MIT Technology Review Insights

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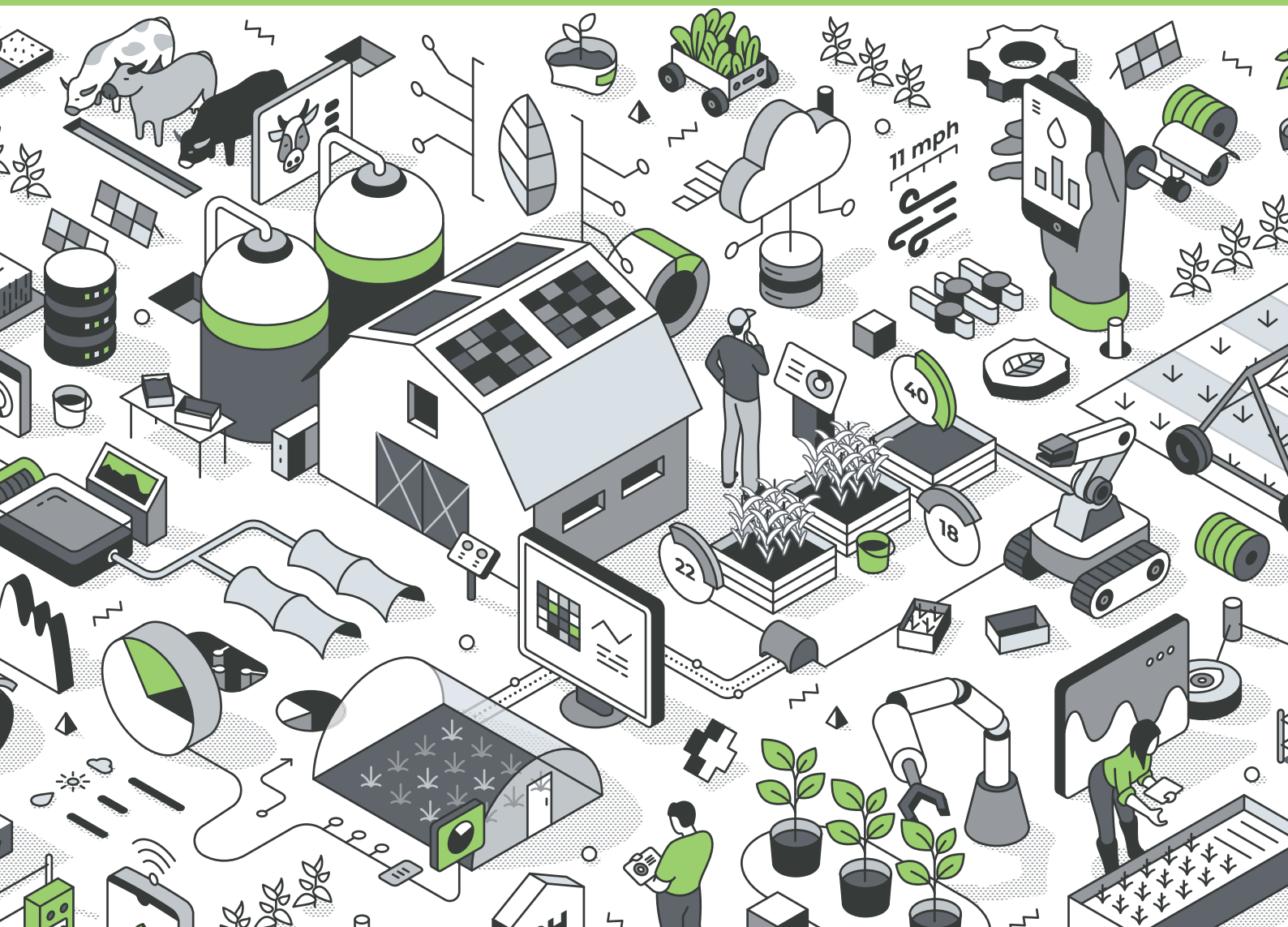
revvity signals

How AI can enhance production and innovation to meet the world's growing need for nutritious food.

Powering the food industry with AI



Preface

"Powering the food industry with AI" is an MIT Technology Review Insights report sponsored by Revvity Signals. This report draws on seven in-depth interviews with senior executives and experts. It seeks to understand how the food industry can use AI to help meet the increasing global demand for nutritious, affordable produce, ensure resilient supplies, and minimize its effects on the environment. Adam Green was the author of the report, Laurel Ruma was the editor, and Nicola Crepaldi was the producer. The research is editorially independent, and the views expressed are those of MIT Technology Review Insights.

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Foreword

As the food science industry moves deeper into the 21st century, it remains a pillar of the global economy. Like many long-established sectors, it is undergoing a profound transformation fueled by artificial intelligence and machine learning. These advanced technologies are accelerating research and development, optimizing productivity, and reshaping the entire food ecosystem. From small-scale farmers to global food corporations, AI-powered innovations are streamlining operations, making processes more efficient, and unlocking new possibilities across the industry.

At Revvity Signals, the software division of Revvity, our name reflects or purpose. Derived from "revolution," symbolizing bold change, and vita, the Latin word for life, we are committed to driving progress where it matters most. Serving customers across the pharmaceutical, biotech, materials science, and food science sectors, our mission is to expand the boundaries of human potential through science. In 2024, we generated more than $2 billion in revenue, and our 11,000-plus employees see every challenge as an opportunity for meaningful impact.

The food science industry faces some of the most pressing challenges of the modern economy. Many operations still rely on legacy infrastructure and outdated processes, even as consumer expectations rise for higher food safety and nutritional standards. Stricter government regulations demand greater accountability, while the urgency of climate change calls for sustainable farming, waste reduction, and pollution control. As one of the largest contributors to direct CO2 emissions, food production must evolve to minimize its environmental footprint. At the same time, consumers are prioritizing healthier, safer foods to enhance their well-being – driving the industry toward a more responsible and forward-thinking future.

The key to meeting these challenges lies in digitization. Advanced technologies are streamlining R&D workflows, reducing waste, and maximizing productivity, all while enhancing overall operational efficiency. By automating and optimizing processes, these innovations empower teams to focus on developing safer, healthier formulations, fostering creativity, and accelerating breakthroughs across the industry.

At Revvity Signals, we are poised to leverage our expertise and legacy of success to help the food science industry forge new pathways – faster and smarter – so it can meet the demands of a rapidly evolving world.

Jun Liu
Senior Product Marketing Manager
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01 Executive summary

There has never been a more pressing time for food producers to harness technology to tackle the sector's tough mission. To produce ever more healthy and appealing food for a growing global population in a way that is resilient and affordable, all while minimizing waste and reducing the sector's environmental impact. From farm to factory, artificial intelligence and machine learning can support these goals by increasing efficiency, optimizing supply chains, and accelerating the research and development of new types of healthy products.

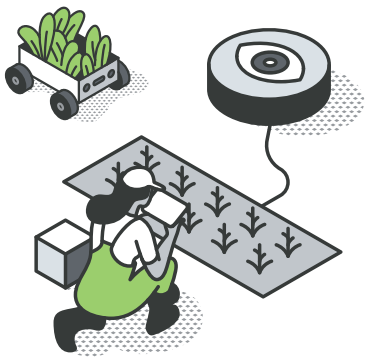
In agriculture, AI is already helping farmers to monitor crop health, tailor the delivery of inputs, and make harvesting more accurate and efficient. In labs, AI is powering experiments in gene editing to improve crop resilience and enhance the nutritional value of raw ingredients. For processed foods, AI is optimizing production economics, improving the texture and flavor of products like alternative proteins and healthier snacks, and strengthening food safety processes too.

But despite this promise, industry adoption still lags. Data-sharing remains limited and companies across the value chain have vastly different needs and capabilities. There are also few standards and data governance protocols in place, and more talent and skills are needed to keep pace with the technological wave.

All the same, progress is being made and the potential for AI in the food sector is huge. Key findings from the report are as follows:

- **Predictive analytics are accelerating R&D cycles in crop and food science.** AI reduces the time and resources needed to experiment with new food products

There has never been a more pressing time for food producers to harness AI to support their tough mission: produce ever more healthy and affordable food for a growing global population, while minimizing environmental impact.

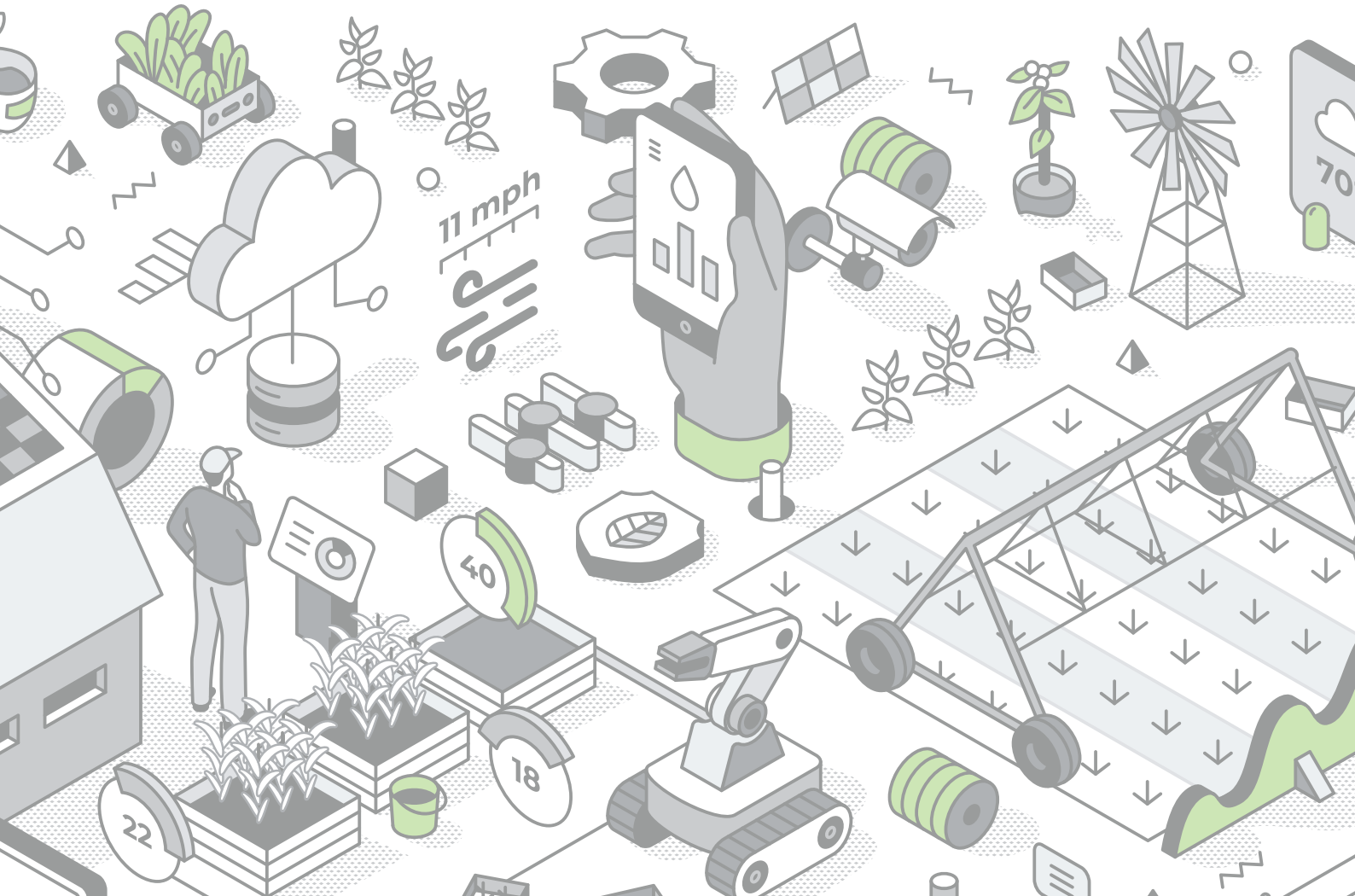


and turns traditional trial-and-error cycles into more efficient data-driven discoveries. Advanced models and simulations enable scientists to explore natural ingredients and processes by simulating thousands of conditions, configurations, and genetic variations until they crack the right combination.

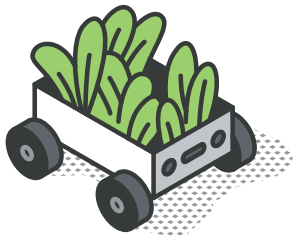
- **AI is bringing data-driven insights to a fragmented supply chain.** AI can revolutionize the food industry's complex value chain by breaking operational silos and translating vast streams of data into actionable intelligence. Notably, large language models (LLMs) and chatbots can serve as digital interpreters, democratizing access to data analysis for farmers and growers, and enabling more informed, strategic decisions by food companies.

- **Partnerships are crucial for maximizing respective strengths.** While large agricultural companies lead in AI implementation, promising breakthroughs often emerge from strategic collaborations that leverage complementary strengths with academic institutions and startups. Large companies contribute extensive datasets and industry experience, while startups bring innovation, creativity, and a clean data slate. Combining expertise in a collaborative approach can increase the uptake of AI.

- **Better data strategies and industry standards are needed.** Current fragmentation in data practices is blocking AI implementation at scale. The industry must develop comprehensive data strategies that balance multiple priorities: secure information sharing, rigorous privacy protection, and standardized data formats. This challenge requires coordinated action across the industry and support for the creation of industry standards. The most important factor in AI success is a robust data infrastructure.



02 More with less



It is the world's largest industry, employing over a billion people[1] and producing more than $9.8 trillion worth of food annually.[2] But the food sector faces mounting pressure to feed a booming global population, all while tackling growing, sometimes opposing challenges in the current system.

Food production is responsible for around one quarter of the world's greenhouse gas emissions (GHGs), including heat-trapping methane. And toxic fertilizers and chemicals used in agriculture can be damaging to delicate ecosystems. Around 30% of the world's habitable land – and two thirds of the land dedicated to agriculture – is used to farm livestock, despite meat, dairy, and farmed fish making up a small percentage of the world's calories (17%) and protein (38%).[3] The meat and dairy industry is a significant contributor to global GHGs, estimated at between 14.5% and 19.6%.[4] And, on a health level, excessive consumption of some meats has been linked to an increased risk of heart-related issues and cancers. All leading to increasing pressure – and a growing appetite among consumers – for meat and dairy alternatives.[5]

The effects of climate change pose a real threat to the food system too. Currently, agriculture accounts for one quarter of the economic losses caused by extreme weather, such as rising temperatures, storms, water stress, and the spread of invasive crops and pests.[6] Large-scale monoculture crops like corn, soy, wheat, and canola, which are staple diets for millions, are the most vulnerable.[7] Producing enough nutritious food consistently and reliably, and at a price that is affordable to all, is an ever-growing challenge as the global population balloons.

Figure 1: Investment in agriculture technology

Venture capital funding in agtech grew in 2020 and 2021, dropping only as the wider market slowed.

Source: Compiled by MIT Technology Review Insights based on data from McKinsey, 2024

Amid these pressures, producers across the supply chain, from farms to manufacturers, are increasingly turning to advanced technologies like AI and machine learning to optimize growing conditions, accelerate seed science, and develop new, better tasting, and more nutritious protein and calorie alternatives. As the development of AI has accelerated in recent years, so too has investment into agriculture technology, only easing as a result of the wider venture capital slowdown (see Figure 1).[8] All in, the food technology market was estimated at $260 billion in 2022, and is forecasted to rise to $360 billion in 2028.[9]

But implementation of technologies like AI is still fragmented across the sector, and more work is needed to realize its full potential. "We view AI as the connective tissue that brings together all the projects across these domains," says Ilias Tagkopoulos, director and principal investigator at the AI Institute for Next Generation Food Systems (AIFS) at the University of California, Davis. "But in reality, these pieces are still quite disconnected. We've made great strides with AI and other technologies to understand plant genetics and traits, but we need to connect that back to improving sensory qualities, consumer preferences, production economics, and reducing waste."

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Ilias Tagkopoulos, Director and Principal Investigator, the AI Institute for Next Generation Food Systems, University of California, Davis

Harvesting data

Chatbot technology is making it easier than ever for agricultural companies to engage with farmers, and empowering the latter with data capabilities. LLMs synthesize data from diverse sources to make it accessible and actionable for growers. Swiss agtech company Syngenta has created Cropwise to share such data with farmers. "We connect growers with years of knowledge and data, and they can query it using a simple conversational approach with an LLM," explains Martin Clough, head of technology and digital integration at Syngenta Crop Protection. "This is then trained on Syngenta's unstructured and structured data and can come back with recommendations on what seeds to plant, when to plant them, what agronomic decisions to make, and how to protect different crops."

Across its portfolio, Syngenta has a vast library of genomic data on biological systems, spanning pests, weeds, diseases, and microbiomes across different environments. "Cropwise gives farmers data and algorithmic recommendations to make decisions that are agronomically sound [on issues including] soil, weather predictions, or the performance of Syngenta's products," says Feroz Sheikh, group chief information and digital officer at Syngenta. The company's digital tools capture data on 100 million hectares of agricultural land.

"By using predictive models instead of extensive biological testing, we can reduce time in R&D cycles, bringing innovation to farmers much faster."

Martin Clough, Head of Technology and Digital Integration, Syngenta

A tastier byte

Governments are pushing farmers to reduce the use of environmentally damaging chemicals. Overuse of fertilizers, for instance, is associated with arsenic, lead, and mercury accumulation in soil, as well as ocean acidification which harms marine ecosystems. Pesticides – only 0.1% of which is estimated to reach its target – can contaminate water and kill plants, and excessive use can lead to pests and weeds developing resistance.[10] Measures like the EU's Green Deal aim to curb the use of these chemicals, putting pressure on farmers to produce more food with fewer of the inputs they have come to rely on.[11]

AI-enabled technologies can support farmers confronting this challenge. Firstly, by helping them create enhanced growing conditions. Instruments like sensors, drones, and GPS can optimize the allocation of chemicals by evaluating factors like crop health, soil composition, and moisture levels, and tweak irrigation based on real-time weather data and forecasting.[12] Some indoor greenhouses are fully automated, with algorithms controlling temperature, sunlight, and ventilation.[13]

AI and data analytics can also guide farmers to optimize irrigation and harvesting times to reduce waste and improve productivity. Orchard Robotics, a Cornell University spinoff, is helping fruit farmers, who lose billions of dollars a year in wasted produce, with cameras and computer vision software that gather information about the size and quality of fruit on trees, helping them accurately time their harvesting.[14] Similarly, farms in water-scarce California are cutting water usage by up to 30% with AI-guided irrigation systems.[15]

In Malaysia, farmers can access satellite data on SKYFLD, a precision platform which helps them monitor crops and identify those in need of treatment, reducing unnecessary fertilizer and chemical use. The platform is accompanied by Plantix, an app that recognizes over 400 pests, diseases, and nutritional deficits in plants.[16]

In Indonesia, the Dr. Tania app offers a similar service with a chatbot advising farmers on managing and treating crop diseases.[17]

These technologies have also been deployed for livestock farming, like the Beef Twin initiative at Nottingham Trent University in the UK, where AI-powered sensor and computer vision data are being used to develop digital twins of cows that analyze their weight, behavior, growth patterns, and environmental impact.[18] Sensors can also enable early detection of diseases and optimize feeding schedules. As well as increasing productivity and efficiency, this can help farmers improve animal welfare,[19] an important factor for 84% of consumers when deciding what meat products to buy, according to one survey in the UK.[20]

Sowing digital seeds

The pressures on farmers to feed an ever-growing population with fewer chemical inputs will require more than optimizing business as usual. Frontier agtech companies are experimenting with more radical tweaks to seed science powered by AI. Molecular breeding combines traditional techniques with tools like CRISPR, which allows breeders to alter plant DNA to improve resilience and nutritional value.[21]

"Breeding has always had the potential to [make crops more resilient and adaptable], but it's an incredibly slow process involving the random shuffling of thousands of genes over many generations. We're now able to make targeted, predictable genetic changes in a single generation," says Ian Miller, chief operating officer at Pairwise, a gene editing startup. AI can analyze genetic data to identify traits that improve resilience, yield, and nutritional content. Predictive analytics can then simulate the outcomes of gene editing experiments to narrow down the number of trials done by scientists. By guiding CRISPR, AI accelerates the discovery of crops that are more resistant to diseases, pests, and environmental stressors.

Pairwise uses CRISPR to edit the genes of fruits and vegetables to make them more appealing and nutritious, and easier to grow.[22] Its products include a gene-edited solution for resistance to Asian soybean rust, a disease that kills soybean crops. "There's a multi-billion dollar fungicide industry built up around controlling this devastating fungus," says Miller. "Our solution could have huge economic benefits while also reducing fungicide use and the associated environmental impact." Another Pairwise product, Conscious Greens, is a salad green that tastes like lettuce and has more nutritional value. It has been launched in U.S. restaurants, marking the entry of CRISPR-developed foods into the mainstream.[23]

Syngenta is also using CRISPR and gene-edited breeding to strengthen plant resistance to weeds, insects, and diseases.[24] The group partnered with InstaDeep, a Tunisian-born AI company, to build an LLM to accurately predict crop performance, trained on trillions of data points from crops such as corn and soybeans.[25] It also collaborated with Insilico Medicine, another AI company, to design molecules via computer rather than in the laboratory.[26] "Instead of synthesizing thousands of new molecules, we create them digitally and then synthesize just a few to test our assumptions," says Martin Clough, head of technology and digital integration at Syngenta. "By using predictive models instead of extensive biological testing, we can reduce time in [R&D] cycles, bringing innovation to farmers much faster."

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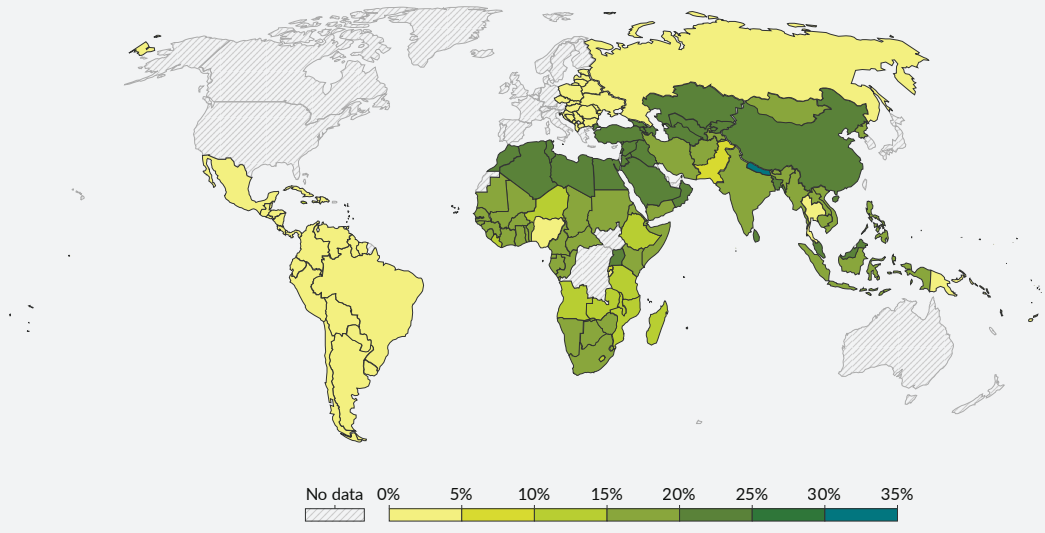
> Ian Miller, Chief Operating Officer, Pairwise

Rivalz, a maker of nutrient-dense foods and salty snacks, is applying AI to its use of the extruder (a piece of food processing technology that produces food in different shapes), using predictive analytics to develop novel product designs that are tasty, nutritious, and affordable. "You can do this without wasting energy and resources, in a controlled fashion, and very quickly – faster, cheaper, and better with AI," says Eric Hamborg, chief commercial officer at PIPA, an AI-driven nutrition innovation group and a partner of Rivalz. Through predictive analytics, Rivalz scientists can understand the ingredients and their interactions at the molecular level across the different stages of processing by simulating the equivalent of

Figure 2: Proportion of the population that cannot afford a healthy diet, 2022

The cost of a healthy diet is calculated as the lowest-cost foods that meet official dietary guidelines. A healthy diet is defined as unaffordable when its cost plus other basic needs is more than daily income.



Source: Compiled by MIT Technology Review Insights with data from Our World in Data, 2025

hundreds of thousands of experiments thanks to its proprietary universal dataset. “Many companies are employing stock AI data, but that is not nearly as valuable or powerful as the Rivalz proprietary data or universal data set,” says Erica Pattni, chief marketing officer at the company. “Tinkering and experimenting to achieve what we have could take a lifetime, but AI has aided Rivalz to gain a much deeper understanding of our ingredients and processing parameters, leading to significantly better outcomes.” PIPA’s software and algorithms have accelerated development, supporting Rivalz in launching its core line of salty snacks in under one year for approximately $1.2 million of expenditure, versus the typical R&D timeline of three to five years and $4 million, the company says.

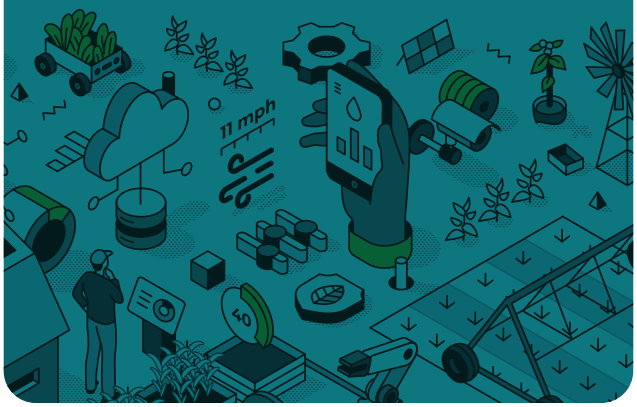
But the industry wants to go further than resilience. Experts argue that the nutritional quality of current foods can also be optimized. “The genetics of seeds, as well as farming, harvesting, and processing practices, all ultimately define the chemical and biological composition of the final food product,” says Tagkopoulos at AIFS. “The products available to buy right now may not be the ideal ones that we should be growing. And to achieve impact, people should know what the products are that not only taste great, but will keep them healthy.” Tagkopoulos believes that affordability and access without compromise is key. “The real transformation will happen when it will be easy and affordable for everyone to buy those superior products in a frictionless way, with no need to sacrifice income or tastes.”

With over 2 billion people affected by micronutrient deficiencies, fortifying staple foods with micronutrients through a process called biofortification could address the scourge of hidden hunger. There are not enough such foods currently, and those that exist are often low quality, according to the World Food Program.[27] Biofortification, which involves modifying crop genetics to improve their nutritional profiles, is increasingly enhanced by machine learning models.[28] AI can improve breeding by identifying the traits associated with superior nutrient density.[29]

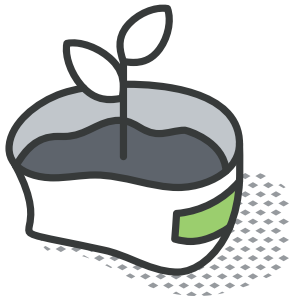
Collaborative crops

Collaboration is proving essential to harnessing AI and analytics. As a startup, health-focused food and agriculture company Pairwise has benefited from partnering with larger companies to scale AI solutions as technologies like CRISPR have become more accessible, says chief operating officer Ian Miller. “Doing this on our own would have been impossible, we just don’t have the global reach that these large agricultural companies possess,” he says. “Teaming up with them is the best way to ensure important innovations like this can have maximum impact in major crop systems.”

AI-driven nutrition science company PIPA recognizes the importance of making innovation achievable for smaller companies. Its data analysis applications, which include LEAP, AllMix, and Ingredient Profiler, give their collaborators – which range from global food manufacturers to startups – access to food science insights. “Our goal is to drive enterprise value for food and beverage companies, including smaller organizations that want to be more innovative but don’t have the money or the personnel to support the necessary R&D,” says PIPA chief commercial officer Eric Hamborg. “Smaller companies and startups don’t have legacy processes and data lakes sitting in various different parts of the organization and they can start from a clean slate. But at the same time, they have less data than large organizations. They can learn from each other.”



03 A budding industry



Seeds and agriculture are only part of the modern food system. Many products we consume are processed. Ultra-processed foods make up over half the calories of the average diet in the U.S. and the UK, and close to a third in Japan, Chile, and Mexico, and are linked to cardiovascular illness, diabetes, obesity, and other health risks. However, not all food processing is equal; processing can provide additional nutrients, enhance food safety, and ensure consistent quality across the supply chain. Some foods classified as ultra-processed can be low in fat, salt, and sugar.[30] AI is helping to improve the safety and quality of food processing while creating new, healthier products that taste just as good.

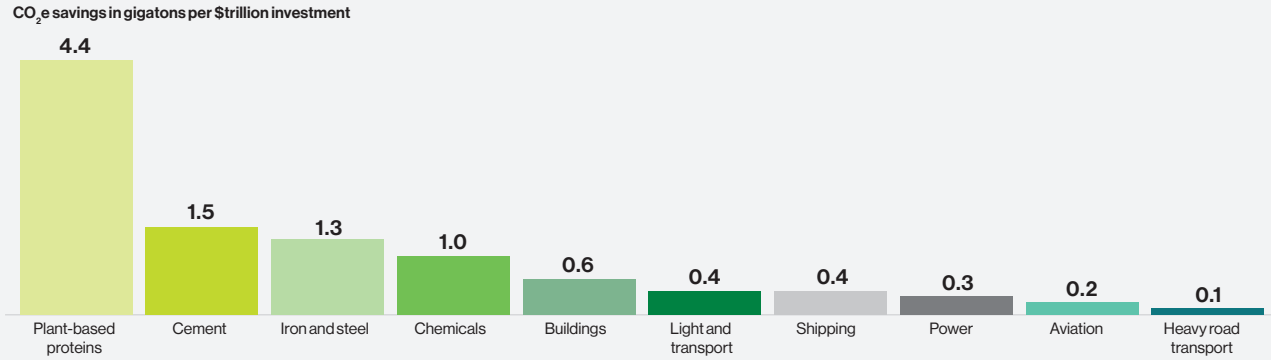
For instance, demand for sustainable and ethical protein sources has surged, with the global market for plant-based proteins estimated to increase from $11.6 billion in 2020 to $85 billion by 2030. Many consumers report that they consider them more healthy, sustainable, and eco-friendly.[31]

AI can identify optimal combinations of ingredients to enhance the texture and flavor of plant-based proteins and mimic meat. The models consider factors such as the interaction between proteins and other ingredients, the impact on texture and flavor, and the nutritional outcomes. NotCo, a Chilean food-tech company, uses an AI platform named Giuseppe to create plant-based alternatives to animal products, by analyzing the molecular structure of animal-based foods and predicting the best combination of plant-based ingredients that can replicate their taste, texture, and functionality.[32] DSM-Firmenich, a Dutch company, developed a grilled beef taste for use in plant-based meat alternatives that it describes as the world's first AI-created flavor.[33]

AI can also help to create alternative plant materials to address issues such as high costs, time-consuming processes, and low-yield crops. Many crucial nutrients and bioactive ingredients are naturally present in plants, but getting them onto shelves and into meals is more complicated. "Health-promoting bioactives, especially the ones from plants, are expensive and inaccessible to most people, so solutions like plant cell cultivation are necessary to fill those gaps," says Weslee Glenn, vice president of innovation at Ayana Bio, a plant cell technology company.

> "Health-promoting bioactives, especially the ones from plants, are expensive and inaccessible. Solutions like plant cell cultivation are necessary to fill those gaps."
>
> Weslee Glenn, Vice President of Innovation, Ayana Bio

Figure 3: Cutting GHGs with alternative proteins
Investing in plant-based proteins has the highest carbon dioxide equivalent savings per dollar of any sector.



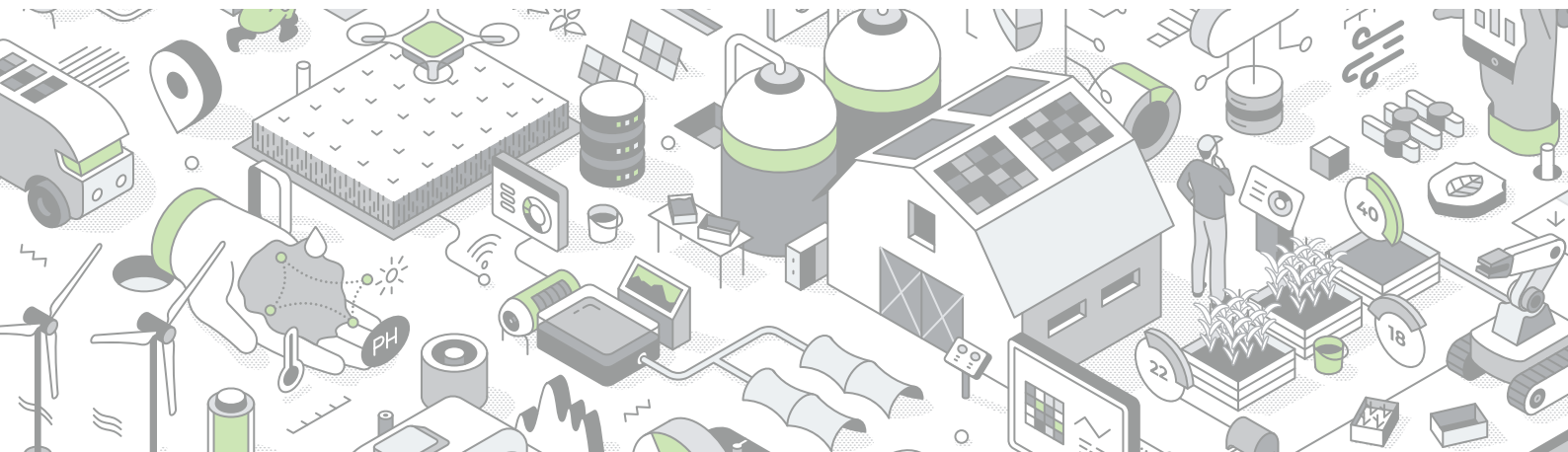
Source: Compiled by MIT Technology Review Insights with data from The Good Food Institute, 2023

Cell cultivation is a means of growing plant materials in a laboratory environment. It leverages the complexity of plant cells to produce bioactives that plants make in nature under certain conditions, enabling the creation of these materials in a controlled setting. "The pathways and reactions are already present within the cells, we just need to figure out how to turn them on," says Glenn. Ayana Bio exposes cells to hundreds of different conditions while tracking their gene expression, and feeds the resulting data into machine learning algorithms to identify the optimal parameters for growth and productivity.

One of Ayana Bio's products is saffron, which has potential health benefits for people with neurological and age-related diseases such as depression, anxiety, and Alzheimer's disease, but is expensive and difficult to grow. As many as 170,000 flowers are required to produce a kilo of saffron.[34] Cell-cultivated saffron can bypass these obstacles and expand the market. AI can further accelerate production and reduce the effort and resources required to experiment with plant materials. "I'd love to get to a point where we don't necessarily have to run hundreds of different conditions for every single plant, and can instead rely on predictive analytics from our previous programs. I think that'll be a real benefit in the very near future," says Glenn.

Safety for food security

When bringing new products to market, safety is the foremost consideration. AI use in food safety could revolutionize the industry by reducing the need for product recalls and predicting machinery failure.[35] Studies have found that AI-powered online process control could solve problems associated with nutrient loss, sensory analysis, and energy consumption.[36] AI can also detect and identify food-borne pathogens and predict safety risks, enabling businesses to shift from reactive to proactive. FreshCheck Hygiene Verification uses AI-based color change technology to make food contamination visible, providing an alternative to conventional safety monitoring.[37]



Up to one quarter of all deaths among adults globally can be attributed to poor diets.[38] Making next-generation food products healthy as well as appealing and accessible is another task that can be accelerated using AI. Drawing insights from medical research can help develop products that address consumer health concerns and unlock new nutritional possibilities. "Pharma has a jump start on the food industry in terms of creating next-generation food focused on health and nutrition, so there's a lot of learnings that we can take from the pharmaceutical industry and apply to the food industry to unlock new ingredients, bioactives, and processes," says Hamborg at PIPA. His group is working with another company that has developed an enzyme to help the body digest protein with less gastrointestinal upset.

Rivalz has also seen AI boost innovation. "Salty snacks are really unhealthy and contribute to the global problem of obesity and diabetes, so we want to make snacks that are tasty, nutritious, and affordable," says Pattni. "AI enabled us to deliver on those three things. Without AI, we could address one, maybe two, but AI really accelerated the process from both an innovation and an optimization standpoint." A key outcome has been the development of a high-protein extruded snack. "Most extruded products before Rivalz were ultra-processed foods high in carbs, fat, and salt, which was the only way people knew how to use this piece of equipment, and we're challenging that," says Pattni. AI-based insights enabled the company to produce an extruded snack from nutritious yellow pea protein.

Advanced food science technologies can enable people to eat more healthily without changing their tastes or restricting their choices. "In our industry, we have the opportunity to build a healthier world," says Miller at Pairwise. "AI technologies can impact the quality of the calories people consume and break down barriers to healthy eating."

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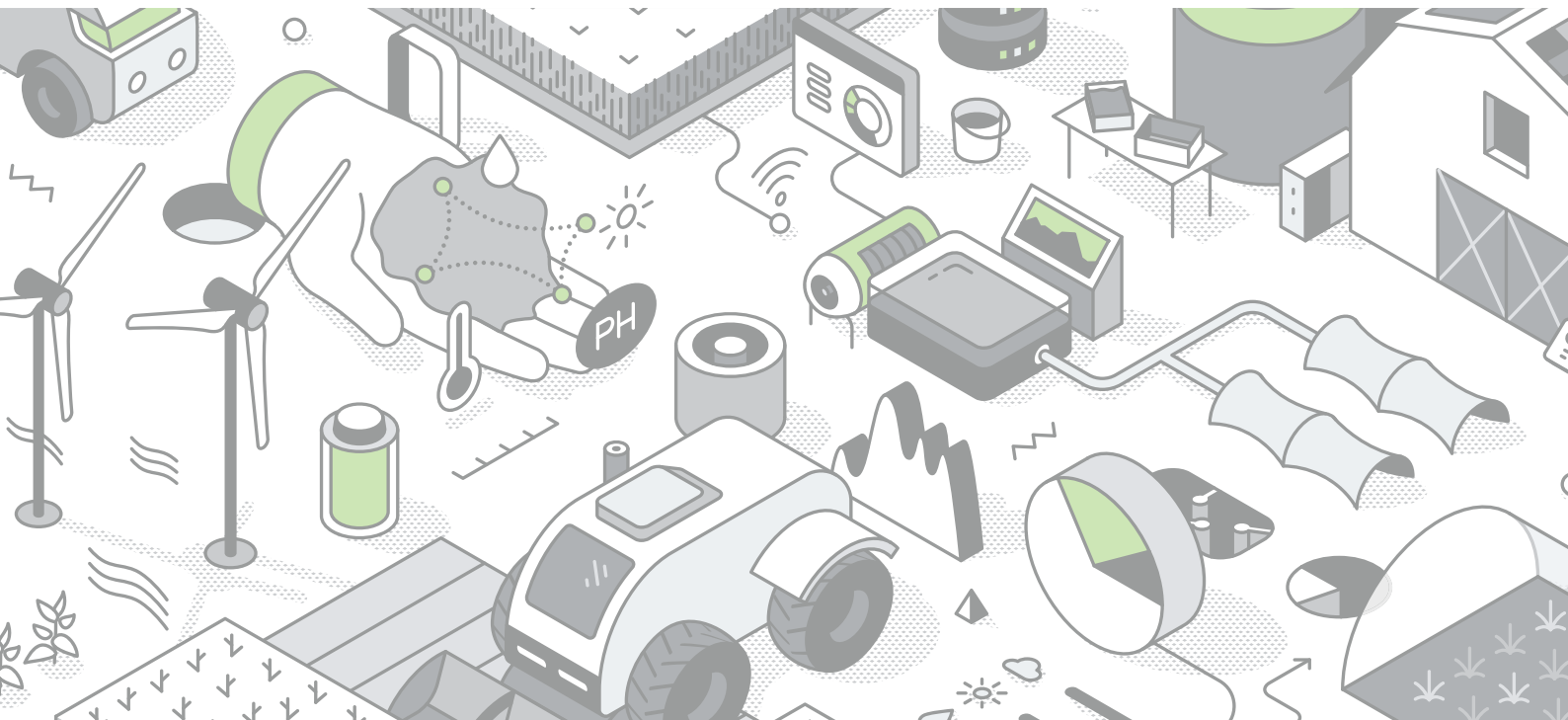

04 Putting data on the table

While innovations in food science show promise, they must be scaled more widely to fulfill their economic, environmental, and health potential. "The food system has lagged behind other industries when it comes to adopting new technologies," says Tagkopoulos at AIFS. "There are still many outdated, legacy ways of doing things, and barriers that prevent more disruptive innovation."

"The number one struggle I hear is that organizations haven't created an enterprise AI strategy yet," says Hamborg at PIPA. "The second is that their data is all over the place: it's sitting in various different business segments, and a lot of it isn't digitized."

Key challenges include access to infrastructure, data, and talent. "In industries like social media, tech, or finance, the financial rewards can be significantly higher than in food and agriculture. This creates a real challenge when it comes to attracting and retaining top talent," says Tagkopoulos. Upskilling workers who have existing experience in the sector can help reduce the need for new experts. "While there's a general upskilling happening, I'm no longer thinking we need to convert people into data experts, it's about making it easier for people to engage with data, and technology can help us with that," says Clough.

Data management and governance are the foundation of the food industry's digital transformation. Access to diverse datasets – including precision farming metrics, supply chain tracking, consumer preferences, and environmental impact measurements – is crucial to successfully deploy AI. However, this requires the right data infrastructure and management in terms of privacy, security, and openness.

Due to the fragmented nature of the food ecosystem, cross-sector communication and data access must be improved. Companies are embracing more open and collaborative approaches. "We want to design products that meet a huge array of properties and requirements that are desired not just by our customers – the farmer, the grower – but by society in general, politicians, and regulators," says Clough. "It would be impossible to meet

> "On any given farm, the farmer is probably working with many different equipment manufacturers, IoT sensors, and farm management systems. In many cases, these systems don't talk to each other because of the lack of standards."
>
> Feroz Sheikh, Group Chief Information and Digital Officer, Syngenta Group

all of these needs if we did it through manual, analogue approaches."

The Shoots by Syngenta platform connects scientists, startups, and researchers with open-source research questions and data.[39] "Agriculture as an industry, with all the different markets and climatic conditions, is far too big and complex for anyone to solve its problems on their own," says Sheikh. "We need to remain open and partner with research institutions, programmers, and startups that are doing interesting work innovating new technologies and models and are happy to contribute." One initiative that Syngenta researchers aim to make open source is computer vision models that can recognize and delineate field boundaries in satellite images, says Sheikh.

Access to data must continue to expand for AI solutions to be widely adopted in food systems. The Periodic Table of Food Initiative is a global effort to provide standardized tools, data, and training to map global food quality.[40]

PIPA's LEAP tool, an AI co-pilot for evidence synthesis and bioactive discovery, also aims to facilitate access to data for research. It integrates dozens of specialized databases with over 32 million scientific papers that it can process 10,000 times faster than human researchers. "If a scientist wants to research the impacts of lactoferrin, a milk molecule, on brain health, LEAP holds all the relevant scientific knowledge in one place," explains Hamborg.

Privacy along the food chain

Food and agriculture organizations deal with sensitive data from diverse partners and customers and must protect it. "There is a whole lot of data that belongs to the customers – the farmers – who are using our tools to, say, get predictions about their spray efficacy," says Sheikh at Syngenta. "We need to make sure that we respect the privacy, the encryption, the anonymity of their data."

Farmers in Australia, for instance, have been reluctant to engage in the widespread sharing of the farm data required to implement smart farming, largely due to a perceived lack of transparency and clarity around data ownership, privacy, and trust.[41] There are no legal or regulatory frameworks aimed specifically at agricultural data, and no standardized international approaches to its management.

This general lack of standardization means there are diverse sources of data across the industry and even within organizations, complicating data integration. "On any given farm, the farmer is probably working with many different equipment manufacturers, many different IoT sensors and farm management systems, and in many cases, these systems don't talk to each other because of the lack of standards," says Sheikh. "In some cases, there are competing standards, and in others there are incomplete standards that don't cover the full space."

Some agtech organizations are working to accelerate standards development. The International Organization for Standardization (ISO) has created a roadmap to developing standards for smart farming and established a technical committee to improve interoperability in agriculture.[42] This committee's contributors include AgGateway, a consortium of companies aiming to drive digitalization in global agriculture and offering resources

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"We've noticed a significant mindset shift – not just among our customers, but within our own team – that continues to drive success."

David Gosalvez, Director, Product Strategy and Business Development, Revvity Signals

and relationships to those seeking to adopt digital processes along the food value chain, of which Syngenta's Sheikh is a board chair.

A "data mesh" approach

Managing diverse data sources in the food value chain requires a strong strategy. One is for companies to adopt a common infrastructure to create a data lake and make all incoming data accessible. However, this strategy can have limitations due to privacy concerns and the number of different inputs, says Sheikh. "We ended up with multiple data lakes because there are different business units operating independently, and because data coming from the Cropwise platform belongs to farmers and is not a dataset that we own. There's no way that we can integrate this into the common enterprise data lake," he explains.

Instead, Syngenta implemented a "data mesh," making data available for query analytics, prediction, and model training across several separate data lakes. The company is already seeing tangible benefits from internal AI deployment, such as automated document processing that can identify cases of overpayment or contractual non-compliance. Sheikh believes that these efficiency benefits can be elevated through social AI or autonomous agents that can engage with each other, reducing the number of steps required to get information across these data lakes. "Why shouldn't the agents talk to each other instead of having another orchestration layer to facilitate across them?" he says.

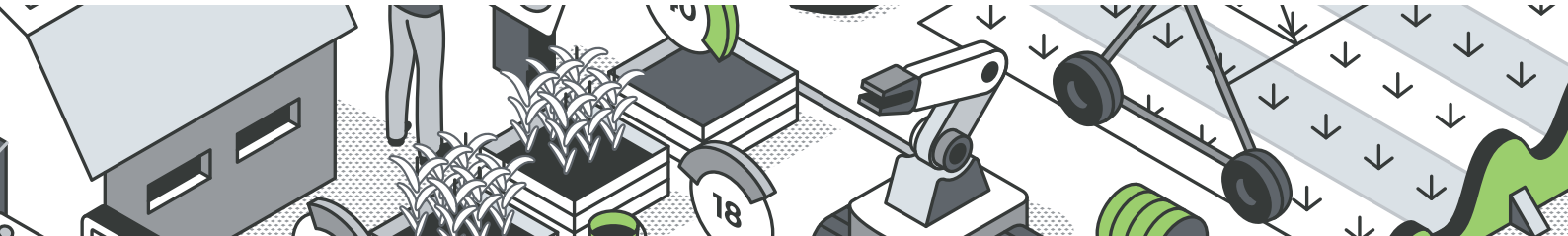
Syngenta's system is one example of enabling knowledge transfers while addressing privacy and standardization concerns. "Our data mesh architecture helps us organize our data to a high standard with good metadata and make it available to scientists, and we've achieved it by carefully picking partners who help us build the structures and handle the data engineering," says Clough. "It's a work in progress, because data mesh, by its very nature, will grow."

Cultivating intelligence

Ultimately, as AI technologies continue to develop across industries, the food sector must take a proactive approach. By promoting comprehensive standardization frameworks, the industry can empower farmers, growers, and small businesses to leverage advanced AI solutions while maintaining data privacy and security. "Every company needs an AI strategy; it's happening and it's going to transform the industry no matter what," says Tagkopoulos at AIFS. "All companies, big and small, they're thinking about AI. There's no question about that."

"We've noticed a significant mindset shift – not just among our customers, but within our own team – that continues to drive success," says David Gosalvez, director of product strategy and business development at Revvity Signals. "Instead of simply requesting a specific product, customers now come to us with the full scope of their scientific work, seeking integrated solutions that streamline data capture, experiment documentation, collaboration, and remote work, reducing the need to juggle multiple software systems. "

Collaborative efforts between industry leaders, technology developers, and agricultural stakeholders will be crucial. Those with existing research and innovation in the space have the ability to initiate progress. "Putting AI at the center of decision-making is a major change. But I tell food and beverage companies, don't worry about being perfect, take that first step," says Hamborg at PIPA. "You want to develop new products and you want to do it faster – I believe the companies that start thinking about how to do this with data and AI will leapfrog other companies pretty substantially."



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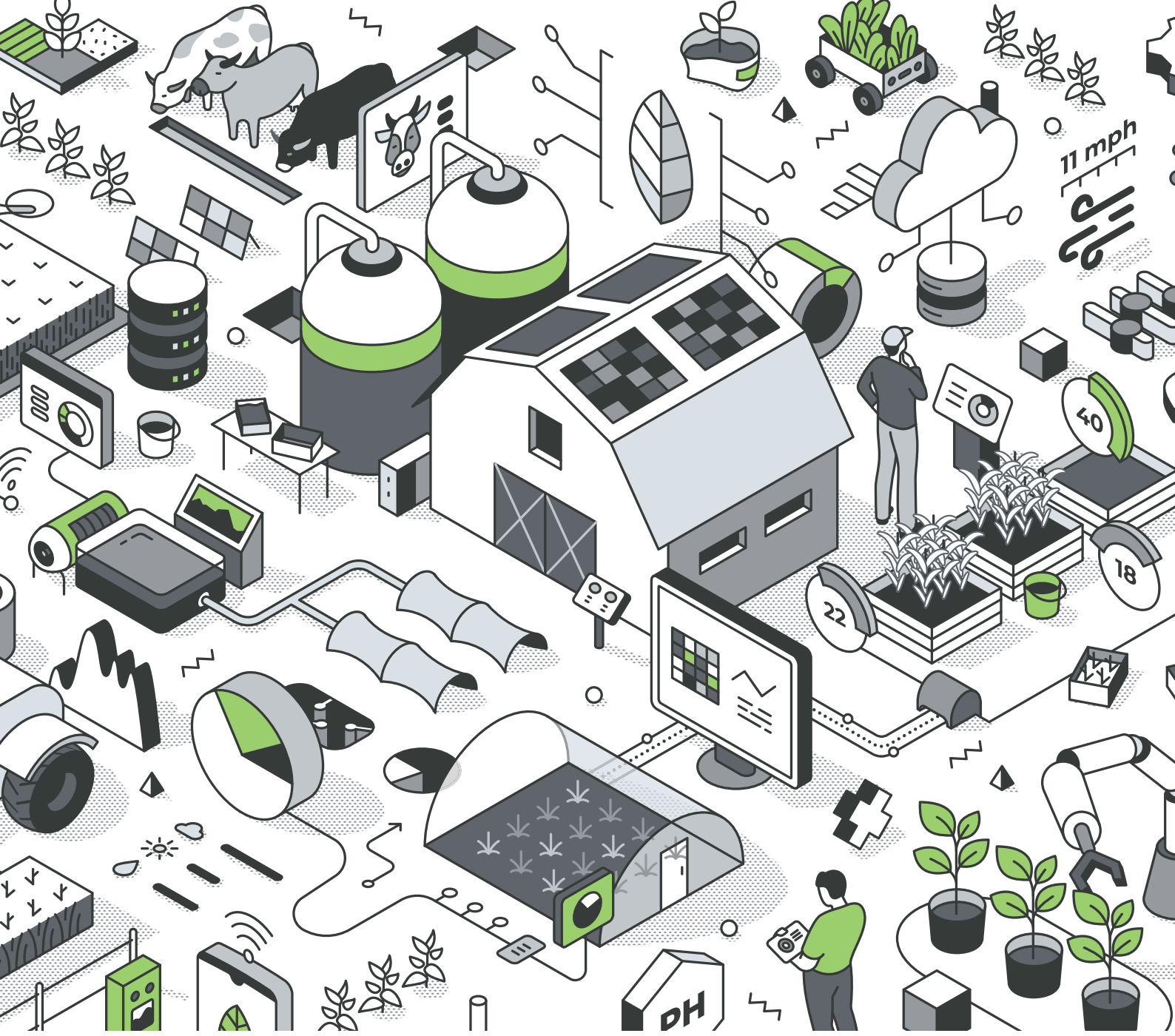

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