An aerial photograph of a large agricultural field. A blue tractor is driving through the field, leaving behind a series of curved, parallel furrows in the brown soil. The field is filled with green crops, and the sky is overcast with grey clouds. Two vertical blue bars are positioned on either side of the text in the upper left corner.

EY Food and Agriculture Navigator

EY Global Agribusiness
2024 H1 Semiannual Report

Spring 2024



Planning for the future

The food and agriculture system continues to undergo change. It will be imperative that leaders across the value chain are ready to react quickly to this change, while maintaining a long-term investment view oriented toward productivity, innovation and sustainability. In this edition of the EY Food and Agriculture Navigator, our team has synthesized a few **selected trends impacting the food and agriculture value chain:**

- ▶ **Geopolitics:** We explore how the future of globalization is being impacted by geopolitical and economic uncertainty and how the ripple effects of changing geopolitical relationships and global trade patterns will continue to impact food prices, food availability and market efficiency.
- ▶ **Sustainability and sector convergence:** As we search for ways to enhance the sustainability of essential inputs to modern life like food and energy, the sector convergence between agriculture and energy is driving increased opportunity and uncertainty on the path to decarbonization. We'll dive into the intersections between the energy transition and impacts on across the agriculture value chain.
- ▶ **Regulation:** As governments look to protect citizens and ensure societal health, they are enacting new regulations to enhance traceability and transparency of food. A new mandate for traceability in the US will have broad impact on agricultural value chains.
- ▶ **Innovation for the future consumer:** Consumer demands are increasingly defining foods we see on shelves and driving innovation across the food and agriculture value chain. We will explore how the demand for healthier living has created an entire market focused on functional foods and beverages.
- ▶ **Emerging technology:** Digital technologies continue to see significant investment and attention in food and agriculture. We'll again dive into the topic of artificial intelligence (AI) to look at how companies are leveraging and taking initial steps toward implementing this technology.

We hope these insights are helpful, and together with our colleagues, we look forward to future collaboration with industry players.



Lauren Chupp
Partner
Food & Agribusiness Co-Leader
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Lee Addams
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A photograph of two men in a field, one pointing at a laptop screen while the other looks on. The background shows green crops and a yellow tractor. The image has a dark blue overlay on the left side where the text is located.

Globalization and impact on agriculture

Executive summary and perspective



The changing levels of globalization and subsequent impact on international trade and development will bring about significant challenges to global food and agriculture markets. Individual countries will seek to address rising food insecurity by shoring up their domestic supply, while broader policy solutions will have to be considered to establish long-term food security.

- 1** Disruption in globalization
 - ▶ Geopolitical instability and challenging macroeconomic conditions have threatened the current level of globalization, forcing more countries to focus on shoring up strategic industries like food and agriculture.
- 2** Direct impact on agriculture
 - ▶ Disruption has acutely impacted agriculture, with supply shocks and trade disruptions leading to elevated food prices in recent years, all of which is being exacerbated by a changing climate.
- 3** Policy implications
 - ▶ Countries are taking greater measures to maintain food supply and mitigate inflationary pressures, ranging from strategic security measures to broader investment and mitigation.
- 4** Key takeaways and advice
 - ▶ Countries and companies must continue to monitor geopolitical shifts in agriculture, ensuring that their operations are diversified and scenario planning is leveraged to help plan for the unknown.

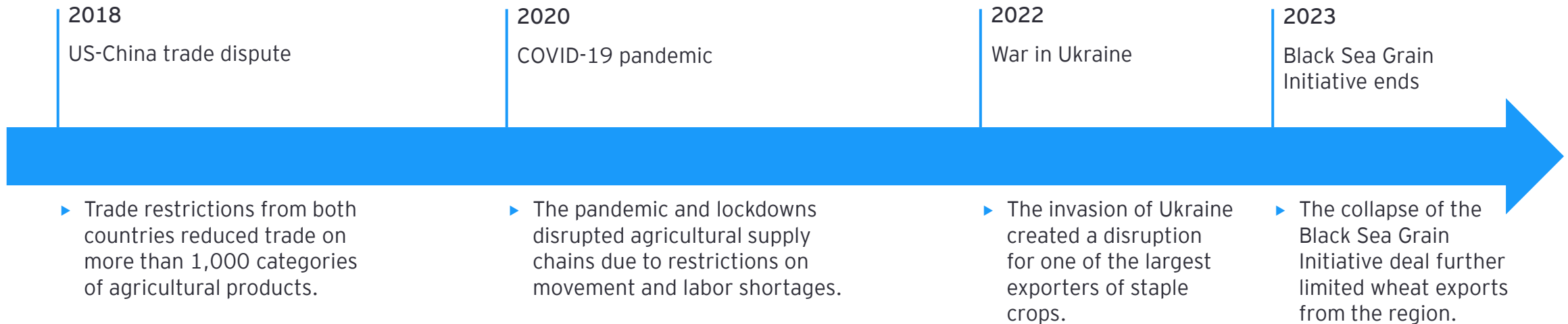


Agriculture is an industry that is inherently dependent on trade due to de-coupled supply (driven by natural resource availability and infrastructure) and demand (driven by population and economic centers) of food and agriculture goods. Geopolitical disruptions have had a significant impact on global trade and on agriculture, where we have seen rising food prices and export restrictions challenging the existing system. These disruptions are further challenged by the reality of biological cycles and other intrinsic agility constraints in the industry. Countries are navigating a complex policy landscape that could have major implications to food prices, food availability and overall market efficiency. It is imperative for leaders to closely monitor geopolitical risks and scenario plan as they prepare for a future that promises to be both dynamic and unpredictable.

Lauren Chupp

Partner, Ernst & Young LLP

Globalization has destabilized in recent years due to both global events and country-specific domestic policies, increasing the strategic focus on food markets



Drivers of disruption

- ▶ In recent years, the global operating environment has become less internationalist and more focused on shoring up domestic capabilities.
- ▶ Because of this, countries are increasingly looking at agriculture as a strategic sector, placing more restrictions on exports of key products.
- ▶ All of this is compounded by climate change impacting crop yields and interrupting supply chains, furthering the need for countries to shore up their domestic agriculture supply.

Instability in agricultural trade

US Agricultural Exports Expected to Decline

The Wall Street Journal

Global 2024 staple food supplies to be strained by dry weather, export curbs

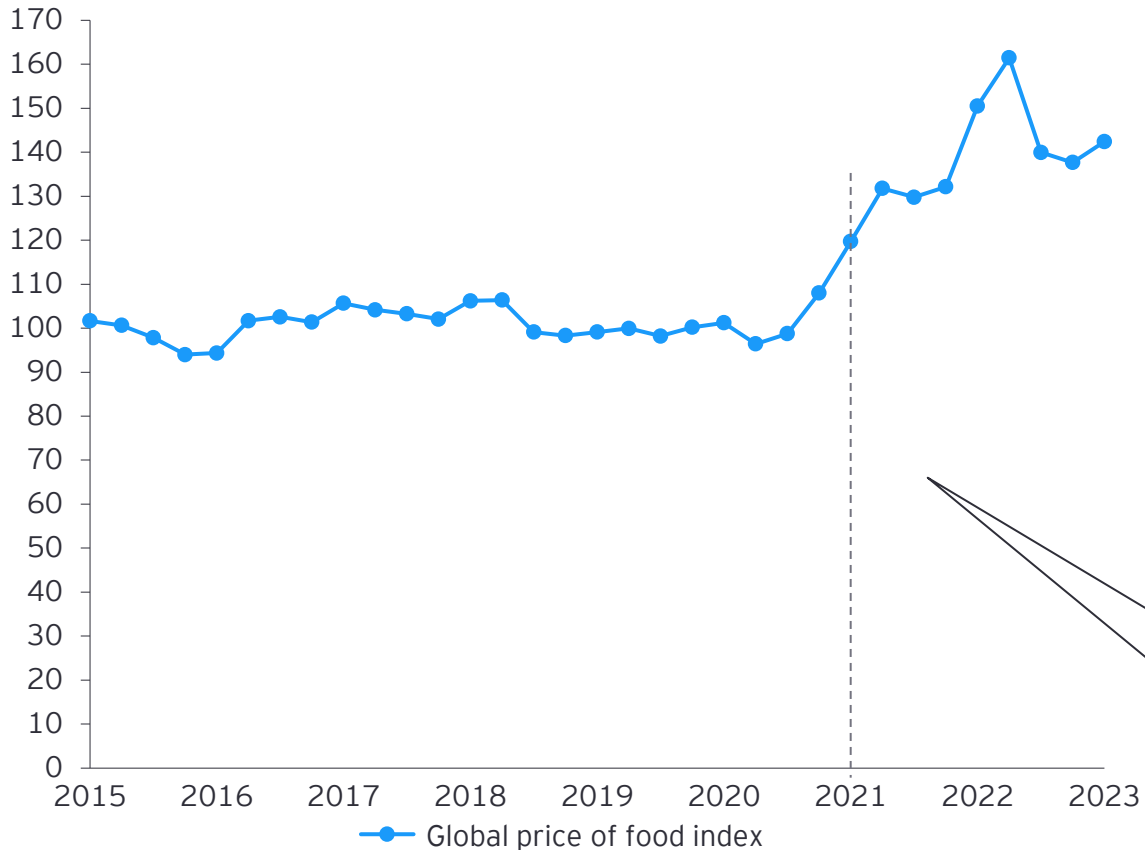
Reuters

India triggers inflation fears after imposing major rice export ban

CNN

The disruption in globalization significantly impacts global agricultural markets by intensifying food insecurity and impacting countries that rely on agricultural trade

Global price of food index¹



Key themes

Due to a disruption in globalization impacting agriculture, food insecurity is on the rise worldwide

- ▶ War, climate change and trade policy have created several major supply shocks in global agricultural markets in the past few years.
- ▶ As a result, since 2021, the global price of food index has hovered at its highest levels since the 1970s.

Countries that rely on imports are greatly impacted

- ▶ Because Africa is the most food import-dependent region in the world, these rising prices have a particularly negative impact there:
 - ▶ In addition, as one of the region's most reliant on subsistence agriculture, climate change disruptions to farming compound the impact.
- ▶ Despite its robust domestic production, China is one of the largest food importers in the world, and because of this, food security is now considered an integral part of the country's national security strategy.

Global food prices are significantly higher than they were several years ago, causing potential challenges for food accessibility and affordability worldwide.

1. Value represents the benchmark prices that are representative of the global market. They are determined by the largest exporter of a given commodity. Prices are period averages in nominal US dollars.
Source: Federal Reserve; World Bank; Brookings Institution

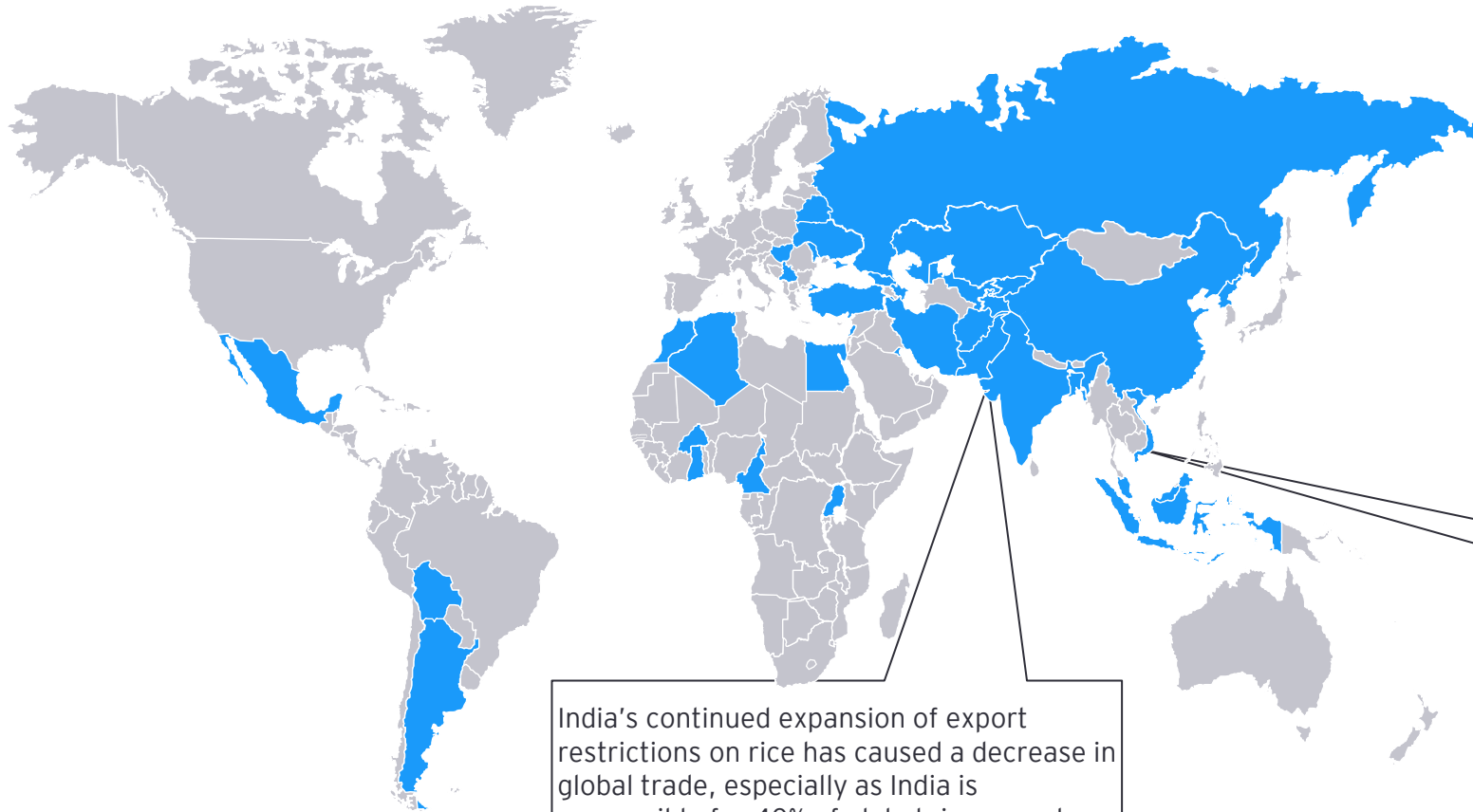
Countries are considering various policies because of receding globalization, ranging from shoring up domestic food supply to strategic international investments

Policy	Description	Examples
Restrict exports and stockpile	<ul style="list-style-type: none">▶ To shore up their own domestic supply, countries are placing further restrictions of food exports to increase domestic stockpiles.▶ These policies range from taxes, to quotas, to outright bans on exports.	<ul style="list-style-type: none">▶ India been placing increasingly stricter export restrictions on wheat as a method of increasing their domestic stockpile.▶ Mexico initiated a temporary 50% tax on white corn exports to guarantee supply and price stability domestically.
Strategically invest abroad	<ul style="list-style-type: none">▶ Countries are now considering food security as a part of broader national security.▶ As a result, countries are increasing investment in overseas agriculture, agricultural technology transfer and broader supply chain infrastructure.	<ul style="list-style-type: none">▶ Under China's Belt and Road Initiative (BRI), agricultural and food security cooperation has seen substantial investment, tapping into global emerging agricultural markets to foster ease of food trade within BRI countries.
Reconsider biofuels	<ul style="list-style-type: none">▶ Because biofuel production requires crops to create energy, some countries are considering the role of biofuels in the food insecurity crisis.▶ If the crisis continues, countries may decrease investment in biofuels as a way of strengthening food supply.	<ul style="list-style-type: none">▶ Germany is considering phasing out the use of biofuels produced from agricultural commodities by 2030, focusing instead on biofuels from garbage and waste.

Since 2022, almost 40 jurisdictions have placed export restrictions on food or fertilizer, signifying an increased focus on food security that limits overall food globalization

Jurisdictions that have placed export restrictions on agricultural products since 2022

Global impact



- ▶ Following the invasion of Ukraine and subsequent supply shocks, countries have been placing export restrictions ranging from taxes to outright bans.
- ▶ Crops that were most impacted by the war in Ukraine were the most targeted, namely wheat, feed grains and vegetable oils.
- ▶ At the peak of this restriction trend, almost 17% of global food and feed exports were affected.
- ▶ Despite some of these restrictions being lifted in recent months, it has placed further strain on global food supply chains.

Key takeaways and considerations

Growers

- ▶ Leverage **funding being driven into food security** as governments look to shore up domestic supply
- ▶ **Increase crop diversity** to limit the risk of key products being affected by export restrictions

Food companies

- ▶ Identify which crops are considered **strategically important** to see if future investments may be impacted by restrictions
- ▶ **Scenario plan** for different geopolitical risks and develop potential solutions to navigate trade disruption
- ▶ **Diversify supply chains** to limit the risk of a single country or region limiting trade

Governments

- ▶ Begin to consider food as a part of **national security**, providing domestic producers with the necessary funding and support to flourish
- ▶ Work with allies and trading partners to establish stable **food supply chains**



A man in an orange high-visibility jacket is standing in a lush green field, working on a laptop. In the background, several wind turbines are visible against a clear blue sky. The scene is illuminated by natural light, suggesting a bright day.

Update on energy transition and impact on agriculture

Executive summary and perspective



As governments around the world push for lower-carbon-intensive processes, we must consider the impact of gaining commercial viability of biofuels to help reduce dependence upon hydrocarbon-based products while maintaining sustainable farming practices and adequate food production levels for human consumption.

- 1** Intersections of energy and agriculture
 - ▶ Energy and agriculture have a unique symbiotic relationship, different from most industrial processes since agricultural outputs require energy inputs and can be utilized a fuel resource in the form of biofuels.
- 2** Biofuel feedstock impacts and advanced biofuels shift
 - ▶ Biofuels are segmented by the feedstock utilized to create the end-product fuel, with a focus trending toward feedstocks that do not compete with food resources and land use for human food production.
- 3** Potential end-user markets
 - ▶ While most advanced biofuel markets are in nascent stages, certain feedstocks and technologies are proving to be more economically viable and useful than others.
- 4** Detailed cost understanding is critical
 - ▶ Due to costs related to fuel switching, inputs, infrastructure and logistics, it is imperative that biofuels value chain stakeholders understand the tax and regulatory implications of investments in the technology.

“

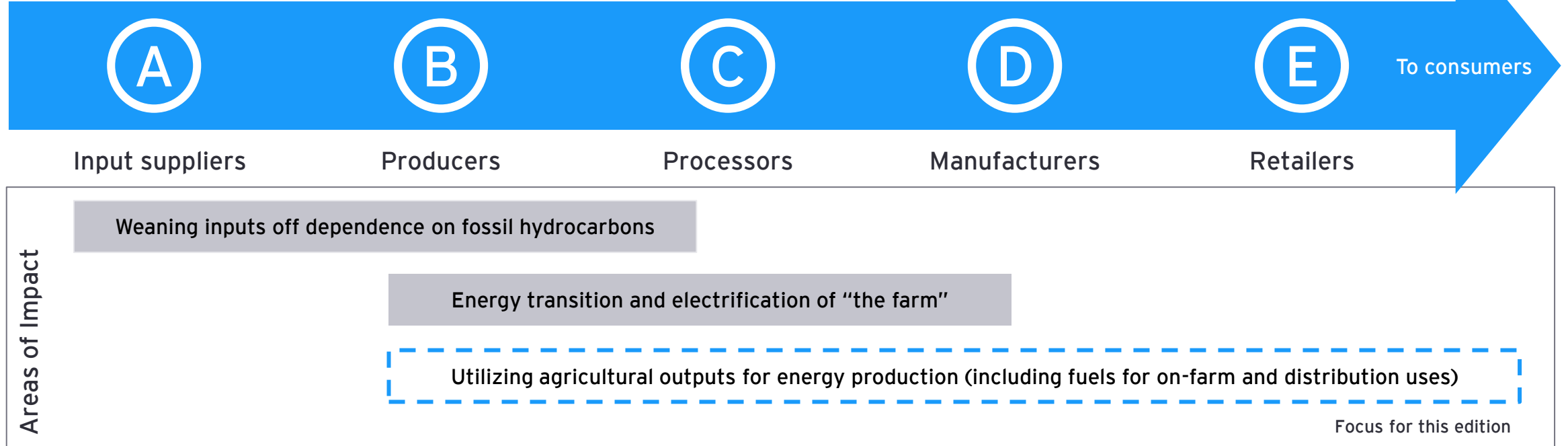
Opportunities abound for primary production agriculture to further become part of the solution on the next phase on the energy transition journey. We anticipate the need for increased partnerships between farmers and energy players — this should in turn bring scale to sustainability-focused incentives in agricultural production.

Lee Addams
Partner, Ernst & Young LLP

As the push for lower-carbon alternatives continues, three distinct areas of intersection can be seen that impact multiple stakeholder groups across the ag value chain

Energy and agriculture key intersections

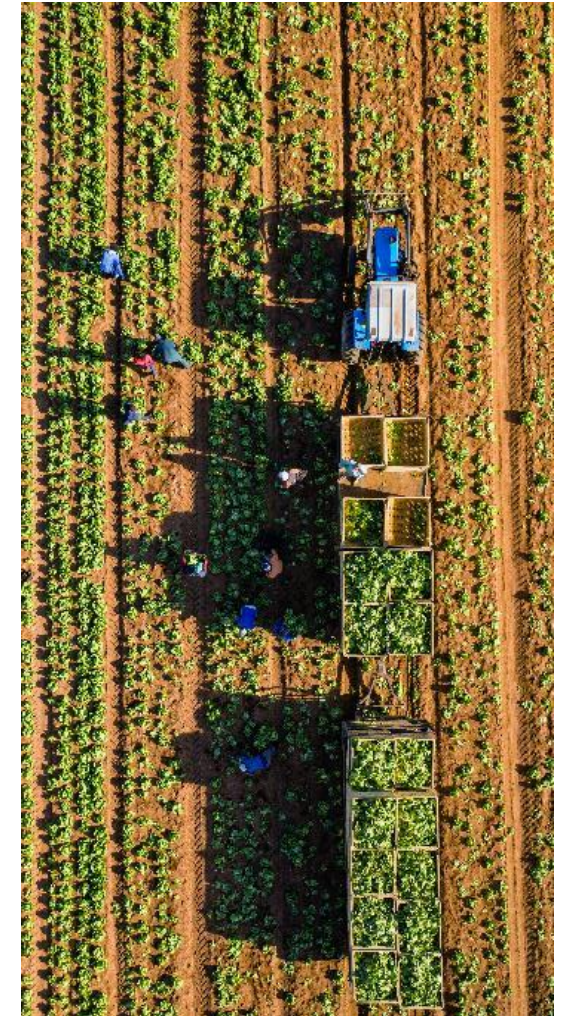
Typical agricultural value chain



Energy and agriculture have a unique symbiotic relationship where agricultural output and waste can be utilized to create typically hydrocarbon-based inputs and fuels necessary to produce crops and food.

Traditionally, focus has been on first-gen fuels; however, as technology and scale develop, advanced biofuels are likely to drive the market in the mid- to long term

- ① The current biofuel market largely consists of first-gen biofuels (i.e., ethanol and biodiesel) plus some renewable diesel (FAME¹ and HVO²):
 - ▶ Other biofuels include second generation derived from plants that are not food (agriculture waste, wood chips, grasses, etc.), third generation derived from algae, and fourth generation derived from specially engineered plants or biomass that are not food sources and don't compete with feed crops for resources.
 - ▶ Engines are not currently built to run solely on ethanol or biodiesel, so first-gen biofuels require blending with gasoline or diesel.
 - ▶ Production of first-gen biofuels competes with food supplies, as they are made from feedstocks such as corn, sugarcane and palm oil.
- ② Despite hurdles, existing production from first-gen feedstocks will continue to be supported by government production and blending targets across key markets (Brazil, India and China for bioethanol; Indonesia, Thailand and Malaysia for biodiesel):
 - ▶ Additionally, despite long-term decline in light-vehicle fuel demand due to electrification, there is some growth potential for ethanol over the next two decades as more countries target blend ratios and as original equipment manufacturers bring more models to market tuned to increasingly higher blends (e.g., E15 or E85).
- ③ Western governments are introducing policies to move from first-gen to second-gen biofuel production (in terms of capacity):
 - ▶ In ethanol, the EU Fit for 55 and the UK Renewable Transport Fuel Knowledge policies set targets of E20 blends, with a limit of 10% from crop-based biofuel.
 - ▶ In biodiesel, the UK has implemented a cap on crop-based biofuels of 4% in 2020, decreasing to 2% by 2032.
 - ▶ Existing US legislation such as the Inflation Reduction Act of 2022 supports several facets of advanced biofuels:
 - ▶ Section 45Z, which outlines the requirements for receiving the Clean Fuel Production Credit, is expected to provide an estimated \$9.4b of support for biofuel support through 2031.



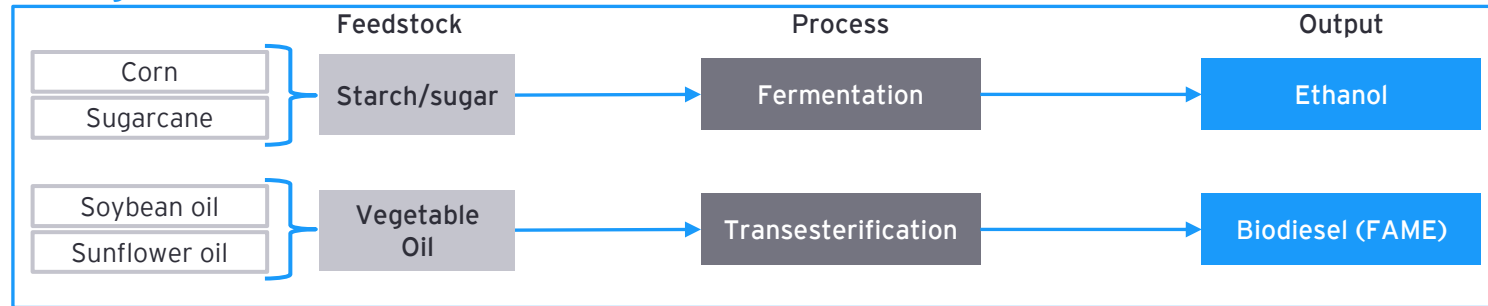
1. FAME: Fatty acid methyl esters, created through the transesterification of triglycerides (fats and oils) with methanol.
2. HVO: Hydrotreated vegetable oil, produced through the hydrotreatment of vegetable oils or animal fats.

Source: EY-Parthenon analysis; IEA

Due to concerns that feedstock sourcing will compete with food demand, the world is seeing a transition from first-generation biofuels to advanced biofuel technology

First-generation biofuels

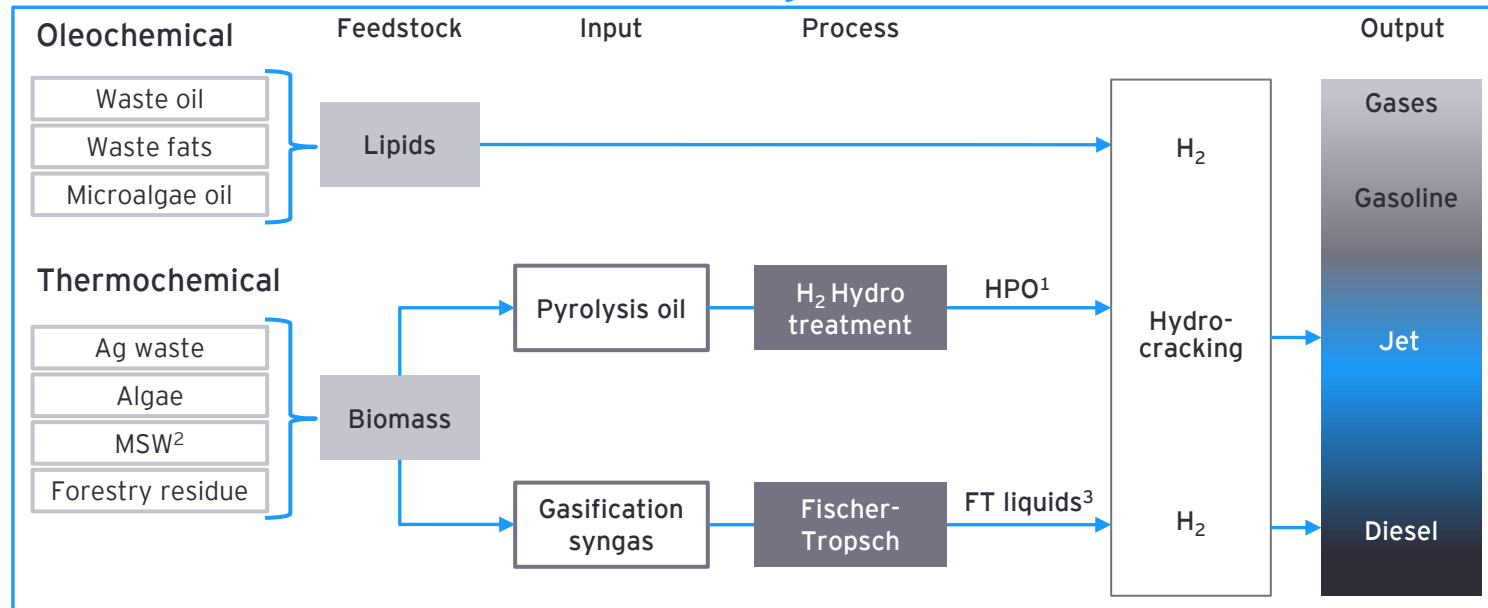
Simplified schematic



- ▶ First-generation biofuels source from sugar, starch and oil crops to produce ethanol and biodiesel.
- ▶ These are not drop-in fuels and require blending into fossil fuels.
- ▶ Feedstock sourcing is limited due to competition with food demand.

Advanced biofuels (second, third and fourth generation)

Simplified schematic



- ▶ Advanced biofuels are produced from waste/residue feedstocks and do not compete with food supplies.
- ▶ Several conversion processes may be used (oleochemical and thermochemical) for production, which produce a range of bio-hydrocarbons across the spectrum.
- ▶ Lignocellulosic biomass is abundant and renewable, but the complex structure is more difficult and costly to break down into simple sugars.
- ▶ These are drop-in biofuels, so they do not require blending.
- ▶ Each process can be adjusted to skew the proportion of desired end products.

1. HPO: Hydrotreated pyrolysis oil, created through treating the pyrolysis oil with hydrogen at high temperatures and pressures in the presence of a catalyst.
 2. MSW: Municipal solid waste.
 3. FT liquids: Fischer-Tropsch liquids, a range of synthetic fuels and chemicals produced by a process known as the Fischer-Tropsch synthesis.

While multiple challenges exist in sourcing feedstock for biofuel production, the pathway to scalability revolves around improved storage, infrastructure and logistics

First-generation feedstocks (food crops and vegetable oils)

- ▶ **Food crops** under debate in "food vs. fuel"/food security.
- ▶ **Regulations** discouraging diversion of food crops for production of biofuels.
- ▶ Use of vegetable oils such as palm oil under scrutiny over **sustainability** of palm plantations.

Municipal solid waste

- ▶ MSW needs to be **collected from various fragmented sources** in cities.
- ▶ Both consumer and post-consumer **separation of organic waste** from mixed waste are **inefficient**.
- ▶ For waste streams like **paper and plastics**, **recycling and reuse** are assumed to be **preferred** long-term alternative.

Agricultural residues

- ▶ **Bulky feedstocks** such as agricultural residues are more **difficult to transport**.
- ▶ Most economically viable in **locations** that provide **high feedstock concentration** and **favorable logistics** to production sites.
- ▶ **No systems in place** in many regions to **collect leftover residues**, and farmers may not be aware of use of these residues for biofuel production.

Cellulosic cover crops

- ▶ Farmers may not have time or **financial incentives** to plant and harvest cover crops.

Waste and residue lipids

- ▶ **Collecting used cooking oil** from various **fragmented sources** presents challenges.
- ▶ **Certain regulations** allow only **specific categories of animal fats** for production of biofuels.
- ▶ Palm oil-related products like **PFAD¹** and **POME²** are not preferred for use due to the **risk of land use change**.

Oil trees

- ▶ **Oil trees** grown on degraded land have yet to be **grown at a mass scale**.
- ▶ **Oil cover crops** are not yet widely available and would take **five to seven years** to generate output.

Forest residues and wood-processing waste

- ▶ Forest residues such as **branches and unmerchantable leftovers** are **left unused**.
- ▶ Residue must be **gathered**, which is **labor intensive** (hence expensive) and then transported to **storage locations**.



● Lignin ● Biofuel ● Other by-products (glycerol, etc.)

1. PFAD: Palm fatty acid distillate, a by-product of the physical refining of palm oil.

2. POME: Palm oil mill effluent, the wastewater discharged from the sterilization process, crude oil clarification process and cracked mixture separation in the palm oil mill.

Source: EY-Parthenon analysis

Biofuels have adoption potential across multiple segments and sectors, but current barriers to greater adoption include high costs and technology limitations

Commercialized	Advanced biofuels (Gen 2+ feedstocks)	End markets			
		Light vehicles	Heavy vehicles	Marine	Aviation
R&D phase	Biodiesel (FAME)	✗	✓ ✓	✓ ✓	✗
	Renewable diesel (HVO)/bio-jet fuel (HEFA ¹)	✗	✓	✓ ✓ ✓	✓ ✓ ✓
	Biomethane	✓ ✓	✓ ✓	✗	✗
	Lignocellulosic ethanol	✓ ✓ ✓	✗	✗	✗
	Farnesane	✗	✓	✗	✓ ✓
	BTL ² (pyrolysis/Fischer-Tropsch)	✗	✓	✓ ✓ ✓	✓ ✓ ✓
	ATJ ³	✗	✗	✗	✓ ✓ ✓

✓ ✓ ✓ High fit
 ✓ ✓ Moderate fit
 ✓ Low fit
 ✗ Not a fit

While biofuels are quickly gaining support from global political powers and industry institutions, high up-front investment costs and bottom-line prices are the primary challenges limiting growth.

1. HEFA: Hydroprocessed esters and fatty acids, synonymous with HVOs.

2. BTL: Biomass-to-liquid fuel.

3. ATJ: Alcohol-to-jet

Source: EY-Parthenon analysis

Public and private investments into research and infrastructure development bolstered by education and targeted policy will be needed to continue the biofuels adoption shift



Research and development

Research in biotechnology, agriculture and environmental sciences could lead to stronger and more transformative crops, more efficient biofuel production processes, higher blending rates, and less environmentally destructive systems.



Agronomy and education

Findings from research and the underlying agronomic impact should be distilled into an easily digestible format. Farmers should be able to quickly and effortlessly educate themselves on production techniques and the preferred crop options that are being adopted as potential fuel sources.



Infrastructure and scale

The infrastructure for production, storage and distribution of alternative fuels is not robust enough to meet current projected demand. Enabling scale will require large capital investments to develop infrastructure that can safely and cost-effectively move both inputs and outputs around the world.



Regulatory/policy support

Continued policy, regulatory and tax support is necessary to gain momentum and sustain growth for the alternative fuels industry. Governing bodies will need to continually monitor the dynamic fuels ecosystem to address the prevailing cost concerns and technical challenges.



Accelerated R&D in biofuel-related fields, bolstered infrastructure for production and distribution, and continued policy support are all necessary for the progression of alternative fuels. These comprehensive changes could not only address current cost and technical challenges but could position the industry to meet future demands efficiently and sustainably.

Key takeaways and considerations

Farmers

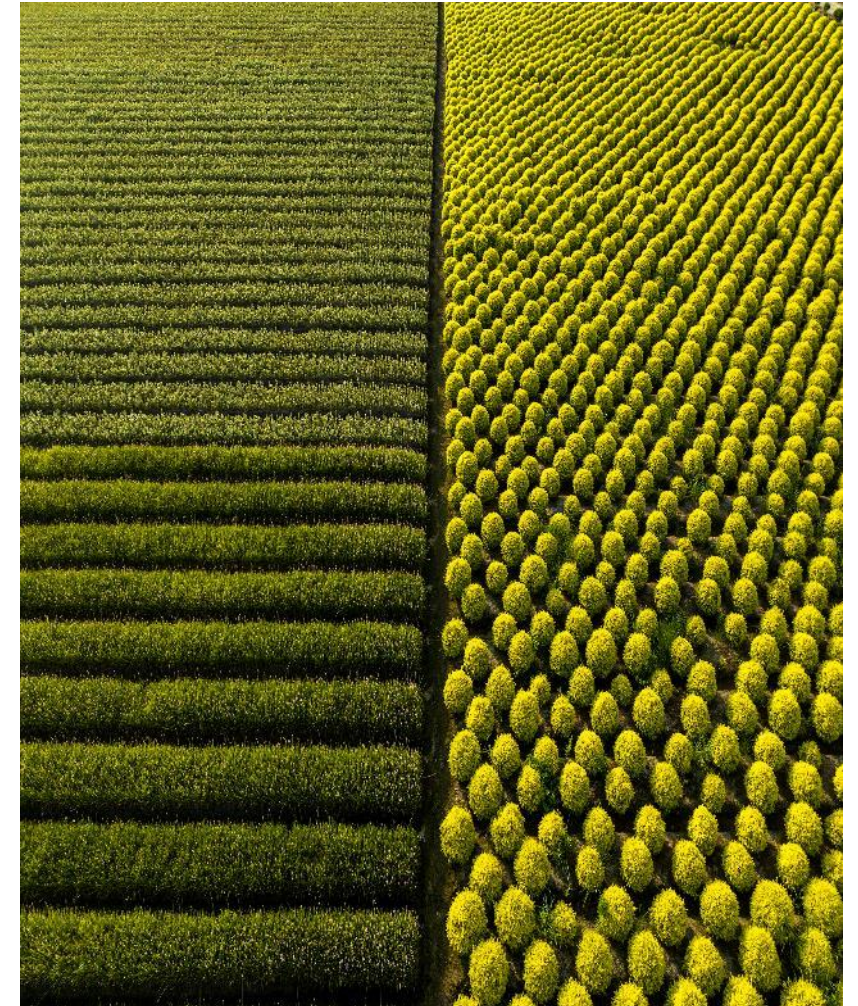
- ▶ Farmers must weigh the **economic implications and feasibility** based on **geography and market conditions** and the **sustainability of transitioning** to growing new crops that can be used as biofuels in addition to or in place of current crops.
- ▶ This involves understanding **initial costs, potential returns, taxable benefits, environmental implications** and any adjustments based on their unique circumstances.

Industry leaders

- ▶ Industry leaders need to continue developing a **robust infrastructure** for biofuel feedstock **storage, refining and distribution** networks for these future energy products.
- ▶ These leaders should employ the benefits of **investment and tax credits** to **reduce risk** involved in fuel switching for future consumption.

Policymakers

- ▶ Policymakers should look to adopt **existing favorable targeted incentives** across the US such as:
 - ▶ Low-carbon fuel standard (LCFS) is a policy that requires **transportation fuels** to meet a certain **energy-related GHG target** within a specified jurisdiction and time frame (adopted on a state-by-state basis).
 - ▶ A **credit system** can be used to facilitate and oversee program compliance during a compliance period where these **credits can be traded or banked for future use**.



A person wearing an orange high-visibility safety jacket is standing in a lush green field, working on a laptop. In the background, several large wind turbines are visible against a clear blue sky. The scene is captured from a low angle, emphasizing the scale of the turbines and the person's presence in the field.

Update on energy transition and impact on agriculture - global perspectives



Energy-agriculture intersection

- ▶ Asia plays a significant role in cultivating crops such as sugarcane and oil palms for biofuel production, providing an alternative to fossil fuels.
- ▶ The region is using renewable energy in farming, with solar irrigation in India and biogas from livestock waste in China, bolstering energy security and helping to curb emissions.
- ▶ Small farmers are learning to adapt to the energy transition, with subsidy programs and skill development programs to support their shift toward biofuel crop cultivation.

Transition/policy drivers

- ▶ Many countries in Asia are transitioning to renewable energy to meet their commitments to reduce greenhouse gas (GHG) emissions under the Paris Agreement.
- ▶ Dependence on fossil fuel imports has driven focus on renewable energy to improve energy security and self-sufficiency.
- ▶ Technological improvements and the falling costs of technologies such as solar PV has prompted governments to reconsider their energy policies.

Impact of regulation

- ▶ The push for renewable energy, particularly biofuels, has led to vast tracts of forests being converted into biofuel crop plantations, which significantly impacts biodiversity.
- ▶ Domination of prevalent and energy-intensive rice farming in Asia demands specific strategies for reducing greenhouse gas emissions in the transition toward renewable energy sources.
- ▶ Regulatory frameworks in many Asian countries incentivize biofuel crops, which could lead to food security risks as farmers choose biofuel crops over food crops.



Energy-agriculture intersection

- ▶ Europe relies heavily on bioenergy from crop residue, contributing substantially to the regional energy mix.
- ▶ Extensive cultivation of specific crops for biofuels and widespread usage of anaerobic digestion for waste conversion underpin the interaction of energy and agriculture.
- ▶ The integration of wind farms on agricultural lands provides dual benefits of renewable energy production and supplemental farm income.

Transition/policy drivers

- ▶ The energy transition is driven primarily by:
 - ▶ EU's aim for climate neutrality by 2050
 - ▶ Policies such as the European Green Deal (2020) and the Fit for 55 plan (2021)
 - ▶ Lowering of financial barriers like high up-front investment costs, via incentives and subsidies for the adoption of energy efficiency measures
- ▶ The Russian invasion of Ukraine has propelled energy transition efforts, notably marked by the European Commission's 2022 announcement of the REPowerEU plan, designed to curtail dependence on Russian fossil fuels and expedite the green transition.

Impact of regulation

- ▶ Europe's focused efforts on integrating farmers into the energy grid through feed-in tariffs (FiTs) and other incentives support a two-way energy system where farmers produce and consume power.
- ▶ Regulatory support through the European Green Deal and national energy and climate plans (NECPs) is driving a comprehensive shift toward sustainability and renewable energy use in agriculture.



Energy-agriculture intersection

- ▶ Latin America uses biofuels such as ethanol and biodiesel, produced from locally abundant agricultural commodities like sugarcane and corn, contributing to significant biofuel exports from the region.
- ▶ Despite its clean energy potential, Latin America still relies heavily on fossil fuels, particularly in transport and industry.
- ▶ Emission reduction efforts are focused on sustainable farming and land-use changes, given their significant contribution to greenhouse gas emissions, with bioenergy crops possibly offering both energy production and emissions mitigation.

Transition/policy drivers

- ▶ Ongoing reform of fossil fuel subsidies promotes the adoption of cleaner energy sources, sparking a shift toward more sustainable forms of energy.
- ▶ Initiatives to link power networks across Latin American countries aim to better share clean electricity, supporting a shift to renewable energy from fossil fuels and benefiting both the energy sector and sustainable agriculture.
- ▶ Latin America has pledged to reach net-zero emissions by mid-century or earlier, driving the shift toward cleaner energy sources and technologies.

Impact of regulation

- ▶ Large-scale conversion of Amazon rainforest into farmland in countries like Brazil, partially for biofuel crops, raises concerns regarding biodiversity, indigenous rights and carbon emissions.
- ▶ Expansion of bioeconomy strategies that aim to integrate bioenergy production, agriculture and innovation offer unique opportunities for farmers, but also bring challenges in balancing food, energy and environmental demands.



Food
traceability

Executive summary and perspective



As advancing digital technologies become increasingly critical to ensuring our food supply chain's security, the FDA's new Food Traceability Rule represents not an obstacle for businesses to overcome but an opportunity for companies to transform their operations for long-term benefit.

- 1 The criticality of food supply chain security

 - ▶ The US food supply contributes nearly \$1 trillion to annual GDP, but every year roughly 1 in 6 Americans gets sick from contaminated food.
- 2 The FDA's new Food Traceability Rule goes beyond existing regulations

 - ▶ Entities that use foods on the Food Traceability List (FTL) in products **consumed** in the US must maintain and share records of key data elements associated with critical tracking events at every step in the value chain, not just "one up and one back." Leading companies are mandating compliance for **all** products.
- 3 The rule presents both challenges and opportunities

 - ▶ Although compliance requires changes to processes, systems and ways of working across the organization, implementation can generate new business insights, advance sustainability goals, reduce costs and facilitate continuous improvement activities.
- 4 The time to start preparing is yesterday

 - ▶ A thoughtful, phased, cross-functional approach is necessary to address the new complexities from FSMA 204 new complexities while helping companies to achieve compliance and generate long-term benefits.

“

The FDA Food Traceability Rule (FSMA 204) should not be seen as a regulatory hurdle, but rather a powerful opportunity for process improvements, deeper insights, better reporting and to make the necessary leap from reactive to proactive food manufacturing. This approach will ultimately contribute to the climb up the S-curve and allow organizations to reach previously unimagined levels of performance.

Lisa Hartkopf

Partner, Ernst & Young LLP

The FDA's Food Traceability Rule (FSMA 204) is designed to improve food safety and is a key component of the agency's New Era of Smarter Food Safety Blueprint

Q What is the FDA's Food Traceability Rule?

Food Safety Modernization Act (FSMA) 204 is designed to enable faster identification and rapid removal of potentially contaminated food from the market, resulting in fewer foodborne illnesses and/or deaths.

A

Q Why is it being implemented?

The requirements help the FDA identify recipients of foods to prevent or mitigate foodborne illness outbreak and address credible threats of serious adverse health consequences or death.

A

Q Who needs to comply?

Entities that manufacture, process, pack and hold foods that the FDA has declared on the Food Traceability List must meet the requirements for additional traceability.

A

Q Are there new regulatory terms related to this rule?

- ▶ **Key data elements (KDEs):** Describe the traceability content (e.g., lot code) that must be identified and tracked
- ▶ **Critical tracking events (CTEs):** Describe the process's step events (e.g., receiving) and what is required for the various steps

A

Foods included in the FDA's Food Traceability List (FTL)

- ▶ Fresh fruits
- ▶ Fresh vegetables
- ▶ Fresh herbs
- ▶ Shell eggs
- ▶ Fresh/frozen seafood
- ▶ Nut butters
- ▶ Ready-to-eat salads
- ▶ Pasteurized and unpasteurized milk
- ▶ Cheeses: fresh, soft, semisoft, unripened cheeses
- ▶ More products will likely be added as the program matures

FSMA 204 applies to all products consumed in the US, whether manufactured domestically or imported. Companies sourcing FTL ingredients from abroad must work closely with their foreign suppliers to establish full compliance.

FSMA 204 will impact businesses across the supply chain, requiring stakeholders to collect, transmit and retain specific information at each stage

ILLUSTRATIVE EXAMPLE

Critical tracking events, key data elements and commentary on the role of FSMA 204 across the value chain

	Growers	Harvesters	Manufacturers and processors	Distribution centers	Retailers
CTEs	<ul style="list-style-type: none"> ▶ Exempt unless grower is harvester 	<ul style="list-style-type: none"> ▶ Source code creation ▶ Shipping key data elements 	<ul style="list-style-type: none"> ▶ Source code creation ▶ Cooling of raw ag commodities ▶ Kill step ▶ Transformation of food: commingling, processing/cutting ▶ Receiving/ transformation/ shipping KDEs 	<ul style="list-style-type: none"> ▶ Source code creation ▶ Transformation of food: commingling, repacking, relabeling ▶ Receiving/transformation/ shipping KDEs 	<ul style="list-style-type: none"> ▶ Source code creation ▶ Receiving KDEs
Commentary	<p>If also acting as harvesters, growers may be subject to traceability regulations if their revenue crosses a threshold level.</p>	<p>Smaller (non-exempt) harvesters may be better positioned to use existing systems or low-/no-cost traceability solutions, facilitating a smoother response process for new regulations.</p>	<p>Product transformation and repacking (e.g., variety packs) can complicate tracking.</p> <p>Technology that enables traceability (including systems already in place, e.g., SAP) reduces the scope of recalls, decreasing related costs and waste.</p>	<p>As intermediaries to retailers, distribution centers could help steer standardization of traceability practices.</p> <p>Technology that enables traceability can reduce the scope of recalls, decreasing related costs and waste.</p>	<p>In dictating products on their shelves, retailers have significant influence over data format and transmission standards.</p> <p>As point of direct consumer contact, retailers may be better positioned to educate consumers on traceability.</p>

As raw materials, ingredients and finished products are distributed to multiple manufacturers, distribution centers and retailers within the supply chain, the complexity of capturing and updating traceability data increases significantly.

Compliance with FSMA 204 requires the involvement of numerous business functions within the organization – presenting different opportunities for each

All functions will need to implement process changes to collect specific KDEs across the CTEs.



Supply chain

- ▶ Assess suppliers on sustainable practices through enhanced traceability data
- ▶ Work with supply chain partners to establish a **unified digital tracking system** for supply chain management
- ▶ Implement FSMA 204-driven process optimization to refine **supply chain** efficiency, pinpoint inefficiencies and mitigate waste



Food safety

- ▶ Use traceability to shift from reactive to proactive operations, leveraging real-time data for continuous improvement
- ▶ Develop and manage a sortable spreadsheet to be provided to the FDA within 24 hours of a request to enable **precision in recalls**
- ▶ Leverage FSMA 204 to boost visibility, allowing real-time monitoring, better inventory control, and **reduced scrap and spoilage**



Human resources

- ▶ Create **training** for employees so they understand/comply with updated traceability protocols
- ▶ Adapt training for new workflows to **maintain productivity** and familiarize staff with new systems
- ▶ Implement a governance structure and change management activities to align the workforce with the new requirements and gain enterprise-wide buy-in for necessary process changes/improvements



Information technology (IT)

- ▶ Analyze and enhance data collection processes to not only meet compliance requirements but also to yield consistent, **enterprise-wide insights**
- ▶ **Bolster security** to protect the increasing amounts of data required for FSMA 204 compliance
- ▶ **Drive IT innovation** in traceability technologies like blockchain, RFID and advanced sensors, which could uncover opportunities for continuous improvement

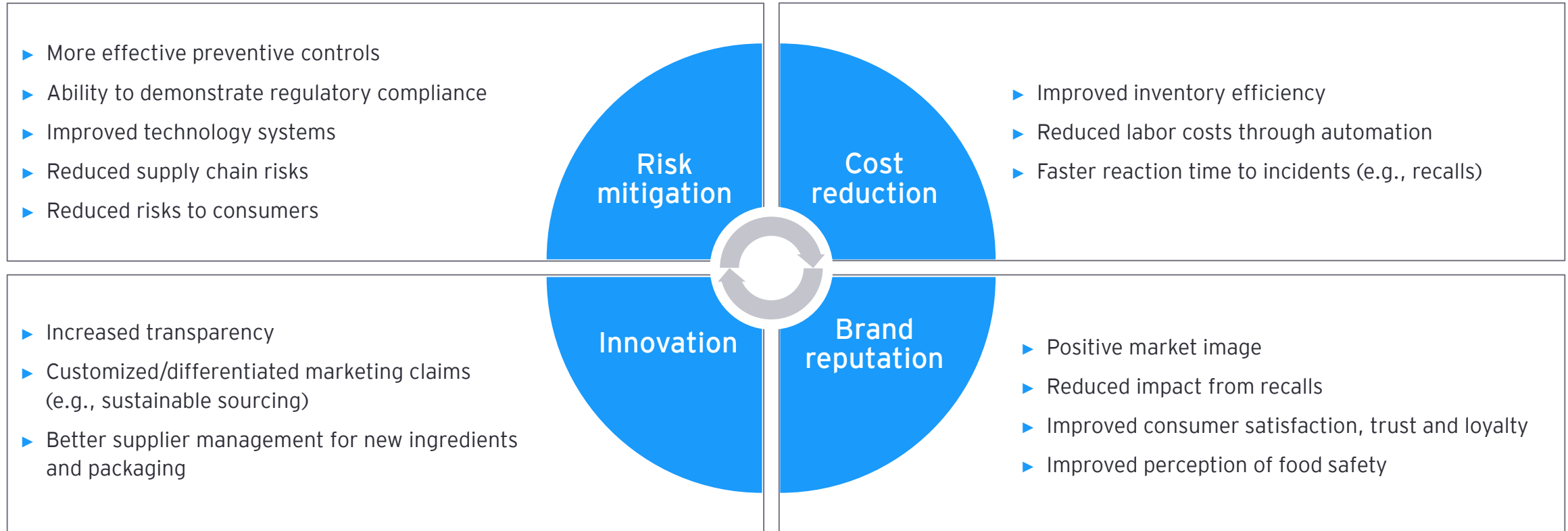


Sustainability

- ▶ Enhance transparency, reduce risk and boost customer trust
- ▶ Support product sustainability claims and improve consumer confidence through **verifiable sourcing**
- ▶ Use traceability data to better understand and address **Scope 3 emissions**

Broadening traceability beyond “one up and one back” can provide benefits across the food and agricultural value chain through various operational impacts

Tech-enabled traceability that covers the entire value chain aligns with strategic business objectives in several ways:



Leading companies incorporate regulatory requirements into business strategy to not only address emerging risks but also to drive growth and efficiencies.

While compliance is not required until January 2026, leading food and agriculture companies have already found ways of leveraging traceability for strategic impact

Companies across the value chain have already developed innovative traceability solutions that go beyond mere compliance.

Major food manufacturer



- ▶ One of the largest global food manufacturers uses traceability solutions to provide **real-time access to supply chain data** such as certifications, temperature and other data points.
- ▶ Through these traceability solutions, the company aims to enhance supply chain transparency and **increase accountability** among supply chain actors.

Fruit and vegetable distributor



- ▶ A major multinational fruit and vegetable distributor is launching an initiative across business divisions to **enhance food safety operations**. The company is working with a leading global computing corporation on the project.
- ▶ Through this initiative, the company aims to **improve the speed at which it spots issues** in the value chain to recall contaminated products.

Coffee retailer



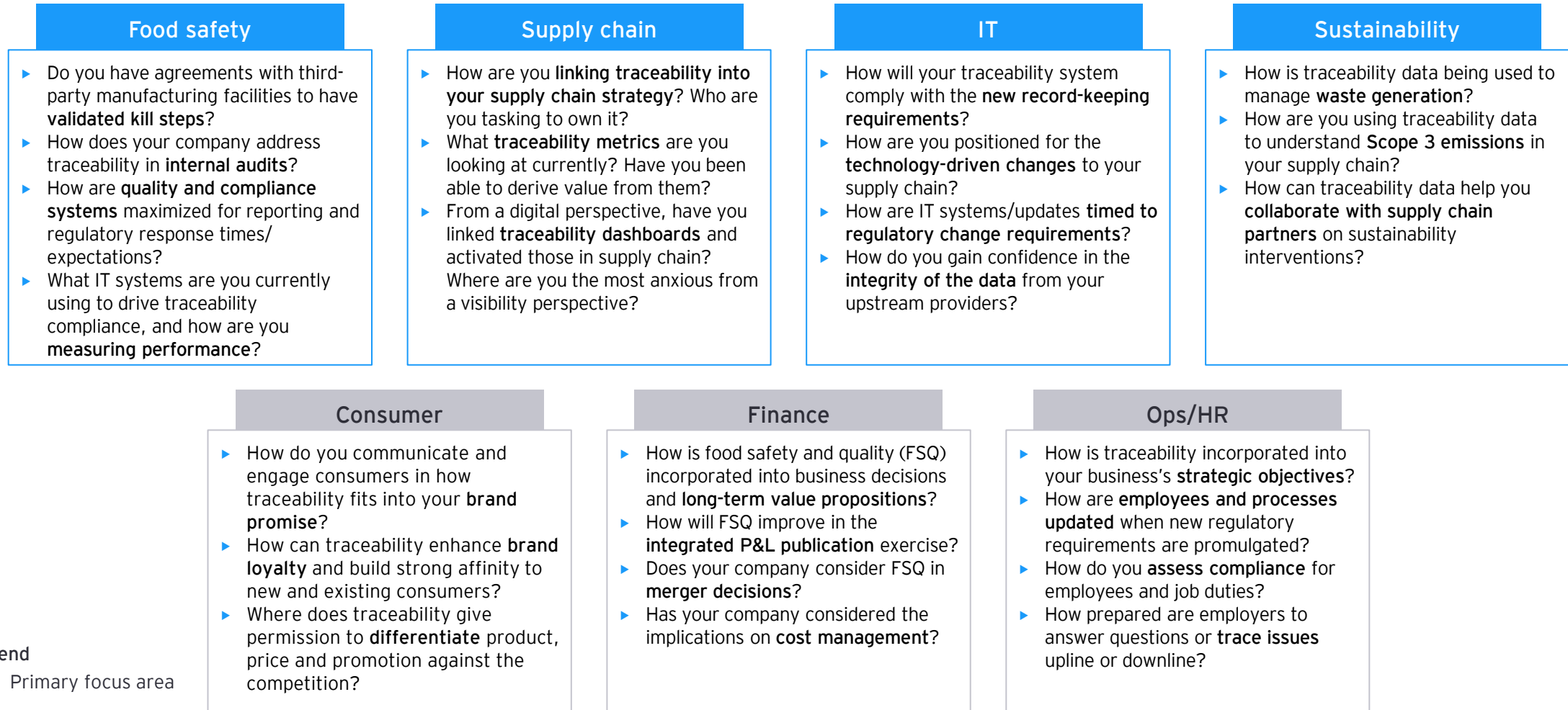
- ▶ A large coffee retailer allows customers to scan the code on the back of their bag of coffee to **understand its journey**, including where the beans were sourced and roasted.
- ▶ The company is committed to 100% ethically sourced coffee. By being transparent about where their coffee is sourced, the company hopes to **build customer trust and loyalty**.

Global retail corporation



- ▶ To **combat foodborne diseases**, a leading multinational retail corporation requires suppliers use traceability systems for farm-to-table/store product monitoring.
- ▶ This mandate came after a food contamination incident. The company's goal is to speed up identifying the source of food safety issues so that the process can **take seconds instead of days or weeks**.

Companies should consider these key questions to determine how expanded traceability fits within each function's responsibilities and the overall business strategy



Key takeaways and considerations

Growers and harvesters

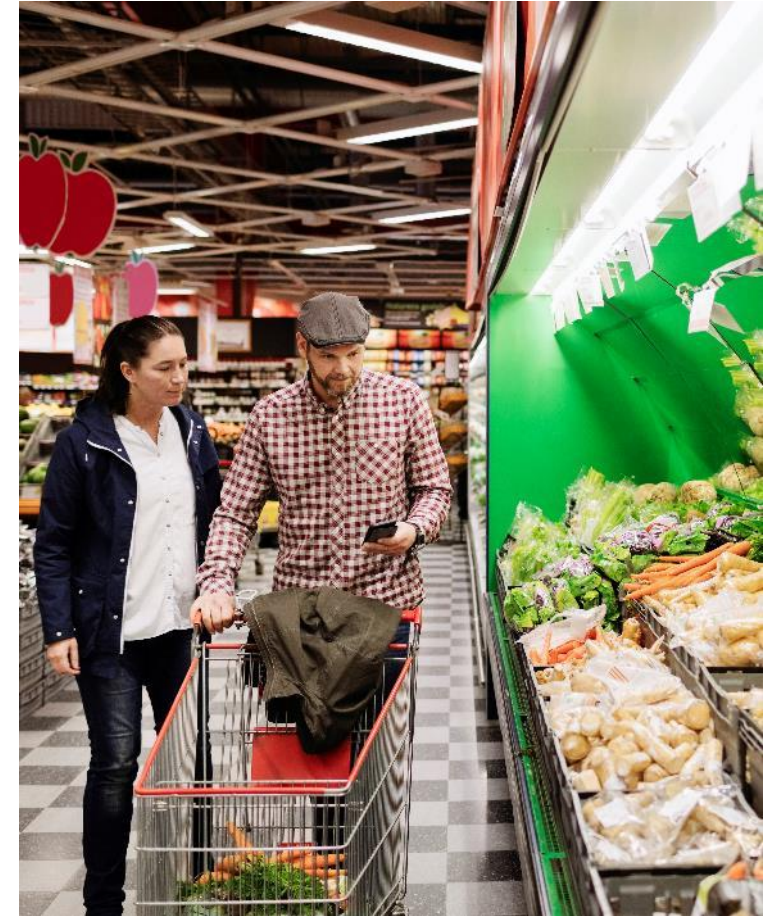
- ▶ **Understand and apply farm-specific exemptions**, including those for farms that sell directly to the consumer, grow but do not harvest raw ingredients, or have an average revenue of less than \$25,000 on a three-year rolling basis
- ▶ Explore **low- or no-cost traceability solutions** suited to small-scale harvesters (where applicable) to maintain compliance without significant financial burden

Manufacturers and processors

- ▶ Assess **network connection points** to verify that the right data (KDEs) are consistently gathered across data collection points (CTEs)
- ▶ Evaluate current state, identify gaps and obtain buy-in across the organization to implement **lasting traceability solutions**
- ▶ **Consider extending changes made for FTL ingredients** to all products, due to possible future FDA requirements and customer demands

Retailers

- ▶ Mandate suppliers implement **clear traceability policies** and procedures to confirm that products with FTL ingredients are compliant ahead of deadline
- ▶ Explore ways to **educate consumers** on how traceability and sustainable/transparent sourcing can support product recalls and improve public health outcomes
- ▶ Leverage buying power over value chain partners to **influence which traceability systems and standards** are adopted





Food traceability -
global perspectives

Asia's stringent food safety laws boost consumer confidence and drive innovation, but increase costs

1	Asia
2	Europe
3	Latin America

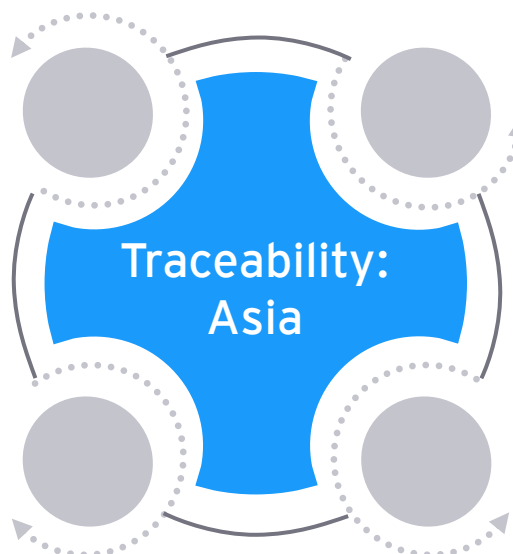


Regional traceability regulation

- ▶ China's Food Safety Law regulates the **entire food production and supply chain**, ensuring the **safe and appropriate use of agricultural inputs** such as pesticides and fertilizers, with stringent penalties for noncompliance.
- ▶ India's Food Safety and Standards Act unifies **food-related laws** and establishes a body to provide **science-based foods standards**, with explicit guidelines for the **use of pesticides and contaminants in the agricultural sector**, thereby ensuring the safety and quality of food products.

Impact on producers

- ▶ Producers must invest in enhancing their food safety management systems to comply with regulations, which are increasing their production costs.
- ▶ Stringent regulations can drive innovation and adaptation of technology, allowing producers to potentially access higher-value markets domestically and internationally.
- ▶ Producers can implement better agricultural methods, such as organic farming or the implementation of more sustainable practices, improving product quality and, potentially, market appeal.



Key drivers

- ▶ Rapid population growth and urbanization are demanding improved food safety standards to ensure public health security.
- ▶ Instances of food safety scandals have highlighted the need for strict laws to maintain trust in the domestic and international market.
- ▶ Improved consumer awareness about food safety, partly driven by a growing middle class, is increasing the demand for stricter regulations.

Implications on import and export

- ▶ China's stringent food safety laws led to sizable foreign direct investment in the food industry due to increased consumer confidence.
- ▶ India's food safety standards have faced certain export rejections primarily from the EU due to noncompliance with global safety standards, demonstrating the challenges in aligning local practices with international expectations.
- ▶ Asia-Pacific's stringent food safety regulations challenge US and EU exporters in forward-thinking sectors like organic and genetically modified (GM) foods, creating entry barriers for these markets.

EU's food law prioritizes public health, which has an impact on trade but enhances consumer trust

1	Asia
2	Europe
3	Latin America

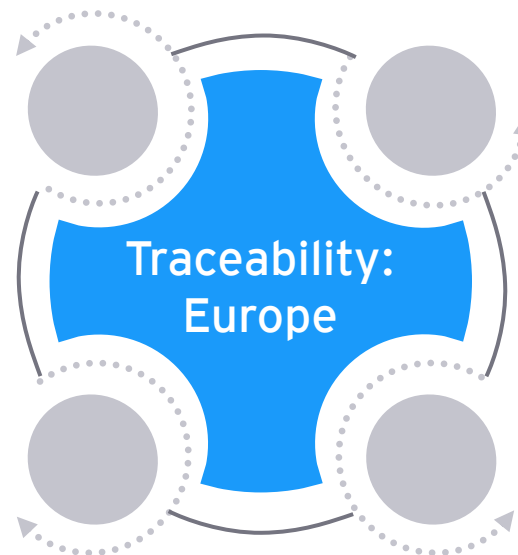


Regional traceability regulation

- ▶ Europe's General Food Law Regulation is a **comprehensive framework** that **upholds food safety** across all EU countries.
- ▶ It mandates **strict traceability of food and feed** at all stages of production and distribution, enabling accountability and control over the entire food supply chain.
- ▶ The regulations also **enforce harmonized safety standards across EU member states**, facilitating a seamless single market while setting stringent import conditions that align with the EU's food safety objectives.

Impact on producers

- ▶ European producers adhering to the comprehensive food safety regulations can **gain consumers' trust, leading to increased market opportunities**, both locally and internationally.
- ▶ Producers will bear the **costs of maintaining traceability**, which may challenge smaller companies or individual farmers and could also result in higher product prices.
- ▶ EU's proactive approach to **emerging risks**, such as those potentially posed by genetically modified organisms (GMOs) or novel foods, may restrict the **types of products that producers can sell**.



Key drivers

- ▶ Growing concerns over the **safety and impact of agricultural inputs**, such as pesticides and fertilizers, in the food supply chain.
- ▶ Need for **increased transparency** and oversight to manage the complexity of the entire food supply chain, **tracing back to the farm level**.
- ▶ Urgency to **respond to emerging risks** and debates around the **use and containment of GMOs** in crop production.
- ▶ Imperative to restore and maintain public confidence in agriculture sector following **devastating food crises in the 1990s**, notably the BSE (mad cow disease).

Implications on import and export

- ▶ The EU's strict GMO regulations have **limited the entry of certain crops into the region**, affecting countries like the **US and Canada**, which are major cultivators and exporters of **GMO crops**.
- ▶ The harmonized regulations across EU member states have **facilitated easier trade within the region** and have become a gold standard that non-EU countries aspire to follow.
- ▶ Exporters to the EU, particularly from developing countries, had to **significantly upgrade their food safety measures** to comply with the General Food Law Regulation, which led to **improved safety standards**, and increased costs, in these countries.

Latin America's robust food safety laws elevate product quality and global trade relations, despite increased costs and strict compliance

1	Asia
2	Europe
3	Latin America



Regional traceability regulation

- ▶ Latin America's commitment to food safety and traceability, is maintained by **laws in countries such as Brazil and Mexico**.
- ▶ Brazil's Food Security and Nutrition Law (LOSAN) guarantees the right to food for all citizens, placing **requirements on the agricultural sector for safety, quality and sustainable practice**.
- ▶ Mexico's Federal Law of Animal Health details the health and safety regulations for the **processing and distribution of animal-based food products**, with traceability measures mandating the identification and registration of livestock, ensuring safe practices.

Impact on producers

- ▶ Producers must **meet the national food safety standards, improving overall product quality**, but compliance may also lead to higher production costs.
- ▶ Greater traceability could open **access to new markets, both domestically and internationally**, as consumers increasingly demand transparency in their food sources.
- ▶ Producers will need to **invest in safety systems and technological innovation** and **partner with local or global entities** to strengthen their food safety.




Key drivers

- ▶ **Increasing globalization and export opportunities** have highlighted the need for compatibility with international food safety standards, driving stricter domestic regulations.
- ▶ **Changes in dietary habits** and a shift toward healthier lifestyles have also emphasized the need for better agricultural and food safety norms.
- ▶ **High-profile cases of food-borne diseases**, such as the cholera outbreaks in Peru during the 1990s and the anthrax cases in Argentina, drove home the necessity for stringent food safety regulations to safeguard public health.

Implications on import and export

- ▶ Increased focus on food safety and traceability law in Latin America has made the region a more attractive destination for food imports, **especially in premium markets such as organic and fair-trade goods**.
- ▶ Brazil's increased regulation of food safety has **boosted its meat exports, especially poultry, to countries like China**, creating a positive economic impact.
- ▶ Strengthening food safety laws in Mexico, especially regarding the **certification of products such as organic avocados**, has **attracted importers from the US and Europe**, boosting market exports.

A woman wearing a blue floral dress, a straw hat with a black band, and a blue backpack is looking at a display of various teas. The teas are stored in large, stacked wooden jars on a wooden counter. Each jar has a small yellow tag with text. The woman is reaching out towards one of the jars. In the background, there are more jars and a shelf with boxes of tea. The scene is set in a market or shop.

Functional foods and beverages

Executive summary and perspective



Products that are at the intersection of consumption and health/wellness are gaining significant traction, as consumer-buying behavior is driving toward a focus on foods and beverages that provide additional functional and nutritional benefits. These innovative products are influencing both traditional and nontraditional companies in the end-to-end value chain to reconsider their strategy for addressing the evolution of these consumer needs.

- 1** Focus on foods and beverages that improve nutrition beyond the basics
▶ The functional food and beverage (F&B) industry's goal is to enhance consumer health through fortification of raw materials with additional ingredients that can prevent deficiencies and support health.
- 2** Shifts in consumer behavior toward health and wellness
▶ Consumer behavior is anticipated to continue shifting toward a focus on health and wellness in the upcoming years, with 73% of consumers noting that they will be more aware/cautious of their physical health and 67% denoting the same for their mental health.
- 3** Significant opportunity from a global market perspective
▶ The global market for functional food and beverage is projected to be \$125b+ in the next five years, with significant benefit from key consumer tailwinds.
- 4** Growth and interest from seemingly unrelated industries
▶ Opportunities to expand upon existing product portfolios has led companies in the beauty and pharmaceutical industries to position themselves as possible contributors.

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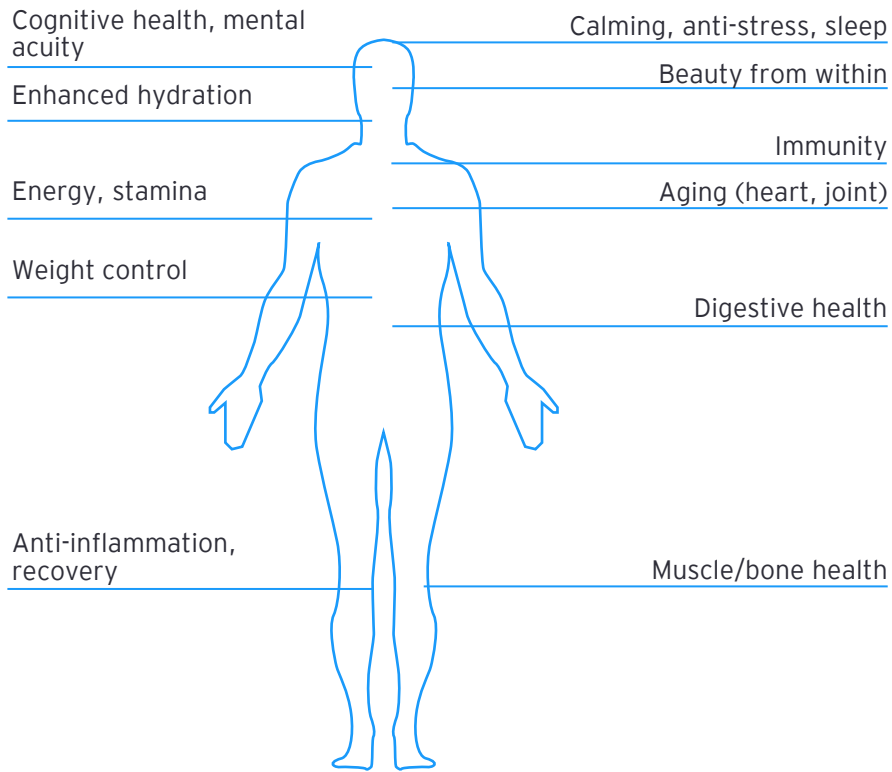
Consumers' continued focus on health and wellness is driving functional food and beverages into the mainstream. Brands looking to capitalize on this growing trend are pulling different levers to enter — whether through acquisition of startups, partnerships, or incorporating functionality to extend existing brands or launching new ones. From ingredients that support skin and cognitive health to mood-enhancing supplements and immune system boosters, there will soon be a time when you can browse store aisles for a food or beverage product for every nutritional need.

Alison Banks

Managing Director, Ernst & Young LLP

Functional food and beverages are enriched with nutrients and ingredients that provide specific health benefits beyond the basic nutritional value of the product

Functional F&B need states



Functional categories and related ingredients

Need states	Common ingredients
Calming, anti-stress, sleep	Ashwagandha, l-theanine, rhodiola, melatonin, CBD
Cognitive health, mental acuity	5-HTP, bacopa monnieri, lion's mane, gotu cola, ginkgo biloba, omega fatty acids
Beauty from within	Collagen, aloe vera, chlorophyll, antioxidants, amino acids
Aging (heart, joint)	Folate, coenzyme Q-10, magnesium, turmeric, glucosamine
Immunity	Zinc, goji berry, elderberry, vitamins C and D, reishi mushrooms
Digestive health	Probiotics, prebiotics, postbiotics, fiber, ginger
Physical performance, stamina	Amino acids, creatine, VMS, electrolytes, cordyceps
Enhanced hydration	Dextrose, dipotassium phosphate, potassium citrate
Energy	Ginseng, guarana, B-vitamins, theobromine, caffeine, matcha
Weight control	Apple cider vinegar, cinnamon, ginger, green tea
Muscle/bone health	BCAA, vitamins B and K, beta alanine, protein, calcium
Anti-inflammation, recovery	Curcumin, turmeric, spirulina, chaga mushrooms, carotenoids

Health and wellness, convenience, and personalization are key factors driving market growth, while pricing, lack of consumer knowledge and cost pressures are curtailing it

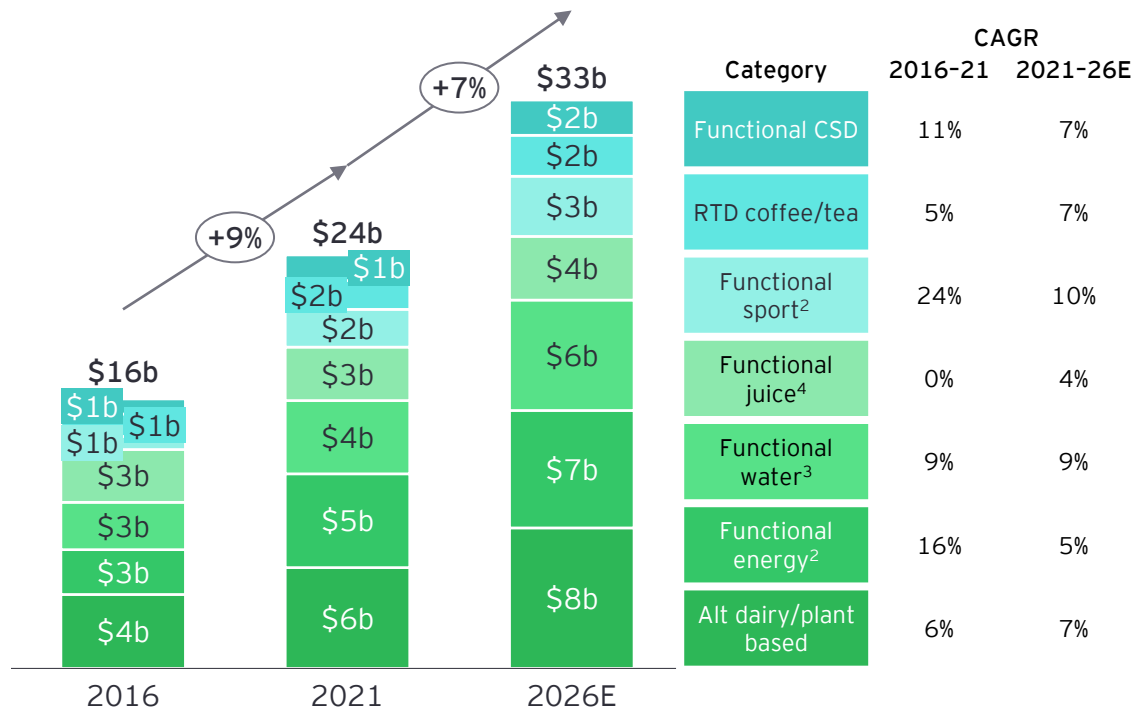
Functional food and beverage market drivers

	Tailwinds		Headwinds
Health and wellness	<ul style="list-style-type: none"> ▶ Skepticism around traditional pharma is pushing consumers to alternative medicine ▶ Category blurring with products made to target multiple need states ▶ Focus on boosting immune system following COVID-19 pandemic 	High price point	<ul style="list-style-type: none"> ▶ Relatively high prices, but in line with broader premiumization and luxury trends ▶ Difficult to enter in Asia and Africa, where functional food and beverages could be highly applicable
Convenience	<ul style="list-style-type: none"> ▶ Category expansion has made functional food and beverages easier to produce and consume ▶ Busy consumer lifestyle driving preference for ready-made and on-the-go products ▶ Diverse channel and marketing presence 	Lack of consumer awareness	<ul style="list-style-type: none"> ▶ Limited consumer understanding about functional ingredients and proven benefits ▶ Regulatory restrictions in new, high-growth categories such as CBD, kava and kratom
Personalized/innovative products	<ul style="list-style-type: none"> ▶ Consumers looking for more targeted products, addressing only relevant need states ▶ Focus on both benefits from a functional perspective along with flavor profile ▶ New drink personalization infrastructure 	High brand failure risk	<ul style="list-style-type: none"> ▶ Difficult to materialize advertised benefits due to irregular consumption patterns ▶ Significant R&D spend required to prove benefits
Organic/natural	<ul style="list-style-type: none"> ▶ Penetration of natural ingredients due to environmental and ethical supply chain concerns ▶ Increase of vegan/vegetarian lifestyles driving plant-based functional food interest ▶ Perceived as healthier and more premium products 	Cost pressure	<ul style="list-style-type: none"> ▶ Significant investments required in R&D, ingredient sourcing and distribution, development technology, marketing, and regulatory labeling

The US functional beverages and food markets will grow significantly between 2021-26, with alternative dairy and dairy products remaining a top category by market size

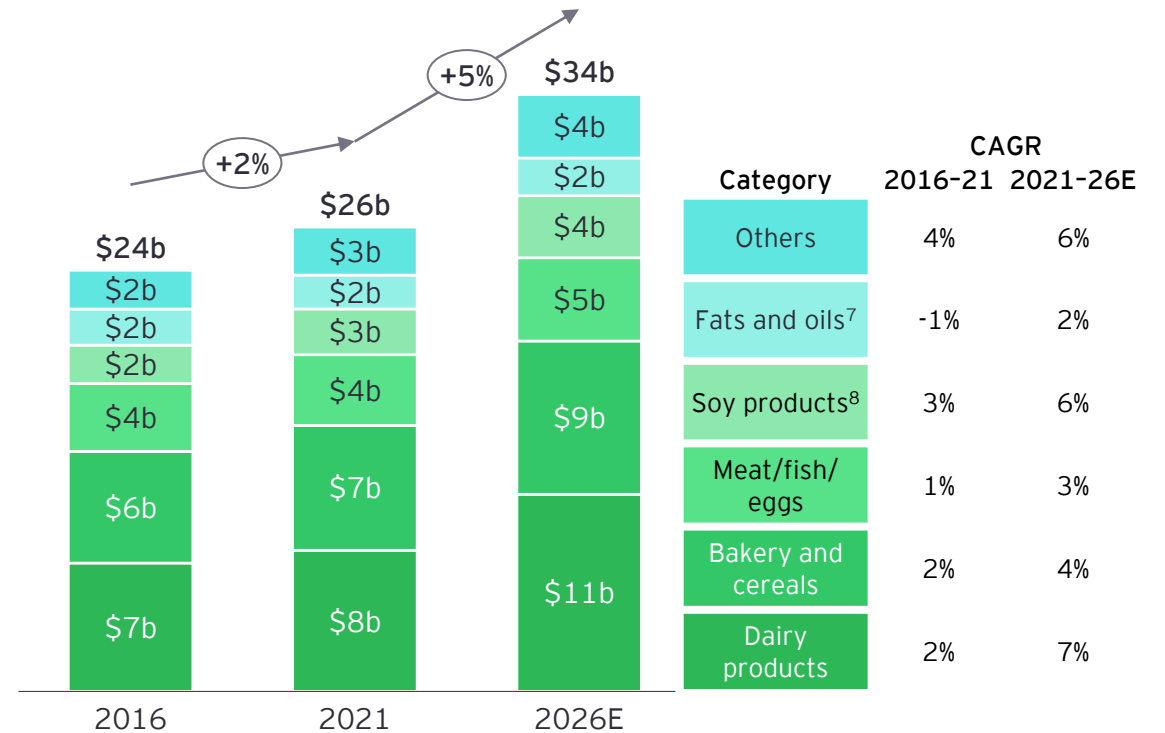
US functional beverages¹ market size and growth by category
\$b, 2016-26E

- ▶ Alt dairy/plant based, functional energy and functional water are the top three categories by market size.
- ▶ Functional sport and functional water are the fastest-growing categories.



US functional food market size and growth by category
\$b, 2016-26E^{5, 6}

- ▶ Dairy products, bakery and cereals, and meat/fish/eggs are the top three categories by market size.
- ▶ Dairy products and soy products are the fastest-growing categories.

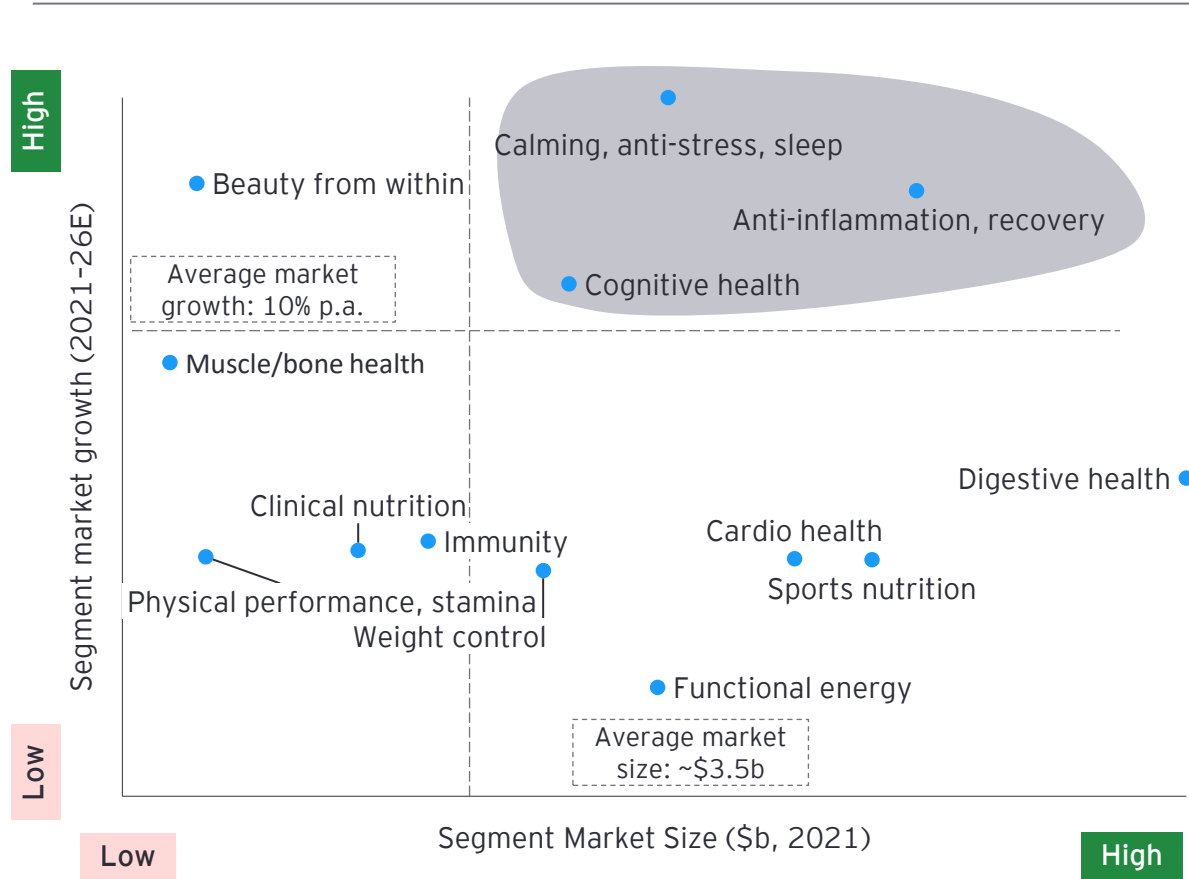


1. Excluding regular energy and sports drinks.
 2. Reduced sugar energy and sports drinks are used as a proxy for functional energy and functional sports, respectively.
 3. Functional water is composed of concentrates and functional bottled water.
 4. Functional juice includes 100% fruit and vegetable juice, juice drinks and nectars.

5. 2021 values extrapolated from 2020 actuals and 2025E forecast.
 6. 2026E values extrapolated from 2025E and 2030E forecasts.
 7. Fats and oils includes omega-3 fatty acids found in fish and certain vegetable oils.
 8. Soy products includes food alternatives such as cheese, meat, flour and tofu.

The top functional food and beverage opportunities in terms of both projected growth and current market size involve combatting mental health issues and fatigue

Initial perspectives on US market size and growth by need states
2016-26E



Commentary

- ▶ **Cognitive health and calming, anti-stress, sleep** are fast-growing categories:
 - ▶ These subsectors have two main growth drivers:
 1. Rising awareness around the importance of sleep, mental health concerns including those related to stress, and an aging population
 2. Increasing popularity of key ingredients like ashwagandha and CBD
- ▶ **Anti-inflammation/recovery and digestive health** are more established functional beverage categories with steady growth and large market size:
 - ▶ The large market size is partly due to the wide variety of ingredients that are included in functional beverages that target these need states.

Functional beverage deal activity has most frequently targeted energy and digestive health need states across categories such as functional water and alternative dairy

Deal activity in US functional beverages market, by need state and category
Jan 2020-Mar 2023

Category	Physical health										Mental health	
	Physical performance, stamina	Enhanced Hydration	Energy, stamina	Anti-inflammation, recovery	Weight control	Immunity	Beauty from within	Digestive health	Aging (heart, joint)	Muscle/bone health	Calming, anti-stress, sleep	Cognitive health, mental acuity
Functional water	167	22	139	103	103	42	66	125	34	40	42	39
Functional CSD	38	6	67	64	46	19	24	69	2	22	14	11
Functional juice	33	3	48	34	42	44	36	43	10	26	7	17
RTD coffee/tea	52	0	107	54	77	44	62	150	4	45	41	12
Functional sport	93	52	50	48	65	40	68	54	7	61	19	8
Functional energy	72	15	246	54	69	42	53	62	5	41	34	52
Alt dairy/plant based	97	9	130	68	160	89	98	157	20	82	53	40

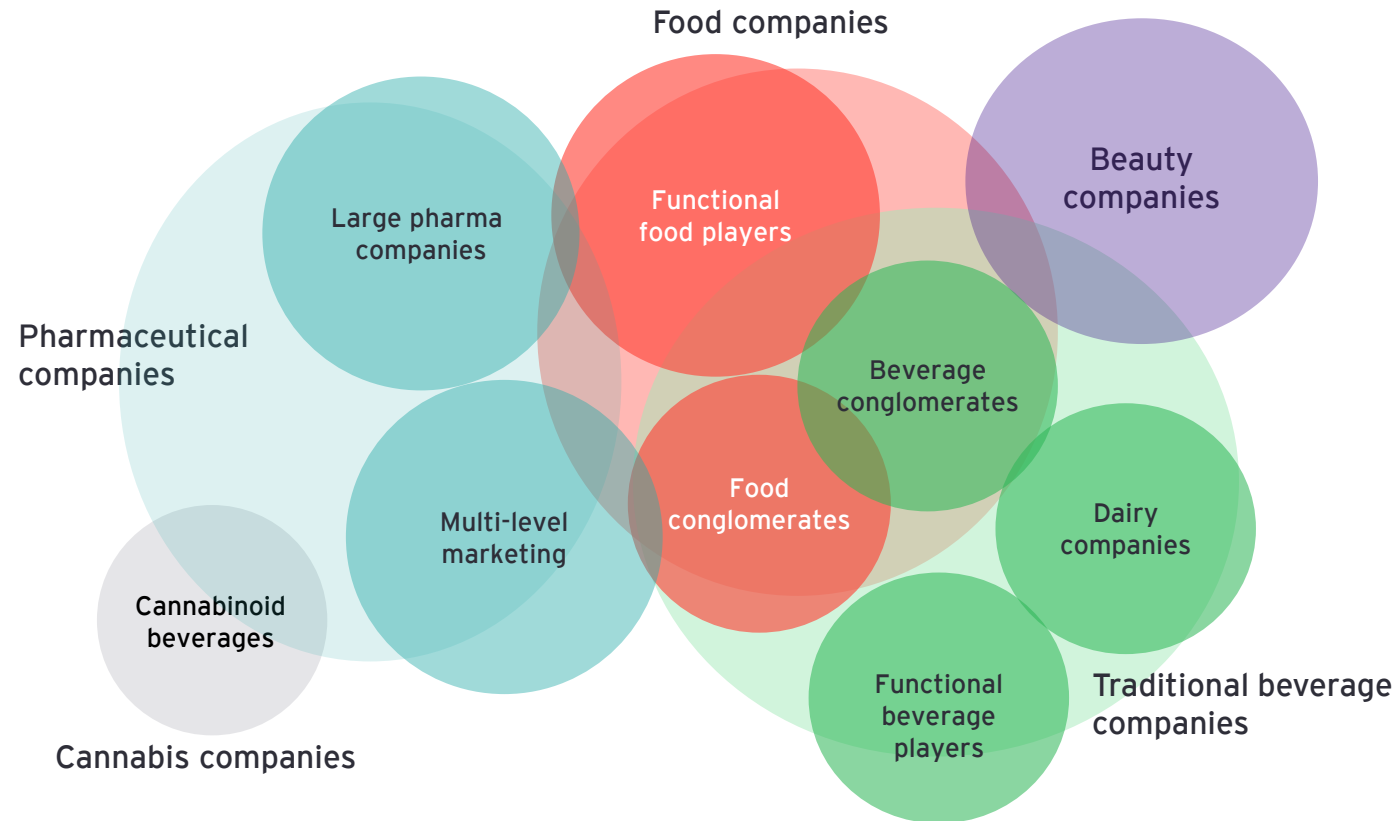
Key:	Significant deal activity (100+ deals)	Moderate deal activity (50-100 deals)	Low deal activity (0-50 deals)
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Note(s): A company could be present across multiple categories and hence could be multi-counted, for purpose of analysis.

Source: Euromonitor International; secondary research

Growth and interconnectedness of the functional food and beverages market have attracted competition from multiple, seemingly unrelated industries

Functional beverage competitive landscape



Commentary

Unorthodox players are becoming increasingly involved in the functional beverage landscape

- ▶ **Beauty companies:** Functional food and beverages offer a way to increase touchpoints and offer preventative treatments.
- ▶ **Pharmaceutical companies:** Leverage their expertise in developing and testing pharmaceuticals to create functional food and beverages. This allows pharmaceutical companies to expand product offering and convert non-prescribing customers to prescribing ones:
 - Multi-level marketing companies tend to be active in the health and personal care industries and are now moving into the adjacent functional food and beverage category.

Key takeaways and considerations

Producers

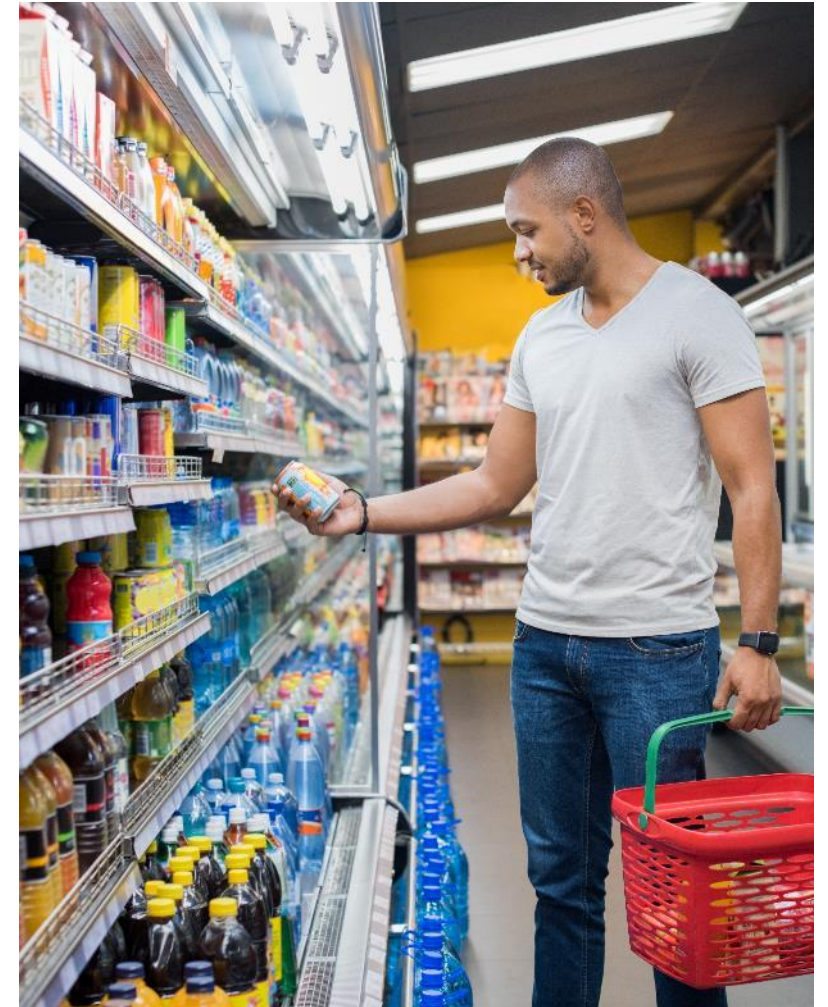
- ▶ Determine and focus production of raw materials on those that are the most **nutrient dense** and can account for **multiple need states**
- ▶ Consider opportunities to leverage **bioengineered crops/organisms** that have been bred to have enhanced nutrient value in comparison to traditional raw materials

Processors and manufacturers

- ▶ Assess the benefits of **acquiring/investing** in challenger brands and compare with developing new products organically through **internal research and development**
- ▶ Leverage technology for **synthetic production** of supplemental ingredients in processing of products
- ▶ Prioritize **pricing** and **sustainability** in addition to health and flavor when designing new products

Retailers and grocers

- ▶ Consider both **emerging** and **developed** countries, specifically targeting those **populations that are health conscious**
- ▶ Create **private label products** that are specific to retailers and grocers at which they are sold



A woman wearing a blue floral dress and a straw hat is looking at a display of various teas in large wooden jars. The jars are arranged on a wooden counter, and each jar has a small yellow tag with the name of the tea. The background shows a market stall with more jars and a brick wall.

Functional foods and beverages – global perspectives

Driven by traditional health philosophies and new wellness trends in Asia, producers innovate functional foods with local ingredients and focused R&D

1	Asia
2	Europe
3	Latin America



Functional foods and beverages

- ▶ The market is shaped by traditional health philosophies, such as the Indian ayurvedic system and Chinese traditional medicine, driving the popularity of turmeric-based products and herbal teas.
- ▶ Japan and South Korea are known for their probiotic drink, Yakult, promoting digestive health.
- ▶ Green tea, particularly from Japan and China, with antioxidant properties and purported benefits for brain health, is consumed widely in the region.

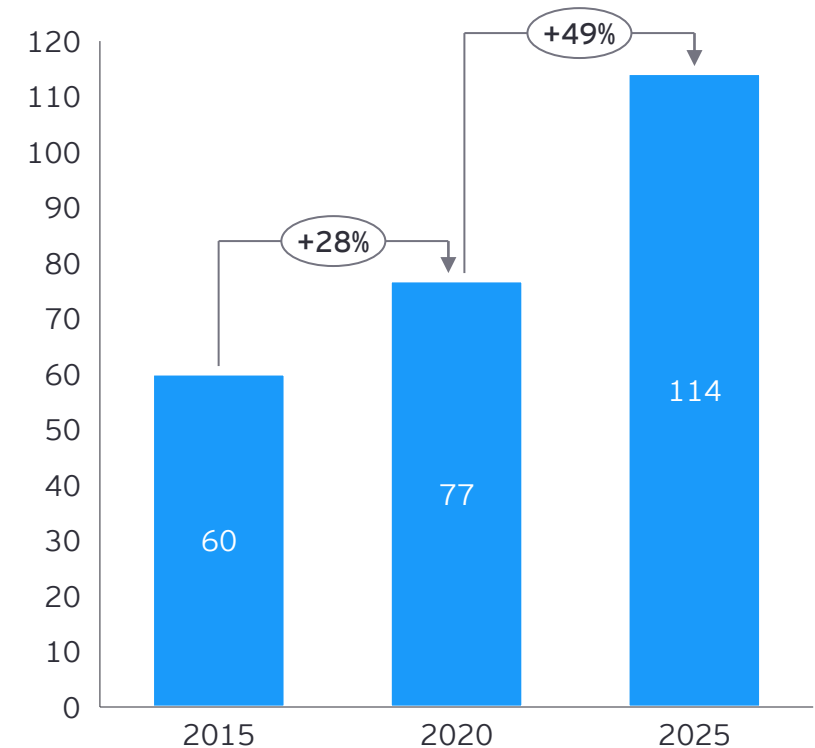
Drivers

- ▶ Increasing consumer consciousness toward healthy living and wellbeing is driving the demand for functional food and beverages.
- ▶ Immune support and energy boosting claims remain key drivers in functional beverages, as their ingredients tend to be familiar among consumers and suggested to contain multiple benefits.
- ▶ Urbanization and fast-paced lifestyle are driving the need for functional ready-to-drink beverages for convenience and health.

Producer strategies

- ▶ Producers are leveraging the region's traditional health practices, incorporating ingredients like turmeric and green tea into products for global appeal.
- ▶ Collaboration with local and smaller businesses is common to source authentic and high-quality ingredients.
- ▶ Companies are investing in research and development to compress nutrition, taste and convenience into single products, such as probiotic drinks.

Functional foods market size
\$b



CAGR growth of 49% post-COVID-19 due to a rise in chronic diseases, which has led to increased health awareness in developed and emerging economies

New health trends and an aging population fuel the demand for functional foods in Europe, leading producers to focus on innovation and transparency

1	Asia
2	Europe
3	Latin America



Functional foods and beverages

- ▶ Europe highlights a line of probiotic-rich food and drink, with products like kefir, a fermented milk drink, which is popular in Eastern Europe and Scandinavia.
- ▶ Scandinavians often consume berry-based products (such as juice from bilberries and lingonberries) known for their antioxidants.
- ▶ The Mediterranean diet, rich in fruits and vegetables, is often considered functional due to its numerous health benefits such as reduced rates of heart disease.

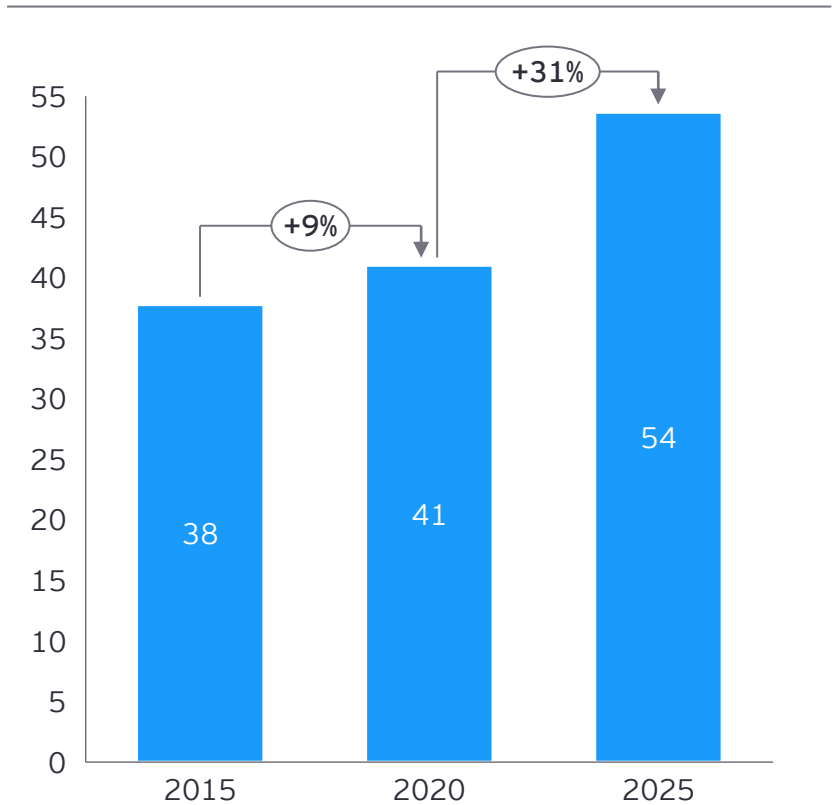
Drivers

- ▶ An aging population, particularly in Western Europe, is increasing demand for functional food and beverages to maintain health and prevent age-related diseases.
- ▶ Healthy-eating trends and increased public interest in food products that may provide health benefits beyond basic nutrition are significant drivers.
- ▶ Regulatory support from organizations like the European Food Safety Authority (EFSA) affirms the credibility and safety of functional foods, thereby promoting their consumption.

Producer strategies

- ▶ Producers often highlight the natural origin and health benefits of their products; for example, they stress the use of Nordic berries or Mediterranean ingredients to imply added health benefit.
- ▶ There is a focus on innovation around plant-based and vegan functional foods due to growing consumer demand.
- ▶ Consumer education is a significant component of their strategy, through clear labeling and marketing, to explain how these foods offer specific health benefits.

Functional foods market size
\$b



CAGR growth of 31% post-COVID-19 due to health-conscious population, strong health care system, demand for organic products and government initiatives

Rise in health consciousness promotes the demand for local functional foods in Latin America, driving producers towards organic sourcing and digital marketing

1	Asia
2	Europe
3	Latin America



Functional foods and beverages

- ▶ Latin America boasts a variety of super fruits (e.g., acerola, guava and acai), which are consumed in the region because they are high in vitamin C and antioxidants.
- ▶ Traditional beverages, such as yerba mate in Argentina and guarana drinks in Brazil, are very popular and are consumed for their energy-boosting properties.
- ▶ Ancient grains native to the region (e.g., quinoa, amaranth and chia seeds) are considered functional foods for their protein content, fiber and various essential nutrients.

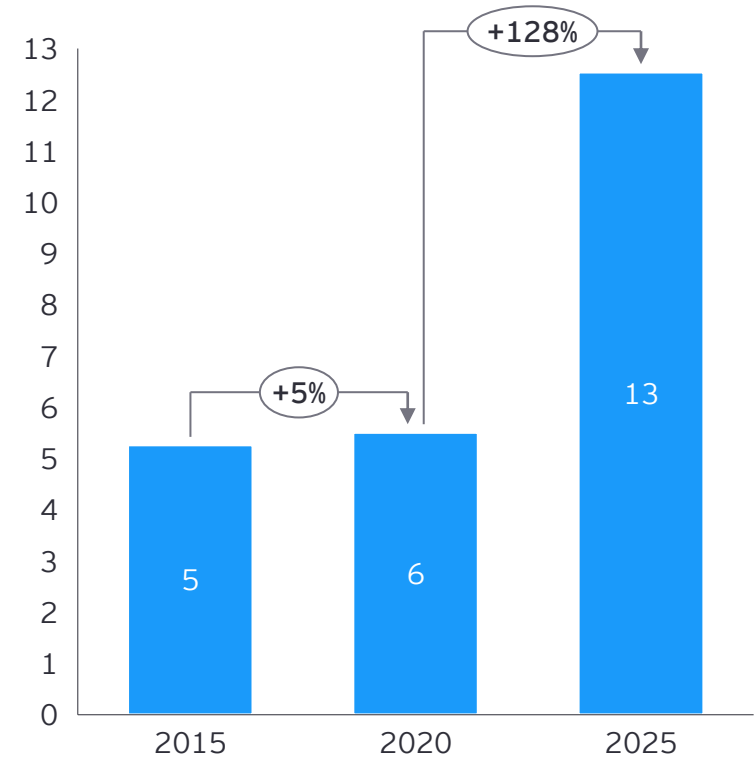
Drivers

- ▶ Market growth is being driven by a growing middle class with increased purchasing power and a higher propensity to pay for functional food with clean labels and natural ingredients.
- ▶ High obesity rates and health conditions such as diabetes are pushing consumers toward healthier diets, including functional foods and beverages.
- ▶ Increasing consumer education regarding the nutritional benefits of native products such as quinoa, amaranth and super fruits is a leading market driver.

Producer strategies

- ▶ Manufacturers are promoting local superfoods to global markets, emphasizing their health benefits.
- ▶ Organically sourced ingredients are increasingly used in functional food production, catering to the rising demand for organic food.
- ▶ In addition to traditional distribution channels, digital platforms are used for enhanced marketing and e-commerce, reaching a broader and often younger customer base.

Functional foods market size
\$b



Fastest CAGR growth of 128% post-COVID-19 due to rising middle-class population with increasing disposable income, health awareness, rates of obesity and urbanization

Artificial Intelligence – a new way forward



TOMATO
Solanum lycopersicum

AVG. 123 grams - 22 kcal

Nutrition Facts: Serving Size: 123 grams (100%)
Amount Per Serving

Calories	22
% Daily Value*	
Total Fat	0.2g
Protein	0.8g
Carbs	8.4g
Sugar	3.9g
Fiber	2.4g
Fat	0.2g
Saturated Fat	0.1g
Monounsaturated	0.1g
Polysaturated	0.1g
Sodium	1.9mg
Cholesterol	0.1mg

Executive summary and perspective



As artificial intelligence continues to become more prominent, it is critical for food and agriculture businesses to explore opportunities to integrate this technology. Optimizing AI across business functions can improve performance and help maintain a competitive advantage.

- 1** Overview of AI
 - ▶ As illustrated in the most recent Food and Agriculture Navigator, there are several types of artificial intelligence – causal AI, generative AI and machine learning – that can be used to address different types of business problems in partnership with other technology.
- 2** Increasingly diverse AI applications
 - ▶ AI can support businesses in optimizing processes across the lifecycle, from sourcing and procurement to after sales services with varying levels of impact and levels of effort to implement.
- 3** Impactful AI use cases
 - ▶ Businesses are finding unique ways to apply AI, relying on variations of the technology to support processes such as pricing predictions, menu creation and advanced farming.

“

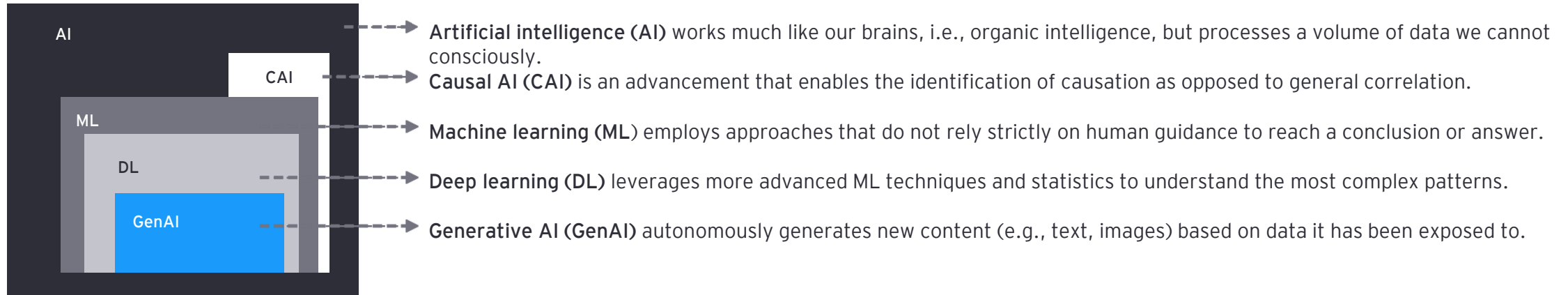
Generative AI can provide suggestions to guide companies on how they might respond to challenges such as climate change, increasing competition and geopolitical conflicts. Companies of all sizes and in all geographic regions need to understand how to responsibly plan for their AI strategy, implementation and execution. AI is not a single product or approach. AI is a family of diverse, multifaceted technologies and methodologies that can be implemented in multiple functional areas simultaneously and can help direct the overall company vision. When executives thoughtfully leverage the three pillars of AI – traditional AI, generative AI and causal AI – they have a better chance of ensuring the longevity and adaptability of their organization.

John K. Thompson
Director, Ernst & Young LLP

There are several types of AI that can be applied in conjunction with other technology to maximize value across the food chain

As illustrated in the previous edition of the Food and Agriculture Navigator, there are multiple, interrelated types of AI.

Overview of common types of AI



ML, DL, GenAI and CAI are not always able to use the same types of data or to model the same relationships. They are not “more mature” or “less mature” versions of each other.

Technology convergence

AI and RFID combine to bring efficiency gains to shipping and logistics industries

RFID's tracking capability combined with AI's pattern recognition and predictability mechanisms has reduced the need for manual counting and can allow for precise item tracking.

AI and blockchain can create trusted supply chains and track raw material journeys end to end

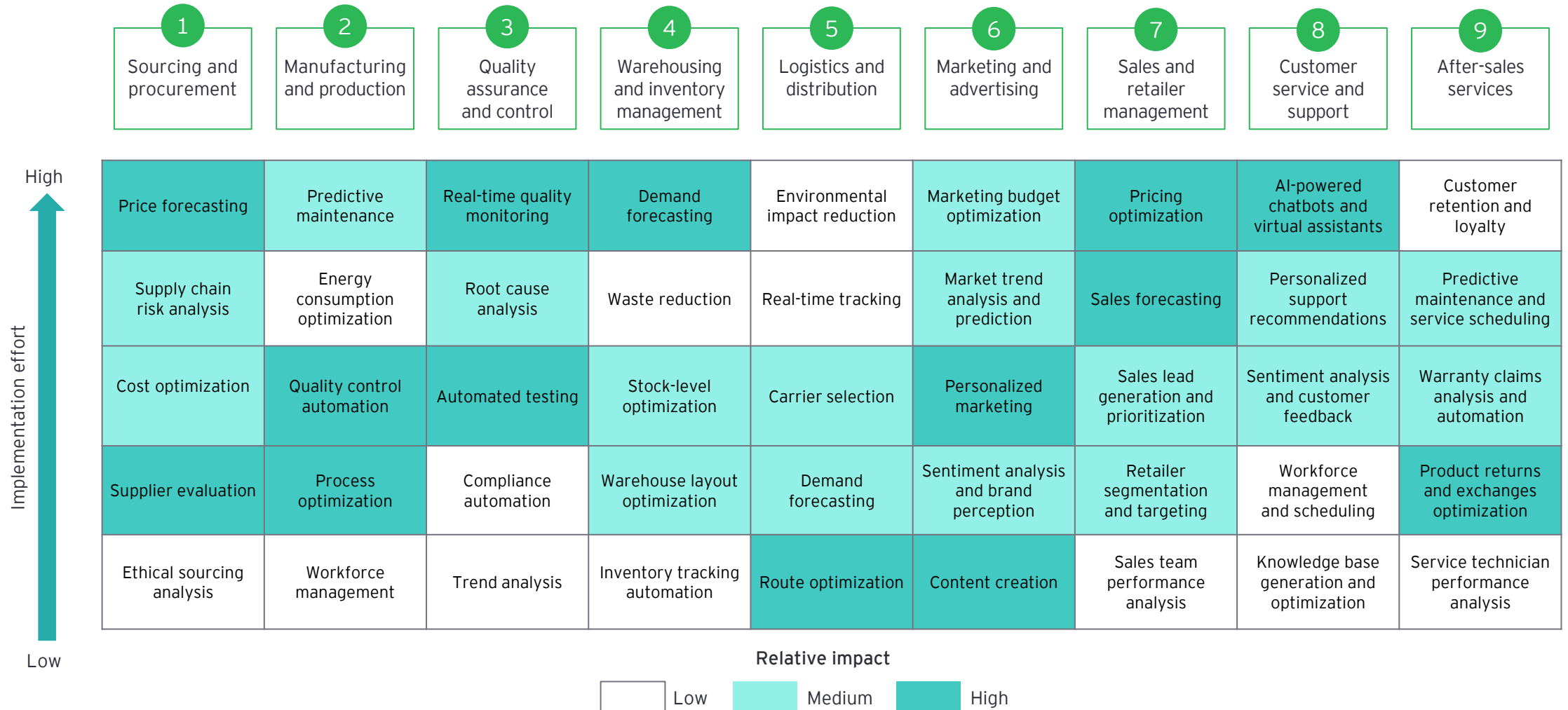
Blockchain's reliable, accessible record-keeping functions can serve as a base for AI to identify patterns to detect product quantity, quality and movements in the product lifecycle.

AI and robotics can uplift automated processes to drive accuracy of food traceability

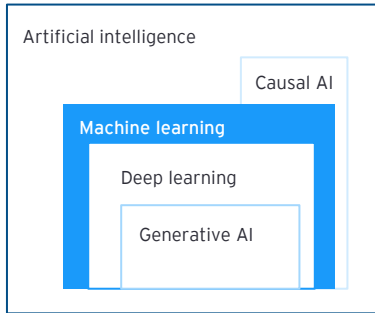
Robotics' advanced sorting technologies paired with AI's ability to increase flexibility of object identification have reduced food waste and increased food safety through reliable item tracing.

AI can support a wide range of use cases across the food and agriculture value chain with varying degrees of impact and implementation difficulty

ILLUSTRATIVE: AI USE CASES ACROSS THE VALUE CHAIN (CONSUMER PRODUCTS & RETAIL)



Food and agriculture players are already leveraging AI in diverse, innovative ways across many use cases



Crop harvesting and price prediction capabilities

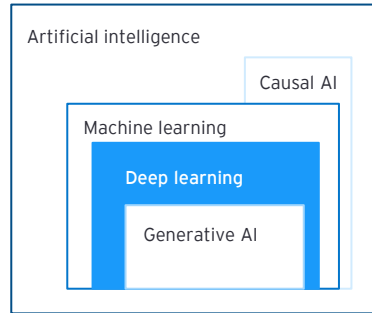
One of the most pivotal decisions that crop producers face is when and how to move their products to market after harvest. Real-time price predictions can help proactive planning and profit expansion.

Price forecasting

Combine multiple data sources to monitor their impacts on commodity prices in real time to inform producer decision-making

Quality control automation

Enhances collaboration across producers to improve data quantity and quality to facilitate better sale prices for all



Menu creation with food molecule interactions

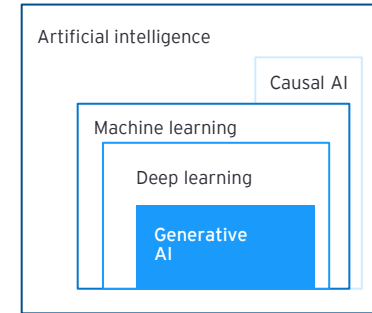
Restaurants are constantly seeking ways to distinguish themselves from their competitors. Existing recipes, AI pattern recognition and AI prediction capabilities can suggest new flavor combinations and offer insight into why some classics are so beloved.

Content creation

Enable restaurants to find new, idealized food combinations and ratios to create new dishes and limit food waste

Demand forecasting

Offers insight on how to create new uses for classic, universally loved flavor combinations in cooking



Vertical farming insights and AI control

Vertical farms have increased in popularity as climate change and urbanization reduce the amount of arable land worldwide. AI and IoT-enabled technology can create insights and enable vertical farm scaling.

Real-time tracking

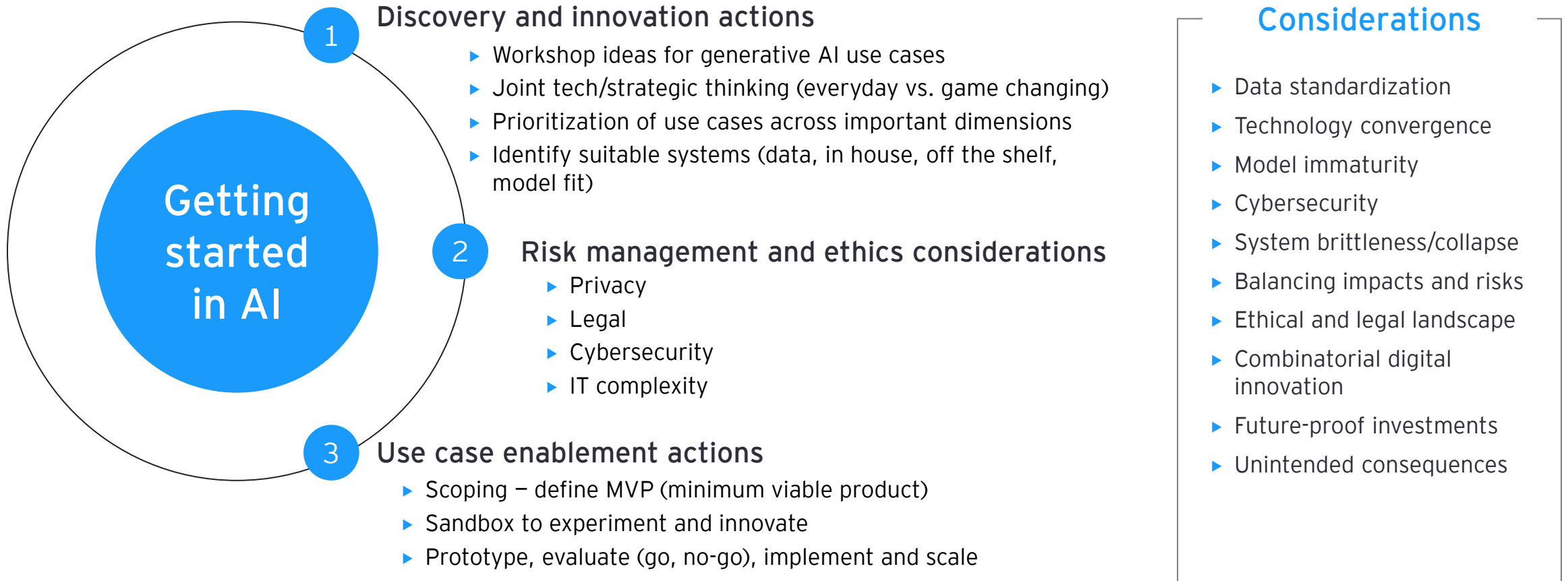
Collect and analyze vast amounts of data to enhance production in a small, abnormal agricultural production environment

Environmental impact reduction

Generate insights for farm managers to help better understand how to improve indoor farming

Refocusing your business to incorporate AI begins with identifying your most pervasive and complex challenges

Starting with AI might seem intimidating, but these considerations and/or actions can help you get started:



Key takeaways and considerations

Growers

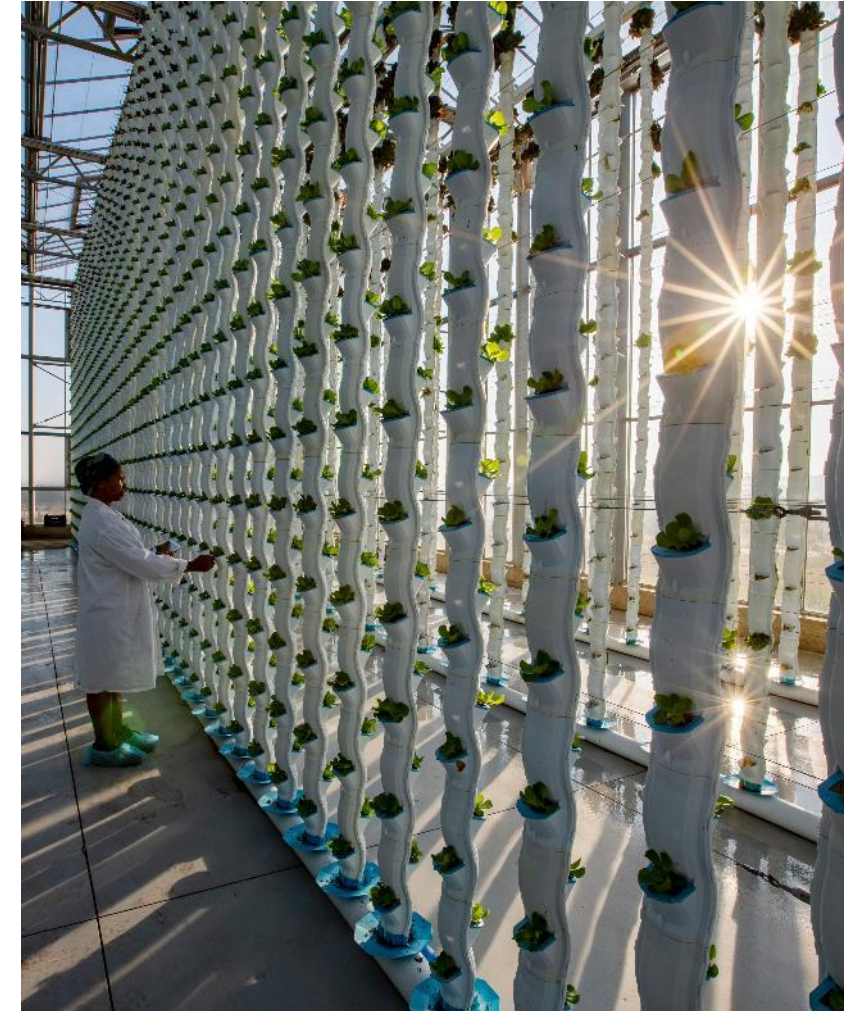
- ▶ All types of AI can **improve on-farm operations**.
- ▶ AI can encourage and securitize data sharing and collaboration with other stakeholders.
- ▶ AI-provided insights can **help reduce farming's environmental impact** and create longevity in the field.

Restaurants and grocers

- ▶ AI can help **optimize standard business use cases** (price optimization, data analytics) and **industry-specific challenges**.
- ▶ **AI patterns can help decode** the ever-changing human palate and food trends.
- ▶ Digital supply chains and trend analysis can **decrease food waste and increase on-site productivity**.

Climate-conscious producers

- ▶ Data insights and process optimization can **help growers adjust to climate change-driven challenges**.
- ▶ AI can help combat climate change and mitigate farmers' impact on the environment.
- ▶ Indoor farming can facilitate an adequate food supply for the world's growing populations.



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