direct interaction with agbiosciences because of the University's land-grant status.

Also of importance is that both Purdue University and the Wabash Heartland Innovation Network (WHIN) are engaged in cross-cutting enablement of R&D, stakeholder collaborations, and piloting and demonstration activities that leverage assets in agriculture, advanced manufacturing, and digital technologies to create a **signature regional development and testing hub for advancing IoT technologies**. The convergence of assets being enabled by Purdue, WHIN, participating companies, collaborating agricultural producers, and other stakeholders gives Indiana a robust position for opening discussions with both in-state and out-of-state companies that may have interests in the AgTech and IoT spaces.



III. Indiana – The Technology Workforce in the Agbiosciences Industry

While it is challenging to tease-out the components of individual tech company or agbioscience company operations that are focused on AgTech, the use of occupational analysis can be useful in profiling the numbers of personnel engaged in tech-oriented jobs. In effect, the presence of core tech and tech reliant occupations in companies serves as a surrogate identifier of likely tech engagement by the companies. TEConomy deployed two analyses to identify relevant occupational data: 1) analysis of staffing patterns among tech- and tech-related occupations in the agbiosciences Industry, and 2) analysis of job postings among tech- and tech-related occupations in the agbiosciences lndustry.

Through the analysis, it is found that while Agbiosciences combine to be among the state's largest key industries, there are comparatively small levels of technology employment within the sector. TEConomy used CompTIA definitions of technology occupations to define the "Core Tech" sector comprising occupations such as computer programmer, computer engineer, systems architect, and so forth. Additionally, TEConomy defines a series of "Tech Reliant Occupations" (for example engineers, scientists, business analysts, etc.) – occupations that are heavy users of tech and typically require personnel to have significant technological and analytics skills. These two definitional clusters of occupations (Core Tech and Tech Reliant) were also examined against non tech occupations in industry sectors. Figure 5 shows the results for Agbioscience compared to other key industry sectors that are employers of tech talent or consumers of tech in Indiana. **A key finding is that in 2021 Agbiosciences had the lowest number of "Core Tech" workers among the 16 industries examined, and it had the third lowest volume of "Tech Reliant" workers. These results suggest that the majority of Agbioscience operations do not have a high-volume of tech penetration currently in Indiana.**

	Core Tech	Tech-Reliant	Non Tech Occupations	Grand Total
Logistics	5.0K	13.6K	249.2K	267.8K
Healthcare Services	1.6K	2.8K	169.6K	174.0K
Automotive/Motor Vehicle	1.1K	12.4K	126.6K	140.2K
Metals	0.6K	10.1K	89.8K	100.6K
Employment/Temp-Related Services	3.8K	4.1K	81.9K	89.7K
Agbiosciences	0.2K	2.4K	72.3K	74.9K
Life Sciences	1.3K	10.7K	37.5K	49.5K
Polymer/Plastics	0.3K	3.8K	41.3K	45.4K
Technical and Consulting Services	3.6K	17.4K	21.3K	42.3K
Information Technology	20.2K	4.9K	13.7K	38.9K
Headquarter/Administrative Operations	4.3K	6.2K	23.6K	34.0K
Consumer Products	0.3K	2.2K	30.3K	32.8K
Energy	0.5K	3.0K	21.9K	25.5K
Direct Insurance Carriers	2.5K	2.6K	17.6K	22.7K
Aircraft/ Aerospace	0.5K	2.5K	4.1K	7.2K
Financial Transaction Services	0.5K	0.5K	5.3K	6.3K
5K 10K 15K 20K 25H IN Employment (2021		0K 5K 10K 15K 20K IN Employment (2021)	0K 100K 200K 300K IN Employment (2021)	0K 100K 200K 300K IN Employment (2021) =

Figure 5: Indiana Employment in Key Industry Clusters Based on Technology Reliance (2021)

Source: TEConomy analysis of Lightcast Staffing Patterns 2022.3

A key finding of TEConomy's forthcoming work for TechPoint is that **all the key industries studied for the state have a relatively low penetration of tech jobs when compared to their respective sectors nationally.** Notable regarding this finding is that the differential between the national and the Indiana tech-occupation penetration level is the lowest for Indiana industries in agbiosciences. This finding is illustrated in Figure 6, where it is evident that the tech-reliant workforce as a component of the sector workforce in Indiana agbiosciences is only 0.1 percent less than that seen nationally. This is not a tech space where Indiana is playing catch-up – the state is very much in the mix. The results are, however, also indicative of the emergence of "tech" work in agbiosciences still being in a relatively early state – both nationally and in Indiana.

Figure 6: Percentage Point Difference Between U.S. and Indiana in Share of Industry Workforce that is Tech-Reliant (2021)



Source: TEConomy analysis of Lightcast Staffing Patterns 2022.3

Figure 7 shows the distribution of Core Tech and Tech Reliant occupations in Indiana agbiosciences for 2010, 2015, and 2021. Growth is clear between 2010 and 2015 – with the largest expansion occurring in the Tech Reliant positions of "business and financial analysts", "engineers", "scientists", and "tech user management" positions. However, there is not a notable difference between the 2015 and 2021 tech occupation totals. It is evident that the Core Tech segment has grown over each period shown, but it is still a relatively small number of occupations overall.



Figure 7: Growth in Indiana Staffing Patterns for Core Tech and Tech Reliant Occupations in Agbioscience

Source: TEConomy analysis of Lightcast Staffing Patterns 2022.3

With the Tech Reliant category comprising the largest component in agbiosciences, useful perspective can be gained by analyzing the Indiana versus U.S. profile of the occupational types therein. Figure 7 shows that "engineering" occupations and "tech user management" occupations comprise a larger share of Indiana's agbioscience cluster than the nation. "Business and financial analytics" occupations see lower penetration in Indiana, as do the "scientists" and "scientific technicians" occupations. Figure 8 also shows the Core Tech occupation comparison for Indiana versus the U.S. with Indiana having 6% of its agbioscience tech and tech reliant jobs being in the Core Tech category, versus 8% nationwide.





Source: TEConomy analysis of Lightcast Staffing Patterns 2022.3

Figure 9 provides further detail on the occupations making up the Core Tech and Tech Reliant categories in Indiana's agbioscience sector.

CompTIA Core Tech	Computer User Support Specialists Computer Network Support Specialists	44 24						
	Network and Computer Systems Administrators	23						
	Computer Systems Analysts	20						
	Software Developers	19						
	Computer and Information Systems Managers	13						
Tech-Reliant - Business &	Accountants and Auditors					303		
Financial Analytics	Market Research Analysts and Marketing Specialists			143				
i manenar / mary nes	Logisticians		92					
	Business Operations Specialists, All Other	28						
	Management Analysts							
Tech-Reliant - Engineers	Industrial Engineers					34	7	
	Mechanical Engineers		103					
	Chemical Engineers	34						
	Electrical Engineers	15						
	Engineers, All Other							
Tech-Reliant - Scientific	Food Science Technicians			127				
Technicians	Agricultural Technicians	_						
	Chemical Technicians	- 4.2	72					
	Life, Physical, and Social Science Technicians, All Other	12		_				
Tech-Reliant - Scientists	Food Scientists and Technologists			172				
	Chemists	12	8					
	Soli and Plant Scientists	15						
Tech-Reliant - Other	Sales Representatives, wholesale and Manufacturing, Technical and Scientific Products	39						
	Machanical Draftore	10						
	Electrical and Electronics Panairors, Commonial and Industrial Equipment	10						
Task Dallast	Electrical and Electronics Repairers, commercial and industrial Equipment	26						
lech-Kellant -	Mechanical Engineering Technologists and Technicians	30						
Engineering Technicians	Electrical and Electronic Engineering Technologists and Technicians	12						
Tech Hear Management	Industrial Production Managers							477
rech-Oser Management	Architectural and Engineering Managers	29						4//
	Architectural and Engineering managers				-			
		0	100	200	3	00	400	500
		Estimated Employees E						
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Figure 9: Leading Technology Occupations Evident in Indiana's Agbioscience Staffing Patterns

Source: TEConomy analysis of Lightcast Staffing Patterns 2022.3

A key finding of the TEConomy analysis is that, while Core Tech jobs do not have a high presence or penetration in the agbiosciences evident through 2021, it does appear that companies have been trying to boost these numbers substantially. Job postings data show that there has been significant activity in terms of agbioscience companies seeking to expand their Core Tech workforce, and their Tech Reliant workforce, far beyond current levels. Analysis of job postings for Core Tech and Tech Reliant workers in the agbiosciences finds 6,700+ unique job postings for Indiana positions since 2015. As noted previously Core Tech positions in Indiana agbiosciences totaled 157 in 2021 (Figure 7), but the job postings data from Lightcast show Indiana agbioscience employers have tried to recruit into 1,149 Core Tech positions from 2015 through 2022 (Table 5).

Table 5: Core Tech and STEM	Job Postings by In	diana Agbioscience (Companies (2015-2022)
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Terminology	Definition	Unique Postings Total Postings Since Jan. 2015 Since Jan. 2015		Median Posting Duration (Regional: 28 Days)
Core Tech	IT-related field, as based on COMPTIA definition	1,149 Unique 2,995 Total Postings Postings		30 Days
Tech-Reliant	Additional science, ech-Reliant engineering and technical fields		16,109 Total Postings	27 Days

TEConomy's recent economic development strategy for the Indiana Economic Development Corporation (IEDC)⁹ highlights challenges being experienced in recruiting personnel across Indiana's advanced industries. The conclusions for IEDC, and for agbiosciences herein, are in alignment, suggesting that access to talent is a notable constraint for Indiana. It should be noted that access to talent is being cited in almost all states and regions of the country as an ongoing challenge in skilled workforce positions, especially as they relate to tech jobs. It is not a challenge unique to Indiana, although relatively flat population growth projections for Midwestern states do suggest the challenge may be particularly acute into the future for the region in terms of overall workforce availability.

Figure 10 shows that since 2017 the number of job postings for Core Tech and Tech Reliant jobs in agbiosciences have experienced a steep increase. **Core Tech postings have experienced 6.8X** growth, while Tech Reliant postings have grown 5.1X. Employers are clearly seeking to hire into these positions, and if demand can be met, then Indiana will experience a significant jump in its Core Tech and Tech Reliant employment in agbiosciences.

Figure 10: Indiana Agbiosciences Core Tech and Tech Reliant Job Posting Trends (Number of Postings and Trendline)



⁹ TEConomy Partners. 2022. "BUILDING AN ECONOMY OF THE FUTURE: Indiana's Strategy for Advancing GDP Growth and Economic Prosperity. Phase II: Strategy and Action Plan." Prepared for Bradley B. Chambers, Secretary of Commerce, State of Indiana and CEO, Indiana Economic Development Corporation.

The types of companies across agbiosciences that are seeking to increase their hires are quite diverse. Figure 11 shows the companies posting the largest volumes of jobs for Core Tech and Tech Reliant positions. Corteva in the plant sciences, and Coca-Cola, Pepsi, and Nestle Indiana locations have the highest demand in both categories. In reviewing the list of companies in Figure 12 it is evident that the plurality is in the food processing sector, and there are also several in the plant sciences sector. Among Indiana-<u>headquartered</u> agbiosciences companies, Corteva, AgReliant Genetics, Envigo, Indiana Packers, and Red Gold have the largest volume of unique core-tech job postings.

Figure 11: Leading Agbioscience Sector Companies with >=7 Unique Core Tech Postings in Indiana and Tech Reliant Job Postings (January 2015 through 2022).



In the Core Tech category, it is computer occupations (e.g., support specialist, systems analyst, etc.) that comprise the top Core Tech occupations appearing in agbiosciences job postings (Table 6). Database Administrators and Software Developers also see relatively strong demand.

Table 6: Leading Occupations for Indiana Agbioscience Sector Job Postings in Core Tech (January 2016	-
September 2022).	

Occupation (SOC)	Total Postings (Jan 2015 - Sep 2022)	Unique Postings (Jan 2015 - Sep 2022)	Median Posting Duration
Computer User Support Specialists	747	227	29 days
Computer Occupations, All Other	432	161	25 days
Computer Systems Analysts	204	120	27 days
Database Administrators	303	105	32 days
Software Developers	205	104	35 days
Data Scientists	151	69	36 days
Information Security Analysts	214	59	40 days
Software Quality Assurance Analysts and Testers	125	58	15 days
Computer Programmers	138	56	34 days
Computer Network Architects	107	55	16 days
Database Architects	59	30	21 days
Network and Computer Systems Administrators	175	29	33 days
Web and Digital Interface Designers	45	23	2 days
Web Developers	32	21	47 days
Computer and Information Systems Managers	23	12	10 days
Computer and Information Research Scientists	16	12	9 days
Computer Network Support Specialists	19	8	41 days

Source: TEConomy analysis of Lightcast JPA 2022.3

Among Tech Reliant fields (Table 7), the significant presence of manufacturing within Indiana biosciences is reflected in the job postings, where the largest occupation category for postings was "Industrial Engineering Technologists and Technicians."

Table 7: Leading Occupations Job Postings in Indiana Agbioscience Sector Tech Reliant Fields (January2016 - September 2022).

Occupation (SOC)	Total Postings (Jan 2015 - Sep 2022)	Unique Postings (Jan 2015 - Sep 2022)	Median Posting Duration
Industrial Engineering Technologists and Technicians	6,670	1,679	24 days
Life, Physical, and Social Science Technicians, All Other	1,131	452	28 days
Computer User Support Specialists	747	227	29 days
Chemists	475	220	23 days
Electrical and Electronic Engineering Technologists and Technicians	721	218	25 days
Food Science Technicians	322	211	32 days
Chemical Engineers	434	206	24 days
Operations Research Analysts	380	183	28 days
Computer Occupations, All Other	432	161	25 days
Industrial Engineers	234	139	21 days
Computer Systems Analysts	204	120	27 days
Electrical Engineers	258	111	21 days
Database Administrators	303	105	32 days
Software Developers	205	104	35 days

Lightcast data allow analysis of the specialized skills being requested of applicants in job postings. Figure 12 shows the results for the Core Tech postings category and indicates that "Automation" and "Computer Sciences" skills are the top specialized skills appearing in agbioscience company postings.



Figure 12: Top Specialized Skills in Core Tech Job Postings in Indiana Agbiosciences

In the Core Tech postings, the MS-Office suite is a fundamental area of expected **software expertise** (Figure 13). Stepping-up into more sophisticated programing and software systems, top areas of need are in SAP and programing languages (especially SQL and Python, and to a lesser degree JavaScript, C, and R).

Figure 13: Top Software Skills in Core Tech Job Postings in Indiana Agbiosciences



Source: TEConomy analysis of Lightcast JPA 2022.3

The skills and software expertise sought in the Tech Reliant fields are quite diverse as illustrated in Figures 14 and 15. Manufacturing oriented skills comprise a significant volume of the postings (evident in the required skills of GMP, food safety and sanitation, and preventive maintenance, automation, and machinery).





IV. Conclusions

Indiana has many evident strengths and assets in AgTech-related fields. Indiana is home to innovative, globally leading companies, with evidence of technological leadership in key platform areas, such as plant sciences, animal health, value-added food and nutrition, and ag equipment. The state is also home to a pipeline of technology-based startups, with growing levels of deal flow in areas such as AgTech software and hardware, animal health and nutrition, and biobased products. The AgTech development ecosystem also benefits from the distinctive piloting, testing, and product development infrastructure established by Purdue University and WHIN. Lastly, Indiana is home to leading universities that are producing significant and increasing volumes of tech talent – led by Purdue an institution that is globally renowned for work at intersection of agriculture and technology.

This report shows that there is a robust and expanding foundation of capabilities in AgTech upon which Indiana can build. At present the penetration of tech into the agbioscience sector in Indiana is on par with the national level, but there is strong evidence that Indiana's agbiosciences companies are endeavoring to significantly boost their core tech and tech reliant workforce, and if connectivity can be increased to the increasing output of students at Purdue, IU and other Indiana institutions, significant employment growth is likely to occur.

The findings contained in the report point to several actions for AgriNovus to consider as it works to realize the opportunity to further grow Indiana as a global AgTech hub:

- 1. AgriNovus should engage in a major educational and awareness building program to highlight the career opportunities in the AgTech sector emphasizing the relevance of jobs in the sector to important work addressing global grand challenges in feeding the world and addressing sustainability and resiliency in ag production and associated industries. Relevance to major challenges of social and global significance has significant student appeal and there is a natural fit with the Field Atlas program of AgriNovus. It is also recommended that AgriNovus present on AgTech opportunities at events, particularly with Purdue University students, and encourage increasing engagement of College of Agriculture students in the Purdue Data Mine program (which is a cross disciplinary advanced analytics skills development program). An immediate opportunity is for AgriNovus to also coordinate participation by agbioscience companies in the forthcoming Data Mine Corporate Partners Symposium being held on April 24, 2023 which showcases the program's ability to connect talented tech and analytics students to industry opportunities.
- 2. AgriNovus needs to run a parallel awareness building program with Indiana's base of tech companies that are not yet engaged in AgTech opportunities. The convergence potential is significant, and AgriNovus' colleagues at TechPoint can be an important asset in discussing and facilitating potential approaches. Options here include:
 - a. Hosting joint regional information sessions
 - b. Cross-posting of blog postings and information between the two CICP organizations
 - c. Participation at tech sector speaking events
 - d. Sponsoring a MIRA award for tech engagement in agbioscience challenges.
- 3. AgriNovus should foster dialog and awareness building between the agbioscience and tech sectors in Indiana by creating a Technology Convergence Committee among its members and others in the AgTech/tech sectors. Because data teams at food/ag related companies are often very small, there may be numerous networking opportunities for cross-firm teams. Once this

technical community is established, there are opportunities for events or initiatives that could bring together representatives from key companies to address shared challenges and common goals. An example of this type of action is MNBold in Minnesota, which is a cross-industry effort focusing on the circular economy for packaging.

- 4. Multiple tech giants (including Google, Microsoft, Amazon, Spotify, and others) have collectively announced downsizing of their employment. The New York Times "The Morning" email on January 25th, 2023, cited 216,000 tech employees having been laid-off from big tech companies since the start of 2022.¹⁰ While these mega companies are rationalizing after boosting employment during the pandemic and recovery period, other sectors across the economy continue to scramble to find tech talent. Mining the pool of tech workers leaving these large companies (using LinkedIn), or still employed at them, may be a potential play for other sectors of the economy, including agbioscience.
- 5. AgriNovus should explore with IEDC the potential for a state incentive program to encourage agricultural producers in Indiana to adopt productivity enhancing AgTech products and services, especially those developed by Indiana companies or startups. One approach may be the extension of the state's Manufacturing Readiness Grants program (administered by Conexus Indiana) to ag producers or agbiosciences firms (or development of a new co-investment fund to support similar activity).
- 6. AgriNovus should develop an outward facing marketing document (and associated Web hosted PDF) for use with domestic and international prospects highlighting the position of Indiana as an AgTech growth hub. The Pittsburgh Robotics Network¹¹ recently used this approach as an outgrowth of their regional autonomous systems and robotics development strategy produced for the Pittsburgh region. Something similar should be deployed by AgriNovus to summarize the opportunity environment in Indiana, covering:
 - a. Key topline statistics
 - b. An industry cluster graphic for Indiana (similar to Figure 4)
 - c. Summary of R&D assets in AgTech
 - d. Synopsis of the higher education and talent development pipeline
 - e. Profile of the ecosystem available to support companies starting and growing in Indiana in AgTech
 - f. Profile of the WHIN/Purdue regional collaborative that enables the piloting, demonstration, and scale-up of AgTech solutions.
 - g. Industry testimonials
 - h. Call to action and connecting.

AgriNovus leaders should attend major domestic and international AgTech events and proactively promote the state and use the document as a media/collateral leave behind

Julie Bosman, National Correspondent. "Good morning. The drumbeat of layoffs in Silicon Valley is partly a result of how the pandemic upended the economy." New York Times email to subscribers of The Morning. January 25th, 2023.
 https://robopgh.org/cluster-profile/



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