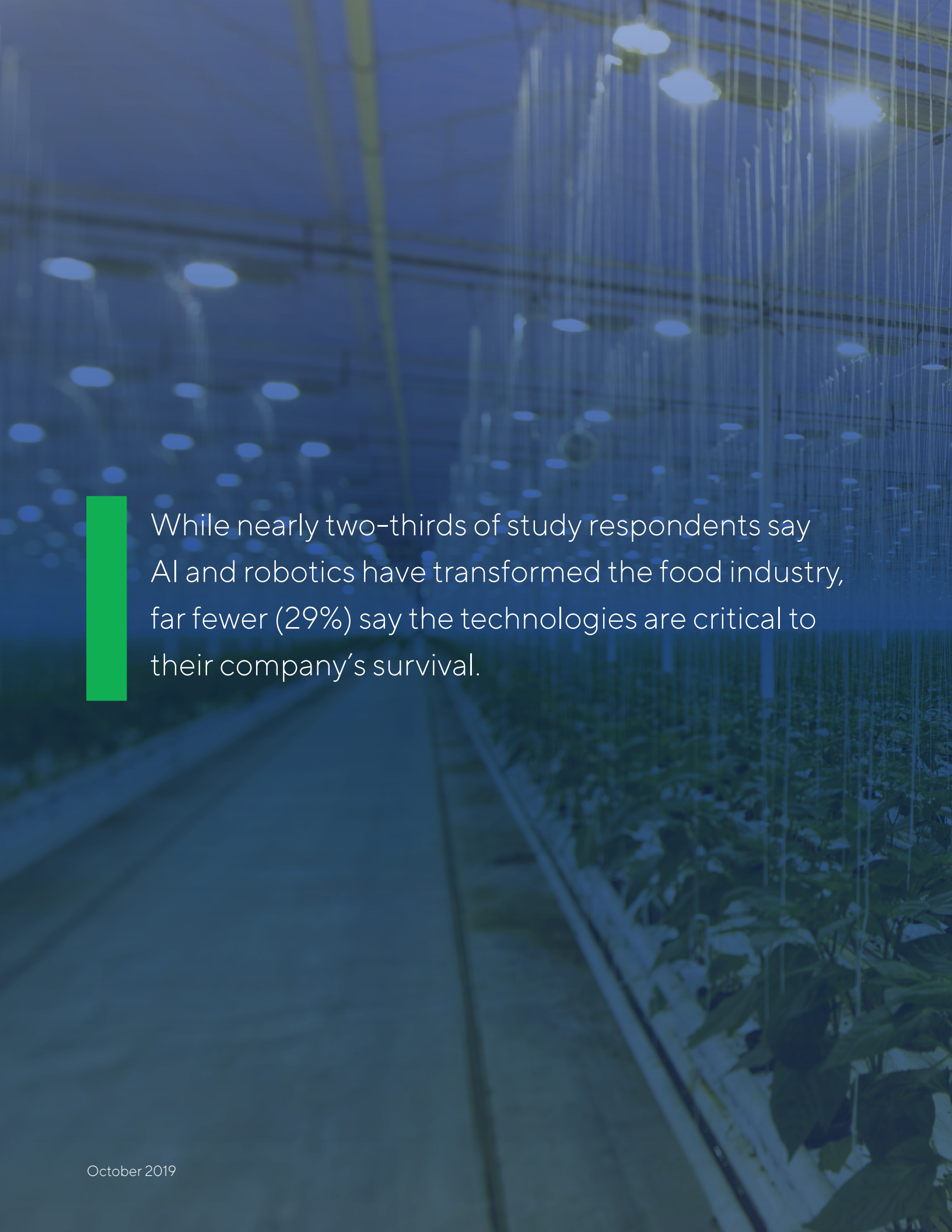
Cognizant

AI, Automation and Appetites: How Technology Will Feed the Future

From how food is grown and formulated, to where and what we eat, the food industry is looking to emerging technologies to address entrenched challenges, according to our latest study.

Center For
The Future of Work



While nearly two-thirds of study respondents say AI and robotics have transformed the food industry, far fewer (29%) say the technologies are critical to their company's survival.

Executive Summary

Throughout recorded history, food has played a central role in the human experience, and central to food's role has been technology. The wheel improved agricultural efficiency. The mill powered the explosion of food production during the First Industrial Revolution. Point-of-sale tills are at the heart of the $570 billion fast-food industry[1] that is a ubiquitous part of the modern world.

Now, a new generation of emerging technologies – analytics, automation and artificial intelligence (AI), in various shapes and forms – is set to upend every aspect of the global food industry. From production (autonomous farming and crop status analytics) to distribution (self-driving vehicles and machine vision inspections) to retailing (cloud kitchens[2] and robotic food preparation), the future of food looks quite different from a mere few years ago. As technological development accelerates, the food industry is poised for considerable change at every level of the supply chain.

This change is long overdue. The global food system faces significant challenges, chief among them climate change, evolving food tastes, new consumption preferences and the need to feed an additional one billion people over the next 12 years.[3] The food industry must step up its adoption of AI, analytics and automation in short order while also reskilling the workforce to adjust to these changes. The stakes for successfully navigating the future of food have globe-spanning consequences.

To understand the relationship between food and technology, Cognizant's Center for the Future of Work teamed with Oxford Economics to survey 304 food industry leaders across the globe to learn how they are preparing for the challenges and opportunities ahead (see page 20 for more on the study methodology).

Among our key findings are the following:

- **Respondents are slow on the uptake about AI.** While well over one-half of respondents say AI and robotics have transformed the food industry, far fewer (29%) say the technologies are critical to their company's survival.
- **And yet the evidence is compelling.** Just under one-third of respondents say their companies have implemented AI broadly across business functions. For these companies, AI investments have made a considerable difference in worker productivity (84%) and quality of worker experience (72%).
- **Labor needs will shift – but not in the way you might think.** Survey respondents expect the number of full-time and contract workers to hold steady regardless of how and where AI is applied. However, the vast majority of respondents (90%) believe that by 2025, AI will boost the industry's need for high-skilled labor, and 74% forecast it will diminish demand for low-skilled work.
- **Climate change is the elephant in the room.** Increasingly volatile weather patterns are proving to be a bane for both consumer and producer alike. Food waste is a major contributor to climate change. As such, 52% of respondents reporting using AI and automation to great effect in reducing food waste.

Just as the Baroque still-life fruit paintings of Caravaggio gave way to Instagrammers posting photos of every #meal to their social feeds, so too is the food experience morphing through the influence of modern technologies.

How does your organization fit within this forward-looking food system? What will happen to the food workers displaced by automation? Will AI-based diet-tracking apps finally put an end to the question of "what's for dinner"? The answers to these questions revolve around the strategic decision-making that will make food production, distribution and retailing more efficient, convenient and sustainable than ever before.

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AI PROVING WORTH ITS SALT

One hundred years ago, a Minnesota clinician working for the Washburn Crosby Company stumbled onto a meal ticket still paying off today. After the worker spilled wheat bran on a hot stove and realized it was tasty, Washburn spent the next three years and over 30 iterations attempting to recreate the magic of the happy accident. Finally, the process was perfected, and Wheaties[4] cereal was born.

Fast-forward to this century, and three years is more than enough time for cereal to be replaced by avocado toast[5] as the breakfast choice *du jour*. The preferences and expectations of food consumers are quickly evolving in unforeseen ways, influenced by almost instant access to products, dwindling free time, less emphasis on home cooking and increasing consciousness of food's impact on personal health and the environment.

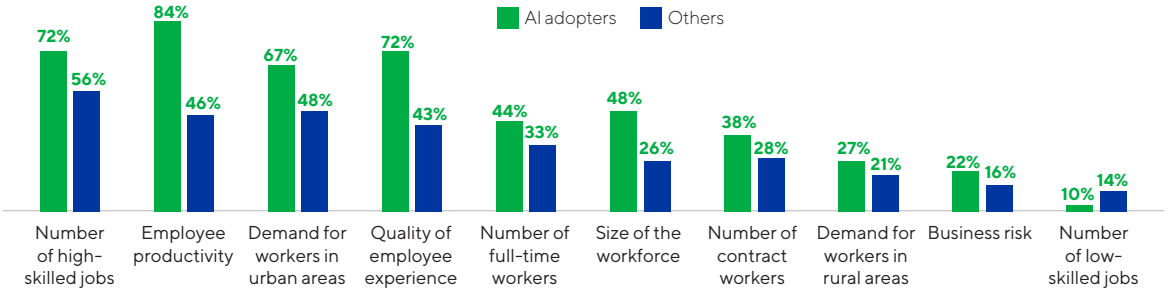
AI innovations are emerging to help food companies keep up with these changing dynamics. Platforms like JourneyAI[6] are helping companies bring new food products to market faster through AI and machine learning (ML) that matches ingredients for preferred nutrients, tastes and textures. Wise Systems[7] uses AI and ML to optimize fleet dispatches and improve last-mile food delivery operations. Goodr[8] uses blockchain and data analytics to divert food waste from landfills, saving companies money while providing a public good.

These startups are indicative of the changing tide washing over the food supply chain; indeed, well over half of respondents in our study (61%) say AI and robotics have transformed the food industry. At the same time, respondents don't necessarily see AI as pertaining to their own company's mission and goals, with only 29% believing the technologies are critical to their own company's success.

Roughly one-third of respondents had implemented AI broadly or integrated it across the business, while the remainder are piloting, planning or not considering AI. Of the AI implementors, most say the investment has made a considerable difference in worker productivity (84%) and the quality of the employee experience (72%) (see Figure 1). At egg producer CMC Food,[9] for example, adding AI-driven robots to its packing process has dramatically improved worker productivity, with robots now handling 200,000 eggs per hour. Such AI deployments can also ease the burden of repetitive, dangerous or uninteresting tasks, which has a direct effect on the worker experience. These results align with our findings at the Center for the Future of Work, where we estimate that AI will enhance the output and productivity of most workers.

Artificial intelligence impacting the workforce

Percent of respondents who said emerging technologies like AI, automation, algorithms and robotics have increased or significantly increased the following areas of workforce operations.



Base: 304 food industry executives (88 AI adopters, 216 non-AI adopters)
Source: Cognizant Center for the Future of Work
Figure 1

Quick Take

Global Cities Address Urban Food Issues with AI

Population growth continues to accelerate across the globe, with the Earth's total population possibly surpassing 10 billion residents around 2050.[10] Adding another layer to these dynamics is the shifting of populations from rural to urban areas. By 2050, 80% of the world's food will be consumed in urban areas.[11] While this increased centralization of food demand makes it easier to build out transportation networks, the challenge is getting enough food into these areas when most of it is grown where there's an abundance of land, typicallyin rural, less populated regions.

Some of the most densely populated cities on the planet have begun piloting programs that address this issue. Deep below London's city streets lie underground farms inhabiting the city's former bomb bunkers. In Tokyo, the farms lie underground, on rooftops or anywhere else a bit of land can be spared. These aeroponic farms are fully automated to light and nourish leafy greens around the clock. Each harvest brings more data on optimal conditions for maximizing yield. One Japanese farm alone is expected to produce 5,000 heads of lettuce per day by 2020.

The cost of indoor farming, however, has been prohibitive for less affluent cities. Despite having the second highest urbanization rate in the world (81%), Latin America and the Caribbean[12] have yet to make significant progress with urban farming. Companies like Seedo look to change that with AI-powered indoor farms.[13] The company's systems automate the lighting and watering processes to produce a range of fruits, vegetables and herbs. Seedo's system is a lower cost option that fits the needs of developing regions. The proliferation of such systems is of particular use in areas where infrastructure connecting to rural farming regions is not as robust as in highly industrialized nations.

FEAST OR FAMINE FOR THE AI-POWERED WORKFORCE

AI and other emerging technologies will also bring about changes to the food industry's labor pool, which serves as an important employment provider in many countries. This is a global commonality from the U.S. (where it's the country's largest private sector employer),[14] to Sub-Saharan Africa, where it accounts for 60% of employment.[15] Changes to labor trends in this sector will no doubt have considerable economic impact.

AI-driven shift toward high-skilled labor

The vast majority of respondents (90%) believe that AI will boost the need for high-skilled labor, and 74% forecast it will diminish demand for low-skilled work.

Base: 304 food industry executives
Source: Cognizant Center for the Future of Work
Figure 2

While AI is expected to enhance jobs for 75% of the global workforce,[16] the remaining 25% face uncertainty. The workers with relevant high-skilled labor experience can look forward to newly created jobs, but others will see their roles eliminated as automation and robotics begin replicating their skill sets in the workplace. The 75%-25% bifurcation correlates strongly with the delineation between low-skilled labor and high-skilled labor in our study. The majority of respondents (75%) expect decreased demand for low-skilled labor by 2025 and increased demand for high-skilled labor (90%) (see Figure 2).

The most endangered workers in the low-skilled labor pool are retail clerks, cooks, food prep and transportation workers[17] – the majority of the frontline food industry workforce. These are often jobs that provide a path of entry into the workforce for young workers or those returning to the labor market. Automated kiosks, bots that flip burgers and self-driving trucks stand at the ready to upend work prospects for many in the food industry.

If history is any indication, the low-skilled food industry jobs lost to automation and AI will give rise to an equipoise of new high-skill jobs. Two types of expertise that will be in high demand, according to our study, are related to artificial intelligence and smart, connected devices, known as the Internet of Things (IoT). Two-thirds of respondents ranked AI as the most important skill over the next two to five years. Computer vision platforms that ensure food safety, new product formulation and even cooking food are all processes now augmented by advances in artificial intelligence.

Quick Take

Emerging technologies address changes in our eating habits

People are spending less time in their own kitchens and more in the dining halls and restaurants that cater specifically to their needs. In fact, U.S. consumers' spend on eating out now exceeds spending on groceries.[18] This trend will likely continue, and with it are opportunities for gain and loss in the industry.

The grocery industry looks to reclaim that lost revenue with investments in customer conveniences. Curbside pickup of online orders is now table stakes for leaders in the industry.

In recent years, entrepreneurs have begun designing mobile grocery stores that bring fresh produce and other food staples to the neighborhoods of customers. Companies like Starship[19] and Robomart[20] are partnering with national grocery chains to convert self-driving vehicles into mini grocers on wheels. These vehicles arrive in neighborhoods of customers that have ordered items online, further reducing the time constraints of preparing meals at home.

The demand for IoT skills by 61% of survey respondents is driven by the proliferation of sensor-outfitted systems throughout the supply chain.

- **In precision agriculture operations**, farms are outfitted with arrays of sensors and observed by satellite or drones to help farmers improved decision making.
- **Manufacturing facilities use the technology** to ensure effective processing of food materials.
- **Instrumented food transportation vessels** keep foods in the right conditions for freshness at the point of sale.
- **Retailers use IoT** to keep shelves stocked and track customer movement around stores.

Such detailed tracking enables more informed decisions and forecasts throughout the industry.

To fulfill these skill needs, the food industry can work on attracting skilled AI and IoT experts from other industries. However, particularly in AI, food businesses face stiff competition from the likes of the FAANG cohort (Facebook, Amazon, Apple, Netflix, Google), which, along with the rest of the top 20 AI recruiters, spent $650 million to hire talent in 2017.[21] With notoriously thin margins, food companies are challenged to acquire that talent without breaking the bank. Additionally, this approach reduces institutional knowledge, as the targeted workers likely have little experience working in the food industry.

Of course, food businesses can also work to upskill the current workforce. Taking a note from UK insurer Aviva,[22] companies could proactively offer to retrain employees who fear their job tasks could be replaced by automation. Such an approach has the dual impact of reducing disruption of low-skill workers caused by automation while supplying food companies with their high-skill workforce of the future. This preserves institutional knowledge and boosts morale as a clear example of investing in workers.

Given the complexity of adequately staffing an industry in the midst of technological upheaval, a hybrid approach to developing the workforce of the future is the best course of action for food companies. Efforts to retrain internal talent for AI and IoT jobs can be bolstered by the acquisition of talent already equipped with such knowledge. The industry must also work with educational institutions to ensure that graduates arrive in the labor pool with skillsets that intersect at technology and food production, delivery and service. Doing so is a matter of survival for both parties in the future of work.[23]

Virginia Tech seeks to bridge the gap between industry and academia via its Smart Farm Initiative.[24] The program seeks to connect university researchers with business partners to develop and deploy innovative technologies in food and agriculture. Advocates from Nebraska to Maryland are reaching out to underrepresented young people via Future Farmers of America to introduce them to opportunities in food tech. Through thoughtful partnerships, food companies can build on this engagement and establish the foundation for their future workforce.

EMERGING TECHNOLOGIES IN ACTION

Artificial intelligence and other technology tools at our disposal are already beginning to reshape the food industry and how we feed ourselves. With AI, each link in the supply chain creates a smorgasbord of data points that provide businesses with more grist for the mill. While the fringe experimentations and innovations in the food industry lack the scalability or price points for mass use, they provide an early indication of where the industry is headed.

Food production

Once, tending to a farm required only hand tools and a hard day's work. That gave way to petrol-powered plows and other machinery. The tools of the trade for the future of food will be data-driven, sensor-equipped and autonomous.

One challenge these tools will address is the risk endemic to farming. Growing conditions are unpredictable, and even when the weather agrees, farmers must still contend with pests and devastating crop diseases. The age-old *Farmer's Almanac* approach will likely be superseded by companies like Gro Intelligence, which offers greater granularity and consistency in insights. The company analyzes data from over 100 sources to create predictive model algorithms for agricultural conditions.[25]

For environments where open-air food production is untenable, like drought-stricken areas or congested city centers, Farm.One[26] provides a solution. The vertical farm grows leafy green vegetables inside shipping containers outfitted with sensors and machinery that automate many cultivating tasks while using 95% less water than traditional farms. The portability and accessibility of the platform opens up new working opportunities in agriculture for populations previously limited due to geography.

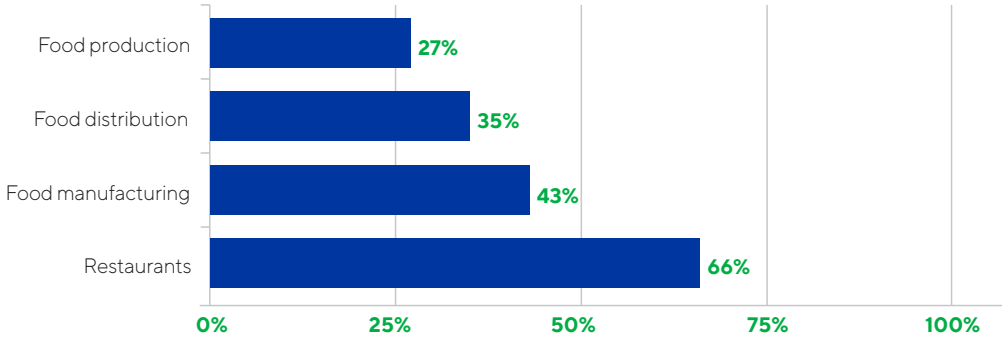
As food products move from cultivation to formulation, artificial intelligence is super-charging the process. Tastes change with the rise and fall of viral food crazes[27] like the cronut or rainbow bagel. Businesses can't afford to spend years developing products that may have fallen out of favor during R&D. Food innovators now have access to JourneyAI databases of food properties, feeding into algorithms that help determine the best combination of ingredients to create new food products. Using Tastewise analytics, these new products can be matched to emerging taste trends to capitalize on emerging sales opportunities.

Food retailing

New business models fueled by AI and analytics are changing the dynamics of food retailing. In our study, 66% of restaurant and hospitality executives say the popularity of new business models have had a positive impact on business. In addition to providing additional streams of income, new business models also generate a new set of data points on consumer demand and preferences. This data can inform decisions ranging from upsell opportunities to merchandising choices or staff scheduling.

New business models fuel positive dynamics

Percent of respondents reporting a positive impact of new business models.



Base: 304 food industry executives
Source: Cognizant Center for the Future of Work
Figure 3

The "cloud kitchen" is emerging as a viable new business model for restaurateurs. The premise of the cloud kitchen (also called a ghost restaurant, dark kitchen or virtual restaurant) is a food service company that provides delivery services without any physical dine-in space for customers. Often the location will house multiple restaurant concepts. The operation works in tandem with on-demand delivery services to fulfill orders and establish a digital presence on their mobile apps. This approach brings agility to the food service industry by drastically reducing the cost of testing new concepts and accelerating time to market.

Emerging technologies will also introduce cost savings for restaurant businesses. By 2025, 60% of study respondents expect to see cost savings from their technology investments as a result of more efficient business models and processes. For example, sushi chain MakiMaki employs robots in the kitchen to help make sushi rolls. Those robotic helpers can prep food faster than their human counterparts, and the cost savings on labor have driven expansion to multiple locations throughout New York City. Larger chains can speed this implementation by rethinking their processes to understand which aspects are better for robots (repetitive, simple or dangerous) and which tasks call for the human touch (creative, complex, customer-facing). Emphasizing the strengths of each will be essential to scaling workforces in the future of work.

While upstarts tend to be the driving forces for innovative concepts in the food industry, even the most established players embrace the benefits of AI. McDonald's has done just that with its recent acquisition of startup Dynamic Yield. The company uses artificial intelligence to customize drive-through displays in real time, offering upsells to customers based on their preferences and factors like weather or local trends. Competitors across the restaurant industry will soon follow suit with 75% of study respondents expecting enhanced personalization and speed from the technology they implement.

Consumer-facing companies aren't the only ones putting artificial intelligence to use in the food supply chain. Food distribution leaders report the highest level of implementation, with 60% of them applying AI and automation to their operations. While autonomous vehicles remain in the testing phase, some of its underlying technology has already been put to use. Through machine learning and sensor-outfitted

vehicles, Wise Systems provides its food services customers with autonomous dispatch and routing software that continuously updates for increased fleet efficiency.

Food waste

Food waste is a massive global problem. The food industry sent $1 trillion worth of food to landfills across the planet last year, which accounts for one-third of all global food production.[28] Rotting food releases methane, a gas that's 20-times more harmful than carbon dioxide when released into the atmosphere. It can take up to 25 years for a head of lettuce to fully decompose[29] at a landfill. By the time the salad you threw out last week is fully decomposed, our global population will have increased by two billion people.

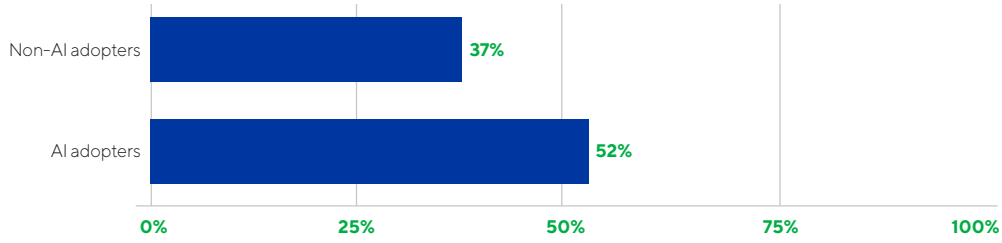
AI is helping companies make better use of food waste and adhere to the principles of "circular economics," a concept in which waste materials are diverted from landfills for use in other products or services. Implementing technology like IoT-enabled kitchens provides food companies with the data they need to begin making changes around operations and waste management. Kitchens are now being outfitted with machine vision trashcans that track which items are tossed and how much. With continuously updated reporting, IoT company Winnow provides restaurants with data on what food gets tossed out, so they can reduce food waste and cut costs.

According to our study respondents, technology makes a notable difference in reducing food waste. More than half of respondents that incorporated it broadly into their business operations had successfully reduced food waste (52%) compared with just 37% of non-AI implementers. Restaurants have done so through the use of Goodr, a logistics service that sources excess food for distribution at non-profits, or via Food For All, a secondary market that matches excess food to customers seeking discounts.

Not only is comprehensive food waste management essential to reducing greenhouse gas emissions; it also saves companies considerable amounts of money. For every $1 that companies invest in alternative uses for their food waste, they realize $14 in savings.[30] In doing so, the food industry can create jobs, relieve the strain on our food system and positively impact the environment. AI is helping companies turn circular economy principles from aspirations into competitive advantage.

Reducing food waste through artificial intelligence

Percent of respondents who say they've reduced food waste.



Base: 304 food industry executives (88 AI adopters, 216 non-AI adopters)
Source: Cognizant Center for the Future of Work
Figure 4

More than half of respondents that incorporated AI broadly into their business operations had successfully reduced food waste (52%) compared with just 37% of non-AI implementers.

Quick Take

Building climate change resilience

With each of the past five years ranking among the five hottest[31] in recorded history, we need not cast our eyes on the future to understand this change. Catastrophic weather events growing in scale and frequency exact a great toll on the residents of areas of impact. Beyond the initial damage and casualties, these events have reverberating effects on food supply chains around the world. As cities begin assessing how to increase resilience to such changes, the food industry must also adopt a resiliency plan for operations.

Agricultural operations face a number of threats as human activity negatively impacts the climate. With less predictable weather patterns and more acidic oceans, previous farming practices yield less and less output. Such changes have already manifested in the UK. Changes in weather patterns have thrown plant and animal life cycles out of sync. As a result, insects are feeding on plants earlier than before and negatively impacting harvests of staple crops like potatoes.

Globally, for every 1°C over pre-industrial levels the Earth warms, wheat yields will fall 6%, according to a 2015 paper in *Nature Climate Change*.[32] The challenge presented to farmers by climate change has led to some moving indoors. Innovative programs at MIT[33] have already begun using automation and data analytics to program indoor farms that precisely manipulate indoor conditions to best grow herbs and vegetables.

Ever more precarious environmental conditions call for constant monitoring of fields for infestations or disease. Big data analytics combined with machine learning of satellite images bring insights that can add value to farmers struggling to make sense of the new climate realities. This is the approach of agricultural analytics firm Farmwave.[34] Using computer vision technology, the company observes clients' farms and provides early identification of pests or pathogens present in the field.

FEEDING THE FUTURE

Eating is a sensory, cultural experience. As such, work in the food industry needs to maintain a human touch.

The destabilization of growing environments, explosive population growth and shifting consumer behavior all exert forces on one another, while also influencing the technological innovations needed for a functioning food system. The winners in the future of food will be those that don't attempt to rail against these trends but instead pick up on the cues of their customers and serve them accordingly while using technology to combat emerging environmental challenges.

The emerging technologies and methods covered in this report give entrée to success in the future of food. As with any good recipe, this won't happen immediately. Ingredients take time to combine and impact one another. With that said, implementing the following recommendations sooner than later gives food companies a larger window for getting it right:

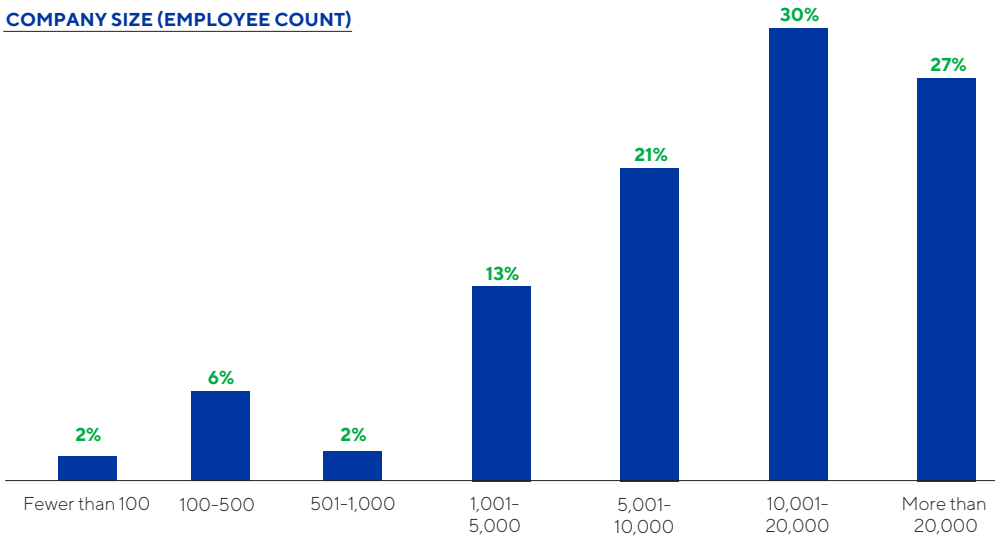
- **Move fast and fix things:** While there's an imperative to keep pace with AI innovators, too many people rely on precarious food systems to disrupt them for the sake of innovation. The typical Silicon Valley approach won't work here. Instead, use AI and automation to discover new solutions for the previously identified customer pain points, such as Dynamic Yield's food ordering kiosks that use environmental cues to predict and improve customer orders.[35]
- **Collaborate with innovative, agile partners:** A robust scene for innovation is already in motion with a myriad of startups and accelerators in the food industry. Launching an accelerator or partnering with pre-existing organizations pairs innovative thinking with in-house expertise. Chobani[36] has reaped the benefits of this approach. The company's incubator program supports food industry startups, and the company has already added 30 program participants to its portfolio.
- **Bring the robots, but mind the humans:** Eating is a sensory, cultural experience. As such, work in the food industry needs to maintain a human touch, no matter how tech-driven it becomes. Double down on anthropological and psychological studies to enhance the sense of humanity as robotics and automation proliferate in the food industry. Miso Robotics learned the value of this approach when it discovered hyper-efficient burger-flipping robots needed interventions to maintain the teamwork required for an effective kitchen.[37]
- **Embrace new models:** The pace of change in the food industry is the fastest it's ever been. Those that fight change will be left in its wake. Instead, observe cultural shifts – less time spent cooking at home or expectations of near-instant delivery – to apply new technologies and methods that facilitate new opportunities.

The new technologies at play present an array of new opportunities and challenges for workers in the industry. Entirely new business models are emerging that take advantage of advancements in technology and cultural shifts around dining. To make these new models work, food companies need a new recipe for success, one that revolves around adopting new concepts to excel in new environments and building on pre-existing knowledge of best practices. An appetite for adaptability is the key ingredient for thriving in the future of food.

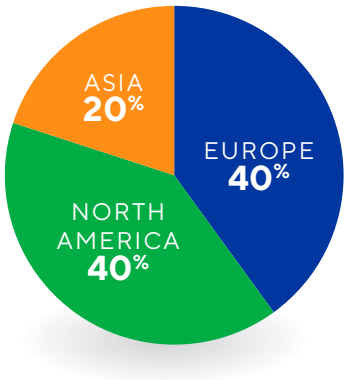
Methodology

In partnership with Oxford Economics, we conducted a study of 304 food industry senior executives (C-suite and their direct reports) in March and April 2019 across regions, industry segments and company sizes.

COMPANY SIZE (EMPLOYEE COUNT)

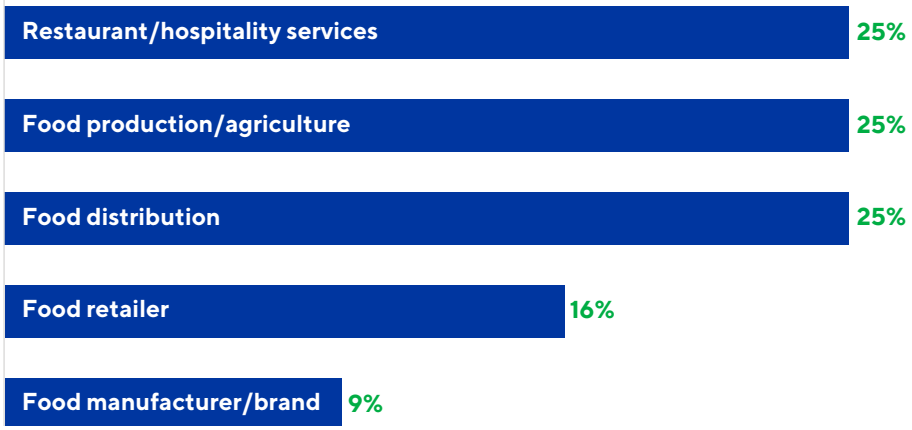


REGION



(Percentages may not total 100% due to rounding.)

INDUSTRY SEGMENT



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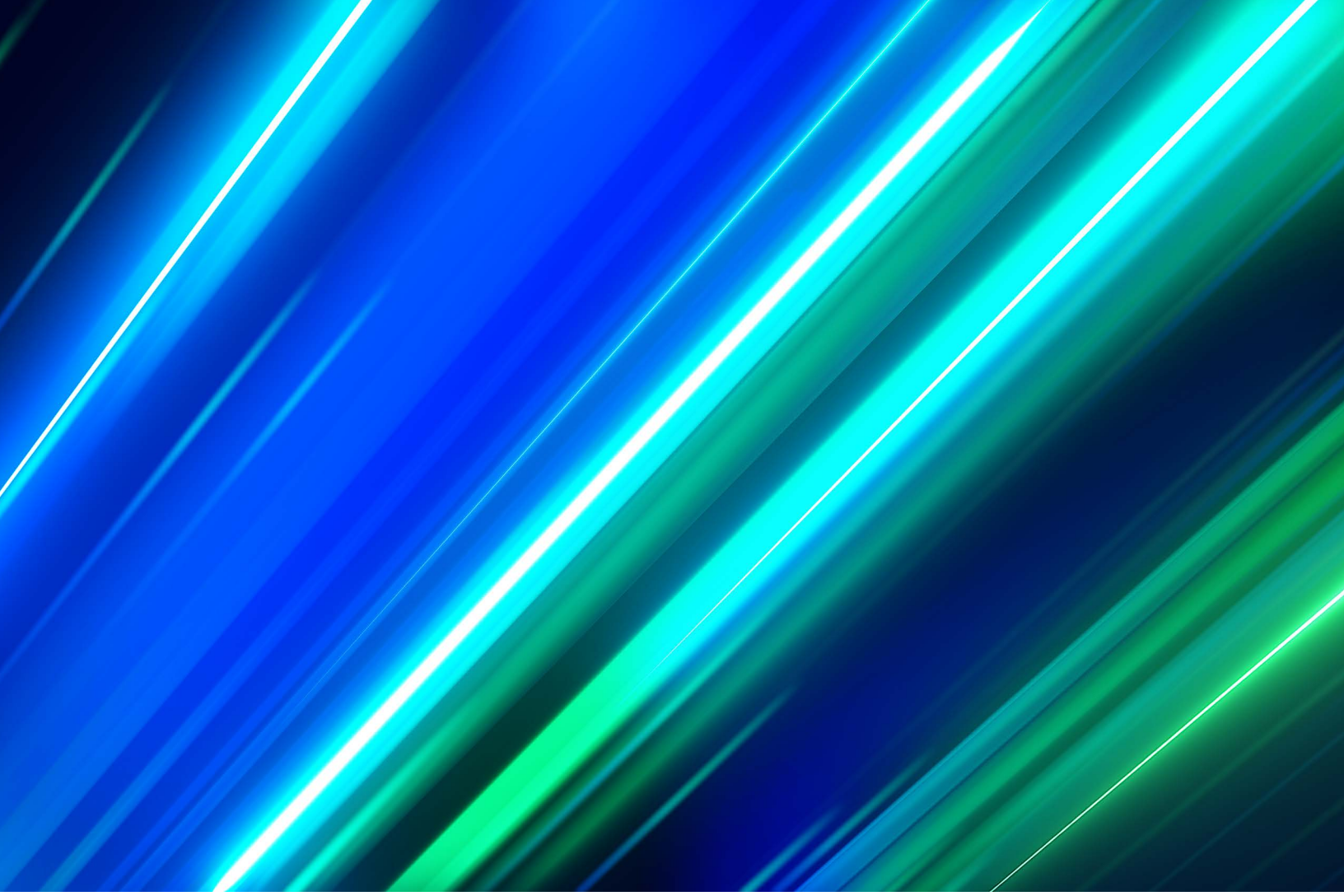
About the author

Desmond Dickerson

Senior Consultant, Center for the Future of Work

Desmond Dickerson is a Senior Consultant in Cognizant's Center for the Future of Work. Leveraging his experience in digital transformation and marketing, Desmond consults with clients on optimizing digital strategies that prioritize user experience and engagement. His research with the CFoW focuses on the human impact of decisions related to technology development and deployment. He has an MBA (data analytics) from Georgia Institute of Technology, and an undergraduate degree in marketing from Georgia State University. Desmond can be reached at Desmond.Dickerson@cognizant.com.



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Cognizant's Center for the Future of Work™ is chartered to examine how work is changing, and will change, in response to the emergence of new technologies, new business practices and new workers. The Center provides original research and analysis of work trends and dynamics, and collaborates with a wide range of business, technology and academic thinkers about what the future of work will look like as technology changes so many aspects of our working lives. For more information, visit Cognizant.com/futureofwork, or contact Ben Pring, Cognizant VP and Managing Director of the Center for the Future of Work, at Benjamin.Pring@cognizant.com.

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Cognizant

World Headquarters
500 Frank W. Burr Blvd.
Teaneck, NJ 07666 USA
Phone: +1 201 801 0233
Fax: +1 201 801 0243
Toll Free: +1 888 937 3277

European Headquarters
1 Kingdom Street
Paddington Central
London W2 6BD England
Phone: +44 (0) 20 7297 7600
Fax: +44 (0) 20 7121 0102

India Operations Headquarters
#5/535 Old Mahabalipuram Road
Okkiyam Pettai, Thoraipakkam
Chennai, 600 096 India
Phone: +91 (0) 44 4209 6000
Fax: +91 (0) 44 4209 6060

APAC Headquarters
1 Changi Business Park Crescent,
Plaza 8@CBP # 07-04/05/06,
Tower A, Singapore 486025
Phone: + 65 6812 4051
Fax: + 65 6324 4051

Codex 5038