

# Resilience through disruption

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The impact of the pandemic on Indiana and the future of food and agriculture

January 2021



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Executive summary



# Executive summary

Indiana health officials confirmed the state's first coronavirus<sup>1</sup> case on March 6, 2020. Like most of the United States (U.S.), Indiana cases initially spiked in April and May followed by a period of low daily cases in June and July and a second spike in the fall of 2020 and winter of 2021.<sup>2</sup> This report was written in the fall of 2020. While Indiana experienced a higher unemployment rate during the spring and summer of 2020 than the U.S. overall, the state recovered more quickly during the summer and fall 2020. Indiana's faster employment recovery is likely due to its faster phased reopening plan relative to other states.

Indiana's economy made up nearly 1.8 percent of the U.S. economy during the second quarter of 2020 and the state's quarterly gross domestic product (GDP) showed a 15 percent year-over-year real GDP decline. The second quarter dip in GDP was unsurprising. Indiana's food supply chain, particularly the consumer-facing food service industry, as well as the manufacturing and processing stages of food production that are labor-intensive, were heavily impacted by the pandemic's unique disruptions. Indiana's real GDP in the fourth quarter of 2020 is expected to be equal to the second quarter of 2016,<sup>3</sup> indicating nearly four years of lost growth due to the pandemic. A return to pre-pandemic output is not expected until the second half of 2021<sup>4</sup> with substantial variance for the timing of vaccine distribution or potential interventions by Indiana and other states to slow the spread of the virus.

## The pandemic's impact on Indiana's food chain

The food value chain contains five key stages: innovate, produce, transform, make and deliver. The pandemic impacted each stage, but in Indiana the impact was concentrated on the produce, transform and deliver stages. The government-mandated closure of food service establishments for in-person dining caused substantial food supply chain disruption. The sudden loss of an entire channel caused significant production, inventory and packaging disruption for an industry whose products are often highly perishable. While many food retailers (e.g., grocery stores) experienced demand spikes as consumers stockpiled necessities, the bulk or single-serve packaging used for food service products combined with low connectivity between channels prevented agile redirection of food service destined products. During the late spring and early summer, processing plants faced reductions in operations and temporary shutdowns as the pandemic spread between employees and forced rapid responses by companies. Plant closures left protein and dairy producers with nowhere to process outputs and therefore no means to get products to market. As a result of the disruptions, even with excess food available nationally, food retailers faced shortages.

Additionally, many farmers were forced to discard some of their products (e.g., milk) or euthanize livestock adding to food waste and reducing farm incomes.

An analysis by Purdue University and EY-Parthenon of five major commodities produced in Indiana, corn, soybeans, hogs, dairy and eggs, indicates aggregate losses attributed to the pandemic of potentially more than \$500 million. The largest impact was borne by corn producers who suffered between \$165 and \$370 million in estimated losses due to shifts in demand and the resulting corn price impacts. Hog producers lost more than an estimated \$80 million and dairy producers an estimated \$35 million; shell egg producers, who sell through the retail channel, were up almost an estimated \$90 million for 2020 through September, while liquid egg production fell by one-third over the same period. The losses were driven by both price and throughput challenges. Corn prices fell as ethanol plants closed and animal producers slowed production. Hog production dropped dramatically in April and May 2020 from a year earlier and then ramped up dramatically in June through September but hog prices compared to one year earlier did not recover until September driving several months of lower revenues for many hog producers. Dairy producers, already suffering from over supply and declining demand prior to the pandemic, suffered year-over-year price declines that drove revenue reductions in April, May and June until prices started to recover in July.

The pandemic also exposed labor as plants operator's weakest link. The forced closures and challenging working conditions highlighted the case for increased automation. The closure of several of Indiana's large meat processing plants, one of the major disruptors to hog and poultry processing, benefited smaller processors by driving demand to them. Small processors responded by increasing their operating hours or attempting to expand capacity. Many processors reported they are booking slaughter and butchery services into late 2021 and early 2022.

Manufacturing suffered the largest share of unemployment during the initial months of the pandemic. As of May 2, 2020, nearly 36 percent of Indiana's continuing unemployment claims were from the manufacturing industry despite being approximately 16 percent of Indiana's total workforce. Agriculture, forestry, fishing and hunting professions, which make up nearly 5 percent of Indiana's workforce, had one of the lowest shares of unemployment at only 0.1 percent.

In the delivery stage of the value chain, the shutdown of in-person dining at restaurants gave rise to a sharp increase in online restaurant, grocery and e-commerce delivery orders. Many of the restaurants that survived developed innovative, new revenue streams, such as do-it-yourself kits, updated

menus and take-out cocktail kits. Across the value chain, many members of Indiana's food and agriculture chain credit the pandemic with accelerating the need for innovation to keep consumers engaged and costs down. The pandemic continues to impact the food service industry. An analysis from Fall 2020 shows that, on average, a daily increase of 1,000 COVID-19 cases reduces food away from home spending by -11.3 percent in Indiana.<sup>5</sup>

The accommodation and food service industries also suffered substantial unemployment during the pandemic. On May 2, 2020, workers from these industries filed almost 16 percent of continuing unemployment claims despite comprising only 8 percent of the state's workforce. Retail trade workers filed 9 percent of total continuing unemployment claims and comprised 9.6 percent of the total workforce.

The pandemic disrupted food and agricultural production and delivery in the state and likely caused over \$500 million in direct revenue losses to producers. In early May 2020 there were over 270,000 continuing unemployment claims in Indiana. Unemployment and reduced incomes have been linked to the adoption of lower-nutrition diets in the long-run, which portends potential health challenges for Indiana residents in the future.

## The future of food

The modern food and agriculture system is built on efficiency and productivity. It focuses on mass production and distribution of large quantities of affordable products. However, evolutions in consumer expectations are driving changes. The agricultural and food chain is expanding its focus to include health, sustainability and transparency while continuing to balance the need for nutritious, affordable and available products. Standardization is slowly giving way to customization. The transformation is being driven back through the value chain by empowered consumers, who continue to learn more about their food system that many took for granted prior to the pandemic.

The pandemic is driving increased focus by consumers on their food and health. Many consumers report they will continue to cook more at home, order online, pay for convenience and focus on their health.<sup>6</sup> As the pandemic recedes, consumers will seek new delivery, new formats and new attributes for their foods. Simultaneously, producers face consolidation, risk management challenges, labor shortages, increasing supply chain complexity and new trade and regulatory barriers.

Food delivery is growing rapidly in the U.S. and helping to mitigate the estimated \$240 billion in losses attributable to the pandemic the food service industry is expected to suffer by

the end of 2020.<sup>7</sup> Total investments in food delivery, including venture capital to post-IPO funding was \$7.3 billion globally between October 2019 and October 2020.<sup>8</sup> Food delivery app mobile installs increased 55 percent between late January and March 2020 driven by the closure of in-person dining during the lock-downs.<sup>9</sup>

A shift to food delivery is also going to transform food access. In 2015, the United States Department of Agriculture (USDA) estimated that between 20 and 50 million people in the U.S. lived in food deserts.<sup>10</sup> The definition of a food desert is based on proximity to a grocery store or supermarket. In a future where grocery stores' business models focus more deeply on delivery, brick-and-mortar footprints will likely shrink. By traditional measurements, increasing numbers of Americans will live in food deserts while simultaneously having access to increasingly diverse foods through low-cost delivery services.

As food delivery is increasing, demand for prepared foods and meal kits is growing. U.S. demand for prepared meals was between \$20 and \$25 billion in 2019.<sup>11</sup> The prepared foods market is growing at over 6 percent annually and as consumers' food purchasing habits change post-pandemic, the category is likely to double by 2030.<sup>12</sup>

Consumers are also driving change in food attributes. The growth in organic, non-genetically modified (GM), plant-based foods and alternative proteins is being driven by consumers' focus on health, sustainability and quality. The global organic foods market was estimated at over \$120 billion in 2019. The U.S. organic foods market was \$49 billion, over 40 percent of the global market.<sup>13</sup> An analysis estimates that Indiana farms produce nearly \$120 million of organic goods each year with output growing at a 16 percent compound annual growth rate since 2012 – faster than the national average of 8 to 10 percent.<sup>14</sup>

Consumers are also slowly demanding food that is non-GM driven by disputed beliefs that GM crops are harmful to humans or the environment. To help producers adapt to consumer demands, farm input manufacturers are developing additional conventional seed, organic and green chemicals and new practices. Simultaneously, any retrenchment from GM production threatens some of the efficiency and sustainability gains made over the past two decades. Continued advancements in production technology and processes should mitigate some of this loss at the farm level.

As plant-based products become increasingly popular the U.S. market for plant-based meat could exceed \$9 billion per year. In 2019, plant-based meat sales were just short of \$1

billion but grew at an estimated 18 percent over 2018 sales.<sup>15</sup> In 2019, plant-based yogurt sales grew 95 percent, plant-based ice-cream grew 34 percent and plant-based spreads, dips and sour creams grew 135 percent.<sup>16</sup> The huge growth of plant-based foods has attracted substantial investment. In alternative proteins, investments have totaled over \$16 billion in the past decade.<sup>17</sup> In the first three quarters of 2020, approximately \$1.5 billion was invested in plant-based and cultivated protein companies.<sup>18</sup> Globally, hundreds of start-ups and corporations are advancing the technology to improve the sensory profiles and reduce production prices, driving increasing consumer adoption.

## The future of agriculture

Trends and challenges such as consolidation, risk management, labor and automation, supply chain complexity and trade and regulation, all compounded by consumer pressures, will slowly change production agriculture. Some of today's acres will need to be diversified, some will need to be repurposed and others may be taken out of production entirely. As always, farmers will need to be economically rational in their adoption of new technologies to drive efficiency and grow profits as they are increasingly exposed to consumer pressures for health, sustainability and transparency. Investments in agricultural technology have risen to record levels in the past few years topping \$19.8 billion<sup>19</sup> in 2019. Some of the largest disruptions to agriculture over the next decade could include controlled environment agriculture, changes to the grocery store, regenerative agriculture and electric vehicles.

### *Controlled environment agriculture*

Controlled environment agriculture (CEA) is capitalizing on the push by consumers for sustainability and local production. Over the past 12 months, investment capital has flowed in 9-figure investments into companies in the CEA space.<sup>20</sup> The CEA industry is still working to gain efficiency, particularly by vertical farm operations that have a low production to energy ratio. However, the technology is efficient at small scale, including in-home units that function like kitchen appliances. The trend for CEA to enter the home decentralizes food production and pushes it further toward the end consumer.

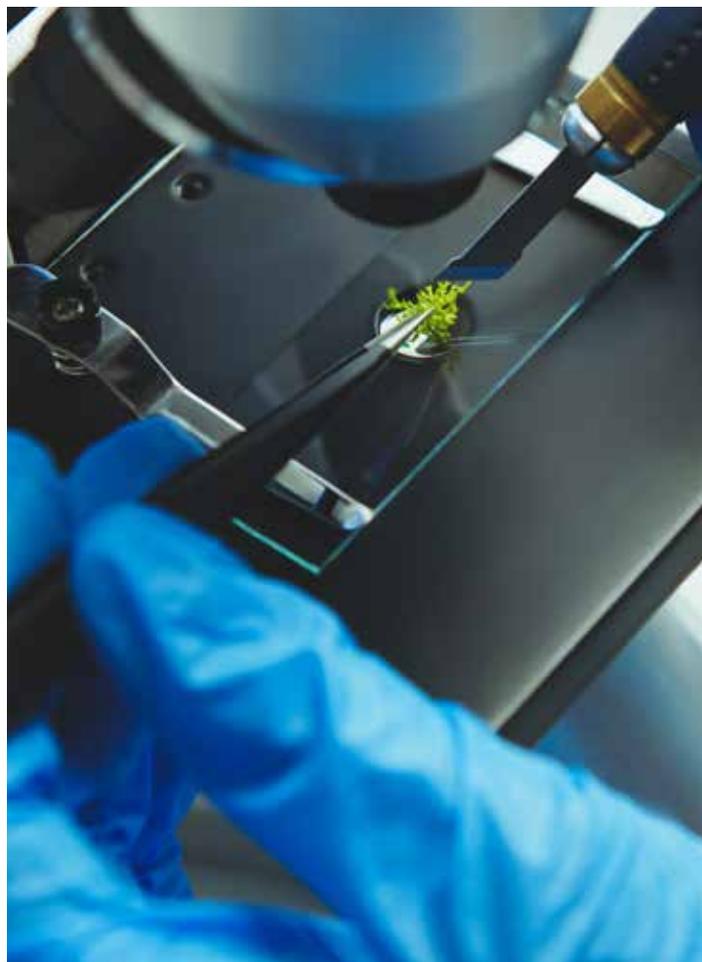
### *Grocery stores*

Grocery stores of the future are expected to reduce their physical footprint, particularly as delivery capabilities improve. The traditional middle aisles of packaged goods will become "dark stores" fulfilled through e-commerce while the fresh aisles of the store will become a consumer experience driven by CEA technology. In the near- and mid-term, CEA will allow

grocery stores to differentiate their offerings through unique product mixes, local products and ultra-fresh produce through onsite production. In the long-term, consumers may even be able to harvest their own products directly at the store.

### *Regenerative agriculture*

Regenerative agriculture and new carbon programs are expected to drive changes to production agriculture. Some of the changes in production practices will be driven by regulatory pressures. Others will be driven by consumer pressures. Regenerative agriculture is increasingly discussed as a solution to environmental challenges; but the solution challenges the efficiency gains made by advances in agricultural practices and genetic and chemical technologies over the past few decades. For many producers, the reduced yield and efficiency losses make a shift not financially viable in the near-term. However, new business models and technologies are emerging to help solve the economics of regenerative and sustainable practices.



## Electric vehicles

By 2040, electric vehicles (EVs) are expected to account for 60 percent or more of new vehicle sales in the U.S. and comprise approximately one-third of the global passenger vehicle fleet.<sup>21</sup> While this appears to be a very long-term proposition, the continued expansion of the EV fleet in the U.S. poses challenges to the biofuel industry, which used nearly 40 percent of the total corn produced in the U.S. in 2019 to produce ethanol and dried distillers grains.<sup>22</sup> The ethanol industry was estimated in 2015 to have an annual impact of \$3.6 billion on Indiana's economy.<sup>23</sup> Electrification of the transportation system would place demand pressure on corn and soybeans over the long-term and is likely to drive diversification at the farm level.

## Recommendations for resilience

There are five recommendations for Indiana food and agriculture companies to improve resiliency and to future-proof when the COVID-19 pandemic subsides: implement transparency and traceability in supply chains, increase collaboration, build last-mile agility and shorter supply chains, reexamine and refine customer segmentation and invest in the future.

- **Implement transparency and traceability:** consumers, customers, processors and manufacturers increasingly require transparency. Beyond changing regulatory requirements, companies need the ability to see real-time information about their supply chains across the produce, transform, make and deliver stages to make agile last-mile pivots or switches between channels. Transparency and traceability are also critical to delivering food, ingredients and commodities with specific attributes. A 2019 survey of 500 executives from across the Americas ranked end-to-end visibility as the primary factor for supply chain success, followed closely by real-time responsiveness to internal and external issues.<sup>24</sup> Advancements in technologies such as block chain, genetic tracing, near-field communication (NFC), radio-frequency identification (RFID) and the internet of things (IoT) can make the operation of multiple supply chains for identity-protected products more efficient and provide quality or identity guarantees to customers and consumers.
- **Increase collaboration:** collaboration requires making strategic plans with customers, suppliers and partners. Increasing complexity and dependency between parties increases the need for collaboration.<sup>25</sup> Partnerships and collaboration in sourcing, manufacturing, branding and commercial strategy are increasing as firms focus on high asset efficiency and targeted consumer segments. They also create robustness in chains and facilitate agility and risk sharing during disruptions.
- **Build last-mile agility:** last-mile agility is a combination of innovation, partnerships and collaboration and transparency and traceability. The technologies deployed to create transparency also create agility. From the manufacturing line to the consumer, a clear view of the chain combined with open collaborations with chain participants facilitate agility to pivot into new channels. Last-mile agility also involves scenario and contingency planning. A robust planning process, involving others in the chain can help companies recover quickly from crises and gain first mover advantages coming out of disruptions.
- **Reexamine and refine consumer segmentation:** consumers continue to evolve and the pace of change is accelerating. The integrated and connected experiences consumers have with technology is changing expectations for almost every interaction. Consumer segmentation is more important than ever, particularly under channel uncertainty caused by events such as the pandemic. The impacts of the pandemic are fundamentally changing the way consumers interact with organizations, products and services. Companies need to reevaluate their segmentation strategy and focus on key purchase criteria and generational differences. They need to integrate their segmentation strategy into their scenario planning and create partnerships for resilient delivery within and between channels.
- **Invest in the future:** Indiana has the infrastructure, knowledge and skilled labor to compete for venture capital and startup funding. Indiana businesses also have the economic incentive to invest in their local food and agriculture startup and business ecosystems given the strong position of the state in agricultural production. Changes in labor availability and consumer demands offer enormous opportunities for investment. Indiana's access to the entire food value chain is unique and corporate organizations should consider partnering with venture capital funders to identify and invest in the future of Indiana's agbiosciences system.

## Indiana and its food value chain



# Indiana and its food value chain

## Indiana state demographics and socioeconomics

### *Population overview*

Indiana, the Hoosier<sup>26</sup> state, has 6.7 million people, approximately 2 percent of the United States (U.S.) population and is the 17<sup>th</sup> most populous state.<sup>27</sup> The state's population increased by 3.9 percent since 2010 and is expected to continue growing to 7.1 million people by 2040.<sup>28</sup> The increase in population is driven by increasing net migration. From 2010 to 2017, Indiana averaged approximately 1,900 residents in annual net inflow, but in 2018 and 2019, Indiana averaged nearly 18,700 residents in annual net inflow,<sup>29</sup> an 884 percent increase. When asked about the massive increase, Patrick Cheek, President of U-Haul Company of Central Indiana, explained, "the low cost of doing business here is a major draw. People are moving to Indiana to create jobs. The opportunities for growth and innovation are never-ending."<sup>30</sup>

Of Indiana's 92 counties, 52 counties had a net inflow migration of people and 40 counties experienced a net outflow of people. Hancock county had the greatest net migration in 2019 with roughly 18.9 movers per 1,000 residents followed by Hamilton (17.0), Hendricks (16.5) and Johnson counties (9.9).<sup>31</sup> Residents concentrating in Indianapolis and its suburbs come primarily from other Indiana counties, surrounding regions, such as the Chicago metropolitan area, Florida and southern California.<sup>32</sup> While a growing population should bring many benefits to the state (e.g., more businesses, increased GDP), it also requires increased supply of and access to food. It is critical to construct a food system that has the infrastructure and capacity to deliver affordable, nutritious foods and that contributes to Indiana's economic development.

### *Demographics*

The rural and urban landscape of Indiana has changed substantially over the past century. In 1920, 49 percent of the state's residents lived in rural areas. Today, more than three-in-four Hoosiers are urbanites with only 22 percent of the state residing in rural areas. Indianapolis is the state's largest city with over 600,000 more people than the next largest city, Fort Wayne. When Hoosiers urbanized, most traded-in agriculture and forestry for manufacturing and service jobs. However, with technology slowly eliminating manual labor and enabling remote work, Indiana may see a slowing or reversal of urbanization.<sup>33</sup> The pandemic may also play a key role in driving people out of the cities making it increasingly important to have agile supply chains, last-mile delivery capabilities and internet access that extends into ex-urban and rural areas.

“

The pandemic brought the divide between rural and urban communities to the forefront. The recent challenges with rural broadband, local food access and healthcare access all highlight the difference between rural and urban regions.”

Brad Fruth, Director of Innovation at Beck's Hybrids

### *Wages, income and food access*

Hoosiers receive 13 percent lower wages than the average American.<sup>34</sup> Indiana's lower than average wages can largely be attributed to Indiana's industries not increasing their workers' pay as quickly as other regions and to economic restructuring that resulted in decreases of jobs with higher-than-average wages and increases in jobs with lower-than-average wages.<sup>35</sup>

Relative to the U.S., Indiana averaged \$5,000 less in median annual income over the past five years. As a result, while Indiana's annual personal consumption continues to steadily increase, it also averaged nearly \$5,000 less in personal expenditure per capita over the past five years than the U.S.<sup>36, 37, 38, 39, 40</sup>

Most of this personal expenditure gap can be attributed to rent and food. On average Hoosiers pay nearly \$200 less for rent per month and 34 cents less per meal relative to the U.S. However, nearly 2 percent more of Indiana's population compared to the U.S. is food insecure,<sup>41</sup> not knowing when or where their next meal will be. Part of the food insecurity can be attributed to nearly 1.5 percent more of Indiana's population living in poverty than the rest of the U.S.<sup>42</sup> Over one-tenth of Indiana's population is food insecure and 22 percent of Indianapolis residents live in food deserts or low-income areas with low access to healthy foods.<sup>43</sup>

Research has consistently found strong correlations between food access and health outcomes. A 2015 literature review<sup>44</sup> found that food insecurity is associated with higher risks of cognitive problems, aggression and anxiety in children. The review also found food insecurity is associated with increased rates of high blood pressure and high cholesterol in adults, both contributing factors to the development of heart disease, the number one cause of death in Indiana.<sup>45</sup>

Topic	Indiana	United States
Median Household Income, 2014-2018	\$54,325	\$60,293
Housing Units (2019)	2,921,032	119,730,128
Persons per household, 2014-2018	2.53	2.63
Percentage of population with bachelor’s degree or higher	26%	32%
Median gross rent, 2014-2018	\$807	\$1,023
Households with a broadband Internet subscription, 2014-2018	78%	80%
People without health insurance, under 65	10%	10%
People with a disability, under 65 years, 2014-2018	10%	9%
Percentage of population in poverty	12%	11%

Source: Feed America, U.S. Census Bureau

Recent research also finds that the presence of “food swamps” – areas with high concentrations of high-calorie food establishments, such as fast foods – predicts obesity as strongly, if not stronger, than food deserts.<sup>46</sup> By one estimate, 65 percent of Indianapolis residents live within a 15-minute walk of a restaurant, while 28 percent live similarly close to a grocery store.<sup>47</sup> There are nearly 4,400 grocery and convenience stores in Indiana, compared to 7,600 limited-service restaurants (such as fast food and quick service establishments), over 8,000 full-service restaurants and 2,300 gasoline stations and dealers in the state of Indiana.<sup>48</sup> Indiana residents, particularly those in food deserts, are dependent on restaurants and non-traditional sources, such as convenience stores and gas stations, for food. As Indiana’s food supply chain strengthens, healthy food accessibility both in terms of geography and availability are critical to future resilience for some of Indiana’s most vulnerable residents.

Topic	Indiana	United States
Number of people struggling with hunger	883,260	37,227,000
Percentage of people struggling with hunger	13%	11%
Percentage of children struggling with hunger	13%	14%
Average meal cost	\$2.68	\$3.02
Annual food budget shortfall	\$400,962,000	\$20,637,209,000
Annual food budget shortfall per person	\$59.56	\$62.87

Source: Feed America, U.S. Census Bureau

# The COVID-19 pandemic and its effect on the Indiana economy

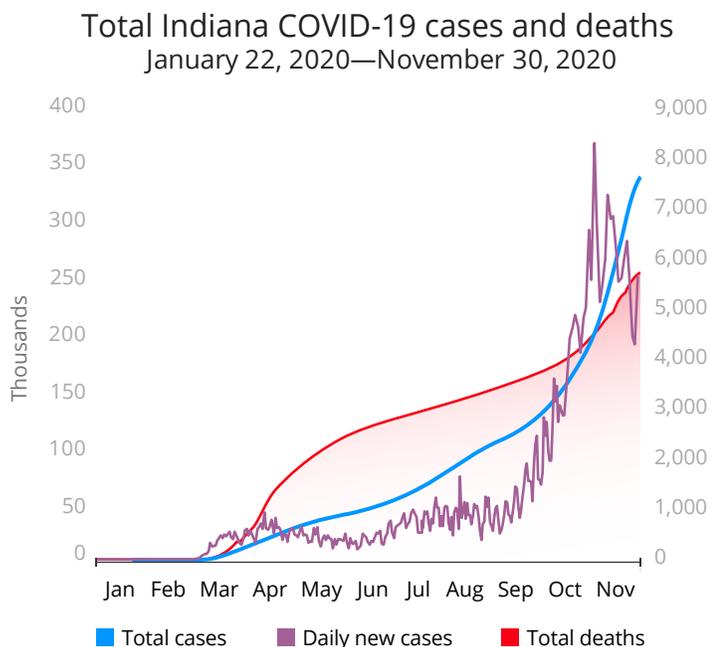
## The pandemic

Indiana health officials confirmed the state's first coronavirus case on March 6, 2020.<sup>49</sup> Governor Eric Holcomb immediately declared a public health emergency in Indiana and on March 23, 2020, Governor Holcomb enacted a "stay-at-home" order.<sup>50</sup>

Phase	Date (2020)	Food service guidelines
1	Mar 23 – May 3	<ul style="list-style-type: none"> <li>Open for carryout, curbside and delivery only</li> </ul>
2	May 4 – May 21	<ul style="list-style-type: none"> <li>Dining room service open to 50% capacity</li> <li>Employees screened daily and must wear face masks</li> </ul>
3	May 22 – Jun 11	<ul style="list-style-type: none"> <li>Dining room service open to 50% capacity</li> <li>Employees screened daily and must wear face masks</li> </ul>
4	Jun 12 – Jul 3	<ul style="list-style-type: none"> <li>Dining room service open to 75% capacity</li> <li>Bar seating open to 50% capacity</li> <li>Employees screened daily and must wear masks</li> </ul>
4.5	Jul 4 – Sept 25	<ul style="list-style-type: none"> <li>Dining room service open to 75% capacity</li> <li>Bar seating open to 50% capacity</li> <li>Employees screened daily and must wear masks</li> </ul>
5	Sept 26 – Nov 14	<ul style="list-style-type: none"> <li>Dining room service open to 100% capacity</li> <li>Bar seating open to 100% capacity</li> <li>Employees must wear masks</li> </ul>
6	Nov 15 –	<ul style="list-style-type: none"> <li>Selective restrictions by county based on case rates</li> <li>Gatherings limited to between 25 to 50 people</li> <li>Limitations on school functions</li> </ul>

Source: Back on Track Indiana

While Indiana maintained a relatively low new daily case rate throughout August, cases started increasing through the fall of 2020. At the end of November 2020, Indiana had administered over 4.5 million tests, and had over 380,000 confirmed cases and 5,700 total COVID-19 related deaths.<sup>51</sup> While nearly 50 percent of verified cases are concentrated in adults between 20 and 49 years old, over 77 percent of COVID-19 deaths in Indiana were concentrated in adults over 70 years old, despite making up less than 12 percent of verified cases.<sup>52</sup>



Source: US Centers for Disease Control and Prevention, December 7, 2020

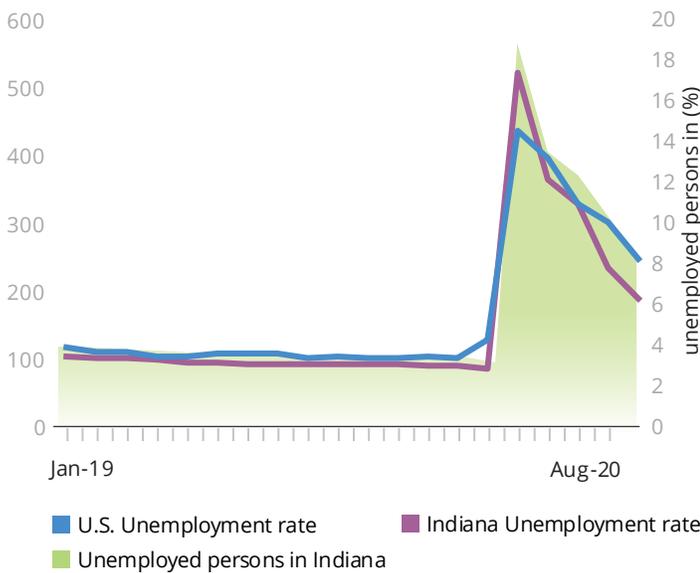
While the virus has a low death to verified case ratio overall (approximately 1.7 percent as of November 30, 2020)<sup>53</sup> in Indiana, the spread of COVID-19 was not contained as of December 2020. On November 15, 2020, Governor Eric Holcomb issued a new executive order requiring increased restrictions for counties with high rates of positive COVID-19 tests, including limiting gathering sizes and school functions.<sup>54</sup> If the state requires further shutdowns, either for COVID-19 or for future pandemics or crises, unemployment will likely rise again and both the state economy and food supply chain will again be susceptible to disruptions.

## Unemployment

Leading up to the pandemic, Indiana had a slightly lower average monthly unemployment rate than the United States. During the peak of the lockdowns in April, Indiana had nearly a 3 percent greater unemployment rate than the U.S.<sup>55</sup> Director of Purdue University Fort Wayne's Community Research Institute, Rachel Blakeman, noted in a news release that "[Indiana] went from full employment to record unemployment in less than 30 days."<sup>56</sup> This is primarily due to the high

percentage of Indiana employees involved in professions (e.g., manufacturing) with some degree of economic exposure to COVID-19. Notably, on April 22, 2020, a major meat plant in Logansport, Indiana that produced three million pound of pork per day was forced to close after 146 employees tested positive for COVID-19.<sup>57</sup> IBIS World ranked Indiana the ninth worst among all 50 states in terms of employee economic exposure to the pandemic, driven by the large number of manufacturing, food services, hospitality, health care and retail workers.<sup>58</sup> In Indiana, manufacturing industries, including food and protein processing, had some of the highest unemployment claims since the beginning of the pandemic, followed by accommodation, food services and retail.

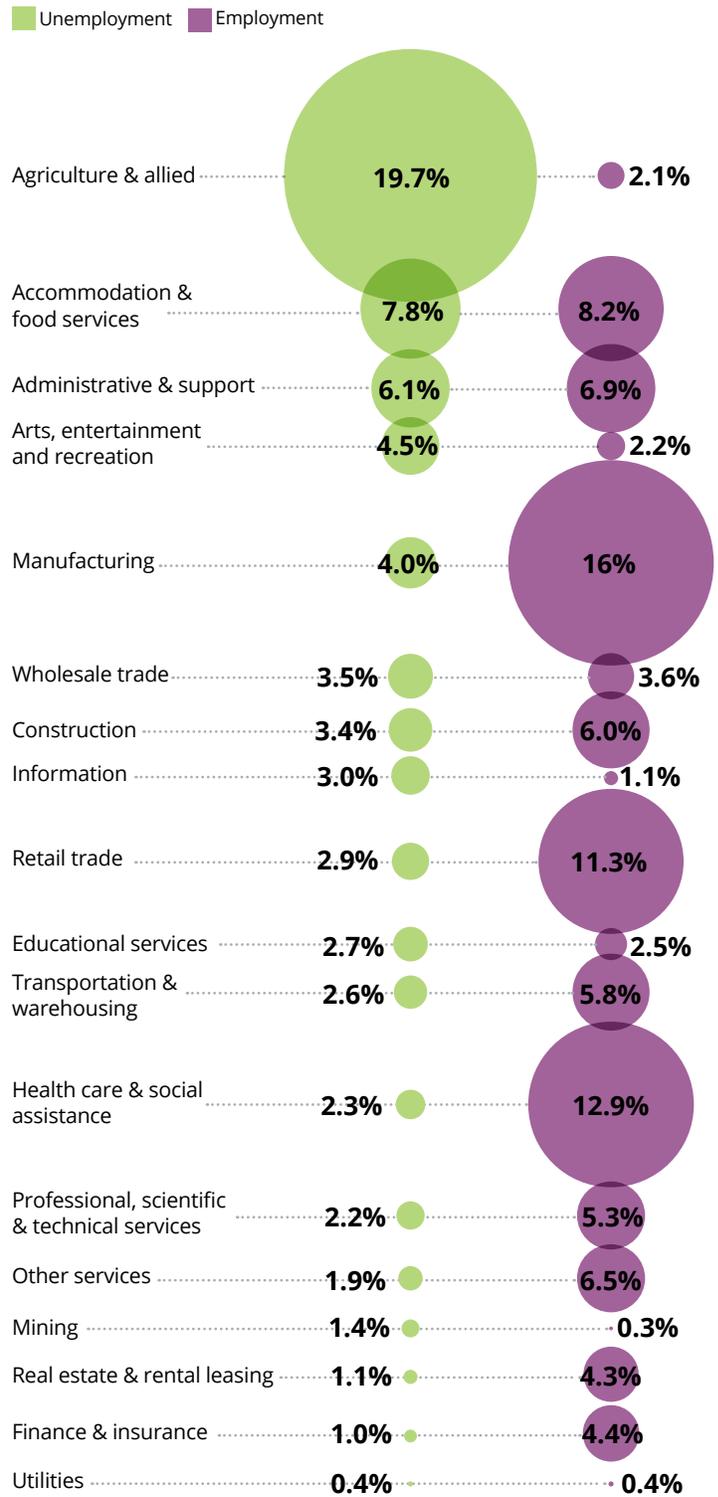
### Unemployed persons and unemployment rate (January 2019 — August 2020)



Source: Federal Reserve Bank of St. Louis, October 8, 2020

While Indiana experienced a greater unemployment rate during the spring of 2020 than the U.S. overall, the state recovered employment more quickly. Indiana had a 2.3 percent lower unemployment rate than the U.S. in July.<sup>59</sup> Indiana's faster employment recovery was likely due to its faster phased reopening plan relative to other U.S. states. On September 26, 2020, Indiana entered stage 5 of its reopening plan. In this phase, face coverings and social distancing in public places were still required but businesses including restaurants, bars, indoor and outdoor venues, gyms, senior centers and personal services (e.g., hair salons) were opened to full capacity.<sup>60</sup> However, new restrictions issued on November 15, 2020 due to rapid increases in cases restricted businesses on a county-by-county basis, threatening increasing levels of unemployment through the fall and winter.

### Indiana total employment by sector



Source: Oxford Economics, IBIS World

Persistently elevated levels of unemployment have lasting negative consequences. Professors from the Booth School of Business and Harris School of Public Policy found that the onset of unemployment reduces monthly spending by 6 percent.<sup>61</sup> They also found that people receiving U.S. unemployment insurance benefits reduce spending by less than 1 percent with each additional monthly unemployment benefit they receive. However, when people exhaust their unemployment insurance benefits, monthly spending falls by 11 percent. As part of this 11 percent decrease, grocery spending drops by 12 percent between months with unemployment benefits and months with no unemployment benefits.<sup>62</sup>

Additionally, a 2018 study<sup>63</sup> on the effects of unemployment on diet composition found that unemployment has a significant impact on consumer diets but the level of impact depends on the length of the unemployment period. In the short-term, the study observed consumers switching to discount stores and increasing consumption of animal-based foods and therefore increasing consumption of saturated fat, total fat and protein. In the medium-term, consumption altogether declined and in the long-term, the diet shifted from fats and proteins to predominantly carbohydrates and sugar.<sup>64</sup> A shift in diet can have significant health implications and business organizations planning their recovery and long-term resilience can offer a public good by focusing on providing budget friendly, nutrient dense options to the unemployed and their families.

Unfortunately, the decreased spending does not stop when someone becomes re-employed. The University of Chicago study<sup>65</sup> found that people who commence a new job prior to exhaustion of their unemployment benefits still spend 3 percent less relative to the onset of unemployment after re-employment. The study attributed decreased spending to the rebuilding of a financial buffer.<sup>66</sup> Though Indiana is currently recovering faster than most states, it should still prepare for an overall decrease in consumer expenditures, likely including food expenditures. Once Hoosiers have rebuilt their financial safety-nets, consumer expenditures will likely increase.

### *State economy*

Indiana's economy comprised nearly 1.8 percent of the U.S. economy in the second quarter of 2020 and the state's quarterly GDP showed a 15 percent year-over-year real GDP decline. Indiana's real GDP in the fourth quarter of 2020 is expected to equal the real GDP in the second quarter of 2016 indicating nearly four years of lost growth. Indiana's total GDP in 2019 was estimated at over \$380 billion and a return to pre-pandemic output is not expected until the second half of 2021 with substantial variance for the timing of vaccine distribution

or potential interventions by Indiana and other states to slow the spread of the virus.<sup>67</sup> Indiana's GDP impact was similar to the U.S. overall. The U.S. GDP decline averaged 31.4 percent across all states in the second quarter of 2020. The pandemic had the smallest GDP impact (20.4 percent decline) on Washington DC, where the government sector makes up a substantial portion of the economy and the largest impact on Hawaii and Nevada (42.2 percent declines), where tourism make up substantial portions of the economies.<sup>68</sup>

Indiana's top five industries comprised 59 percent of its 2019 GDP.<sup>69</sup> Indiana's agbiosciences industries comprise approximately \$15 billion directly and over \$27.5 billion total, or about 7 percent, of the state's GDP.<sup>70</sup> For the U.S., the top 5 industries comprised 48 percent of the 2019 national GDP and food-related industries comprised 6 percent of national GDP.<sup>71, 72</sup> These statistics reveal Indiana is highly dependent on its top five industries, manufacturing, real estate and rental leasing, health care and social assistance, state and local government and retail trade. Further disruptions to these five industries and their employees can have deep and lasting impacts on Indiana's economy.

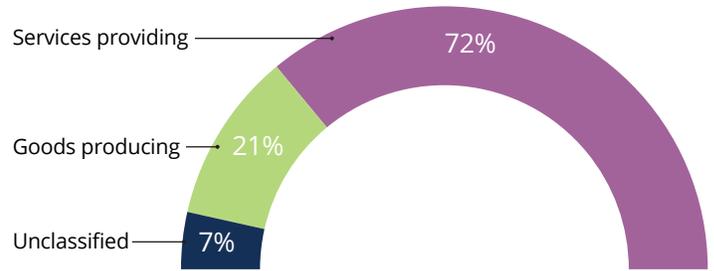
While there is overlap between Indiana's top five industries measured by GDP and employment, food is overweighted in employment in Indiana's economy compared to its GDP contribution. Food related<sup>73</sup> industries employees represent nearly 11 percent of Indiana's total employees but account for only 6 percent of GDP indicating that investments in technology and value-added food industries could increase total output per employee and strengthen Indiana's food sectors.

The top five largest industries measured by headcount and Indiana's food-related industries are predicted to grow at a 1 percent CAGR through 2028 and, among them, only manufacturing and food manufacturing are expected to have declining employment due to automation.<sup>74</sup> Shutdowns across food manufacturing and processing plants deeply impacted the food supply chain and proved to many operators the need for increased automation. Investments in automation technology will play a role in resilience against future disruptions.

In Indiana, employees in manufacturing, accommodation and food services, health care and social services, retail trade and administrative and support services, which together comprise 52 percent of Indiana's workforce, were most impacted by the pandemic.<sup>75, 76</sup> Agriculture, forestry, fishing and hunting professions, public administration and government employees and finance and insurance employees, which together are approximately 20 percent of Indiana's workforce, were the least impacted.<sup>77, 78</sup>

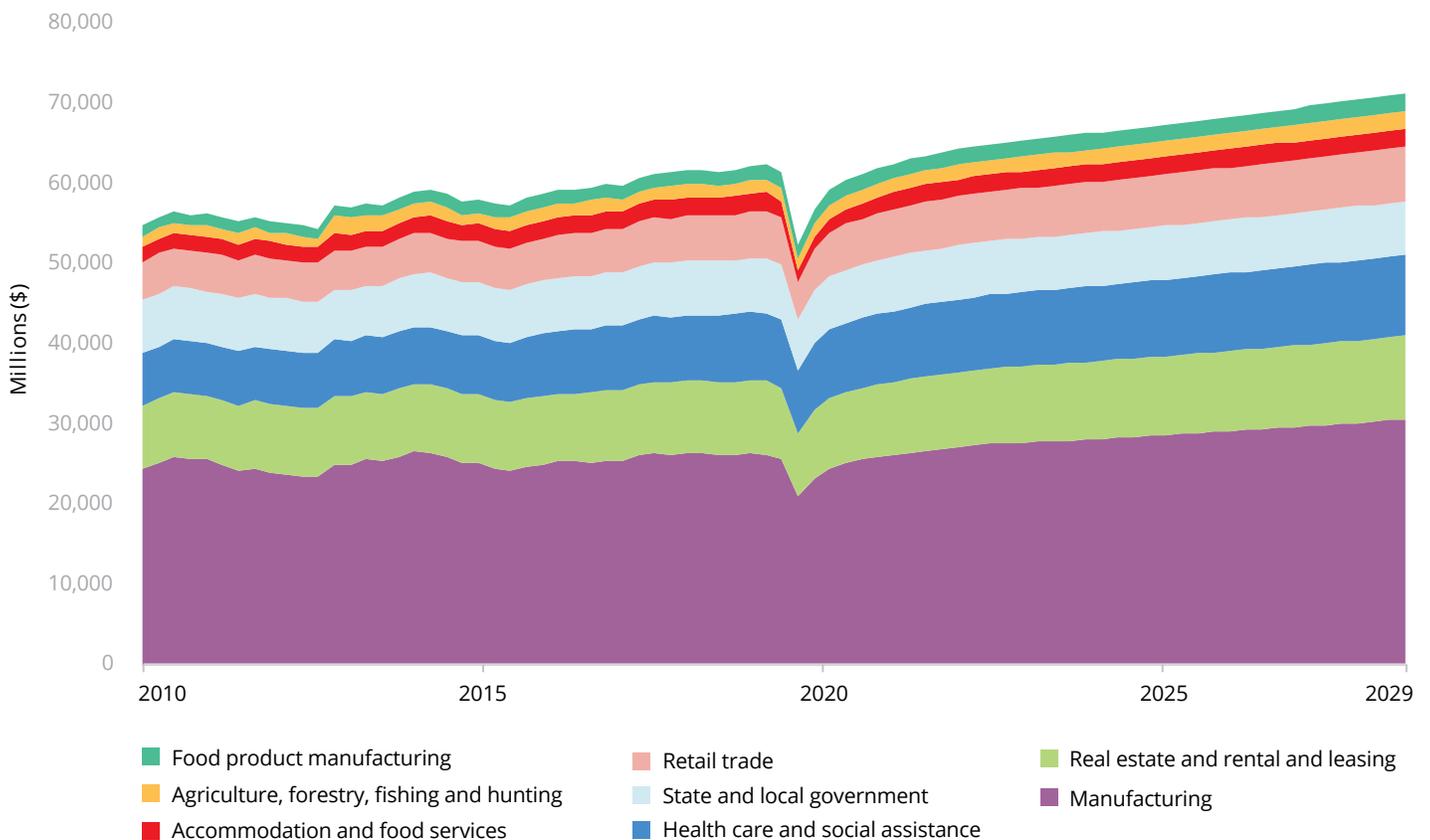
Indiana's food supply chain, particularly the services and retail components that are consumer-facing, as well as the manufacturing and processing stages that are labor-intensive, were heavily impacted by the pandemic's unique disruptions.

### Employee distribution by industry type



Source: IBIS World, Indiana Department of Workforce Development

### Indiana nominal GDP for top five industries and food-related industries

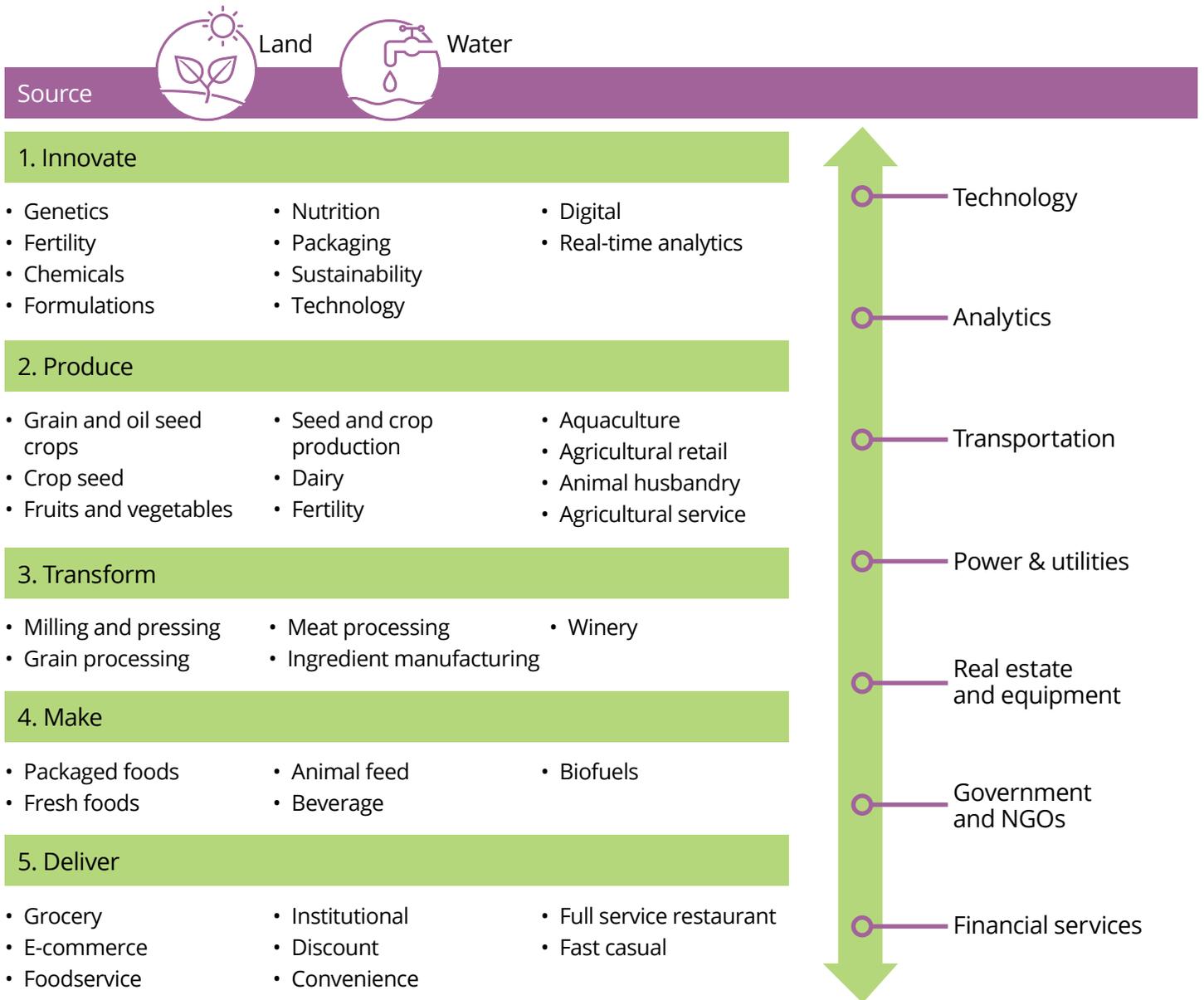


Source: Oxford Economics

# Food value chain

Indiana’s food value chain contains five key stages: innovate, produce, transform, make and deliver. “Innovate” is the leading stage of the value chain. Innovation enables the entire supply chain and develops new crop inputs, genetics, food and ingredient formulations, packaging, digital technology and more. “Produce” is the second stage of the chain focused on crop and livestock production. “Transform” is the third stage, focused on processing agricultural outputs into intermediate

goods and ingredients. “Make” is the fourth stage focused on manufacturing finished goods, such as packaged foods, from the raw and intermediate goods from the first two stages. “Deliver” is the final stage and focuses on channels through which goods reach the final consumer. Supporting industries span the value chain, providing goods and services in technology, transportation, power and utilities, real estate and equipment, financial services, and government sectors. Each of the stages of the value chain has been impacted by the pandemic in different ways.



**Consume 9.8b** — World population by 2050

Source: EY-Parthenon

Though the innovate stage occurs prior to the release of products and processes across the value chain, to understand the pandemic's full effect on the food value chain, innovation is discussed throughout produce, transform, make, and deliver.

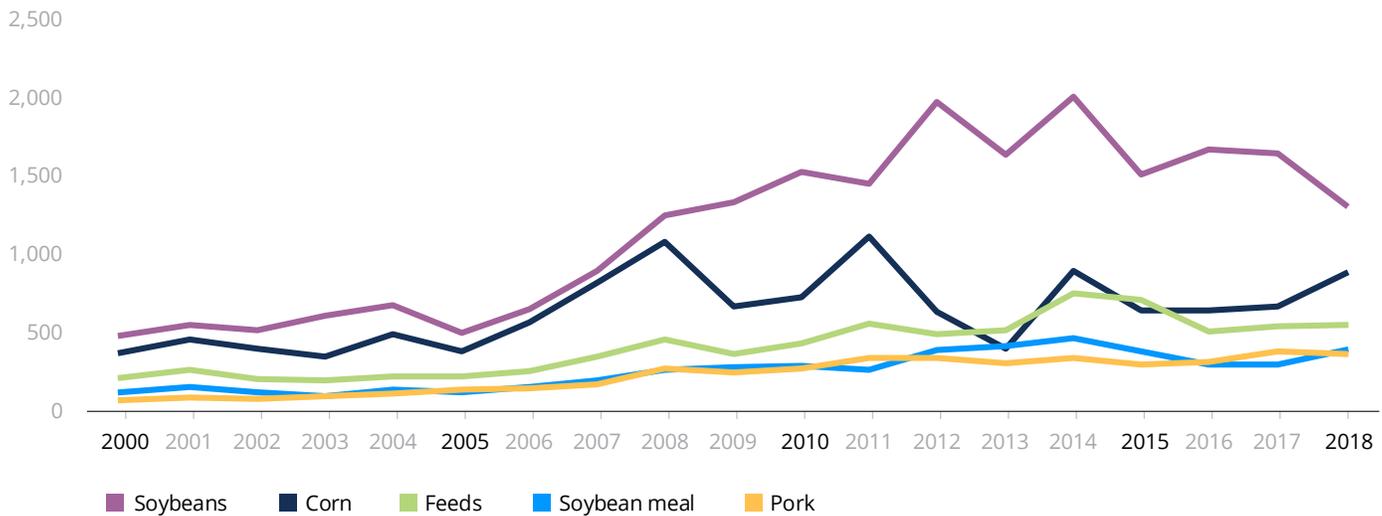
### Produce and transform

The share of U.S. farms with more than \$1 million in gross sales is approximately 3.9 percent of total farms, while 81 percent of U.S. farms have gross sales of less than \$100,000.<sup>79</sup> Less than 4 percent of farms are responsible for most U.S. agricultural production.<sup>80</sup> In Indiana, over 5 percent of farms generated sales of \$1 million or more in 2019<sup>81</sup> indicating that the share of large farming operations in Indiana is higher than the U.S. overall. When disruptions happen in the U.S. food supply chain, the potential for last-mile pivots of raw materials in the agriculture chain are dependent on less than 4 percent of farms. The imbalance in productivity is due to

growth in efficiency and scale by large operations, as well as the presence of many small, hobby farms where farming represents very little, if any, of the producer's income. Over 40 percent of producers in the U.S. rely on off-farm income.<sup>82</sup>

Indiana ranked 8<sup>th</sup> in the United States for total agricultural exports in 2018.<sup>83</sup> The top five agricultural exports for the state were soybeans, corn, feed and other grains, soybean meal and pork.<sup>84</sup> In 2019, there were 56,000 operating farms<sup>85</sup> and approximately 14.9 million acres of farmland in Indiana. While Indiana produced 6,400 acres of peppermint, 3,900 acres of spearmint, 6,100 acres of watermelon, and 5,000 acres of pumpkins in 2019,<sup>86</sup> the largest crops are corn and soy, totaling over 10 million acres combined.<sup>87</sup> The state produced over \$3.3 billion of corn and nearly \$2.5 billion in soybeans in 2019, representing half of Indiana's unprocessed agricultural commodity sales.<sup>88, 89</sup>

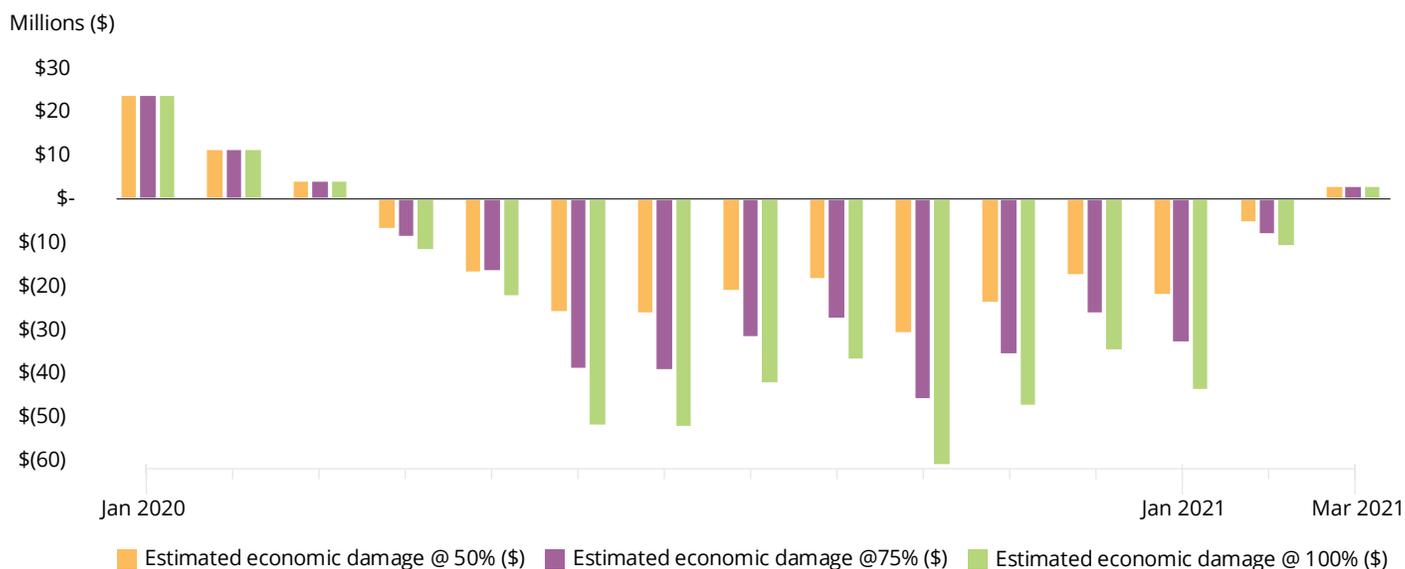
Indiana top five exports (Millions \$)



Source: United States Department of Agriculture

An analysis on the impacts of COVID-19 on corn prices found estimated losses attributed to COVID-19 to be between \$165 million and \$372 million for corn production in Indiana.<sup>90</sup> The commodity price in 2019 was compared to the actual price, or interpolated future price for 2020 and the difference was calculated.<sup>91</sup> There were three different assumed values for the potential impact of COVID-19 on commodity prices: 50 percent, 75 percent and 100 percent. Each of these percentage impacts was calculated and used to find the range of economic damage that can be attributed to COVID-19. This number was then multiplied by the number of bushels impacted in any given month, which was found by multiplying the percentage of crop marketed each month by total 2019 production in Indiana.<sup>92,93</sup> The significant decrease in the price of corn was likely a result of the decreased demand for ethanol and animal feeds as a result of the statewide stay-at-home order and closure of food services.

### Estimated monthly economic damage to corn crop in Indiana due to the pandemic



Source: Purdue University and EY-Parthenon analysis

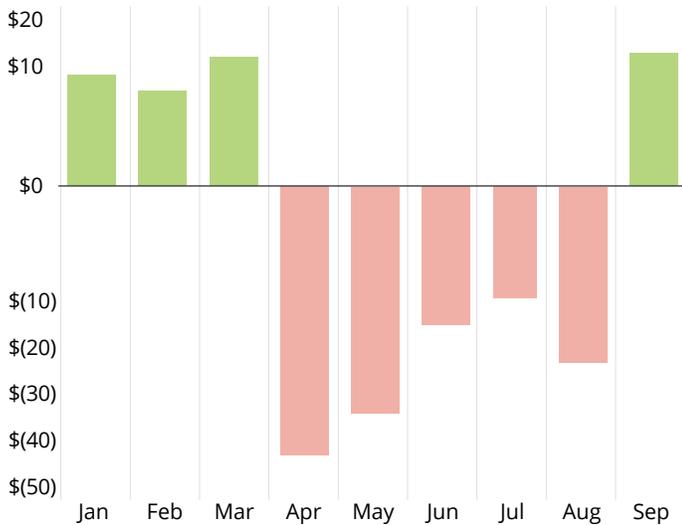
A similar analysis compared 2019 and 2020 monthly soybean commodity prices. March was the only month with a decrease in price (a \$0.06 decrease). Following the approach used for corn, there was an associated loss ranging from \$488,000 to \$977,000 to Indiana soybean producers for the month of March. However, month-over-month commodity prices showed increases through the end of 2020 for soybean producers. Unlike some ethanol producers, the biodiesel plants in Indiana did not shutdown, which kept demand for soybeans stable compared to corn. Biodiesel is used primarily in transport and logistics, including buses, mail trucks, garbage trucks and tractor-trailers,<sup>94</sup> services that did not shut down and in some cases expanded during the pandemic.

Commercial hog production, also one of Indiana’s top exports, is steadily increasing, growing at approximately 5.2 percent per year from \$297 million in 2015 to \$364 million in 2018.<sup>95</sup> More than 8.5 million hogs were slaughtered in Indiana in 2019, over 6.5 percent of the total number of hogs slaughtered in the United States for that year.<sup>96</sup>

Pork production in Indiana is driven in part by the presence of meat processors in the state. The three largest meat processors in Indiana, Indiana Packing Corporation, Tyson Foods and Tri-Eagle, exceed 33,000 head per day at full capacity.<sup>97</sup> The capacity requires imports from surrounding states making Indiana a net importer of hogs and a net exporter of pork.<sup>98</sup>

To examine the impact of the pandemic on hog production, a regression analysis<sup>99</sup> was used to estimate the number of hogs that would have been slaughtered monthly in Indiana between March and December 2020.<sup>100</sup> The estimates were compared to the actual Indiana hog slaughter numbers for 2019. The prices used in the estimation were the reported prices through September 2020, Chicago Mercantile Exchange (CME) hog futures price and interpolated monthly prices. The losses to the Indiana hog industry due to COVID-19 were estimated at more than \$83 million through September 2020.

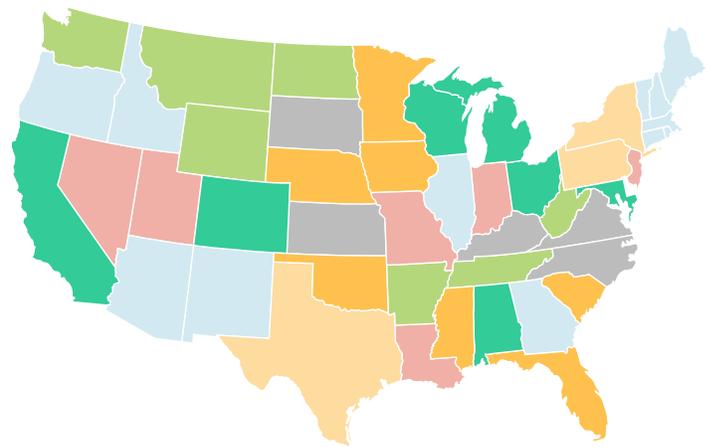
### Estimated hog production losses each month (Millions \$)



Source: Purdue University and EY-Parthenon analysis

In addition to a thriving hog production and processing industry, Indiana is home to a significant number of poultry operations. In August 2020 there were more than 28.6 million pounds of live weight young chickens in Indiana.<sup>101</sup> Additionally, there is significant egg production, for both retail and food service, in the state. The pandemic had a mixed impact on egg producers in the state of Indiana.<sup>102</sup> In the early stages of the pandemic when consumers stock-piled grocery items, shell egg demand at grocery stores and retail outlets spiked. Concurrently, the sales of breaker eggs (liquid eggs and egg product) and shell eggs for food service declined as restaurants shut down. While the demand for eggs at retail stabilized in the fall of 2020, producers are unsure when they expect demand to return to pre-pandemic levels for the food service industry.<sup>103</sup> Even if producers had the supply of shell eggs available to meet consumer demand, egg-carton manufacturers were unable to keep up with carton demand through 2020 due to the pandemic driving retail sales. Carton manufacturers and egg producers typically use summer months to stockpile cartons for the holiday season and were unable to do so during 2020.<sup>104</sup>

### YoY change in Hog Slaughter



- Missing
- (0.66) — (0.21)
- (0.17) — (0.08)
- (0.08) — (0.03)
- 0 — 0.08
- 0.09 — 0.26
- 0.41 — 1.89

The change in the number of hogs slaughtered in April & May 2019 compared to April & May 2020. Indiana is in the "red" which indicates a large decrease in the number of hogs slaughtered in 2020 due to the COVID-19 pandemic.

source: <http://jaysonlusk.com/blog/2020/10/5/size-and-vulnerability-in-meat-packing>

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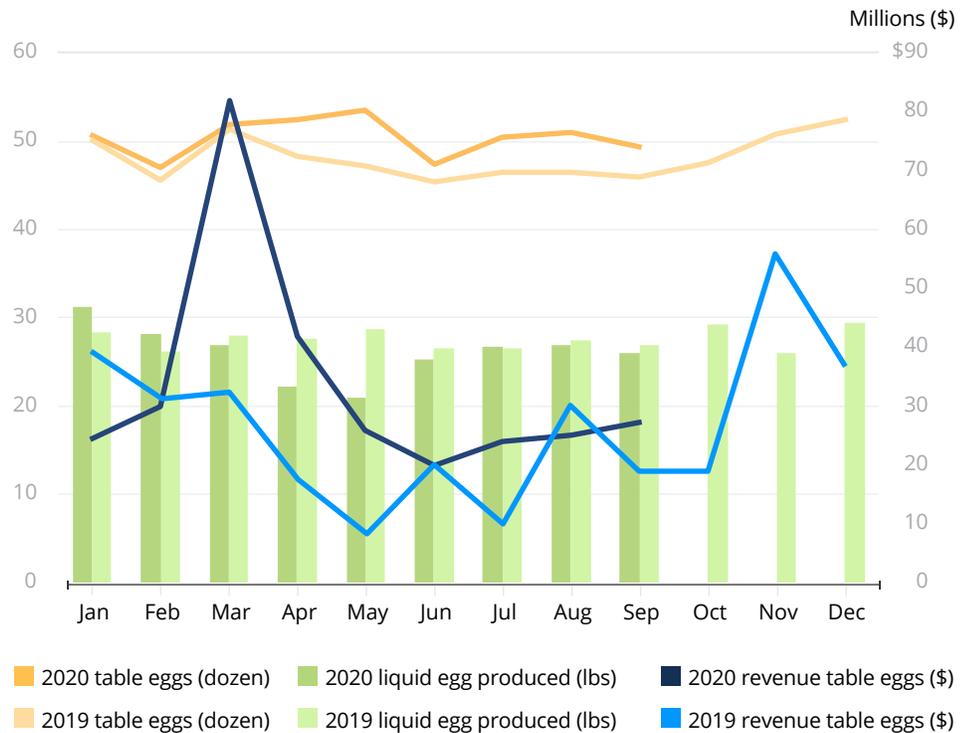
When COVID-19 hit, consumers stockpiled eggs and cleaned out the shelves. We could not keep our eggs stocked and even had to ration our retail products. The retail demand spike drove up shell egg prices while food service product prices dropped substantially.

Greg Hinton, Vice President of Sales, Rose Acres

An analysis of the impact of the pandemic on egg production in Indiana found a dramatic increase in the price of shell eggs in the immediate months following the lockdown of a majority of America.<sup>105</sup> Shell egg producers were estimated to have increased revenues of \$88 million in 2020 through September due to retail purchase increases paired with price increases.<sup>106</sup> Liquid egg production, typically destined to food service channels, fell from 31 million pounds in January (up by 3 million pounds from 2019), to less than 21 million pounds in May 2020, approximately 9 million pounds less than in May 2019. After an initial spike in March and April, by June the price of shell eggs returned to levels corresponding much closer to 2019 production levels.

Indiana’s dairy industry was also impacted by the pandemic; however, the impact was less dramatic than anticipated. The state’s dairy industry revenues declined by an estimated \$34.6 million between April and June 2020.<sup>107</sup>

Indiana egg production and estimated revenue losses



Source: Purdue University and EY-Parthenon analysis

Between July and September revenues increased year-over-year, indicating that the dairy industry in Indiana is recovering from the pandemic.

More than 352,000 Hoosiers are employed in agriculture and related food industries in Indiana.<sup>108</sup> More than 2,500 of them tested positive for COVID-19 during the early stages of the pandemic, many of whom were working in hog processing. Many meat processing plants were forced to close, resulting in a loss of nearly 2 percent of total United States hog production in the early months of the pandemic.<sup>109</sup> Producers were unable to schedule processing for their animals, resulting in on-farm backups and inventory buildup. The disruption spilled into the future with slaughter scheduling pushed into 2022 for many producers.

In addition to hog processing plant closures, the U.S. had a 40 percent decrease in beef production through April 2020 versus 2019 due to shutdowns.<sup>110</sup> While many processing plants took precautions, the lack of knowledge about transmission pathways hampered early efforts to contain the virus as it spread through employees working in close

quarters. Suggestions have been made to decrease the size of individual plants such that there are fewer individuals per plant but a greater number of total plants; however, this ignores the scale effects in processing and would be challenging to implement. Indiana food experts claim that the impact of the pandemic on processing labor supply will drive increasing automation of many labor-intensive activities.<sup>111</sup>

Disruptions to supply chains pushed substantial losses onto Indiana producers and processors. While some disruptions, such as reduced levels of driving, are challenging to control, others, such as the impact on labor can be mitigated or managed. Some producers in Indiana are working to develop fully automated production systems and many food experts indicate that automation across the value chain will increase post-pandemic.

One example of the push to automation is from *Pure Green Farms*, a company based near South Bend, Indiana. Pure Green Farms operates an automated controlled-environment hydroponic lettuce farm. The indoor farm was built in response to the disfunction of the supply chain of traditional

“

We control the quality, yield, and safety of our greens. We completely control the growing environment, limiting human interaction, eliminating the use of pesticides and herbicides, supplementing with lights when needed and reducing the transportation that California and Arizona farms require.

Joe McGuire, CEO Pure Green Farms

lettuce farming system, predominantly based in California and Arizona. Some of the increasing challenges with traditional vegetable farming include food safety challenges (e.g., E. coli), climate change, labor availability and costs, water regulations, and transportation requirements. CEA could be the future of vegetable farming as it slowly tackles many of these challenges while improving its efficiency.

Additionally, studies show hydroponic farms can generate approximately 8-11 times higher yield<sup>112</sup> relative to traditional farms. Through CEA's reduction or even elimination of the impacts of once uncontrollable factors, such as climate change and labor challenges, Indiana has a chance to play a key role in localizing, and thereby strengthening, the Midwest food supply chain.

Heliponix, which makes the GroPod© is another Indiana-based CEA company headquartered in Evansville. Heliponix produces and sells the GroPod© smart-garden at-home appliances for consumers. The appliance shifts production to the point of consumption by enabling consumers to grow produce in their homes.<sup>113</sup>

“

We do not want to compete with the grocery store – we want to be the grocery store for eligible crops.

Scott Massey, Founder and CEO of Heliponix

### Make

After production and transformation, the make stage of the chain manufactures finished consumer goods. Fifty-five food and beverage manufacturers are headquartered in Indiana. Collectively these companies generate over \$4.2 billion in revenues annually and employ more than 18,000 employees across all production sites.<sup>114</sup>

In 2018, more than 1.8 million people were employed in the U.S. food and beverage manufacturing sector.<sup>115</sup> In the U.S. in 2018, it was estimated that more than 29 percent of food and beverage manufacturing employees worked in meat and poultry processing.<sup>116</sup> One of Indiana's food manufacturers is Red Gold Foods which operates three manufacturing locations in Indiana.<sup>117</sup> When their customers had to make a shift toward take-out and delivery options, Red Gold took the opportunity to innovate with a new larger and wide-mouth ketchup Pull-Top Ramekin™ to support increased demand.<sup>118</sup> Red Gold's quick action is only one example of how many manufacturing companies innovated in order to meet evolving customer needs quickly.

Indiana is soon to be home to a large plant-based protein factory. *Greenleaf Foods, SPC* plans to open a facility in Shelbyville, Indiana.<sup>119</sup> In addition, the Massachusetts based aquaculture company, *AquaBounty*, has a salmon hatchery located in Albany, Indiana where they are raising the first GM salmon approved for human consumption by the FDA.<sup>120, 121</sup> The new production facilities will not only bring agriculture and food manufacturing jobs but also new, innovative technologies to Indiana. The state is positioned to attract and invest capital for food and agricultural innovation.

During the second and third quarters of 2020, there was a dramatic increase in the dollars and volume sales of meat alternatives due to the surge of consumer stockpiling early in the pandemic. Retailers were limiting purchases of traditional meat products, and as a result, consumers experimented with alternative meats. Additionally, with the closure of restaurants consumers could no longer purchase alternative protein

products through food service channels and they switched their spend to retail, driving retail sales higher.

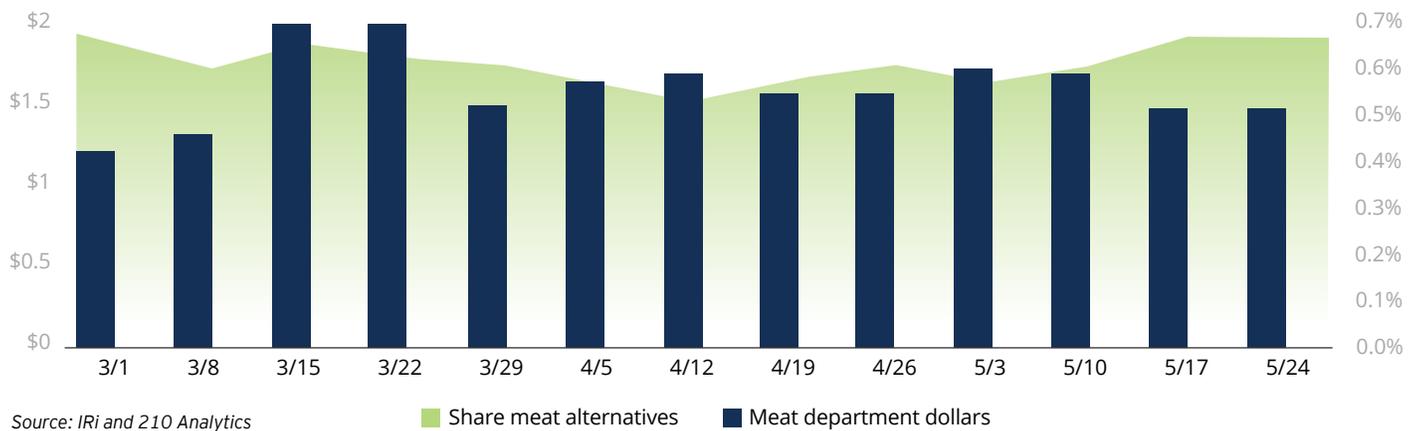
While alternative protein sales during the pandemic have grown, the percentage of alternative protein sales as a proportion of total meat sales is relatively small making up less than 1 percent.<sup>122</sup> Total dollars spent in the meat department increased dramatically the week of March 15, 2020 to almost \$2 billion as lockdowns took effect and then slightly decreased, while maintaining higher than pre-pandemic levels. Alternative meats equaled 0.66 percent of meat sales the week of March 1, and despite meat sales increases of over 80 percent in the two first weeks of March, alternative meats still equaled 0.64 percent of total meat sales, indicating a large spike in sales.<sup>123</sup>

The spike in demand for alternative meat products persisted, remaining at similar levels through the end of May 2020, potentially indicating a durable change in consumer adoption.

### Deliver

Whether fresh or processed, products need a route to market. Food retail and food service in Indiana generated an estimated \$18.5 billion in revenues in 2019 and are expected to grow by nearly 3 percent to \$19.0 billion in 2020.<sup>124</sup>

Sales meat department vs. refrigerated plant-based meat alternatives  
Billions(\$)



“

Alternative proteins and other competing products should encourage conventional producers to make our products better and more appealing to the consumer. The pandemic has created an opportune moment to educate the consumer about food and where it comes from.

Nick DeKryger, Vice President of Business and Finance at Belstra Milling

## Food retail

In 2019, Indiana food retail generated approximately \$8.7 billion of revenue and is expected to bring in \$10.5 billion of revenue in 2020.<sup>125</sup> The nearly 20 percent year-over-year growth is driven by the government-mandated shutdown of in-person dining in March and April and ongoing capacity restrictions forcing consumers to cook at home. Within Indiana's food retail sector, grocery stores, other food retail stores and convenience stores dominate the market with 28 percent, 27 percent and 25 percent, respectively, of the nearly 4,400 food retail operations.<sup>126</sup> Twelve percent of establishments are supermarkets, while both specialized meat and seafood markets and fruits and vegetable markets are each less than 5 percent of establishments. Indiana has fewer food retailer outlets per capita than the overall U.S. with 7 fewer grocery stores and 6 fewer convenience stores per 100,000 residents.<sup>127</sup>

The pandemic has damaged food access, especially for children and families with children. The Hamilton Project found that the percentage of U.S. households with children under 18 with food insecurity increased from 15 percent in 2018 to 35 percent in April of 2020.<sup>128</sup> Several factors drove the increase in food insecurity including the shutdown of schools, shutdown or reduced operation of food banks and increase in unemployment. Jessica Jones, the principal of Burriss Elementary School in Mitchell, IN, noted, "this past year we were at 62% free and reduced lunch and half of our students ended up taking advantage of that program."<sup>129</sup> With half an elementary school's students relying on free or discounted food pre-pandemic, it is likely that the longer the shutdowns persists, leaving schools and food banks closed or operating a limited capacity, food insecurity, particularly for children will continue to grow. Under conditions in which many producers or supply nodes are faced with surpluses due to the closure or restriction of food services, programs such as the *Farm to Food Bank* program could play key roles in bridging the gap between producers who have excess products and consumers that need it most.

### Indiana food retail types and quantities



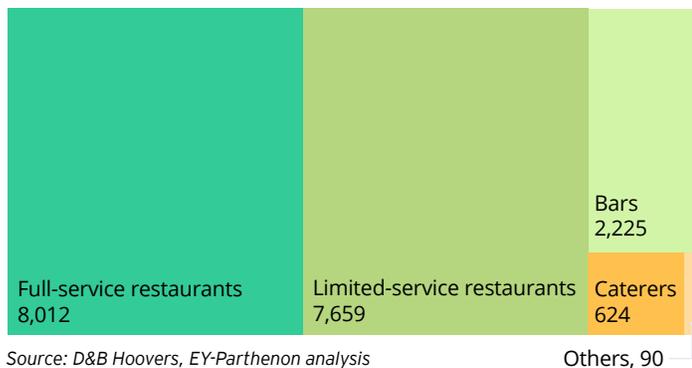
Source: D&B Hoovers, EY-Parthenon analysis

## Food service

The Indiana foodservice market was approximately \$9.8 billion in 2019 and is expected to decrease by 12 percent to \$8.6 billion in 2020.<sup>130</sup> Government-mandated restrictions on in-person dining in restaurants and limited seating capacity have been the primary drivers of the 12 percent decrease. Further county-by-county restrictions implemented in the Fall of 2020 could drive additional declines in the industry. Indiana food service is dominated by full-service and limited-service restaurants, which account for 43 percent and 41 percent, respectively, of total restaurant establishments. Bars account for 12 percent of total restaurant establishments and caterers and other types are approximately 4 percent collectively.<sup>131</sup>

Indiana trails the U.S. in restaurants per capita with 50 fewer restaurants per 100,000 people. Indiana has 276 restaurants per 100,000 residents, versus the U.S. average of 326.<sup>132, 133</sup> The gap may reflect a preference from Indiana consumers to eat away from home less than the average American or it could reflect the spread-out and rural nature of Indiana versus the rest of the nation.

### Indiana food service types



Nationally, food away from home sales, such as restaurants, surpassed food at home sales, such as grocery stores, in 2010.<sup>134</sup> Mandatory closures of restaurants across the U.S. in March 2020 caused a 48 percent decline in food away from home sales between February and April, and a 26 percent increase in food at home between February and March 2020<sup>135</sup> as many people stockpiled consumer staples. Indiana shut down restaurants for in-store dining on March 16, 2020.<sup>136</sup>

An analysis using consumer spending data from Affinity Solutions, acquired publicly through TrackRecovery.org, along with the number of daily COVID-19 cases in Indiana reported by the New York Times identified the impact of daily COVID-19 cases on food away from home spending.<sup>137</sup> The results of the regression show that, on average a daily increase of 1,000 cases reduces food away from home (FAFH) spending by -11.3 percent in Indiana. FAFH is defined as consumer spending on accommodations and food services and is calculated as seasonally adjusted credit/debit card spending relative to January 4 through January 31, 2020 in accommodation and food service merchant category codes, 7 day moving average.<sup>138</sup>

The mandatory shutdowns and the resulting large dip in food away from home sales forced restaurants to furlough and lay off employees. U.S. restaurants experienced a 36 percent decline in employment from March to April 2020.<sup>139, 140</sup> The decline was driven primarily by full-service restaurants, which had a 56 percent reduction in headcount. Limited service restaurants, which have fewer employees than full-service restaurants, were impacted less, with a 19 percent decline.<sup>141, 142</sup> The difference is likely due to the use of drive-throughs, which in many locations could continue operations, as well as flexible menus.

In September 2020, the National Restaurant Association reported that nearly one-sixth, or approximately 100,000, of total U.S. restaurants had closed permanently or for an extended period.<sup>143</sup> The restaurant industry lost \$165 billion in revenue between March and July 2020 and is on track to lose \$240 billion by the end of 2020.<sup>144</sup> The pains from restaurant closures were felt upstream as well. While demand at food distributors focused on retail soared, distributors serving restaurants struggled. Sysco, the world's largest broadline food distributor, reported a 42.7 percent reduction in fourth quarter revenue year-over-year,<sup>145</sup> and U.S. Foods, another large U.S. food distributor, claimed its Q2 EBITDA was down 72.5 percent.<sup>146</sup> Because of the perishable nature of food, distributors continue to look for innovative ways to increase sales, including increasing their supply of both frozen and pre-packaged products.<sup>147</sup>

Faced with restaurant closures, Hoosiers turned to alternative food sources. While many people turned to cooking at home, others also turned to food delivery and e-commerce, such as ordering food and grocery online and through apps. In the U.S., e-commerce retail sales grew by 32 percent between January and April.<sup>148</sup>

“

The pandemic gave us the opportunity to accelerate into our e-commerce business. Our e-commerce business is up 100% this fiscal year. We were able to be agile in converting our food service products to retail products and making them available directly to consumers.

-Scott Tucker, Co-President at Maple Leaf Farms

Keeping up with the massive growth in e-commerce, Indiana’s retail trade workforce grew by 23 percent in the first two quarters of 2020.<sup>149</sup> With Indiana restaurants open to full capacity in fall 2020, it will be important to monitor whether increases in delivery demand are persistent.

Imperfect Foods is an example of a company that benefited from the e-commerce food boom. Founded in 2015 with a mission to eliminate food waste by offering a subscription service for discount produce, eggs and dairy, Imperfect Foods has doubled its sales through the COVID-19 pandemic. Ed O’Malley, Imperfect Foods’ vice president of merchandising, accredited Imperfect Foods’ “ability to source foods and manage logistics” as reasons for its success during disruption.<sup>150</sup>

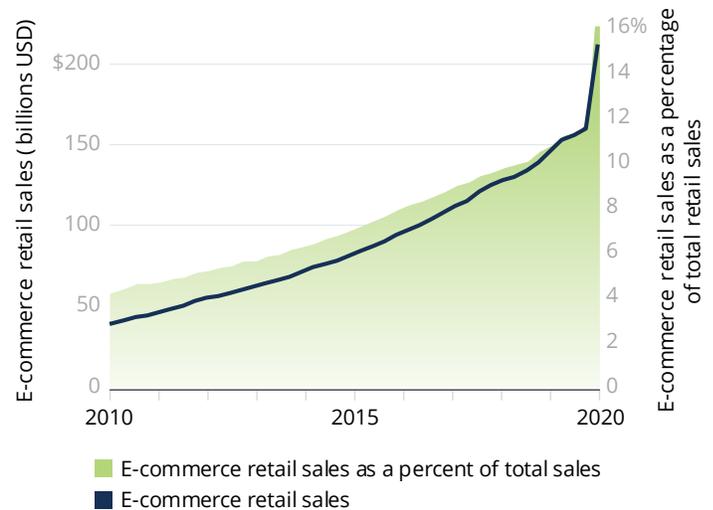
Imperfect Foods has sources spread out across North America and uses a variety of types of sources including, family farms, food hubs, brokers and co-ops. Adam Berger, a managing director at the firm leading Imperfect Foods’ Series C funding, explained, “the grocery store has been evolving for years, yet this particular moment highlights an urgent need to reinvent our food supply chain with innovative technology and keep people safe.”<sup>151</sup>

**Innovate**

Due to widescale disruptions across the food value chain, many producers, manufacturers, and restaurants were forced to innovate. While many of the initiatives that resulted from the pandemic (e.g., manufacturing automation, controlled environment agriculture) were already in-flight, the pandemic accelerated the need for many of these innovative food chain solutions.

In response to dining shutdowns, beyond expanding their delivery services, restaurants sought new revenue streams to stay solvent. Overnight, U.S. restaurants began using outdoor space, rapidly seeking permits to have tables and patios on the street. Many restaurants opened pickup and takeout windows to be more accessible to the customers. Many large cities, including San Francisco and New York,

E-commerce Sales  
(January 2010 – April 2020)



Source: Federal Reserve Bank of St. Louis

enabled bars to quickly access temporary pandemic-related permits to sell drinks to customers nearly anywhere, including sidewalks, streets, parking lots and plazas.<sup>152</sup>

Because of the lower volume of customers and therefore orders, many restaurants have tried to reduce variable costs and maximize profits through different means beyond reducing headcount. Many restaurants have reduced menu offerings to streamline operations, enabling them to capitalize on economies of scale, reduce waste and train new employees faster as restaurants reopen. For example, IHOP, a casual restaurant chain, reduced its 12-page menu to 2-pages and Dave & Buster’s reduced its 40-item menu to 15 items.<sup>153</sup> Some restaurants have implemented a time limit for in-house dining to turn tables faster and increase throughput.<sup>154</sup> In an industry with thin margins before the pandemic, restaurants must do anything possible to reduce costs and grow revenues.

Restaurants and other players along the food value chain have adapted their business models. Panera Bread was one of the first restaurant chains to start selling excess supplies as groceries.<sup>155</sup> Similarly, Moe's Southwest Kitchen began selling items in bulk to consumers and both Shake Shack and California Pizza Kitchen launched do-it-yourself meal kits (e.g., DIY burger kit).<sup>156</sup> Because of supply chain challenges, some Indiana animal producers began selling meat directly to consumers where permitted. Industry observers predict this trend will continue with consumers actively seeking connections to the farm.<sup>157</sup> The most resilient companies within the food supply chain adapted quickly to COVID-19 disruptions, finding new customers, new revenue streams and new ways to get their products to market.

### *Food waste*

Along with reducing personal food expenditures, increasing food service unemployment, and reducing food service revenues, the mandated restaurant shutdowns and the inflexibility of the food system to shift food service products to food retailers caused large increases in food waste across the value chain.

At the producer level, two of the primary challenges caused by the closure of restaurants were demand disruptions and packaging. Because planning and planting happen in the winter and spring, producers were unable to adjust their production mid-season when food service disruptions occurred. Farmers could not pause the growth of their crops or stop the maturing of their livestock when the pandemic hit. To add to the challenges caused by U.S. restaurant closures, the export market for many food products, including milk and meat, dropped considerably,<sup>158</sup> reducing total demand and putting increased pressure on producers to limit supply. In addition to supply and demand disruptions, packaging was a major issue. Most producers package their products to meet channel expectations, such as five-pound bags of flour for retail and fifty-pound bags of flour for food service. Because of packaging differences, perishable food service products, such as liquid whole eggs, that were no longer needed by restaurants could not easily transform into food retail products. As a result, food waste increased while grocery stores faced shortages. The inability to switch products from one channel to another caused substantial upstream disruption. For example, food service focused egg producers were forced to kill many of their birds to reduce output and cut production costs, reducing America's egg producing flock from 341 million to 317 million.<sup>159</sup>

Processors and manufacturers are typically the least wasteful stages of the value chain, and though they were significantly impacted by COVID-19, the pandemic has arguably had the least food-waste impact on the transform and make stages. Though processors and manufacturers were struck by labor shortages and shutdowns, processors did not incur more food waste during this time. However, processing shutdowns left many producers with limited offtake options. As a result, many producers had to discard or bury their products increasing food waste at the producer level. In response to these processing challenges, to help local Indiana farmers, many smaller Indiana meat processing plants extended their operating hours.

At the delivery stage in the value chain, many food service businesses were forced to discard much or all of their food inventory because of the shutdowns. Consumers also incurred increased food waste at home because they stockpiled perishable items during the lockdown and ultimately could not consume them before expiration.

Different types of foods faced different supply chain challenges. Dairy farmers struggled during the pandemic because the largest milk purchasers, such as schools, were forced to close and producers struggled to find alternative routes to market. At the same time, due to the heavy shortages, many Indiana grocers limited the amount of milk customers could purchase further distorting the market.<sup>160</sup> As a result of the disruptions, many dairy farmers with surpluses disposed of large quantities of milk. Beef farmers on the other hand had ample demand but beef producers faced problems at processing due to plant closures. With no way to stop the growth of the cattle, a few farmers were forced to euthanize their animals. Field crops did not face as many disruptions as dairy and protein except for farmers who sold to food service establishments. Crops that were predominantly used at restaurants, such as potatoes and onions, suffered extreme short-term demand shocks.<sup>161, 162</sup>

A lack of supply chain agility at the consumer-facing end of the value chain hampered producers, processors and manufacturers and led to increased food waste across almost all stages of the value chain.

## Major trends impacting the food and agriculture industries



# Major trends impacting the food and agriculture industries

The global food system is transforming. Populations are growing. Demand for nutrition is rising. The world is expected to have nearly 9.8 billion people by 2050 and estimates indicate that the world needs to produce over 50 percent more calories to meet nutritional needs under a “do nothing” scenario.<sup>163</sup> The agri-food system in the U.S. transformed post-World War II to focus on production maximization. In 1947, the U.S. planted 85 million acres of corn and the average yield was 28 bushels.<sup>164</sup> In 2020, the U.S. planted 91 million acres of corn and had an average yield of 174 bushels.<sup>165</sup> The U.S. yield average for corn grew over 500 percent during the seven decades from the beginning of the Cold War to now. Driven by massive efficiency increases in total factor productivity, the U.S. and world found numerous uses for cheap corn: fuels, feeds, food ingredients, plastics, industrials and more.<sup>166</sup> Much of the U.S. food and agricultural economy was built on corn. The U.S. grain production system helped feed the world, revolutionized agriculture and even helped win the Cold War.<sup>167</sup> The scale of production and task of feeding the world led to standardizing food and what it meant. Packaged foods, quick service restaurant offerings and staples all offered a level of standardization that allowed the food system to scale and provide affordable foods that could be transported long distances and stored for long periods.

Today, the system is changing, even as more uses than ever for its products emerge. It is expanding its focus to include health, sustainability and transparency while continuing to balance the need for nourishing, affordable and available products while maintaining or improving supply chain profitability. Standardization is slowly giving way to customization. The transformation is being driven back through the value chain by empowered consumers, who continue to learn more about their food system that many took for granted. With the spread of COVID-19, for the first time in many Americans’ lives, the grocery shelves were empty of their familiar products. The experience is expected to accelerate these trends even faster.

Emerging empowered consumers are driving the reimagining of food and the diversification of production. The desire for customization is impacting consumer’s food choices. Across the short-, mid- and long-term – the now, next, and beyond – these trends will transform the food and agricultural system.

## The future of food: food delivery, food formats and food attributes

The consumer’s relationship with food is evolving. In the 1960s, the average grocery store offered 6,000 SKUs – today, it offers over 33,000.<sup>168</sup> The explosion of offerings hints at the increase of complexity and the evolution of consumer expectations. Modern consumers expect more from their food than ever before: taste, health,<sup>169</sup> affordability, sustainability<sup>170</sup> and transparency.<sup>171</sup> And, like almost everything in the modern world, technology is changing how we understand what we eat from production to consumption and changing how firms and organizations respond to consumer preferences.

The reimagining of food is not new: facilitated by new technologies, humans have been innovating food since the “discovery” of fire. Waves of innovation in food technology have shifted consumers’ experience and expectations of food. The shift from ancient technologies to modern ones, such as from smoking and salting to refrigerated shipping systems for preservation, has increased consumers’ expectations for diversity and quality. Simultaneously, impacted by two large recessions in the past decade and the challenges of the COVID-19 pandemic, consumers are driven to find affordable and healthy foods for themselves and their families.

As the pandemic continues, consumers fall into four segments: hibernate and spend, stay calm and carry on, save and stockpile, and cut deep.<sup>172</sup> The segments reflect today’s concerns about the future and the state of consumers’ household balance sheets.



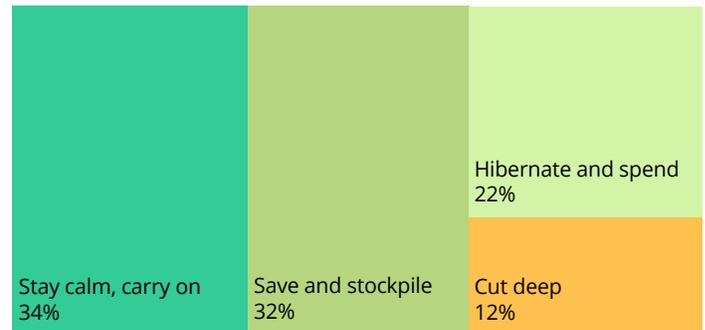
Pandemic consumer segment	Key traits
<i>Hibernate and spend</i>	Concerned but well positioned for the future; favors authentic, trusted companies
<i>Stay calm and carry on</i>	Least impacted, no big changes; no change in priorities
<i>Save and stockpile</i>	Some concerns and changes, focused on essentials; favors local and ethical brands
<i>Cut deep</i>	Most impacted and pessimistic; focused on price and health

*Stay calm and carry on* and *save and stockpile* comprise the largest segments (34 percent and 32 percent, respectively).<sup>173</sup> They may have some concerns and have made small changes but are focused on the future and adjustments in their spending are targeted toward local, ethical brands with limited digital interactions. The *hibernate and spend* segment are concerned about the future but are well positioned financially to weather the pandemic. They seek authentic brands and companies favoring those that align with their personal values. The *cut deep* segment was most impacted by the pandemic's economic and health shocks, have lost the most income, and are limiting their spending to only the essentials.

As the pandemic hopefully becomes history, with the wide availability of a vaccine and increasing levels of natural immunity, consumers' behaviors will shift based on their level of optimism and priorities for the future. Post-pandemic, consumers will fall into five major segments: *affordability*, *health*, *planet*, *society* and *experience*.<sup>174</sup> These segments speak deeply to the trends driving consumption, which existed before the pandemic and are in many cases being accelerated by it. Nearly 60 percent of consumers will fall into *Affordability first* and *Health first* segments (32 and 25 percent, respectively). These groups are most concerned about the

future and reflect that concern in price sensitivity and a focus on health and wellbeing. Almost a third of consumers will focus on the *planet* and *society* as they refocus on the future (16 and 15 percent, respectively). These consumers are willing to adapt to a new and changing reality, many of them believing that the pandemic has further exposed social and environmental challenges. They are interested in transparent and sustainable goods and services and owning fewer but higher quality products.<sup>175</sup>

### Pandemic consumer segments



Source: EY Future Consumer Index

Future consumer segment	Key traits
<i>Affordability first</i>	Least optimistic; saving not spending; affordability over purpose
<i>Health first</i>	Most concerned about the pandemic; focused on protecting health and wellbeing
<i>Planet first</i>	Coping but changing; focused on local and transparent with limited environmental impacts
<i>Society first</i>	Optimistic and willing to make big changes; focused on owning less, but higher quality products
<i>Experience first</i>	Unconcerned and comfortable; focused on benefits over purpose

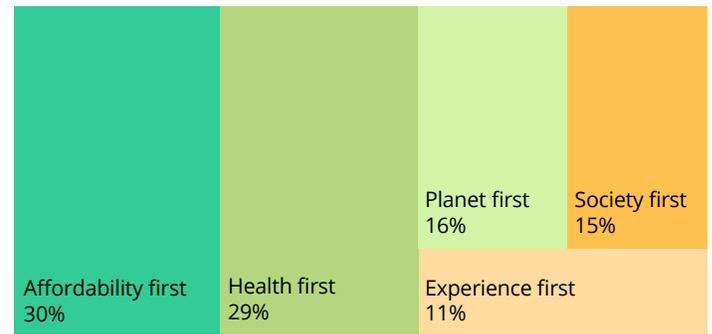
Indiana producers and food manufacturers can adapt to these trends through diversified and refined offerings catering to a broad set of consumers.

At the same time Hoosiers are adapting to the post-pandemic economy, producers and manufacturers are adapting to the economic effects. They are faced with the question of how to deliver fresh, healthy and tasty foods that are affordable for the consumer and profitable for the producer. The shift in consumer segments will drive change in delivery, product quality and even product mix.

The food system is changing as a reflection of the food characteristics that consumers demand. The challenge to meet multiple consumer segment's requests is reflected in the changing product mix and production technologies. Tasty, healthy, affordable, sustainable and transparent offerings are emerging in the form of plant-based and alternative proteins, prepared and ready-to-eat meals at grocery stores, delivery

meal-kit services, and labeled products. The reimagination of food continues to address how food is delivered, its format, and its attributes – all of which create opportunity for consumers and producers.

### Future consumer segments



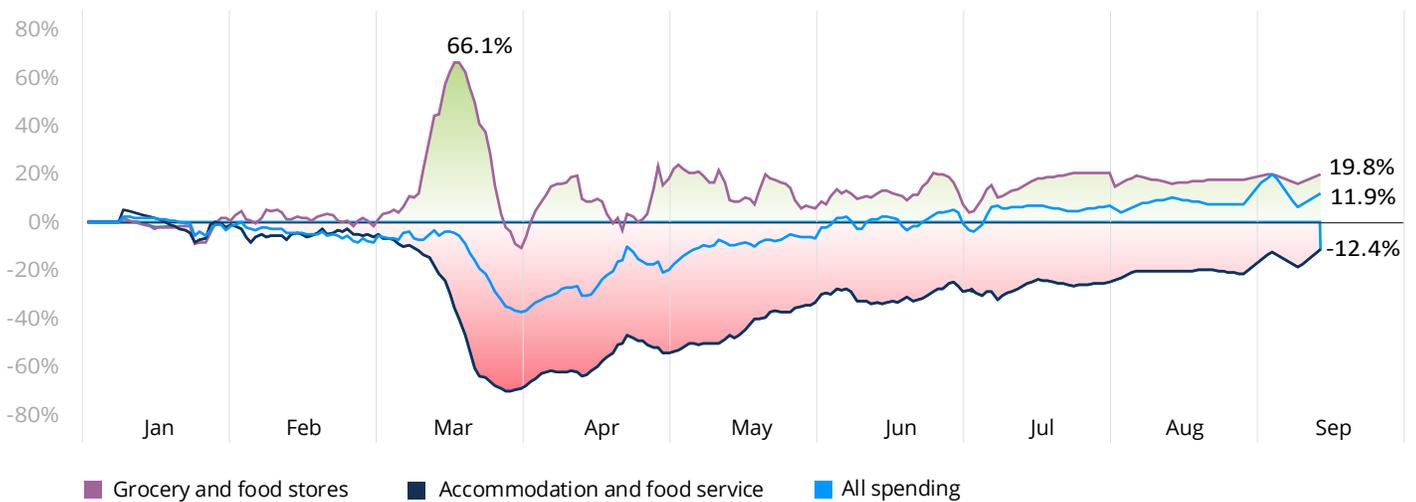
Source: EY Future Consumer Index

### Food delivery and access

In Indiana, spending at accommodation and food services was down by over 12 percent and grocery spending was up nearly 20 percent from the beginning of the pandemic through September 2020.<sup>176</sup> EY Future Consumer Index surveys indicate this change is partially durable with 44 percent of U.S. consumers indicating they will cook for themselves and their families more often after the pandemic has receded. Even

when consumers order from restaurants, they are not “eating-out” – one estimate indicates that 85 percent of restaurant transactions in the U.S. as of September 2020 were for food consumed off-premise through takeout and delivery.<sup>177</sup> Many packaged foods and consumer goods companies see these changes as durable across most consumer segments given the lifestyle changes induced by the pandemic, including more frequent cooking, takeout and delivery.<sup>178</sup>

### Spending in Indiana by category, January 13 through September 20, 2020



Source 3: "The Economic Impacts of COVID-19: Evidence from a New Public Database Built from Private Sector Data", by Raj Chetty, John Friedman, Nathaniel Hendren, Michael Stepner, and the Opportunity Insights Team. September 2020. Available at: [https://opportunityinsights.org/wp-content/uploads/2020/05/tracker\\_paper.pdf](https://opportunityinsights.org/wp-content/uploads/2020/05/tracker_paper.pdf)

E-commerce's disruption of retail accelerated due to the pandemic, with shoppers taking to websites and apps to gather information and make purchases with increasing frequency. There is a clear upward shift in e-commerce sales in the U.S. between the first and second quarters of 2020.<sup>179</sup> E-commerce sales in the U.S. grew at an estimated 15.1 percent compound annual growth rate between January 2010 and January 2020. E-commerce sales in 2020 grew 30 percent, jumping from 11.8 to over 16 percent of total retail sales, between January and April 2020. Indiana is reflective of the nation and the trend toward online sales drives economic activity in the state; employment in e-commerce grew from just under 9,000 to an all-time high of 11,000 between January and August of 2020 supported in part by the expansion of Amazon Logistics opening additional operations near Indianapolis and Fort Wayne, IN in 2019 and 2020.<sup>180</sup> Originally driven by online book sales in the early 2000s, e-commerce acceptance and adoption by consumers transformed the retail landscape over the past two decades. Food delivery has been a holdout, historically relegated to pizza delivery, but the pandemic promises accelerated consumer acceptance of grocery and restaurant delivery.

Riding the e-commerce growth wave, funding in the food delivery space has increased substantially with an estimated \$7.3 billion invested globally between October 2019 and October 2020, including \$2.8 billion in venture and startup funding.<sup>181</sup> Most investment is focused on scaling new business models and gaining critical mass. Investments are accelerating to capture the trend toward delivery with Instacart raising \$200 million in October 2020 and DoorDash raising \$400 million in June 2020.<sup>182</sup> Highlighting the impact of COVID-19 and lockdowns on the food delivery industry, food delivery app installs increased 55 percent between late January and late March 2020.<sup>183</sup> Market Wagon, an Indianapolis-based startup that connects local farmers with gig-drivers to fulfill orders for fresh, local products reported a 600 percent increase in sales over two weeks at the start of the pandemic.<sup>184</sup> Additionally, ClusterTruck, an Indiana based food delivery start-up, received \$10 million in funding in 2017.

Increasing availability of food delivery will drive a new understanding of food access in the U.S. In 2019, it was estimated that Amazon could achieve one-day delivery to over 70 percent of the U.S. population.<sup>185</sup> This speaks to the shift in consumer expectations and the ability of companies to fulfill immediate gratification. It also demonstrates the ability for companies to deliver fresh foods to consumers and as networks continue to expand it challenges and potentially eliminates the traditional notion of a food desert. In 2015, the USDA estimated that between 20 and 50 million people in the U.S. lived in food deserts.<sup>186</sup> The definition of a food desert is

based on proximity to a grocery store or supermarket. But in a future where grocery stores' business models focus more deeply on delivery, brick-and-mortar footprints will likely shrink. By traditional measurements, increasing numbers of Americans will live in food deserts while simultaneously having access to increasingly diverse foods through delivery services. One of the largest challenges facing businesses as they increase delivery offerings and build-out delivery systems is finding ways to include populations with limited internet connectivity. Food access in the future may be less dependent on transportation or proximity to a full-scale retail outlet and more dependent on reliable, accessible internet.

### *Food formats: prepared foods*

U.S. demand for prepared meals was between \$20 and \$25 billion in 2019.<sup>187</sup> The prepared foods market is growing at over 6 percent annually and as consumers' food purchasing habits evolve the category is likely to double by 2030.<sup>188</sup> An estimated 74 percent of purchases in prepared foods took place at grocery stores, including hyper- and supermarkets in 2018, while 14 percent of purchases were at convenience stores.<sup>189</sup> This represents strong historical dominance by traditional channel players. But the market is likely to shift both in channel and in growth in coming years.

Meal kits, semi-prepared meals, are also growing in popularity, but some early entrants are struggling with a saturated market as grocery stores have entered the space. Consumers already purchase ready-to-eat, meal kit products through grocery stores, such as salad kits, pre-washed and cut vegetable packets and seasoned and pre-cut meats. It was easy for grocery stores to enter meal kit space, such as Kroger's Home Chef line of meal kits. This forces delivery services to focus on deeper consumer needs: a reexamination of the occasion matrix – particularly as it gets reoriented around food-at-home – and a renewed understanding of consumer expectations.

Changes in delivery and services are transforming consumers' access to and expectations of prepared meals. While traditional stores historically dominated prepared foods, startups are growing quickly by offering differentiated quality. Freshly, an e-commerce and food delivery startup based in New York, delivers chef prepared meals to consumers' homes. Its last funding round was in 2017, when it raised \$77 million, bringing its total funding to \$107 million.<sup>190</sup> Territory Foods, a startup from Virginia focused on customized, chef-prepared meals, has raised nearly \$20 million since its founding in 2011.<sup>191</sup>

Meal delivery and chef-prepared foods are enabled by the growth of ghost and cloud kitchens. Similar to car-sharing and home-sharing business models that have taken off over the

past decade, new startups are focusing on kitchen-sharing. The ability to generate value from underutilized assets is one of the greatest benefits technology has brought over the past decade by creating double-sided markets to connect those with assets and those who need them. Kitch, for example, is a New York City based commercial kitchen marketplace, letting commercial kitchens monetize their downtime. Another company in the space, CloudKitchens, is a real-estate company that provides smart kitchens to delivery-only restaurants.<sup>192</sup> In November 2020, CloudKitchens secured \$400 million in venture funding from Saudi Arabia's Public Investment Fund.<sup>193</sup>

The U.S. cloud kitchen market was estimated at \$16 billion in 2019, but declined substantially due to the pandemic in 2020, declining by an estimated \$7 billion.<sup>194</sup> However, the market continues to grow at over 10 percent annually and is expected to do so through 2030 as more prepared food and delivery services begin taking advantage of the benefits of off-site and shared kitchens.<sup>195</sup>

Consumers continue to evolve the occasion matrix, particularly as it has been redefined around the home during the pandemic. One of the largest food categories is prepared snacks, which generated \$40 to \$50 billion in sales in the U.S. in 2019.<sup>196</sup> Driving some of the growth in snacks and prepared foods is the growth in "free-from" foods – products such as dairy-free creamer, gluten-free crackers, sugar-free candy and more. Free-from foods are prepared for specific target markets, such as diabetics and people with lactose or gluten intolerance. In the U.S., the free-from food market was estimated at over \$14 billion in 2019 and is growing at nearly 9 percent per year,<sup>197</sup> potentially surpassing \$34 billion by the end of the decade.

The growth of prepared foods, including snack and specialty products, is driving food companies to get closer to consumers. Food companies are actively acquiring and building consumer facing brands to provide consumers with tailored and even customized products. Prepared foods such as chef-created meals demand last-mile agility as final assembly and preparation of the food occurs very close to the consumer. Free-from foods require firms to know increasingly more about targeted consumer segments and to track the relationships between various ingredients and health implications. Ultimately, the growth of prepared foods is driving companies toward consumer intimacy and continues to both transform and respond to changing consumer expectations.

### *Food attributes*

The reimagination of food is most noticeable on the plate or in the labeled attributes of food products. Historically, food labels were created to signal food safety and quality, particularly

as food handling in the 19<sup>th</sup> and early 20<sup>th</sup> centuries caused frequent foodborne illness.<sup>198</sup> Today, food labeling in the U.S. includes not only mandatory nutritional information but also attribute claims such as organic and GMO free.

The global organic foods market was estimated at over \$120 billion in 2019.<sup>199</sup> The U.S. organic foods market was \$49 billion, over 40 percent of the global market.<sup>200</sup> With estimated annual growth rates of between 8 and 10 percent, organic as an attribute is growing rapidly.<sup>201</sup> The U.S. Department of Agriculture's National Agricultural Statistics Service's 2017 Census of Agriculture reported that in 2012, Indiana had 283 organic certified operations and nearly \$36 million in organic farm output.<sup>202</sup> By 2017, that had risen to 575 farms with over \$75 million in sales, approximately \$131,000 per farm – up \$5,000 per farm from 2012.<sup>203</sup> By October 2020, the USDA's Agricultural Marketing Service reported over 900 organic certified farms in Indiana through its Organic INTEGRITY Database.<sup>204</sup> At 2017 per farm revenue levels, Indiana farms produce nearly \$120 million of organic goods each year, a 16 percent compound annual growth rate since 2012 – faster than the national average.<sup>205</sup>

As the organic market continues to mature, non-GM, clean labels and gluten free offerings are growing. In particular, demand for non-GM products has the potential to drive change across the value-chain to the producer and the input manufacturer. Many farmers report that while growing GM corn and soybeans are still key components of their portfolios, they are shifting some acreage to non-GM corn and soy.<sup>206</sup> The global GM seed market peaked in 2017 with almost 53 percent of the total market. Non-GM seed sales outsold GM seeds globally for the first time in 2019 and since 2014 have grown



at a 3 percent compound annual growth rate, while the global GM seed market declined slightly over the same period.<sup>207</sup> This trend is partly due to changes in acreage for non-GM products, such as wheat and rice. Global wheat production acreage increased between the 2018/19 crop year from over 530 million acres to 548 million acres in the 2020/21 crop year, an increase of 18 million acres.<sup>208</sup> Over the same period, corn plantings increased from 474 to 486 million acres.<sup>209</sup> Planted GM corn and soybean acreage in Indiana has been very stable at between 86 and 88 percent of total corn and 91 to 92 percent of total soybean planted over the period from 2015 to 2020.<sup>210</sup> The stability in GM crops in the U.S. is driven by animal protein and biofuels demand and while this will likely continue for the near- and mid-terms, Indiana producers and food manufacturers need to consider a world in which corn and soy demand are significantly lower than today.

As consumers increasingly demand non-GM products, it requires food manufacturers and animal protein producers to seek non-GM inputs from their suppliers. In turn, farm input manufacturers are working to meet demands from producers for conventional seeds, organic and green chemicals and new practices. Simultaneously, any retrenchment from GM production threatens some of the efficiency and sustainability gains made over the past two decades. Continued advancements in production technology and processes can mitigate some of this loss at the farm level.

Many consumers equate food attributes with health benefits. As consumers seek health, particularly post-COVID-19, they are focusing on plant-based and fresh foods with enhanced ingredients. In one survey, 83 percent of consumers reported seeking out plant-based foods and beverages to improve their health and nutrition, 51 percent reported they wanted to eat clean foods and 14 percent indicated it is for environmental reasons.<sup>211</sup>

In 2019, sales of plant-based milk were \$2 billion, or 14 percent of the retail milk market in the U.S.<sup>212</sup> An estimated 41 percent of U.S. households purchased plant-based milk products in 2019.<sup>213</sup> The U.S. conventional meat market will generate over \$92 billion in producer sales in 2020 and could exceed \$100 billion by 2030 at its 1 percent annual growth.<sup>214</sup> As plant-based products become increasingly popular, the U.S. market for plant-based meat could exceed \$9 billion in a scenario similar to dairy before accounting for substitution and income effects and dietary changes.<sup>215</sup> In 2019, plant-based meat sales were just short of \$1 billion but grew at an estimated 18 percent over 2018 sales.<sup>216</sup> As the plant-based market diversifies through new products and consumers and increases in dairy allergies, its sales could accelerate. In 2019, plant-based yogurt sales grew 95 percent, plant-based ice-cream grew 34 percent and plant-based spreads, dips and sour creams grew

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Over the next ten years we may diversify our crops, but probably will focus on more non-GM products. We will also have to really focus on our community relations. There are so many opportunities to get the story out about farming. The number of farmers that share their story is too small, and people don't realize the importance of farming or don't understand the importance of their food or where their food comes from.

Kassi Rowland, Member and Public Relations Lead at Tom Farms

135 percent.<sup>217</sup> The huge growth of plant-based foods, albeit off of a small base, has attracted substantial capital. Over the past decade, total investments in alternative proteins have exceeded \$16 billion, with over \$1.5 billion in the first three quarters of 2020.<sup>218</sup>

When meat sales doubled between the first and third weeks of March 2020, due to lockdowns and food service closures, plant-based meats kept pace. At the beginning of March 2020, meat sales were estimated at approximately \$1.1 billion and meat alternatives had nearly 0.7 percent of the market.<sup>219</sup> When meat sales skyrocketed, alternative meats were carried along, maintaining their market share.<sup>220</sup> The change in both conventional meat and alternative meat retail sales has been persistent. As consumers focus on cooking healthy foods at home over the coming years, increasing interest in plant-based products will continue to accelerate.

The interest in non-GM, organic and plant-based foods shows that consumers are increasingly focused on ingredients. Consumers are looking for clean label foods with limited processing. Plant-based food manufacturers are working rapidly to shorten their ingredient decks and create simplified formulations. One popular U.S. brand of plant-based burgers has 18 ingredients. A European startup focused on alternative chicken has only 7 ingredients – which includes their spice

blend coating.<sup>221</sup> Consumer demand and investment are quickly driving product innovation in the space.

The ultimate short ingredient deck for alternative proteins is likely to be lab-cultivated meats. In 2020, Memphis Meats raised \$161 million and Mosa Meat raised nearly \$65 million (55 million Euro), both companies focused on cellular meat products.<sup>222</sup> These two investments in 2020 already equal more than the \$166 million invested between 2016 to 2019 in cultivated meats.<sup>223</sup>

Investment in new plant-based and cultivated technologies came historically from outside the traditional food industry, often from venture capital and investment management firms. In recent years, increasing amounts of money are being invested by traditional protein and consumer packaged food firms. The investment trends point to a future of increasing product innovation and consumer adoption.

Most consumers are value-driven – they want a balance between product quality and price. While many have reported their willingness to pay for organics, non-GM, clean label, or plant-based products, actual consumer spending indicates that they are slow to adopt. However, in many products the “rising tides” of consumer income and demand tend to erode price

premiums as supply catches up. Organic produce volumes in the U.S. increased nearly 9 percent per year between 2016 and 2018 – down from nearly 14 percent increases between 2013 and 2015 – but unweighted average prices declined 0.4 percent.<sup>224</sup> Some poultry producers reported large increases in cage-free production expanding from a couple hundred-thousand birds to multiple millions over the past five years. Some of that demand is driven by consumers’ willingness to pay the premium, by the erosion of premiums and by regulatory pressures by states. Many food trends originate at the top of the income distribution and through increasing supply to meet increasing demand become approachable to value driven consumers. The same trends occurred in cellular phones, flat screen televisions and automobiles where advances in technology drove down production costs and consumer demand drove up supply. While food trends constrained to annual agricultural cycles and exposure to more price sensitive consumers, are slower, there are few reasons to believe they will not follow a similar path.

“

We used to have 200,000 cage free birds, but now we have 5 million. Most of our customers have committed to go cage free by 2025. Today, there is not enough cage free production in the U.S. to supply California when they go fully cage free due to law in January 2022.

Greg Hinton, Vice President of Sales, Rose Acres

## The future of agriculture: diversification of production

One of the key shifts in recent years is a strong focus on consumer food preferences. Today's consumer has more information than ever before. With information at their fingertips, they increasingly understand their food chains and ultimately vote with their wallets. The change in information availability is driving a transformation of the agricultural value chain from push – where consumers eat what is produced – to pull – where consumers are actively driving value chain activities. The traditional farm-to-fork model is being flipped to “fork-from-farm” as consumers drive demand back through the value chain.

Evolving consumer expectations and mindsets are driving key changes that will shape the future of agriculture. The reimagining of food demands the reimagining of agriculture. Unique processing, specialty products, new technologies and value-sharing business models will drive transformation at the production end of the food chain. Producers will adapt as food manufacturers and processors focus on balancing the demands for health, sustainability and transparency with the need for nutrition, affordability and availability. The agricultural system, which for decades has focused on efficiency, may find increasing financial incentives to focus on quality, crop attributes and diversified production – even to the point of giving back some efficiency gains.

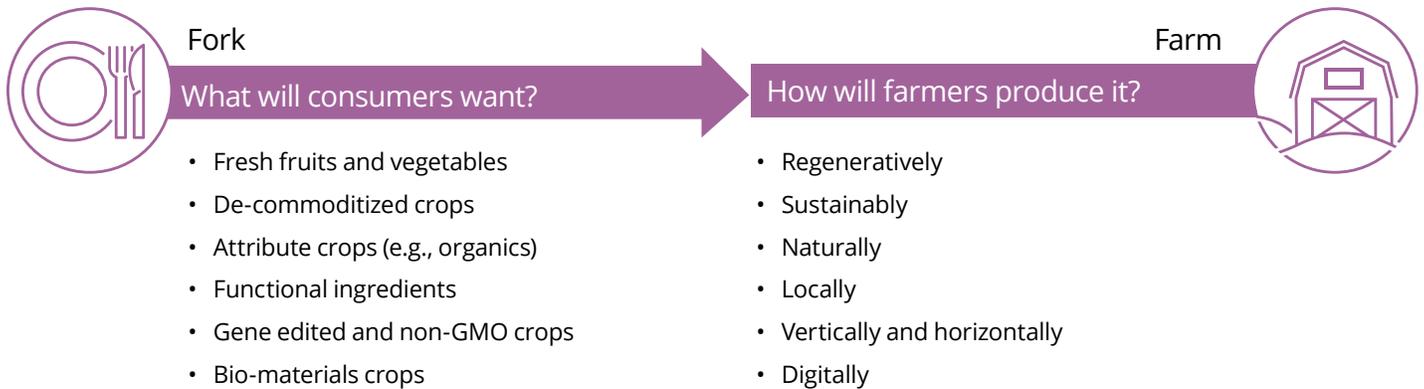
### Traditional value chain — push



### Emerging value chain — pull



## Agriculture is being impacted by both ends of the value chain



Sustainability is the avoidance of the depletion of natural resources to maintain an ecological balance. The concept is not new. In the 1930s, the country was mired in the Great Depression and the plain states were experiencing the Dust Bowl. In response, New Deal programs for soil conservation were implemented. The act of rotating crops became common and farmers changed the way they performed tilling and other on-farm operations. Norman Borlaug, founder of the World Food Prize, was awarded the 1970 Nobel Peace Prize for his contributions to crop breeding and production practices that are credited with massively expanding agricultural productivity through the 1950s and 1960s – a period known as the Green Revolution.<sup>225</sup>

Increased focus on sustainability and advanced production practices continued throughout the next few decades but hit a tipping point in recent years. Today, Millennials and Gen Z are bringing new food ideas and values to the table. As consumers learn more about their food and the systems that produce it, they expect more. The agricultural system will transform to meet growing expectations for healthy, transparent and sustainable foods that are affordable and accessible.

## Producer impacts

Changes at the consumer end of the value chain flow back to the farmgate. In 2020, approximately 30 percent of farm income was provided from a government subsidy totaling an estimated \$37 billion.<sup>226</sup> Comparatively, in 2019, government farm subsidies totaled approximately \$22.6 billion representing over 20 percent of farm income – the impact of COVID on trade and consumption has clearly hurt producers.<sup>227</sup>

Farmers are expected to be economically rational in their decisions. Consumer-driven change will create new, unique opportunities for Indiana's producers to try new crops and business models to diversify their current operations, improve profitability and stay ahead of these coming trends and protect their long-term viability. Trends and challenges such as consolidation, risk management, labor and automation, supply chain complexity and trade and regulation, all compounded by consumer pressures, will change production agriculture. Some acres will need to be diversified, some will need to be repurposed and others may be taken out of production entirely. As always, farmers will need to adapt to meet the changing landscape.

## Consolidation

Today, large farms control most production across the U.S. and Indiana. Less than 8 percent of farms control over 40 percent of the acreage across the U.S.<sup>228</sup> With many of the next generation leaving the farm as part of a larger urbanization movement along with a “get big or get out” mindset by producers to drive returns through scale, consolidation will continue to impact the dynamics and demographics of farming. There is already a movement toward corporate-style farming in traditional row crops, including increasing vertical integration and concentrated land ownership. Over 30 percent of farm land in the U.S. is owned by non-operators and 10 percent of all farmland in the U.S. is owned by corporations, trusts and other entities.<sup>229</sup> The poultry industry is a clear example of vertical integration and consolidation in agriculture: five firms are estimated to control over 60 percent of the U.S. broiler market.<sup>230</sup>

The incentives for concentration are high. In 2020, the USDA estimates that large farms, those with revenues of over \$1 million, will capture nearly \$700,000 per farm in net cash income.<sup>231</sup> Farms with between \$500,000 and \$1 million in revenues will take home approximately \$192,000 in net cash income.<sup>232</sup> At the other end of the spectrum, farms with less than \$100,000 in net cash income will lose money. Over 40 percent of farmers in the U.S. have off-farm income.<sup>233</sup> As operators age, land is sold or rented to land management companies or large-scale operators. Consolidation is expected to continue and even accelerate.

## Risk management and long-term planning

As the availability of farm analytics increases, farmers are harnessing it to make operating decisions. Increasingly sophisticated farm management platforms allow for more data-driven decisions in key areas of risk management, in-season decisions and longer-term planning that go beyond selection of crop and hybrid. For many operations, agronomists are being augmented by algorithms to maximize efficiency through precision technologies. The tools are evolving in sophistication. Maximizing yield is going to give way to maximizing portfolio returns across fields.

Long-term planning and risk management will involve producers diversifying operations, treating the farm as a portfolio of products. With a forecast for long-term stagnation of market price for soy and corn, producers will look to capitalize on evolving consumer trends reshaping the value chain. They will increasingly produce differentiated products, such as high-protein soybeans or peas for ingredient processing or non-grain crops for local markets. In the near future, row crop producers may appear to be operating a

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## Farmers are the original entrepreneurs

Mitch Frazier, CEO at AgriNovus Indiana

homogenous field but are in-fact growing extremely different varieties of corn or soybean for specific end users, such as high starch and oil corns for food ingredient manufacturers.

Many producers are already beginning to experiment. Large grain producers are beginning to diversify their row crop selections to include non-GM corn and soy into their operations or have diversified with crops such as hemp and tomatoes in Indiana. Meanwhile, biotech startups like Benson Hill along with industry incumbents Corteva, Syngenta and others are developing specialized versions of corn and soy that are purpose-built for specific end uses. Corn is being developed with a specific starch profile for ethanol production, while protein and oil specifications within wheat and soybeans continue to evolve. Farmers can participate in specific offtake programs that offer premium pricing and continue to become a larger part of the overall row crop ecosystem. Likewise, in animal production, consumers continue to drive markets for organic, grass-fed, pasture-raised versions of poultry, cattle and swine. While the space is small, it is growing faster than conventional proteins.

Growers can also offset risk by growing different crops. Indiana is well-suited to grow seasonal quantities of many fruits and vegetables. Growers can already set aside acres to test products such as watermelon and strawberries to capitalize on fresh and local trends. COVID-19 has accelerated consumers' interest in finding local producers and exploring channels besides the traditional grocery store.<sup>234</sup>





### *Labor/mechanical trade-offs*

Labor shortages are a major hurdle in agriculture, particularly in specialty crops that are grown mostly outside of Indiana. Traditional commodity crops do not have sufficient margins to allow the payment of a wage that attracts reliable talent, which creates issues with sourcing labor.

Innovations across the mechanization spectrum will automate many of today's manual processes in agriculture. Traditional harvesting and picking equipment are already being automated to reduce the need for specialized labor. Many of today's labor-saving innovations have focused on labor augmentation; however, advances in automation portend a future in which farm labor is increasingly replaced. As a result of COVID-19 and the close, confined working areas of animal processing, for example, a renewed push to automate labor is top of mind for companies and operators.

Agricultural equipment of the future will be automated, connected, electric and small. Disruption is expected to occur for large, human operated equipment that will be replaced by small, nimble, autonomous options that have lower carbon footprints. Early challenges in the development of automated, small equipment included the need to achieve large scale coverage such as the ability to spray thousands of acres. But advances in technology and changes in production trends are overcoming the hurdles.

As technology prices drop, farmer adoption increases. For example, average IoT sensor prices have fallen from \$1.30 in 2004 to an estimated \$0.38 in 2020, a decline of 70 percent.<sup>235</sup> The decline in prices is driving a global 13 percent compound annual growth rate in agricultural sensor adoption.<sup>236</sup>

### *Increased supply chain complexity*

The increasing complexity of supply chains will be another challenge for producers, particularly in a diversified agricultural market. When a farmer grows both GM and non-GM soybeans, there are logistical challenges in storage, transportation and marketing. Originators have historically been challenged to run identity preserved supply chains alongside tradition ones; but increasingly companies, such as Indigo Ag, are working to disrupt the traditional origination model. Increasing demand for specialized crops, such as the expansion of high-protein soybeans or peas for plant-based protein manufacturing, will require unique and even proprietary supply chains. Conveniently, the technology to track and operate under increasing complexity already exists in other industries, such as pharmaceuticals, and is slowly making its way into agriculture.

Alongside increasing complexity and deeply entangled with it is the push to increase transparency and traceability. Whether participating in a complex offtake arrangement or newly founded carbon program, there are various tracking stages and data requirements for ensuring adherence to contractual obligations, product characteristics or marketing claims. This requires infrastructure upgrades to deploy tracking technologies such as IoT or blockchain. As one of the most critical steps in the food chain, producers will increasingly be pressured to deploy technologies enabling transparency into their operations.

### *Trade and regulatory barriers*

Recent trade disputes between the U.S. and other countries impacted the agricultural commodity market and resulted in lost producer income. U.S. agricultural exports increased from \$133 billion in 2015 to \$139 billion in 2018 before falling \$3 billion in 2019.<sup>237</sup> For year-to-date in 2020, agricultural exports were \$2 billion short of their 2019 levels indicating another year of declines for American producers.<sup>238</sup> As nationalism increases globally, supply chain disruption is expected to be compounded.

The regulatory environments in Asia and Europe have also challenged the use of biotech traits and certain chemistries and this could particularly limit the advances in production technologies for producers. For example, the lack of GM wheat and rice is largely attributable to regulatory barriers, particularly European resistance to allowing these technologies into human food supply chains. Regulatory barriers create increased fragmentation across and between value chains and limit advancements in on-farm technology. Frequently, these types of regulatory barriers also reinforce consumer's negative perceptions of GM technologies. Ironically, as various countries

restrict technologies, they increasingly demand higher levels of sustainability, such as water use and chemical application restrictions, which could be addressed through advancements of genetic technologies.

Land use for agriculture in developed nations will also continue to decrease. Agricultural land at the urban-rural margin will increasingly become more valuable as residential and commercial property. Indiana has extensive prime farmland, although much of it is located near growing urban regions, such as Indianapolis. Estimates indicate that Indiana lost 144,000 acres of prime farmland to urban development between 1992 and 1997<sup>239</sup> and that between 2007 and 2012 approximately 52,000 acres of Indiana farmland were converted to developed land.<sup>240</sup>

National programs like the Conservation Reserve Program (CRP) have room for expansion as well. As of 2018, there were 22 million acres enrolled in these programs, while the 2018 update to the Farm Bill increased the cap to 27 million acres.<sup>241</sup> As sustainability concerns grow and commodity prices remain flat, these programs will likely continue to increase.





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The idea of what makes a ‘good farmer’ is evolving. Years ago, clean fields, high yields and good stewardship were the marks of a good farmer. That definition has expanded to include sustainable or regenerative practices as well.

Christy Wright, Global Food Chain Leader, Global Crop Protection at Corteva Agriscience

## The future of agriculture

Investment in Agricultural Technology (agtech) has risen to record levels in the past few years topping \$19.8 billion<sup>242</sup> globally in 2019. The agriculture sector was historically overlooked by venture capital and technology investors, with only \$2.2 billion invested in 2013.<sup>243</sup> The influx of investment from outside will result in disruption and an outside-in reassessment of the food and agricultural value chains. The precision farming technology market was estimated at \$5.2 billion in 2019 and is expected to grow to \$9.4 billion in 2024.<sup>244</sup> At nearly 13 percent annual growth over the period, it is one of the fastest growing innovation platforms.

Disruption will bring new methods, new technologies and new players that will look to solve traditional problems with innovative solutions. These will focus on cost-effective measures to shorten value chains, reduce carbon footprints and drive sustainable solutions. Some of the largest disruptions include controlled environment agriculture, regenerative agriculture, carbon programs and changes to the grocery store.

### *Controlled environment agriculture*

CEA is another key agtech trend that is capitalizing on the push by consumers for sustainability and local preferences for food. Investment capital is flowing in 9-figure investments into companies like Plenty, BrightFarms and AppHarvest in the last 12 months.<sup>245</sup> Early companies in this rapidly growing area are promoting their practices to produce local, healthy produce that reduces land and water use and reduces or eliminates chemical applications compared to traditional production. Given controlled environment infrastructure, they can grow year-round with no or limited seasonal or weather impacts.

While Plenty and BrightFarms are locating facilities close to major urban centers on the coasts, hoping to capitalize on the presence of large demand centers, AppHarvest is taking an alternative approach.

AppHarvest is constructing the largest greenhouse in the world in Morehead, Kentucky. This small town is approximately 100 miles east of Indiana’s eastern border. In fact, from Indianapolis, most of the east coast of the U.S., as well as Chicago and Atlanta are within a one-day drive. The logistical ability to reach huge parts of the U.S. population are why CEA continues to grow in the Midwest and Great Lake States.

Combined with Indiana’s historical agriculture and manufacturing production knowledge and crop marketing capabilities, the state is well positioned to take advantage of CEA technology as it continues to advance.

Controlled environment agriculture can also be executed at “in-home” scale. Production of leafy greens could take a similar path from centralized to decentralized in the home. The GroPod® by Heliponix, an Indiana based startup, is working to make that happen.

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Consider the ice industry. Decades ago, people received ice deliveries regularly. But innovations in refrigeration miniaturized the manufacturing process and made localized production available to everybody in their home. Why can’t this type of innovation revolutionize the agriculture and food industries?

Scott Massey, Founder and CEO, GroPod



### *The grocery store of the future and controlled environment agriculture*

This is only the first generation of CEA. The future of growing leafy vegetables is expected to reside in the store. Grocery stores of the future are expected to reduce their physical footprint with the traditional middle aisles of packaged goods becoming “dark stores” fulfilled through e-commerce. The fresh aisles of the grocery store, where produce, meat and dairy products are found, will become the grocery store experience of the future. In the near- and mid-term, CEA is expected to allow grocery stores to differentiate their offerings through unique product mixes, local products and ultra-fresh produce. As the technology evolves, CEA is expected to allow customers to harvest their own vegetables in the store. The value chain for this may effectively be reduced to an autonomous CAE planting seeds and the end consumer putting them in their cart. A substantial impact of CEA will be the redistribution of the supply chain, pushing production of certain produce as far toward the consumer as possible. Seed and input companies are positioned to capture value, as are appliance manufacturers, while traditional retailers and intermediating nodes in the value chain are positioned to lose without adaptation.

### *Regenerative and sustainable agriculture*

Regenerative agriculture goes a step beyond sustainability and emphasizes regenerating resources by reversing some of the impacts of agricultural practices.

The term regenerative agriculture is defined as farming and grazing practices that rebuild soil and restore degrading biodiversity in nature.<sup>246</sup> Proponents of these programs believe they can remove carbon dioxide from the earth’s atmosphere and return it to the soil while creating beneficial impacts to soil health and the environment.

Some of these measures taken include reducing soil tilling, adding cover crops during traditional non-planting seasons or years and rotationally grazing livestock. It is likely that new certifications will follow the consumer trend, identifying products produced with regenerative methods, similar to current organic, non-GM or sustainability certifications. As much as certifications follow consumer demands, they create them through awareness as well. The development of new regenerative certifications gives consumers the opportunity to vote with their wallets and pay more for these practices while giving producers the opportunity to increase their margins through the increased value generated.

Some consumer demands, such as those for regenerative agriculture, organic crops, non-GM food products and more, will offset efficiency gains made by the traditional agricultural system over the past several decades. Organic crops and grass-fed, pasture-raised livestock produce lower yields, requiring more land to produce the same amount of food. Pasture-raised or cage-free animal production systems typically have higher mortality rates and greater biosecurity challenges. Organic crop systems have lower yields, increased pest challenges and can even require higher levels of organic chemical application. For many producers, the reduced yield and efficiency losses make a shift financially non-viable in the near-term. However, new business models are emerging to help solve the economics of regenerative and sustainable practices.

### *Carbon programs*

Companies like Indigo,<sup>247</sup> Bayer,<sup>248</sup> and others have developed carbon programs to encourage the carbon capture benefits of regenerative agriculture. The programs plan to enroll farmers into a platform backed by digital agriculture technologies to document practices on each acre of production land. In the Indigo Carbon Program, the marketplace is created by selling “credits” to a food manufacturer who can market the benefits of the farming practices with their products. In one example, a brewery could purchase the credits on land that grows barley for beer, rewarding the farmer for minimal tilling and cover crops on the land and providing the customer an opportunity to purchase sustainable products that act as a carbon sink.

### *Electric vehicles*

At the end of 2018, the U.S. had approximately 1 million EVs on the road. By the end of 2030, there could be an estimated 18.7 million electric vehicles in the U.S. and annual electric vehicle sales will top 3.5 million, or more than 20 percent of vehicle sales.<sup>249</sup> Total sales of EVs are expected to continue to increase. By 2040, EVs will account for 60 percent of new vehicle sales in the U.S. and comprise approximately one-third of the global passenger vehicle fleet.<sup>250</sup> While this appears to be a very long-term proposition, producers value land on longtime horizons. The continued expansion of the EV fleet in the U.S. poses challenges to the biofuel industry, which used nearly 40 percent of the total corn produced in the U.S. in 2019 to produce ethanol and dried distillers grains.<sup>251</sup> In Indiana, the ethanol industry operates 15 production plants with an estimated capacity of 1.35 billion gallons per year or approximately 32 million barrels.<sup>252</sup> The ethanol industry was estimated in 2015 to have an annual impact of \$3.6 billion on Indiana’s economy.<sup>253</sup>

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We can’t be afraid of sustainability and environmentalism in this industry – let’s communicate transparently with our communities and consumers about them.

Trent Torrance, Chief Operating Officer at United Animal Health

In April 2019, the U.S. produced 282 million barrels of finished gasoline, including an estimated 31 million barrels of ethanol.<sup>254</sup> In April 2020, the U.S. produced 175 million barrels of finished gasoline, including only 17 million barrels of ethanol.<sup>255</sup> Gasoline production fell nearly 40 percent and ethanol production fell 45 percent.<sup>256</sup> By August 2020, gasoline production had rebounded to 264 million barrels and ethanol to over 27 million barrels.<sup>257</sup>

Two potential scenarios for the ethanol and gasoline industries in coming years are: transportation and travel behavior returns to normal or transportation never returns to normal as the pandemic permanently changes how we work and commute. On top of these scenarios, the EV market could be either a fad, never taking substantial market share, or the technology could advance rapidly, grabbing substantial market share of the passenger and logistics markets.

Major companies, such as Microsoft, have announced that they will allow employees to work from home at least some of the time on a permanent basis. As companies overcome the challenges of remote work and observe some of the benefits, a shift in commute behavior may be permanent. Simultaneous, the EV market continues to grow and most observers believe EV sales will overtake combustion engine vehicles. Even excluding Tesla, which itself secured more than \$20 billion in funding, the EV market has attracted substantially more than \$25 billion in investments, including for EV-specific battery technology.<sup>258</sup> Combined, these two effects foretell a permanent shift in demand for gasoline and ethanol.

## The Now, Next and Beyond

Today's food and agricultural system relies on mass production and economies of scale. It is driven by farm-to-fork and is prescriptive in what consumers receive with limited transparency. Huge quantities of commodity crops, such as corn, soybean, wheat and cotton, are produced to provide energy, protein, packaged foods, food ingredients, bio-industrial products, pharmaceuticals, paper goods, textiles, housing and more. Today's system is not going away. There will continue to be demand for low cost, high volume conventional commodity products. But food and agriculture are changing and diversifying.

Consumers are seeking new delivery, new formats and new attributes for their foods. Simultaneously, producers are facing consolidation, risk management challenges, labor shortages, increasing supply chain complexity and new trade and regulatory barriers. Major trends, such as sustainability, decarbonization, local production and electrification, promise to disrupt the modern agricultural system slowly but inevitably.

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Production has to increase to feed the world. It's going to happen in South Asia, Africa and South America. They need to get to US yield levels from the 1990s, and we can feed the next two billion people in the world.

Jay Hulbert, Ag Alumni Seeds CEO

New technologies and practices promise a path forward. Over the coming decades, the food and agricultural system will transform from Now to Beyond, enabled by technology that increases transparency, customization and partnerships.

Today, companies are focused on identifying efficiencies and maximizing today's portfolios. Research and development are often focused on sustaining innovations, not revolutionary innovations.<sup>259</sup> Consumer choices are frequently dictated by commodity chains that produce varied products with the same inputs, such as corn, wheat and soybean. It is, in many ways, the illusion of choice. Corn, for example, is an ingredient

in an estimated 4,000 food products today.<sup>260</sup> The consumer today faces a prescriptive choice set born of mass production. Investments in technology will help redefine the tools for tomorrow.

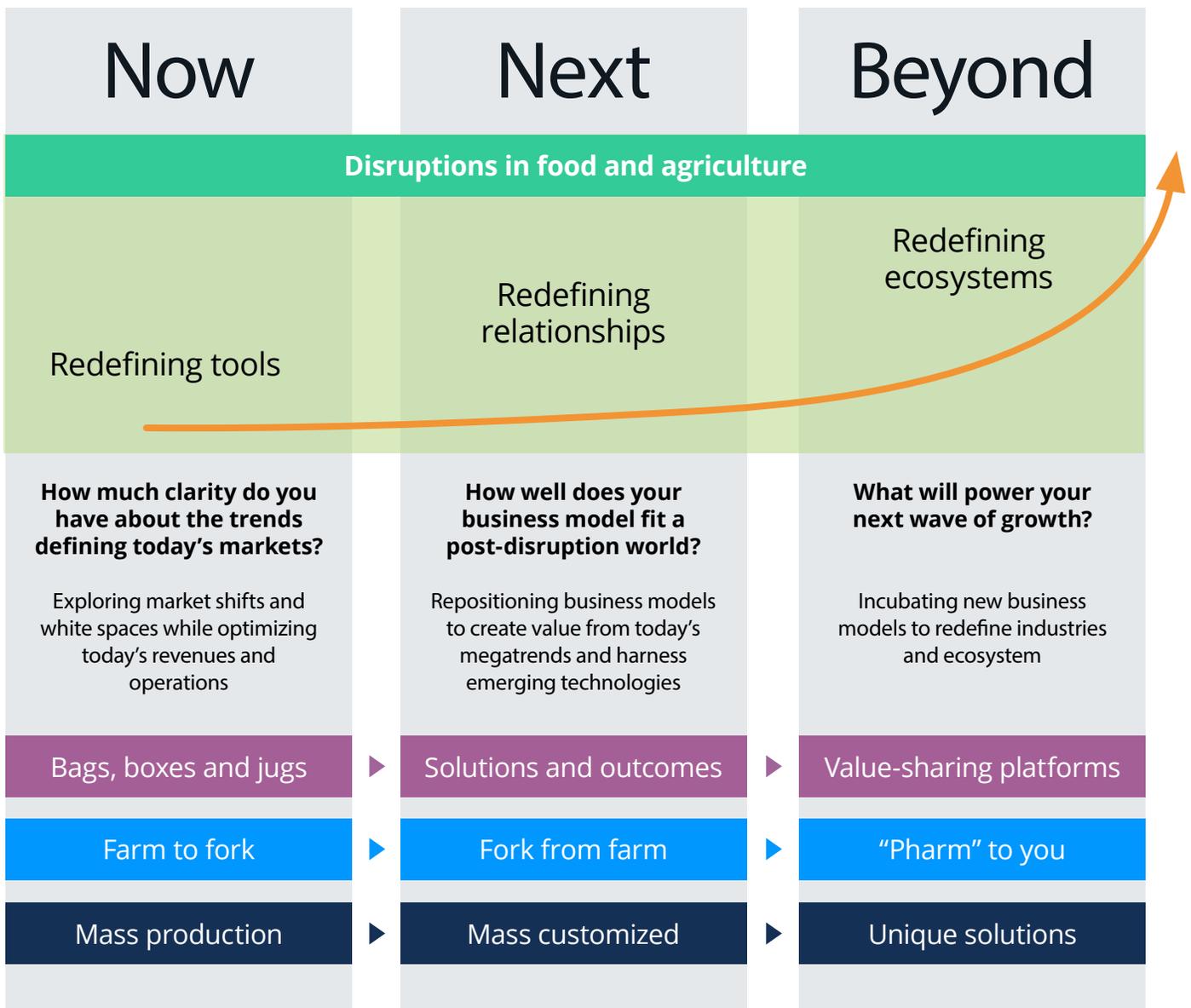
Consumer pressure is changing the illusion of choice to real choice and companies are examining the Next wave of value creation. They are repositioning to respond to new trends and technologies that enable evolved and repositioned business models. Bags, boxes and jugs are giving way to solutions and outcomes-based models for producers. Input manufacturers are starting to consider new ways to share risk and reward with producers, support producer diversification, support their switch to organic, green and regenerative practices and identify new financing models.<sup>261</sup> Evolving business models, such as outcome sharing, would be impossible without on-farm technologies that measure and track each interaction the producer has with their fields and provide prescriptions and advice to maximize profits. New technologies and practices are the precursor to a wave of mass customized products for both the producer and consumer. Manufacturing and production technologies, such as 3D printing, household-scale controlled environment agriculture and advanced fermentation, foretell the ability to push final production further down the chain, close to or even at the consumer level and increasingly customize consumer products. The push model of farm-to-fork is giving way to a "pull model" of fork-from-farm. Consumer choice is expanding to include direct-to-consumer customized diets. As the technologies and processes enabling the Next revolution of business models mature and prices fall, additional segments of society will increasingly have access to new, affordable, nutritious and targeted foods. The Next wave of technology and process evolution will redefine relationships between buyers and suppliers, customers and companies and people and their foods.

Planning for the Now and the Next only solves half of today's business problems. It might optimize today's revenues or identify emerging spaces but it rarely opens white space or creates new business models. Today's strategies, designed to create and maintain competitive strategic advantage, are slowly becoming irrelevant.<sup>262</sup> In the decades Beyond today, companies will have evolved entirely new business models. Popular ride-sharing and house-sharing apps, founded only a decade ago, have transformed and threatened entire industries, transformed capital allocation and created true asset-light business models. They are built on platforms that connect, share value and redefine ecosystems. The transformation of the food and agriculture system may lag but the industries are not immune to redefinition. New business models, enabled by technology, will emerge that offer mass personalization and unique solutions. They will be

built on technology platforms and operated within evolving ecosystems of partnerships and competition. Companies in the food and agricultural industries need to consider a world in which today's high-efficiency systems are entangled with deeply customer intimate systems. Absent new, high-volume and ultra-efficient uses for commodity grains, the future of Indiana's agriculture will look substantially different.

The reduction in prime farmland <sup>263</sup> in Indiana, often due to urbanization, has historically driven more marginal land into production.<sup>264</sup> In decades to come, as transportation and protein technologies advance, the evolution of Indiana

farmland is expected to accelerate. Land will likely leave production and new technologies will enable an ever more diverse crop mix. New and highly specialized corn and soybeans will target specific uses, such as customized ingredient formulations for the next generation of consumer product manufacturers. The farm of the future is expected to be diverse in its portfolio of crops and genetics, enabling more sophisticated risk management strategies. It is expected to be integrated into the value chain, transparent from end-to-end and targeted to support unique solutions for consumers.



## Recommendations



# Recommendations

There are five recommendations for Indiana food and agriculture companies to be resilient and future-proofed as the COVID-19 pandemic continues and in the event of additional disruptions: implement transparency and traceability in supply chains, increase collaboration, build last-mile agility and shorter supply chains, reexamine and refine customer segmentation and invest in the future.

Indiana is a leader in food and agriculture today and is well positioned to continue. Between 2010 and 2020, Indiana attracted over \$1.3 billion in investments to the biotechnology and life sciences industries, focused extensively on pharmaceutical and medical research and another \$2.3 billion in information technology, software, e-commerce and information services.<sup>265</sup> Over the same period, the state attracted approximately \$45 million in investments in food and agriculture startups, including breweries and restaurants.<sup>266</sup> The massive investment flow into biotechnology and technology indicates the presence of high-skill labor and opportunity in the state. Indiana also has three world-class research universities, including one of the nation's preeminent land-grant institutions. Purdue University, Indiana University and the University of Notre Dame all have startup incubators and entrepreneurial support networks to encourage new ideas and collaboration. Indiana offers the infrastructure to develop and deliver the technologies to enable the recommendations.

Like the other Midwestern states, Indiana's food and agricultural industries focus on high-efficiency production of mass commodities. It is time to diversify and establish the platforms and ecosystems to position Indiana to grow its leadership in the agbiosciences of the future.

## Implement transparency and traceability in supply chains

Consumers, customers, processors and manufacturers increasingly require transparency. Beyond changing regulatory requirements, companies need the ability to see real-time information about their supply chains. The COVID-19 pandemic dramatically highlighted the need for timely information about the location and status of products in the produce, transform, make and deliver stages. Some estimates indicated that a strict global lockdown for two months could create value-added losses of over 26 percent of GDP and that even if the lockdowns were limited to only the U.S. and Europe, the losses could be over 12 percent.<sup>267</sup> The ability to trace the supply chain provides real-time insights into post-pandemic opportunities and challenges, particularly with new levels of uncertainty. A 2019 survey of 500 executives from across the Americas ranked end-to-end visibility as the primary factor for supply chain success, followed closely by real-time responsiveness to internal and external issues.<sup>268</sup>

Transparency and traceability are also critical to delivering food, ingredients and commodities with specific attributes. The food traceability technology market is expected to reach nearly \$19 billion by 2023 and is growing at over 9 percent annually.<sup>269</sup> Advancements in technologies such as block chain, genetic tracing, near-field communication (NFC), radio-frequency identification (RFID) and the IoT can make the operation of multiple supply chains for identity protected products more efficient and provide guarantees to customers and consumers. Track and trace technologies offer the ability to create and validate certifications for consumer products at low cost. They also facilitate rapid tracing in the event of a contamination incident and the ability to conduct extremely targeted recalls, avoiding disruption across entire route-to-market channels. The implementation of traceability and transparency technologies promises to create resilience during times of disruption by enhancing collaboration and agility.

There are large number of studies showing consumers value and are willing to pay for traceability in the food supply chain.<sup>270</sup> Traceability is also taken as "given" by many consumers and will emerge as a market access issue for producers.

The lack of widespread traceability in the meat and livestock sector creates several risks, such as inadequate responses to food safety recalls and animal disease outbreaks. As international trade has played an increasingly important role in the overall demand for U.S. meat, it is important that U.S. producers can promptly respond to safety or disease issues to prevent loss of export markets. The case of the bovine spongiform encephalopathy (BSE) outbreak in the U.S. beef herd in 2003 is particularly telling; after that event, 53 countries banned imports of U.S. cattle and beef, resulting in over a 60 percent fall in beef exports that year. While mandatory traceability systems have faced stiff opposition in some livestock sectors, it is also the case that many producers are willing to participate in voluntary programs particularly if provided by private industry.<sup>272</sup>

Improvements in technology have lowered the cost to animal identification and traceability, and the emergence of platforms like blockchain, are enabling rapid transmission of information, including location, and origin of production, across the supply chain. Analysis by Pouliot and Sumner (2008) shows the dynamic benefits of added traceability to a food supply chain. Research has shown that added traceability prompts suppliers to improve safety and quality because of the potential for liability and reputational effects that traceability provides.<sup>273</sup> Moreover, these effects prompt consumers' willingness to pay to increase as quality and safety improves.<sup>274</sup>

Traceable and transparent supply chains also enable environmental, social and governance goals, such as the elimination of forced labor from supply chains for food manufacturers, animal welfare validation for conventional protein producers and the meeting of sustainability goals along the entire chain. Emerging technologies promise new governance models to support companies' environmental and social goals and the ability to communicate advances clearly to the market. As companies continue to adopt obligations to broader stakeholders, transparency and traceability will deliver the proof points.

## Increase collaboration

In the race to meet evolving consumer needs for nutrition, affordability, sustainability and transparency, food companies are increasingly searching for a route back to the farm. Some food companies, such as potato processors and protein producers, have historically had deeper connections to the farms that grow their inputs. Shifts in expectations from consumers are driving traditional packaged food companies to validate their sources of supply, requiring increased collaboration. The pandemic highlighted the need for collaboration between buyers and suppliers and demonstrated the value of processes for collaboration with suppliers and customers to measure and assess risk.<sup>275</sup>

Collaboration goes beyond sharing strategic plans. It requires making strategic plans together. The more complexity and dependency that exists between parties, the more important it is for them to collaborate.<sup>276</sup> As the food and agriculture industries evolve into platforms and ecosystems, partnerships within the value chain are increasing even among competitors. Examples abound, including ingredient formulation companies that manufacture their own consumer-facing finished products and manufacture competing finished products with their ingredients for other consumer-facing firms. Partnerships in sourcing, manufacturing, branding and commercial strategy are increasing as firms focus on high asset efficiency and targeted consumer segments.

To bring your suppliers and buyers into your strategy can be challenging, but within the confines of the collaboration, companies should share their planning activities. Companies are increasingly turning to scenario planning and war gaming as uncertainty and risk have multiplied from the pandemic. When source of supply is critical, bringing suppliers and buyers together to scenario plan and war game can be an effective approach to collaboration.



Collaboration can also improve the flow of products between channels or from low to high demand areas. Relationships with other actors in the value chain can facilitate market connectivity and information sharing, both of which enhance resilience against disruption. During the pandemic, increased collaboration could have redirected products between channels more rapidly, reducing losses and waste.

Technology platforms are a critical component of collaboration, but they facilitate multi-sided relationships and it is the relationships that matter most. Shifting into the Next and preparing for the Beyond require redefining relationships. Roundtables, conferences and executive summits can be platforms for relationship building and collaboration and today they can be digitally enabled. Companies and organizations in Indiana should find opportunities to connect and collaborate, drive discussion and create lasting relationships throughout the value chain. Executives should focus on developing relationship platforms within their own value chains and determine when and how to engage members in planning activities to improve resilience and robustness.

## Build last-mile agility

Solutions to Indiana's disruptions to the food chain, such as the redirection of dairy and egg products, meat and food service products, during the pandemic are lessons in ingenuity and rapid response. Examples abound from shifting sales to e-commerce, developing new packaging for takeout and redirecting farm goods directly to consumers, food suppliers found new channels and customers and adapted to wild swings in demand.<sup>277</sup> As quickly as late February after the global onset of the pandemic, 94 percent of Fortune 1000 companies reported supply chain disruptions.<sup>278</sup> In October 2020, 49 percent of consumers reported visiting physical stores less and 33 percent reported ordering more non-grocery products online, while 25 percent reported ordering more groceries online.<sup>279</sup>

Last-mile delivery is growing at over 10 percent per year,<sup>280</sup> and will continue growing as costs decline and network effects increase. The pandemic has transformed consumer food interactions in the short-term and many of these changes will be durable. Nearly half of U.S. consumers report that they will cook for themselves and families more often and 13 percent of consumers report they will use grocery delivery services more often.<sup>281</sup> Approximately a quarter of consumers report they will pay a premium for convenience.<sup>282</sup> Last-mile consumer-focused delivery systems can play a critical role increasing agility and members of the food and agriculture industries should consider developing relationships with consumer-facing, last-mile delivery organizations. Last-mile agility is enhancing the

consumer experience, allowing purchases from stores without nearby brick-and-mortar operations and allowing consumers to remain at home during the pandemic.

Last-mile agility is a combination of innovation, partnerships and collaboration and transparency and traceability. The technologies deployed to create transparency also create agility. From the manufacturing line to the consumer, a clear view of the chain combined with open collaborations with chain participants facilitate agility to pivot into new channels.

Manufacturing has transitioned to "just-in-time" over the past two decades frequently under the assumption that supply chain disruptions were manageable and idiosyncratic, not systemic. The pandemic shows the need to balance efficiency with robustness to plan for systemic disruption. Manufacturers should consider inventory holding arrangements with adjacent chain participants to build disruption buffers. They should also develop a robust scenario planning process that includes specific, detailed contingency plans for systemic and idiosyncratic disruptions, including last-mile pivots.

As companies recover and plan for the Next and Beyond, they need to reconsider their asset base and strategic plans. The future is built on platforms within ecosystems. Developing targeted, specific asset bases and asset light strategies with partnerships and alliances allows companies to share challenges in downturns and support growth in rebounds. The approach of broader collaboration within ecosystems also diversifies risks associated with specific channels by having relationships for fast pivots in place before a crisis.

## Reexamine and refine consumer segmentation

Consumers continue to evolve and the pace of change is accelerating. The integrated and connected experiences consumers have with technology is changing expectations for almost every interaction. As the pandemic fades, consumers will segment in the Beyond into Affordability first (32 percent), Health first (25 percent), Planet first (16 percent), Society first (15 percent) and Experience first (13 percent).<sup>283</sup> Over two-thirds of consumers in the Affordability first segment report that they believe their experience with technology will improve over the long-term. Over 40 percent of consumers in the Experience, Health and Planet first segments report they will mostly shop online in the future and over 40 percent of all consumers report they would give up some data to have tailored promotions and deals.

Approximately one-in-six consumers report that locally sourced will be a key purchase criterion for fresh foods in the future. At least one-third of consumers report that healthy will be a key purchase criterion in the future rising to 45 percent of consumers for the two largest segments, Affordability and Health. Unsurprisingly, all segments report that price will be important, with Affordability first reporting the most price sensitivity and Society first reporting the least price sensitivity.<sup>284</sup>

Consumer segmentation is more important than ever, particularly under channel uncertainty. Consumers are changing the way they shop, the products they purchase and the attributes they prioritize. Millennial and Gen Z consumers will predominantly be Planet First (23 percent) and Health First (22 percent) focused, with Affordability First a close third (20 percent).<sup>285</sup> The generations that prior to the pandemic were known for focusing on experiences will focus on wellbeing in the Beyond. They report slightly lower levels of price sensitivity than older generations. Food attributes and formats will become increasingly important as younger generations' purchasing power increases. As companies come out of the pandemic, they should redevelop their portfolios to be relevant to future consumers, provide digital and online customer experiences to reflect changing shopping behavior and create transparency to build consumer trust.<sup>286</sup>

The impacts of the pandemic are fundamentally changing the way consumers interact with organizations, products and services. Companies need to reevaluate their segmentation strategy and focus on key purchase criteria, shopping behavior and expectations and generational differences. They need to integrate their segmentation strategy into their scenario planning and create partnerships for resilient delivery within and between channels. The food chain is transforming from push to pull and consumers are driving change at all levels. All companies, regardless of their positions in the chain, need a consumer-centric segmentation strategy. A consumer segmentation strategy fundamentally informs the technologies and partnerships in which companies should invest.



## Invest in the future

Over the past decade, Indiana startups have raised nearly \$2.7 billion in pre-IPO funding. Five of Indiana's peer states' businesses have raised a total of \$21.9 billion in pre-IPO funding.<sup>287</sup> North Carolina businesses raised over \$9 billion; Minnesota businesses raised over \$7.2 billion; Missouri businesses raised \$2.9 billion; Wisconsin businesses raised approximately \$2.1 billion; and Iowa businesses raised almost \$700 million.<sup>288</sup> Indiana lags some of its peers, but the state has the infrastructure, knowledge and skilled labor to compete for venture capital and startup funding. Indiana businesses also have the economic incentive to invest in their local startup and business ecosystems. Changes in labor availability and consumer demands offer enormous opportunities for investment.

Indiana producers report labor as one of their most pressing challenges.<sup>289</sup> Some startups and new businesses are working to design fully automated production systems for high-value crops, such as lettuce and vegetables. Investments in labor technologies are shifting from labor augmentation – such as larger tractors and equipment – to labor replacement. The need in Indiana continues to grow as agricultural labor continues to shrink. The capital requirements for innovation are high but the returns are potentially large. High profile examples of companies that invested deeply in the future are Tesla and Space Exploration Technologies Corp., known as SpaceX. Elon Musk, the CEO of both companies, invested everything back into growth at the firms. As of early December 2020, Tesla was valued at more than \$600 billion, making it one of the world's most valuable companies.<sup>290</sup> Investments enable innovation, and in Indiana the need for automation is growing. This is particularly true to protect against future labor shocks, such as those created by the pandemic.

Consumer demands, such as for new food attributes, plant-based products, food delivery and food traceability, all drive the need for new technologies and tools. Indiana companies need to increase their engagement with the startup ecosystem and invest in new businesses to develop, validate and scale new technologies. A willingness to take risks through new technologies and business models is critical to advancement of the agbiosciences in Indiana.

The access that many Indiana organizations have to the entire food chain, from farm to fork, is unique. It offers visibility and collaboration opportunities that many states would be challenged to provide. Most of Indiana is within a one-day drive of a large part of the U.S. population and the state has substantial experience in food and agricultural production. Investments in Indiana are critical to transform its future into a producer of not only higher-value agriculture but also new technologies to meet emerging demands.

# Endnotes

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