Food Innovation

recipes
for the next
decade

INSTITUTE FOR THE FUTURE

FOOD
FUTURES LAB | iftf.org

About Institute for the Future

The Institute for the Future (IFTF) is an independent, nonprofit strategic research group celebrating 48 years of forecasting experience. The core of our work is identifying emerging trends and discontinuities that will transform global society and the global marketplace. We provide insights into business strategy, design process, innovation, and social dilemmas. Our research generates the foresight needed to create insights that lead to action and spans a broad territory of deeply transformative trends, from health and well-being to food, technology, the workplace, and human identity. IFTF is based in Palo Alto, California.

About IFTF's Food Futures Lab

IFTF's Food Futures Lab identifies and catalyzes the world-changing innovations that have the potential to reinvent our global food systems. We use a suite of methodologies to systematically envision future possibilities, and draw insights to drive action today. We align the minds, innovations, and resources shaping the future of food with a long-term perspective. The Food Futures Lab challenges assumptions and reveals new opportunities to make a resilient, equitable, and delicious future of food.

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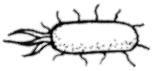
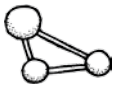
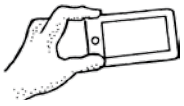
FOOD INNOVATION

RECIPES FOR THE NEXT DECADE







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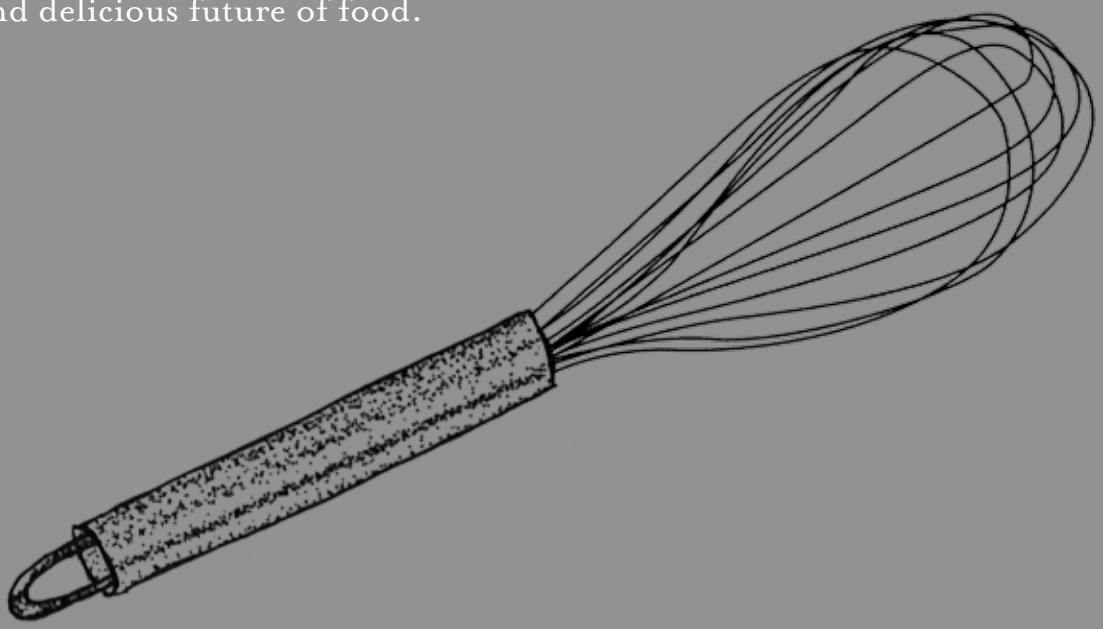
EXECUTIVE SUMMARY

Recipes and food go hand in hand. Some recipes are passed down from generation to generation, becoming long-standing traditions. Others invite us to explore new regions and their native ingredients, awakening our palates to new tastes. They promise to help us reinvent our bodies. They even encourage us to reimagine the food spaces in our lives, from our kitchens to our marketplaces. The power of recipes is the power to combine ingredients in novel ways, using perhaps unexpected methods to catalyze equally unexpected culinary experiences. As we look at the changing landscape of food innovation over the coming decade, we see the potential for an explosion of new recipes that will help us meet challenges that extend well beyond what to make for dinner tonight.

This is a book of recipes for food innovation. It introduces you to five **ingredients for change**—each of which contains three **forecasts** supported by today's early **signals**—and five **catalysts for transformation** that intersect to create new **recipes for food innovation**. These recipes provide pathways to transform our food experiences and build a more resilient, equitable, and delicious future of food.



The world is facing complex global challenges—sustaining ecosystems, ensuring affordability of a good life, reimagining healthy bodies and lifestyles, celebrating diversity and minimizing conflict, and strengthening economies and communities. And we increasingly look to food to meet them, creating a diversity of new demands and pressures on food systems that we can't solve by continuing on the same trajectory. We need new recipes to open our minds to tomorrow's possibilities that are already emerging from the convergence of global disruptions in three domains:

Science and Technology | reengineering relationships

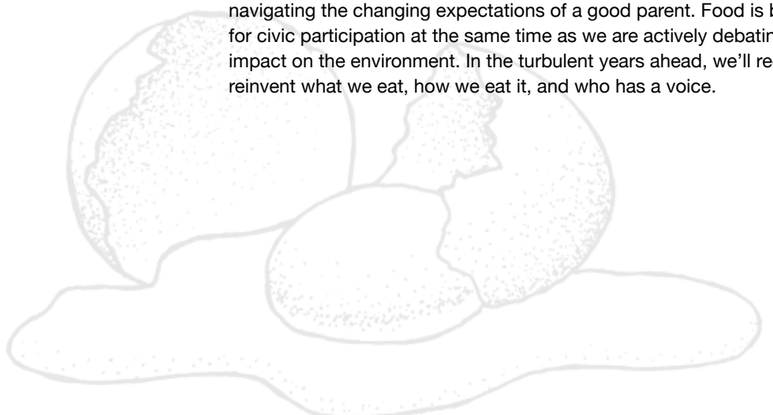
The proliferation of technology embedded in the world around us, including biotechnologies, creates opportunities for entrepreneurs, artists, and citizens to cook up previously unimaginable offerings. In the near future, we'll continually capture and analyze data across the food system, design custom seeds and soil microbes on demand, deploy human and material resources through algorithmic coordination, and embrace a symbiosis with machines. At the same time, communications technologies will reshape the ways and speeds at which we share food recipes, rituals, and meals. These cloud- and crowd-based capabilities will open up possibilities to reengineer our relationships with our food, our bodies, our environment, and each other.

Agriculture and Food | decentralizing food systems

The global agriculture and food sector used to be the domain of governments and multinational food companies. Now the tools that give these organizations their advantage are being disrupted. Today innovation outside of organizations and outside of traditional communities of expertise can have far-reaching impacts. Already food start-ups are outpacing legacy brand growth, and farmers are hacking together equipment using open source code and manufacturing platforms. As we look out ten years, the ability to automate everything from crop rotation to food safety compliance to marketing will level the playing field for anyone to design their own solutions according to their own needs—and create opportunities for organizations to help cultivate and scale these efforts.

Culture and Society | reconfiguring our lives

Food and culture are inseparable, but today the relationship between them is different. The systems that give shape to our food experiences—education, government, work, health, and business—are rapidly changing. Today food decisions can be as much about optimizing productivity in the workplace as navigating the changing expectations of a good parent. Food is becoming more accepted as an avenue for civic participation at the same time as we are actively debating our understanding of the human impact on the environment. In the turbulent years ahead, we'll reconfigure our lives and in the process reinvent what we eat, how we eat it, and who has a voice.



As we move into this future, we're already witnessing people and organizations like you—innovators who want to change our food systems and our world—undertake thousands of experiments. They are writing new recipes for food innovation to grow markets, design meaningful food experiences, improve human health, strengthen communities, and build resilience against climate and market disruption.

This is a book of recipes for food innovation. It introduces you to five ingredients for change—each of which contains three forecasts supported by today's early signals of change—and five catalysts for transformation. At the intersections of these ingredients and catalysts are new recipes for food innovation that will shape our food system and our world a decade or a century from now. These recipes strike a balance between science and artistry, constraint and abundance, tradition and invention. And they help cultivate a shared ethos rooted in openness and participation, inviting unfamiliar actors, from blockchain architects in the cloud to biodesigners with a taste for protein, to join in food system change. You can experiment with the recipes in this book and use the questions we pose to create your own, incorporating your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.

Whether you're a food entrepreneur or an established food manufacturer, a farmer seeking a sustainable model for farming in the 21st century, or a health professional hoping that food can help your community improve its health outcomes, the ingredients, catalysts, and recipes in this book will help you harness the most innovative opportunities now and in the decade to come.

How to use this book

immerse

in the ingredients for change to imagine possibilities for the next decade. Each ingredient includes three **forecasts** about how it will potentially transform the food system and a set of **signals**, early indicators or disruptions that point to directions of change emerging today.

experiment

with new recipes for food innovation—pathways to overcome limits, transform our food experiences, and meet complex global challenges. Recipes for food innovation emerge when we leverage the ingredients with catalysts to accelerate and amplify transformation.

explore

the five catalysts for each ingredient to map the different ways to leverage the most innovative potential.

create

your own recipes for food innovation, incorporating your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.

ingredients for change

Many new ingredients for change—new capacities, tools, and platforms—will emerge from the converging global disruptions in science and technology, agriculture and food, and culture and society. The recipes in this book are built on five ingredients that have the greatest potential for transformation in the coming decade:

SCALABLE BIODIVERSITY

Toward robust ecosystems in the gut, factory, and field

The ability to tap millions of species across scales from microbes to watersheds will open up new possibilities for the future of food.

REWRITABLE NARRATIVE

Toward open food stories

Food narratives will be told across more mediums, become more open to remixers who leverage technology for writing and personalization, and shift faster than ever before.

CLOUD INTELLIGENCE

Toward decentralized, efficient management of food systems

The capacity to connect food, people, tools, and data together in vast networks will result in more efficient, more productive, and more responsive food systems.

ENGAGED EATERS

Toward eater-led reinvention of the food system

New ways to engage eaters will create a food system rooted in values of sustainability, health, sociality, and pleasure.

EXPERIMENTAL BIODESIGN

Toward reinventing food experiences and food systems

The ability to harness the biological building blocks of food will allow us to design new food experiences that reorient our paradigms—building from the organism up.

catalysts for transformation

In recipes, catalysts activate ingredients and accelerate their transformation into something else. The enzymes in rennet accelerate the coagulation of milk in centuries-old recipes for cheese. The enzymes in yeast power the conversion of sugar to alcohol in beer brewing. In recipes for food innovation, catalysts also power transformation. These five catalysts can help you develop strategies that leverage the ingredients for change to accelerate and amplify food innovation:

RECALIBRATE RISK

Ingredients that seem the most risky today might be the most obvious opportunities for growth in the future—or the most likely points of disruption. Undertaking experiments with new business models, simulating impacts of new technologies at scale, and identifying new metrics to track today can strengthen readiness and nimbleness in the longer term.

CULTIVATE NETWORKS

As the food innovation landscape becomes more open and enables smaller-scale players to compete with established stakeholders, it will be critical to build sustained connections across traditional barriers of scale, competition, and industry. Catalyze innovation over the next decade by cultivating networks—of data, of microbes, of synthetic bio-blocks, and even of crowdsourced narratives.

CUSTOMIZE FOR QUALITY

Understanding the needs and desires of different people—whether that means access to clean drinking water or novel multisensory meals—will amplify the experience of any innovation ingredient. Design packaging, retail spaces, and more to dynamically meet a range of needs and open ways for people to personalize experiences to boost the impact of the innovations you create.

UNLOCK LATENT VALUE

Latent value is value that may not be immediately apparent. It might be hidden in idle equipment in the off-season or in untapped expertise. By using the new capacities, tools, and platforms the ingredients offer to supercharge innovation—such as networking assets to quickly and easily identify underused capacity—you can capture new kinds of value for your organization and others.

BUILD RESILIENCE

Resilience—the ability to absorb and withstand shocks—is a catalyst for long-term return on efforts. Over the next decade, building organizational resilience will increasingly depend on building ecological and human resilience. Identify new ways these ingredients can impact the markets, environment, and people beyond your own enterprise to develop innovations that are flexible and collaborative and have staying power.

recipes for food innovation

At the intersections of the ingredients for change and catalysts for transformation are recipes for food innovation: pathways to overcome limits, transform our food experiences, and meet complex global challenges. The recipes below are a starting point, but there are almost limitless ways to creatively combine these elements to grow markets, build environmental resiliency, enhance human health, or align with your strategic goals. **Experiment with these recipes or write your own, incorporating your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.**

INGREDIENTS FOR CHANGE New capacities, tools, and platforms to reinvent food experiences	CATALYSTS FOR TRANSFORMATION Ways to leverage the ingredients to accelerate and amplify transformation				
	RECALIBRATE RISK	CULTIVATE NETWORKS	CUSTOMIZE FOR QUALITY	UNLOCK LATENT VALUE	BUILD RESILIENCE
 SCALABLE BIODIVERSITY	Develop scenarios that integrate the risky edges of science and traditional stewardship principles to strengthen innovation.	Experiment with crowdsourced microbial data to increase the robustness of microbiome research and augment market research.	Design new product formulations that tap into dynamic microbial information to support personalized health and flavor experiences.	Identify the points in your supply chain with rich natural microbial resources and leverage them to capture new value.	Engineer biodiversity across scales to harness the dynamism of natural systems for organizational and ecological resilience.
 CLOUD INTELLIGENCE	Prototype strategies to begin testing and shaping cloud-enhanced food experiences today.	Foster and follow industry wide standards for data collection, sharing, and storage to enable interoperability.	Leverage algorithms that track thousands of variables from soil to shelf to allow people to choose their own quality metrics.	Network internal infrastructure to identify and monetize underutilized assets such as idling capital equipment.	Identify unique opportunities across a product's life cycle to make low-effort, high-impact decisions for managing ecosystems.
 EXPERIMENTAL BIODESIGN	Map the ecosystem to anticipate changes in the commercial and regulatory environments and new innovation opportunities.	Catalyze cross-industry, multidisciplinary networks to share knowledge and develop principles for innovation and safety.	Clearly communicate how food is produced and manufactured so people can choose foods that align with their expectations for quality.	Identify unique food science and other capacities to lead others in understanding the emerging biodesign landscape.	Develop ecosystem metrics and tools to model the ecological impacts of biodesigns as they move from experimental to integrated.
 REWRITABLE NARRATIVE	Experiment with a small group of loyal customers to build readiness for the shift from broadcast to open food stories.	Open up brand narratives to local storytellers in a city or region to create narratives that are more complex and compelling.	Augment interfaces and surfaces throughout retail spaces with tools to customize narratives for quality food experiences.	Open up data and analysis tools to help people develop coherent, comprehensive sensor-based narratives across the food system.	Reveal labor and other practices across your supply chain to cultivate practices that are healthy, sustainable, and ethical.
 ENGAGED EATERS	Experiment with crowdsourcing models to build engagement for a product or service that seems risky at scale today.	Identify nontraditional spaces—such as public parks or a classroom—to create experiences that enhance social interaction through food.	Identify a target market and tap into the vast data generated by wearable technologies to customize food experiences.	Prototype new ways to engage with small-scale food entrepreneurs to support their projects and guide your own innovations.	Creatively share your nutrition and environmental expertise to help eaters understand long-term impacts of their choices.

Source: U.S. Department of Agriculture

INGREDIENT

SCALABLE BIODIVERSITY

Toward robust ecosystems in the gut, factory, and field

Anxiety over the shrinking diversity of plant and animal crops is being tempered by the realization of stunning diversity many orders of magnitude smaller, at the microbial level. Microbes have been our allies in food innovation for hundreds of thousands of years, but our understanding and command of these living ingredients is getting more granular every day. Research in this realm is giving us a new metric in our innovation strategies, while the ability to tap millions of species across scales from microbes to watersheds is opening up new possibilities for the future of food.

High-throughput DNA scanning is rendering entire communities of microbes visible, and the cost of this has been plummeting while research and patents in this area have been growing exponentially over the last several years. An intriguing area of innovation is emerging where this new scientific clarity is intersecting with ancient methods of preserving foods and enhancing flavor. This “microbial terroir” brings rigor to elusive definitions of quality. Microbes are now recognized as part of the terroir that each place on earth can potentially bring to the future of food.

Understanding biodiversity at this micro scale not only casts new light on traditional processes but also reframes innovation across the food system in terms of engaging and supporting ecosystems—the ecosystems of bacteria in, on, and around human bodies, soil, processing equipment, and kitchens. As hospitals reconsider their use of antibiotics and closed-system air conditioning, food processors and retailers will also be challenged to find safe and healthy alternatives to commercial sterilization.

Emerging understanding of what keeps the human gut microbiome healthy also links back to biodiversity at the macro scale: a greater variety, especially of plants, is great for the gut. As the evidence around what supports human health on the microbial level evolves, people’s desire for natural diversity in their diets may well accelerate beyond what the current agricultural system supports at scale. Overlap between “what’s good for me” and “what’s good for the planet” will only boost this trend, as awareness of crop blights and other vulnerabilities of industrial monoculture increases.

FORECAST

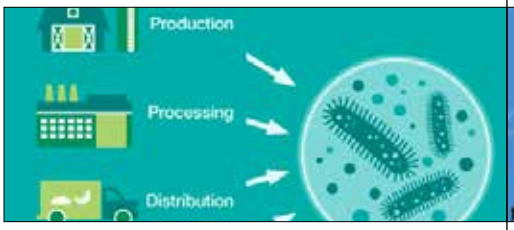
microbes for safety and flavor

From minimizing microbes to cultivating healthy ecosystems

Scaling safe and consistent food production in the 20th century was all about minimizing variables: a few carefully chosen, homogenized ingredients brought into environments as sterile as possible to create a world of flavor. Scalable food innovations in the 21st century will emerge from embracing local microbes, their migration, and their role in achieving food safety outcomes and depth of flavor. We'll be able to track microbes and use new metrics to make decisions for food safety with unprecedented speed and precision. Collaborations like the ones emerging between bioinformatics powerhouses and the agriculture and food sector will power this new pathway for innovation, while traditional processes that hinge on microbial diversity will find new grounding.

SIGNALS

The Consortium for Sequencing the Food Supply Chain (SFSC) is sequencing the baseline metagenome of all the microbes found naturally across the food supply chain. While most food safety sequencing efforts focus only on known pathogens, a more biodiversity-embracing portrait of entire microbial communities in fields, factories, and warehouses will enable rapid detection of deviations—and allow for preventing food contamination outbreaks at the source.



Source: IBM and Mars

The Alfred P. Sloan Foundation's Microbiology of the Built Environment program is a collaborative effort involving scientists, engineers, and architects in studying the microbial ecology of indoor environments. The knowledge that will emerge from this program—from understanding biofilms inside buildings to the impact of different ventilation systems on microbes—will shape the design of supermarkets, kitchens, and transport systems to support food safety.

Source: Sloan Foundation; Image source: Wikimedia

Nuova Castelli, the largest producer of certified D.O.P. Parmigiano-Reggiano cheese in Italy, is scaling and automating within the limits of traditional production requirements to respect the natural variation of milk and microbes. Every stage of production, down to washing the kettles for warming milk with whey instead of disinfectant cleanser, manages the microbial ecosystem of the factory to optimize flavor, and in so doing, safety.

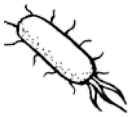
Source: Food Innovation Program

FORECAST

dynamic personalization

From fad diets to microbial nudging

The premise underlying the heated battles of the last decade over what constitutes a healthy diet—namely, that there is one healthy diet that will work for everyone—is becoming increasingly suspect. A decade of research from Stanford to London is finding variations in how even genetically identical twins respond to the same foods and is discerning the active role played by the gut microbiome in these variations. With the proliferation of devices and services that will give people the ability to track their own microbiomes over time or at any given moment, the next decade will see a vast expansion of support for making food choices based on personalized, dynamic information.



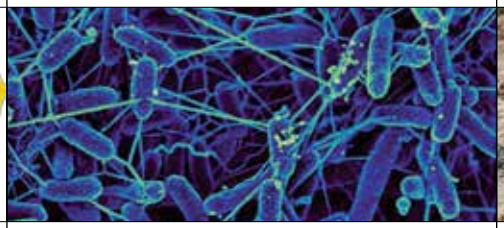
SIGNALS

The Personalized Nutrition Project of the Weizmann Institute of Science, focused on studying the microbiomes of prediabetic individuals and their reactions to "bespoke" diets, has been coalescing over the past several years from Israel's biotech cluster. Early results from the study are promising that gut microbiome data and algorithmic modeling will yield personalized and effective dietary recommendations.

The Unified Microbiome Initiative launched by a group of leading scientists aims to span epicenters of innovative research on the microbiome and connect researchers across disciplines. Within a decade, researchers like Rob Knight at the University of California, San Diego, anticipate bridging the divide between correlative and causative insights, between description and predictive nudging.

The American Gut Project and the Human Food Project combine a vast collection of citizen-donated microbial samples and compare these DNA-sequenced populations with samples taken from people living traditional farming or hunting-and-gathering lifestyles from Peru to Namibia. While the researchers are duly skeptical of their early findings, the results seem to point toward the healthfulness of a more diversified diet than Westerners typically consume.

Source: Weizmann Institute of Science



Source: Science Magazine; Image source: DOE Pacific Northwest National Laboratory

Source: Human Food Project

FORECAST

food diversification

From diverse guts to diverse crops

The early findings of research projects based on citizen-donated microbial samples suggest that the common denominator of healthy diets for humans is high fiber from naturally diverse, plant-based sources. The relatively low diversity of the modern Western diet, which commonly includes just over three hundred species and an unprecedented proportion of animal products, seems to be highly correlated with many of the lifestyle diseases of Western populations. As the evidence evolves, people may demand more natural diversity in their diets than what the current agricultural system can provide at scale. Initiatives to diversify the areas of the world that gave us corn and soy monocrops could help meet this potential demand, while efforts to realign supply chains toward regenerative supply webs would have global ecological and human health impacts.

SIGNALS

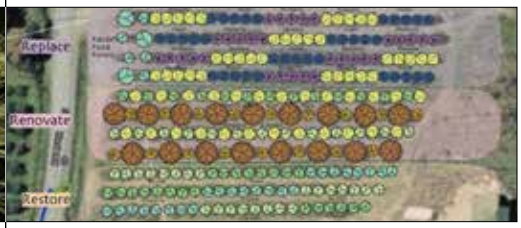
Celebrity chef Gastón Acurio is an ambassador of contemporary culinary innovation in Peru, which has grown directly out of the biodiversity of the Andes and the micro-entrepreneurial ventures that have thrived on it for millennia. Acurio has used his clout to support both the science and the business of diverse foods and their purveyors.

Source: Washington Post; Image source: Pixabay

The Land Institute in Salina, Kansas, is breeding perennial grains and researching how to grow them in polycultures—mixtures that enjoy the benefits of the complex ecosystems found in the prairie—with the hope that the first such crops will be field-ready in the next decade or so. Plant breeding efforts like this lead the way in developing alternatives to the world's current grain supply, obtained from annual plants grown in monocultures.

Source: The Land Institute

Terra Genesis, a permaculture consulting group, worked with a cosmetics company to reorganize its supply list by climate zone. For instance, almonds are categorized by a Mediterranean climate, though most of the company's are grown in California. Terra then sought genetic variations from the heirloom orchards in other Mediterranean climates like in Spain and Morocco to design a new kind of Californian almond orchard that, if it works, would actually return water to aquifers. This points to a future in which we transform extractive supply chains into regenerative supply webs.



Source: Terra Genesis International

recipe workbook

Combining **scalable biodiversity** with the catalysts for transformation creates recipes for food innovation that tap millions of species across scales to support robust ecosystems in the gut, factory, and field. In the following pages, explore the five catalysts for transformation that leverage scalable biodiversity to accelerate and amplify food innovation. Experiment with the five new recipes for food innovation at the intersections of scalable biodiversity and the catalysts. Then, create your own recipes for food innovation that incorporate your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.

SCALABLE BIODIVERSITY

catalysts

EXPLORE these five catalysts to develop strategies that accelerate and amplify food innovation.

recipes

EXPERIMENT with these recipes for food innovation.

RECALIBRATE RISK

Embracing innovation through scalable biodiversity challenges many paradigms, from models of healthy eating to how we think about food safety. By constructively challenging our assumptions, scalable biodiversity may reveal opportunities in both the short and the very long term to temper uncertain science with traditional production and agricultural methods.

Develop scenarios that integrate the risky edges of science and traditional stewardship principles to strengthen innovation.

CULTIVATE NETWORKS

Advances in understanding the microbiome have depended on crowdsourced contributions and citizen science. The microscale of scalable biodiversity will be catalyzed by new ways for food producers and purveyors to engage eaters, from handheld microbe sensors in smartphones to networks of people sharing starters for sourdough or vinegar. Cultivating these networks of data, microbes, and people will also provide new metrics for market segmentation.

Experiment with crowdsourced microbial data to increase the robustness of microbiome research and augment market research.

CUSTOMIZE FOR QUALITY

Scalable biodiversity challenges how we think about both quality and personalization. The quality of microbially diverse foods is measured not just in terms of flavor and micronutrients but also in terms of the foods' impact on individuals' health. Offering a range of product formulations keyed to different microbial profiles will ensure that people in varying contexts will value the product for its healthfulness and flavor.

Design new product formulations that tap into dynamic microbial information to support personalized health and flavor experiences.

UNLOCK LATENT VALUE

Microbes, far from being enemies, may well be latent assets. The location of production facilities and the length of supply chains can be reconsidered with an eye to how beneficial local microbes can contribute both to depth of flavor and to safety through healthy competition with pathogens. A new understanding of the value of microbial interactions among foods, people, and places can result in a revolution in what local means.

Identify the points in your supply chain with rich natural microbial resources and leverage them to capture new value.

BUILD RESILIENCE

The ultimate promise of biodiversity at any scale is resilience. Embracing biodiversity as an ingredient for food innovation builds a strong bridge between novel, profitable businesses and climate-resilient, healthy food systems. As we begin to understand, model, and engineer biodiversity across scales, the dynamism of natural systems will support similarly dynamic business models.

Engineer biodiversity across scales to harness the dynamism of natural systems for organizational and ecological resilience.

create your own recipes

USE THE QUESTIONS below as inspiration to write your own recipes for food innovation, combining scalable biodiversity with the catalysts for transformation.

What assumptions does scalable biodiversity challenge, and what new ways of doing things does it inspire?

How can you cultivate crowdsourced microbial data to help biodiversity become scalable?

In what new ways can scalable biodiversity help you meet the needs and desires of people in a variety of contexts?

In what ways can you capture new value from the invisible microbial layer of guts, factories, and fields?

How can scalable biodiversity reshape your practices in ways that contribute to organizational and ecological resilience?

"When we think about building design, agriculture, medicine—we need to consider the total ecosystem: the air, the floor, the dust, the water, the dogs, and consider those as ecologies before we design responses or behaviors."

Jonathan Eisen,
evolutionary biologist
KQED Forum,
September 2015

Source: WorldFish, M. Yousuf Tushar

INGREDIENT

CLOUD INTELLIGENCE

Toward decentralized, efficient management of food systems

Agriculture—and the global food system more broadly—is set to be reinvented with the help of low-cost, high-tech methods for connecting food, people, tools, and data together in vast networks. Whether enabling precision-based crop management or empowering home cooks to enlist their appliances in precise food preparation, sophisticated cloud intelligence will create a food system that is more efficient, more productive, and more responsive to shifting social and consumer demands for food.

The rise of the Internet of Things is moving us toward a world in which even the simplest objects can be tracked and managed with stunning levels of precision. With the cost of sensors and other hardware steadily declining, tens of billions of things are coming online in the next decade—including living things such as bees, cows, lettuce, and grapes. A new economy of objects that can negotiate, trade, and market with each other will be automatically responsive to external conditions—ranging from shifting consumer appetites to increasingly volatile climate patterns. Networks of home appliances and wearable devices will communicate directly with large-scale production and distribution systems, expanding the scope of flexible ecosystem management beyond traditional industry boundaries.

The ability to tap into self-managing systems will be accelerated—and democratized—by the emergence of cloud robotics. This term refers to an assemblage of networked robotic systems that can learn from each other. Thanks to the cloud, a robotic system in California will be able to learn from and share cooking techniques with a similar robot in London. As we infuse robotic systems—ranging from tractors and agriculture bots to basic home appliances—with cloud intelligence, innovation will become democratized and shareable.

Over the next decade, cloud-enhanced technologies will shift more of the human labor involved in food production to machines. But in sharp contrast to previous generations of autonomous systems, these technologies—defined by relatively cheap software as much as expensive hardware—will create a playing field where small-scale producers and manufacturers can compete far more equally with massive-scale operators, and individuals can more readily experiment with and participate in food innovation.

FORECAST

new measures of quality

From ambiguous data to precise metrics

As the push toward quality continues, particularly in mature markets, intelligent systems will be used to create precision metrics and strategies to optimize freshness, taste, sustainability, and overall perceived quality of food experiences. These systems will offer new ways of engaging and interacting with actors across the food system—from individual plants and animals to eaters. For farmers and growers, these cloud-based systems will provide faster, more precise views into the state of their livestock and crops, enabling early actions that stave off disease outbreaks and ensure peak quality. For traditional manufacturers, they will create new opportunities to meet eaters' preferences in personalized ways and at the same time increasingly undermine models built on mass-produced food products.

SIGNALS

The FungiAlert sensor developed by two students at Imperial College London is a prototype for a low-cost sensor that detects and signals early signs of crop-damaging phytophthora fungi. It allows farmers to bypass traditional lab testing and take early action to avoid ruining crops, like this image of an infected strawberry plant. These kinds of technologies will empower growers to avoid disease outbreaks and ensure peak freshness and quality at the time of harvest.

Source: Imperial College London; Image: Wikimedia

Quantified Ag is one of several new systems designed to network individual livestock using biometric sensors and to help ranchers manage the health of the herd by identifying animals that are most likely to become sick. Systems like this could improve safety and efficiency on farms while also providing in-depth information about the quality of food from the beginning of the supply chain to eaters.

Source: Quantified Ag

Design firm Hirsch & Mann developed a smart spoon for Unilever's Maille mustard brand that captures shoppers' flavor preferences, hinting at a future where preferences will be quantified and tracked for personalization. During in-store tasting, individuals tap the smart spoon against RFID sensors associated with their favorite mustard flavors and are given customized recipes and a list of mustard flavors they can later purchase online—and Maille gains a database of customer preferences.

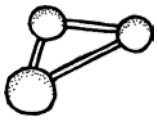
Source: Hirsch & Mann

FORECAST

peer-to-peer robotics

From knowledge sharing to automated manufacturing

Small-scale producers are already networked and share political and other resources to attempt to compete more equally with multinational organizations. Likewise, swapping recipes is a time-honored tradition that has already been greatly accelerated by today's Internet and that has helped further fragment the market into new diets and categories. As robotic systems emerge that can follow recipes and growing instructions with guidance from the cloud, peer-to-peer producers will share knowledge and tools to control these systems. The end result will be innovative food products and experiences that are on par with, and even better than, mass-produced foods.



SIGNALS

Blossom Coffee is a wireless coffee maker developed by MIT engineers that downloads brewing settings from a database populated by roasters who want to ensure peak flavors of their coffee in homes. It signals a new category of kitchen appliance that automates the cooking process based on precision recipes shared from the cloud. As these appliances emerge, they will simultaneously create new precision methods for cooking and open up new platforms for experimentation and peer-to-peer sharing.

Source: Blossom Coffee

Innit is a prototype of the next-generation consumer kitchen—completely connected and integrated. The system consists of a combination of relatively cheap sensors and machine intelligence to identify the foods in the kitchen, detect details like the food's freshness and weight, and then precisely cook the food using recipes from high-end chefs. Innit highlights a future in which machine intelligence moves into our appliances to automate aspects of food preparation and cooking.

Source: Innit

The MIT Media Lab's Food Computer is a controlled-environment system that uses robotics for small-scale indoor farming. Climate recipes—collections of settings for carbon dioxide, humidity, and more—can be imported to automatically set the conditions needed by given plants. Part of the new Open Agriculture Initiative, the Food Computer lets anyone tap into a database of recipes that have been successfully tested or experiment regardless of their agricultural expertise.

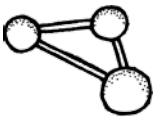
Source: MIT

FORECAST

optimized efficiency

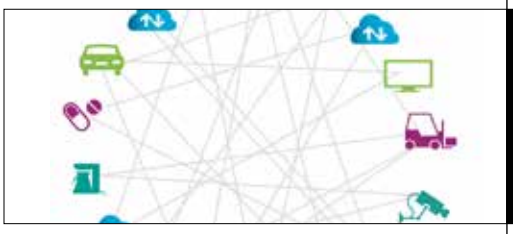
From human-managed to self-managing systems

In the next decade, our food markets, like our financial markets, will become dominated by automatic transactions, from negotiating large-scale deals between vendors to automating home orders. As we build out the infrastructure to catalog and manage discrete parts of our food system over the next decade, they will begin to form interoperable, self-managing systems. Producers, distributors, and manufacturers will gain a constantly refreshing and improved database to not only simply reduce inefficiencies but to automate transactions throughout the system—transforming our approaches to everything from production to home purchasing.



SIGNALS

IBM and Samsung are combining several network technology architectures to build what they call Autonomous Decentralized Peer-to-Peer Telemetry (ADEPT), a protocol to enable things to negotiate with each other. For example, envision a home appliance that communicates with other appliances to negotiate power use. These kinds of self-organizing systems could become the basis of more efficient and flexible manufacturing and distribution systems.



Source: IBM

Amazon's new **Dash Replenishment Service** is an application programming interface (API) that hardware manufacturers can build into any new appliance or piece of hardware to identify when supplies are low and automatically reorder from Amazon. For instance, Brita is using this API to detect when its water filters are no longer effectively removing minerals from drinking water and then to trigger an automatic reorder.

Source: Amazon

Spread is a Japanese food company that is building a self-managing indoor vertical farm with robotic systems to plant, manage, and harvest 30,000 heads of lettuce per day. Spread's new technology is far more efficient than traditional agriculture and even its current indoor growing technologies: the "vegetable factory" will use 98 percent recycled water and no pesticides, reliably produce food through controlled climate settings, and through automation deliver locally-grown produce more cheaply.

Source: Fast Company; Image: Spread

recipe workbook

Combining **cloud intelligence** with the catalysts creates recipes for food innovation that leverage the capacity to connect food, people, tools, and data together in vast networks to create a more efficient, productive, and responsive food system. In the following pages, explore the five catalysts for transformation that leverage cloud intelligence to accelerate and amplify food innovation. Experiment with the five new recipes for food innovation at the intersections of cloud intelligence and the catalysts. Then, create your own recipes for food innovation that incorporate your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.

CLOUD INTELLIGENCE

catalysts

EXPLORE these five catalysts to develop strategies that accelerate and amplify food innovation.

recipes

EXPERIMENT with these recipes for food innovation.

RECALIBRATE RISK

The shift toward networked homes and appliances will introduce multiple tiers of engagement for goods, services, and information. This will open up a new kind of fragmentation in areas like purchasing, with a rise in automated subscription commodities driving retailers to create increasingly immersive, interactive food experiences to draw people into stores. Prototyping for this and other types of fragmentation today will help you turn the risk of disruption into opportunities for innovation to stay ahead of the industry.

Prototype strategies to begin testing and shaping cloud-enhanced food purchasing experiences today.

CULTIVATE NETWORKS

The quantification of the food system will create entirely new kinds of data sources, ranging from producers capturing high-resolution variables around soil to consumers gathering metrics via wearable devices. The process of networking the food system will add layers of complexity to our current analytic tools. In the longer term, cloud intelligence will become a more powerful ingredient as more people and objects are connected and are able to speak to one another.

Foster and follow industry wide standards for data collection, sharing, and storage to enable interoperability.

CUSTOMIZE FOR QUALITY

As even basic, everyday products gain cheap sensors and computational power, cloud intelligence creates opportunities to integrate multiple quality metrics into foods and food experiences. With two-way channels between these metrics and eaters' data, these quality metrics can be matched with specific personal needs and goals. Design of food system elements like on-demand formulation and packaging will need to accommodate these two-way channels while providing multiple levels of information about price, safety, sourcing, nutritional content, and ecological impact.

Leverage algorithms that track thousands of variables from soil to shelf to allow people to choose their own quality metrics.

UNLOCK LATENT VALUE

Networking assets will not only bring efficiency benefits but also help capture new value from existing systems. As we build out the infrastructure to catalog and manage discrete parts of our food system, producers, distributors, and manufacturers will gain a constantly refreshing and improving database that can automate transactions throughout the system. This will create new opportunities to monetize existing assets, resources, and information flows in ways not previously profitable.

Network internal infrastructure to identify and monetize underutilized assets such as idling capital equipment.

BUILD RESILIENCE

Too much data can be overwhelming in any domain, and managing our food system will be no different. The groups best positioned to take advantage of this new ecosystem are those that can identify the critical points in a product life cycle when low-effort, high-impact decision making is possible. Identifying problems before they scale—for instance, via systems that determine individual cows at high risk of a disease that can infect the herd—will also build resilience across the entire food system.

Identify unique opportunities across a product's life cycle to make low-effort, high-impact decisions for managing ecosystems.

create your own recipes

USE THE QUESTIONS below as inspiration to write your own recipes for food innovation, combining cloud intelligence with the catalysts for transformation.

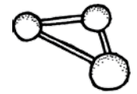
In what areas can you build cloud intelligence prototypes to simulate and anticipate future impacts?

How can you systematically collect and contribute data that would accelerate the scope and impact of cloud intelligence?

In what other contexts can cloud intelligence accommodate multiple levels of engagement, information needs, and goals?

How can you use cloud intelligence not only to optimize efficiency of food systems but also to identify and monetize underutilized assets?

What efforts are you undertaking that cloud intelligence could help shift from reactive to anticipatory?



"It is hard to imagine anything that would 'change everything' as much as a cheap, powerful, ubiquitous [cloud] intelligence — the kind of synthetic mind that learns and improves itself. A very small amount of real intelligence embedded into an existing process would boost its effectiveness to another level. We could apply mindfulness wherever we now apply electricity. The ensuing change would be hundreds of times more disruptive to our lives than even the transforming power of electrification."

Kevin Kelly,
author and founding editor of *Wired* magazine

Source: Claes Bech-Poulsen. Used with permission.

INGREDIENT

EXPERIMENTAL BIODESIGN

Toward reinventing food experiences and food systems

Culinary artists and scientists have always experimented with the tools of their disciplines to develop new foods. Louis Pasteur's fascination with fermentation is just one example of humans' longstanding curiosity about the processes of cooking and preserving food. In more recent years, the proliferation of research labs that combine the culinary arts with food science has expanded the scope and pace of food innovation. And as synthetic biology evolves, new capacities at the intersection of culinary arts and food science and technology will accelerate the design of new flavors, food experiences, and food systems.

The convergence of two drivers of change will enable experimental biodesign as an ingredient for food innovation over the next decade. First, an emerging effort to integrate biological systems with design—biodesign—seeks to create more robust and resilient systems by harnessing living organisms' "tremendous power and potential utility [and] natural interaction," in the words of design historian William Meyers. Biological building blocks like microbes have always been in our food, but as we gain better understanding of their functions, we will be better able to manipulate these building blocks to reinvent food experiences.

Second, synthetic biology—the ability to redesign the biological building blocks themselves—will expand the scope of biodesign for food. Synthetic biology uses advanced science and engineering to make living organisms by writing new genetic code. This is happening with increasing speed and ease. For instance, Harvard University's Wyss Institute for Biologically Inspired Engineering built a machine that uses natural evolution principles to generate billions of different genomes in a day, dramatically reducing the time and effort required to create genomes with desired properties for organism design.

Taken together, biodesign and synthetic biology—the integration of living organisms as building blocks into larger systems, and the ability to make those building blocks with specific properties—create a platform for innovating rapidly, iteratively, and with an ecological perspective. Over the next decade, experimental biodesign will expand our potential to create new flavors and food experiences with systems-level impacts.We'll see new relationships among scientists, chefs, designers, and biohackers as the tools become more accessible. And as we experiment at the level of biological building blocks, we will reorient our paradigms toward cellular food systems—building from the organism up. This raises an imperative to think about where this rapidly changing technology will intersect not just with our food system but also with our values.

FORECAST

precision flavor

From culinary intuition to engineering

Chefs have traditionally relied on time-tested recipes, secret ingredients, and culinary intuition to create delicious foods with complex flavors. Over the next decade, we will gain faster, more dynamic ways to quantify, engineer, and invent flavors. Already chefs are beginning to augment their understanding of flavor at the molecular level, building their own tools for tracking flavor metrics to ensure intended outcomes. Synthetic biologists are engineering yeast to produce flavors—and potentially create new or revive lost flavors—that can be labeled as natural. As appetites for artificial flavors shift, the ability to quickly prototype and design new organism-derived flavors may become more attractive. But there are pitfalls to this approach; early consumer protests over cultured flavors indicate that we will need to reconsider our intentions for engineering and using living organisms as our capabilities expand.

SIGNALS

An **umami meter** created at the Noma culinary lab in Copenhagen uses a simple Arduino-powered sensor and LED light to measure free glutamate, a proxy for umami—a basic taste that gives savory depth to food. This analysis normally requires an expensive spectrophotometer. The meter prototype points to a future in which chefs will leverage cheap technology and molecular indicators to quantify flavor and build precise recipes.

Source: Noma; Image source: Instagram user arielle_johnson

Ginkgo Bioworks is one of several companies engineering yeast to produce synthetic flavors that can be labeled as natural; since the final flavors don't include the engineered yeast, they contain no genetically modified organisms. Ginkgo's organism designers use robotics and automated systems to design and analyze microbes at industrial scale.

Source: ginkgobioworks.com

In 2014, advocacy group Friends of the Earth launched a **campaign against vanillin produced with synthetic biology**, spurring ice cream brands to announce their products will never contain cultured vanillin. Critics called the campaign misplaced, since synthetic vanillin produced from petrochemicals has been used commercially for nearly a century. The introduction of synthetic biology into the food system is likely to lead to similar consumer protests and calls for transparency.

Source: National Geographic; Image source: evolva.com

FORECAST

multidimensional food experiences

From static to dynamic food and packaging

The same tools that are reinventing flavor are expanding the scope of bio-based experimentation across many dimensions of our food experiences, from textures to packaging to multisensory stimulation. Innovators are using the same culturing methods as flavor engineers to produce early prototypes of animal proteins derived from engineered yeast. In the longer term, we can imagine designing foods with new textures, functions like elasticity, or the ability to express properties over time. Beyond food itself, the fashion and materials industries are designing living materials that will potentially enable packaging with new functionalities. These early experiments point to a future in which we'll harness the natural dynamics of living organisms for more dynamic food experiences.

SIGNALS

Clara Foods is one of several start-ups harnessing yeast to prototype cultured animal proteins. It aims to produce egg whites with a more dynamic set of properties than animal egg whites, such as a more complete protein profile and increased foam stability for meringues and other baked goods.

Source: clarafoods.com

Living Food is a speculative design project from London-based artist Minsu Kim that explores a future in which synthetic biology creates new kinds of human-food interactions and multisensory stimulation. Kim portrays dining experiences where food behaves like a living creature, inviting us to imagine further possibilities for novel eating experiences and also foods that are designed to change over time, perhaps to curb spoilage.

Source: minsukim.net

Biocouture founder Suzanne Lee designed clothes using a biomaterial that was fermented by a mix of bacteria and yeast. Experimental biodesigners like Lee imagine microbes will be the factories of the future, accelerating a materials revolution that is also being helped along by synthetic biology. Grown materials could have new sensing capabilities and functionalities that could be incorporated in food packaging.

Source: dezeen.com

FORECAST

cellular food systems

From extractive to cultured food

Redesigning the biological building blocks of food will reshape food systems. Scientists are experimenting with synthetic biology to reprogram biological systems of plants, not just microbes, for effects like improved nitrogen fixing. The innovators pioneering cultured flavors and proteins plan to scale quickly to overcome the environmental constraints, animal welfare concerns, and lack of food affordability in today's extractive food systems. Others are building advocacy campaigns and do-it-yourself platforms to build public literacy about synthetic biology—to shift food cultures toward cultured food. Biodesigners who seem experimental today may not be so experimental in ten years—even cultured beef is expected to be on the market within the next decade, according to Mark Post, who led the team that developed the first cultured hamburger. As these foods become available, we will wrestle with new elements of the already complex environmental, political, and ethical dimensions of our food system.

SIGNALS

The **OpenPlant** collaboration among the University of Cambridge, the John Innes Centre, and the Sainsbury Laboratory aims to reprogram entire biological systems of plants, not just microbes, for sustainable agriculture, bioproduction, and improved land use. It hopes to introduce plant traits ranging from new forms of symbiosis and nitrogen fixing to improved leaf structure, while promoting responsible innovation and open exchange among scientists.

Source: openplant.org

New Harvest is a U.S.-based nonprofit that is advancing the "post-animal bioeconomy." Powered by donations, the organization has helped channel more than two million dollars to efforts that are developing cultured beef, eggs, and milk. It also fosters dialogue and education across the scientific community, entrepreneurs, investors, and the public.

NEW HARVEST

Source: new-harvest.org

Created by the MIT Media Lab, **The Amino One** do-it-yourself organism engineering kit allows anyone to experiment with organism design by making the process as simple as using an app. The creators intend to democratize the science and enable personalized manufacturing. Products like the kid-friendly, laptop-sized Amino will encourage a new generation of people who are familiar with synthetic biology and point to a future in which the tools are more accessible.

Source: amino.bio

recipe workbook

Combining **experimental biodesign** with the catalysts creates recipes for food innovation that harness biological building blocks to design new food experiences that reorient our paradigms—building from the organism up. In the following pages, explore the five catalysts for transformation that leverage experimental biodesign to accelerate and amplify food innovation. Experiment with the five new recipes for food innovation at the intersections of experimental biodesign and the catalysts. Then, create your own recipes for food innovation that incorporate your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.

EXPERIMENTAL BIODESIGN

catalysts

EXPLORE these five catalysts to develop strategies that accelerate and amplify food innovation.

recipes

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RECALIBRATE RISK

The speed and scope of experimental biodesign will likely reshape innovation time horizons across the food system, particularly where it intersects with the longer cycles of agriculture. Mapping the ecosystem of innovations and research using tools like the Synthetic Biology Project's database, which crowdsources data about synthetic biology applications and commercialization, will help you anticipate the areas of your business most likely to be disrupted and to adjust your long-term innovation strategy.

Map the ecosystem to anticipate changes in the commercial and regulatory environments and new innovation opportunities.

CULTIVATE NETWORKS

The White House has mandated updating the U.S. regulatory framework for synthetic biology while open-source prototyping tools for biotechnology are being developed in Shenzhen. How experimental biodesign unfolds over the next decade will depend on the people shaping the ecosystem. Cultivating networks of food system stakeholders—from farmers to academics to consumers—to share knowledge and develop principles across industries, disciplines, and scales will be key to transformative, responsible innovation.

Catalyze cross-industry, multidisciplinary networks to share knowledge and develop principles for innovation and safety.

CUSTOMIZE FOR QUALITY

The shift toward cultured food systems will introduce new questions about what constitutes quality food. Some people will focus on process—whether a modified organism was involved in the making of a food—while others will be more concerned with the taste, safety, or affordability of the final product. Communicating clearly about the origins and production of food will allow individuals to choose foods that align with their particular expectations for quality food.

Clearly communicate how food is produced and manufactured so people can choose foods that align with their expectations for quality.

UNLOCK LATENT VALUE

While regulators grapple with changing science and consumers call for transparency, people will look to experts for help understanding the biodesign landscape as it emerges. Large food companies in particular will be well positioned to utilize their capacities for market research, quality control, risk analysis, and communications—perhaps developed during previous periods of food system transformation—to establish leadership in interpreting this emerging world. These capacities may even be amplified through new partnerships.

Identify unique food and nutrition science capacities to lead others in understanding the emerging biodesign landscape.

BUILD RESILIENCE

As experimental biodesigns integrate into the food system, significant ecological impacts may occur. Advocates hope that these new foods will feed a growing population without taxing our natural resources, while improving nutrition outcomes and food access. However, as foodborne disease outbreaks and commodity price shocks illustrate, what happens in one part of our interconnected food system ripples throughout others. Everyone from large food companies to community biohackers will need to foster an ecological perspective on the biodesigns they create.

Develop ecosystem metrics and tools to model the ecological impacts of biodesigns as they move from experimental to integrated.

create your own recipes

USE THE QUESTIONS below as inspiration to write your own recipes for food innovation, combining experimental biodesign with the catalysts for transformation.

In what areas will experimental biodesign create threats and opportunities, and how can you stay ahead of them?

In what ways can you engage across industries, disciplines, and scales to leverage experimental biodesign?

How can you address varied demands for quality food, both in terms of process and end product?

How can you utilize current capacities and previous experiences to generate value as a biodesign leader?

What kinds of metrics and tools will help you foster an ecological perspective on biodesign?

"Yes, natural is good and healthy, and whole foods are important. However, experimentation is important too. Once you realize that cooking is a science, you realize that it's the only science in which innovation is frowned upon—where there are powerful efforts to stifle and stall innovation. It doesn't have to be that way. Instead, let's celebrate the kitchens, labs, and people who are creating foods and tastes that we've never experienced before."

Chef David Chang
in *Wired* magazine

Source: bengtham

INGREDIENT

REWRITABLE NARRATIVE

Toward open food stories

Food narratives are the stories we tell around food—recounting its history and its place within culture, and embodied in its preparation, presentation, and marketing. Narrative has always been an important part of the food experience, shaping its value, and story is clearly a critical tool in selling food products. Increasingly, food purveyors are seeing the experience and narrative of food as core to their offerings—and sometimes the only way to differentiate one food product from another.

Food narratives shift and evolve, but recently we've seen the pace of change accelerate and the voices that have a say proliferate. Large food companies and governments used to have an outsized role in the stories we tell about food. But we're moving from a world in which those stories can remain comparatively fixed toward a world of more open food narratives. In this world, stories move faster; they go through more devices and channels, more storytellers, and more iterations. Over the next decade, no one entity will be able to craft a food story and expect it to remain unchanged.

In the past, a story would be broadcast on a limited number of channels and print outlets. Today, once a story breaks, it can spread around the world in minutes through social media, being modified, adapted, and remixed by the countless people sharing it. And going forward this will only be truer. New communication platforms will be even more open and participatory than the social media of today. Communication devices will be more numerous—from at-a-glance wearables to immersive virtual reality simulations—and in many cases will generate new materials with which people can tell and remix stories. The data individuals will gather through wearable sensors will be used to create and rewrite food stories on the individual, community, and planetary levels.

By 2025, expect people to leverage new platforms and data to tell new food stories, challenge existing ones, and catalyze conversations around food issues that matter to them. Participating in and cultivating these open food narratives has the potential to inspire new channels for more authentic relationships between brands and people.

FORECAST

new remixers

From broadcast to participatory storytelling

Today, spaces for consuming stories and for discussing them are for the most part segregated. People watch a show on broadcast television and offer live commentary on Twitter. Most websites have a comments section, but it appears at the bottom of the page. In contrast, Wikipedia is editable by anyone, and Japanese video-sharing website Niconico lets commenters place text directly over videos. These sites are hotspots of collaborative remixing; narratives evolve and shift as many people create them together. Going forward, the advent of augmented reality will allow people to add a layer of digital graffiti onto anything in the physical world, and augmented intelligence will make modifying video easier than ever before.

SIGNALS

Niconico is a Japanese video-sharing website that displays comments, often subtitles or lyrics, directly onto videos as they play. Users can add new comments or respond to others—creating a conversation that unfolds as more people watch the video. Many videos are popular as much for the comments overlaid on them as for the video content itself.

Genius, a site dedicated to crowd-sourced annotation of music lyrics, offers a web browser plug-in that lets anyone add annotations to any web page. The service has been used to annotate fast food chain menus and popular products' nutrition labels. In the physical world, "culture jammers" have long modified big companies' billboards and other advertisements to tell new stories. This opens up similar storytelling spaces in the digital world to such remixing.

Culture jammers recently set up fake social media accounts to impersonate customer service representatives for two large food companies, Frito-Lay and Campbell Soup Company, to defend the companies against complaints about their LGBT-friendly products or marketing. This shows that if a food producer genuinely connects with people around issues they care about, it can leverage remixers to extend its stories in positive ways.

Source: Niconico

Source: Genius

Source: Huffington Post

FORECAST

new mediums

From static surfaces to paintable canvases

In a future where everything has become media—with computing power and Internet connectivity embedded in everything from human bodies to vehicles to the tools and surfaces of our kitchens—we will be able to write and rewrite stories on any surface. People have always used food arrangement and ambience as ways to tell food stories. But with the advent of programmable lighting, augmented reality, and other communications technology, we'll be able to change the aesthetics of food and the environment it is presented in with much less effort. When manipulating the sensory environment becomes as easy as downloading an app, we'll see many more people rewriting the narratives of food in this way.

SIGNALS

The **Philips Hue** lighting system uses Wi-Fi-connected light bulbs to let users manipulate the appearance of a given environment with a smartphone app. We're already seeing food photographers use the Philips Hue system to make food appear more attractive, and they are sharing these techniques with each other online. As technology makes creative food presentation effortless, expect many more people to participate, particularly to reinforce an identity or express creativity.

Source: Phillips

Marriott Hotels has launched **VRoom Service**, the first in-room virtual reality travel experience, allowing users to put on a virtual reality headset to travel around the world. The first travel destinations offered include an ice cream shop in Rwanda and a street market in Beijing. This kind of multisensory technology can make narratives about foods and food experiences—wherever they might be—available to many more people.

Source: Marriott

In a **study reported in the *Archives of Pediatrics and Adolescent Medicine,*** children chose an apple with a sticker of the cartoon character Elmo on it over a cookie. This study hints that food aesthetics can be used to nudge people toward particular choices, something large companies have long understood and leveraged. When everything becomes media, people will write new food narratives, even on foods themselves, to encourage healthy choices or reinforce identities or ethics.

Source: flickr user automania

FORECAST

new evidence

From science- and marketing-based stories to sensor-based narratives

Stories from countless sources, ranging from scientific research reports to glossy advertisements, tell us how food impacts our bodies and minds. But going forward, we're going to see an important new source of information emerge: sensor data. As powerful and accessible sensors in, on, and around us quantify anything and everything, we'll use the data to tell new stories about how we interact with food. New food narratives will proliferate, and they'll be much more varied and idiosyncratic than before. People will be able to track how food impacts them as individuals, new affinity groups will emerge, and communities will be able to draw new connections between food and outcomes they find desirable.

SIGNALS

Bulletproof Coffee, a recipe invented by Dave Asprey through self-experimentation, blends coffee with butter to boost cognitive function. This recipe is associated with the quantified self movement—people tracking metrics about themselves over time to uncover patterns and gain insight into how their bodies and minds work. Going forward, as sensors make such experimentation much easier, expect more food narratives to be rewritten through self-study.

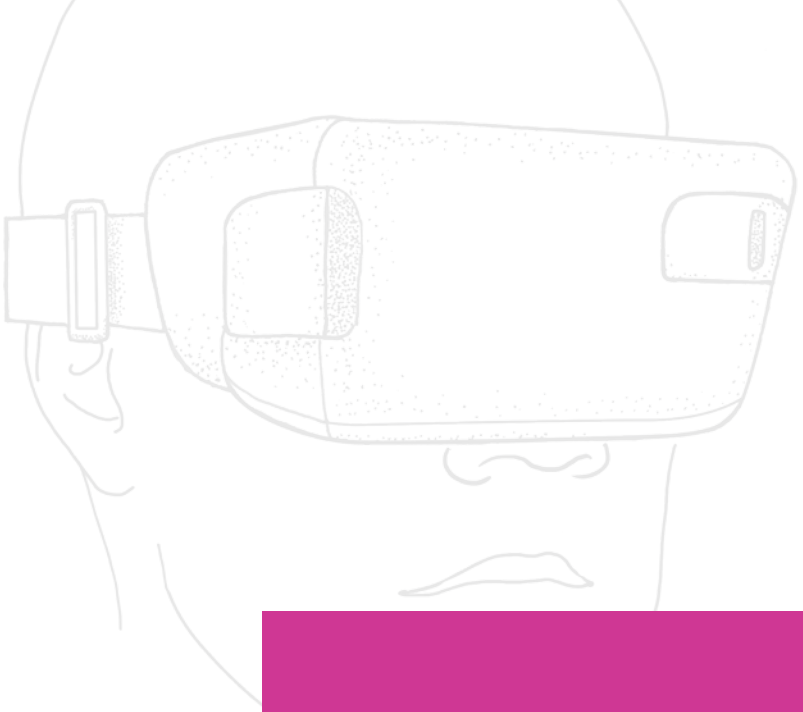
Source: Bulletproof

Wrap Genius, an enhanced digital food labeling framework, was developed by NYU graduate student Sam Slover. Slover tracked his grocery purchases for three months and came up a visual framework for understanding and telling his personal food story, such as the number of ingredients consumed and how far the foods had traveled. New tools will let us automatically track and display this kind of data in visual, personal food narratives with actionable information.

Source: Wrap Genius

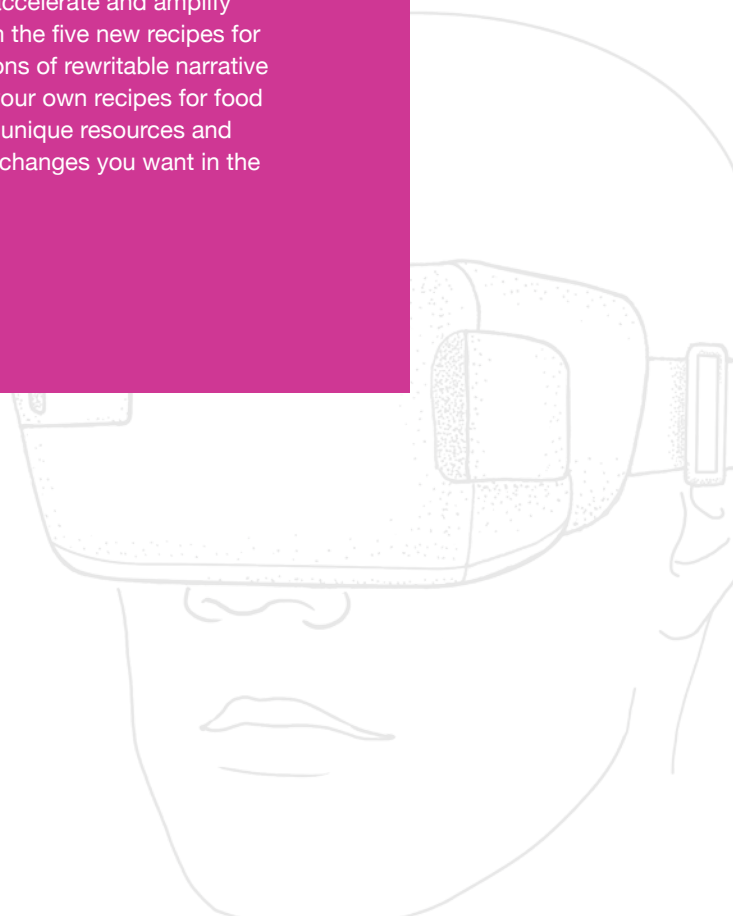
A study by Alia Crum at Columbia University found that food labels affected people's levels of ghrelin, a hormone associated with satiety. Two groups of people drank the same milkshake, for one group labeled as a high-calorie indulgent shake, for the other a low-calorie health shake—and those who drank the latter shake actually produced less ghrelin. Labels evoke beliefs, and these beliefs matter in the complex interactions among story, food, bodies, and minds.

Source: *Health Psychology*; Image source: flickr user su-lin



recipe workbook

Combining **rewritable narrative** with the catalysts creates recipes for food innovation that leverage the capacity to collaborate with more storytellers across more mediums to create open food stories. In the following pages, explore the five catalysts for transformation that leverage rewritable narrative to accelerate and amplify food innovation. Experiment with the five new recipes for food innovation at the intersections of rewritable narrative and the catalysts. Then, create your own recipes for food innovation that incorporate your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.



catalysts

EXPLORE these five catalysts to develop strategies that accelerate and amplify food innovation.

recipes

EXPERIMENT with these recipes for food innovation.

RECALIBRATE RISK

Going forward, no single entity will be able to control narratives. Attempts to do so could be met with skepticism, if not anger. Instead, a larger organization can seek to become a catalyst for conversation—a more robust role in the creation of rewritable narratives. It's also a role that challenges current practices for messaging and brand management. Experimenting within safe spaces will help you learn how to effectively and authentically open food narratives.

Experiment with catalyzing conversations with a small group of loyal customers to build readiness for the disruptive shift from broadcast to open food stories.

CULTIVATE NETWORKS

Expert storytellers exist everywhere. They have wildly diverse voices and work in a range of mediums, from canvases to the virtual worlds of games. There's a huge opportunity to allow these storytellers to rewrite your stories with their own unique sensibilities. Building a network of such artists could make possible more complex and compelling story creation. However, such relationships require genuine partnerships in a world where no one story fits all.

Open up brand narratives to local storytellers in a city or region to create narratives that are more complex and compelling.

CUSTOMIZE FOR QUALITY

In the future, consumers will expect stories around food to be more personally relevant and customized. And, in a world in which everything is media, narrative will become an even more influential aspect of people's expectations for quality. The food system is full of surfaces that can be augmented with tools for rewriting narratives. Design these in ways that create a portal to two-way engagement around the origins and experience of food to align with a wide spectrum of expectations for quality and self-expression.

Augment interfaces and surfaces throughout retail spaces with tools to customize narratives for quality food experiences.

UNLOCK LATENT VALUE

In a world of ubiquitous digital connectivity, telling narratives that resonate will require analysis across massive amounts of data—and enlisting much of this data to rewrite with us. Networking supply chains to purchasing systems to public health databases will help people understand their personal food narratives, as well as make food narratives at the scale of cities and nations richer and more actionable. Contributing data or even rewiring systems currently used internally to build tools for people to easily track and display information will unlock new value.

Open up data and analysis tools to help people develop coherent, comprehensive sensor-based narratives across the food system.

BUILD RESILIENCE

People want to be able to connect with a larger narrative, especially one having to do with sustainability, health, and ethics. By being radically transparent, and finding new ways to tell your own food stories, you can provide the materials for stories that create change across the food system. This might mean revealing a problem, such as Nestlé's 2015 report of poor labor practices among its seafood suppliers in Thailand. However, radical transparency can spur action across entire industries and might become more necessary in a world in which information leaks are common.

Reveal labor and other practices across your supply chain to cultivate practices that are healthy, sustainable, and ethical.

create your own recipes

USE THE QUESTIONS below as inspiration to write your own recipes for food innovation, combining rewritable narrative with the catalysts for transformation.

In what ways can you experiment today for a world of open food stories?

How can you identify the best storytellers and engage with them?

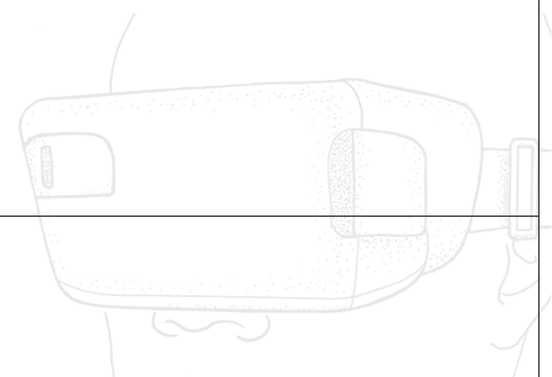
How can you engage people in rewriting and sharing narratives to elevate the quality of their food experiences?

What assets do you have that you could open to the ecosystem of information and people rewriting food narratives?

How can you adopt new levels of transparency to create change across the food system?

"Our wealth is measured neither in money nor land but in a portfolio of stories. Without stories, peaches become a commodity and consumers are attracted by their cheap prices. Gone are the words that help commit experience to memory. When we lack a language of taste, we lose one of the main ingredients for creating lasting meaning."

David Mas Masumoto, farmer and writer in *The Perfect Peach: Recipes and Stories from the Masumoto Family Farm*



Source: flickr user kris krüg

INGREDIENT

ENGAGED EATERS

Toward eater-led reinvention of the food system

What's food innovation for, if not the eater? Providing food to satisfy a basic need of billions of people is the whole point of our global system of agricultural production, manufacturing, distribution, and shopping. In recent times, many eaters have been disconnected from how food is made, and efforts led by food companies and governments only incrementally changed ingredients or packaging. But eaters have lost trust in food companies and are once again getting engaged. By 2025, eaters will be much more than just the demand at the end of the supply chain. They will lead innovation that creates a food system rooted in values of sustainability, health, sociality, and pleasure.

Eaters have always been an important part of the innovation story. Today's beloved food traditions are the result of innovations of the past—dreamed up by eaters who creatively used the technology at hand to meet a challenge, respond to a resource glut or constraint, or create a new flavor experience. During the past few decades, eaters demanded a food system that produced greater quantities of cheaper food—and with the help of industrial innovations, they got it. But now they are seeing the many trade-offs and limits of that system, and are demanding and creating change. Almost every major food company is responding to these engaged eaters by reducing antibiotic use, using natural colors and flavoring, and offering organics.

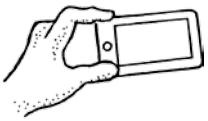
In the coming decade, engaged eaters will make more informed consumption choices, join in participatory production, and help to co-create foods. They will embrace new technologies, both to create fun, novel foods and to address urgent planetary-scale challenges. Rather than being passive consumers of convenient and delicious calories, engaged eaters will want to help address the complex connections between human health, economic mobility, environmental resilience, culinary heritage, and collective and personal identity. It's a big ask, but the food industry is well positioned to help engaged eaters be a lever of change across all of those things.

FORECAST

informed consumption

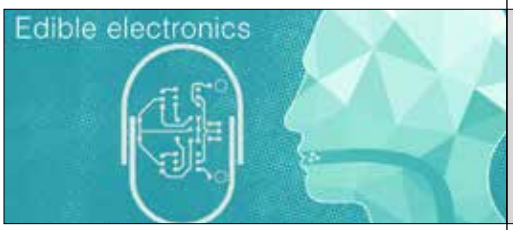
From unreliable information to knowledgeable purchasing

Eaters today know they can't always rely on their own five senses for accurate food information. Supermarket produce is big and shiny but often flavorless. Packaged foods are formulated with empty calories and addictive "bliss points." Even ingredient labels are not always trustworthy. As engaged eaters take it upon themselves to fill regulatory gaps and search for transparency, they will be aided by technologies in, on, and around their bodies. Such devices will let them precisely measure their dietary needs, metabolic reactions to foods, and environments. Everyday objects with embedded sensing capabilities will also make a lot more data available to eaters at the point of consumption. And as new technologies make it easier to analyze food samples at the molecular level and make the data public, some eaters will gain new confidence in their buying choices. However, as more of this data comes from non-traditional food authorities, some of it will be highly contested.



SIGNALS

Ingestible sensors are being developed by materials science and biomedical engineers at Carnegie Mellon University as a way to observe the gut—to look for signs of infection, check out abnormal gastrointestinal activity, and study the microbiome. As such sensors become smaller and are equipped with nontoxic on-board power supplies, eaters will adopt them for an instant feedback loop about how food affects their bodies.



Source: Cell Press

Baidu, a Chinese search engine giant, has developed chopsticks that it claims can measure the freshness of cooking oil and alert users to contaminated oil via a smartphone app. The chopsticks respond to food safety concerns in China, which has been rocked with scandals involving everything from toxic milk to glow-in-the-dark pork. These smart utensils put eaters in control of verifying a food's quality and safety.

Source: Baidu; Image source: The Next Web

Clear Food is a consumer initiative launched by Clear Labs. Monthly Clear Food reports, available to the public at no cost, help eaters identify the most high-quality foods based on molecular analysis. The first report, in October 2015, made headlines with test results that some vegetarian hot dogs contain human DNA. This garnered criticism as being misleading and highlighted the contested nature of new food authorities.

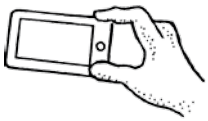
Source: Clear Labs

FORECAST

participatory production

From distant farms and factories to local makers

Whether in megacities in Southeast Asia, small towns in Italy, or suburbs in the United States, eaters will take a more active role in producing and processing their own food. Stemming from the same motivations as the maker movement, growing and cooking food is an empowering, engaging experience. Participatory production starts with kids, who are gaining basic food literacy through edible education curricula at school. As they learn to grow and cook food, their values shift and they see themselves as more than just consumers—and they will want to eat food that reflects this identity. Traditional practices, like small-scale farming or fermentation, will take on new precision with the help of sensors, and new conveniences with the help of automation technologies. Innovative food products are sure to emerge as eaters participate in producing foods they like, just as many of today's successful craft beer brands started as home brewing projects.



SIGNALS

Weekend farmers are a growing movement in Bengaluru, India. At the center of India's high-tech industry, the city has seen a rise in working professionals heading out of the city on weekends to tend their organic farms. Driven by fears about industrial farming practices and a desire to connect their children to the land, this type of part-time farming might become more popular as urban populations increase.

Blending tradition with food innovation, **Acetaia San Giacomo**, a traditional balsamic vinegar producer in Reggio Emilia, Italy, worked with the local Fab Lab to produce a vinegar kit that people can use to make vinegar at home. The kit features a 3D-printed, Arduino-powered pH sensor and aerator plus starter bacteria from Acetaia San Giacomo's own barrels.

Leaf, an automated at-home medicinal cannabis growing system, continuously monitors the growing environment and automatically makes adjustments to optimize plant health, while providing real-time environmental data via mobile. With its innovative nutrient dosing system and custom LED growlight, Leaf could provide a model for similar systems to grow produce at home.

Source: The Hindu

Image Source: IFTF

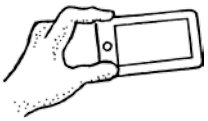
Source: Leaf

FORECAST

co-created markets

From passive consumers to innovation allies

The traditional capital structures of the food industry are shifting, and thanks to co-creative financial arrangements, eaters are gaining more direct control over what food is produced and marketed. Companies are thinking of eaters as investors and collaborators as they consider how to embrace new technology and feedstocks while satisfying longstanding human desires for food to be delicious, nutritious, and social. New food brands are finding financial help from both the bottom up and the top down—innovative food projects have raised more than $70 million on Kickstarter, and billions of dollars in venture capital are pouring into food and agriculture technology. And established food brands are adapting their innovation strategies in response to political and economic pressure from engaged eaters. This new entrepreneurial ecosystem will create jobs, grow markets, and help eaters align their intentions with their actions.



SIGNALS

The **Exo Protein Bar**, made from cricket flour, was originally developed with the financial backing of 1,241 people who pledged a total of $54,911 on Kickstarter. Engaging with early supporters, Exo could guarantee that what might seem like a risky product had a market before going into production. As crowdfunding and co-creation platforms grow, there will be more ways to engage eaters as partners.

Source: Exo

French supermarket chain Intermarché launched a campaign to showcase the beauty of ugly produce, and the **@UglyFruitAndVeg campaign** in the United States has a large, active social media following. By crafting a fun and compelling narrative, this distributed group of activists is changing perceptions of imperfect fruits and vegetables, thereby reducing food waste and growing an entirely new market for once discarded foods.

Source: twitter.com/UglyFruitAndVeg/media

General Mills' new venture capital arm, **301 INC**, is seeking emerging food brands that need capital to reach the next level. It aims to make direct equity investments and share expertise to grow small businesses and elevate their products. This partnership model represents a new kind of alliance for food innovation, leveraging the scale and resources of a large company and the fast-paced flexibility of a start-up.

301 INC
EMERGING BRAND ELEVATOR

Source: General Mills

recipe workbook

Combining **engaged eaters** with the catalysts creates recipes for food innovation that leverage new technologies and shifting social demands to create a food system rooted in values of sustainability, health, sociality, and pleasure. In the following pages, explore the five catalysts for transformation that leverage engaged eaters to accelerate and amplify food innovation. Experiment with the five new recipes for food innovation at the intersections of engaged eaters and the catalysts. Then, create your own recipes for food innovation that incorporate your unique resources and affordances to make the kind of changes you want in the foodscapes you inhabit.

ENGAGED EATERS

catalysts

EXPLORE these five catalysts to develop strategies that accelerate and amplify food innovation.

recipes

EXPERIMENT with these recipes for food innovation.

RECALIBRATE RISK

With platforms from Kickstarter to Betabrand, companies are bringing consumers in as decision makers from the start. The point is to develop new products in line with eaters' interests—whether nutrition and obesity, food waste, farm labor practices, or novelty—and open new feedback loops around product ideas or markets that might seem risky at scale today. When eaters contribute money or their ideas, they form a different kind of relationship with brands and have a stake in making sure the products they want reach the critical mass of support needed to go into production.

Experiment with crowdsourcing models to build engagement for a product or service that seems risky at scale today.

CULTIVATE NETWORKS

From popsicle trucks that promote civic participation to platforms that organize dinners for those grieving the loss of a loved one, people are using food to make meaningful social connections. As people's demands shift from products to services to experiences, cultivating networks of eaters around social food experiences will be increasingly important and may open new channels for marketing and deeper consumer insights. Exploring networks of eaters through today's tools like social media analysis might be a good first step.

Identify non-traditional spaces—such as public parks or a classroom—to create experiences that enhance social interaction through food.

CUSTOMIZE FOR QUALITY

In a world in which eaters look to devices in, on, and around their bodies to help them make informed choices, expectations for food quality will increasingly include customization according to a vast amounts of data. Think of ways to leverage this data to give eaters what they need in different contexts. For example, what if sleep tracker data showed a night of restless sleep and you could deliver a morning energy boost to an eater on her way to work? Leveraging engaged eaters in this way may require new partnerships and cloud intelligence for the data you need.

Identify a target market—such as athletes or diabetics—and tap into the vast data generated by wearable technologies to customize food experiences.

UNLOCK LATENT VALUE

Engaged eaters, especially those actively making their own food, want to be part of the reinvention of the food system. Much of the consumer frustration of the past decade has come from a lack of avenues for participation that really makes an impact at scale. Think of the values and goals of engaged eaters as assets to help you grow or create markets, while at the same time looking for new ways to contribute your resources like factories and distribution channels to nascent efforts across the food system.

Prototype new ways to engage with small-scale food entrepreneurs to support their projects and guide your own innovations.

BUILD RESILIENCE

Engaged eaters want to know they are supporting the health of their bodies and the global food system. Already eaters have leveraged their dollars and voices to decrease antibiotic use, reduce artificial colors and flavoring, and support organics. Many more facets of the food system could be made more sustainable, and eaters will want to be able to make choices to support resilience. Give eaters clear opportunities to invest in the responsible practices they want to see.

Creatively share your nutrition and environmental expertise to help eaters understand long-term impacts of their choices.

create your own recipes

USE THE QUESTIONS below as inspiration to write your own recipes for food innovation, combining engaged eaters with the catalysts for transformation.

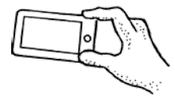
What prototypes or ideas are you developing that would be a big win if eaters were engaged early?

How does your food already play a central role in convening informal networks of eaters, and what could you do to enhance this role?

What types of data and analyses do you need to be able to customize for a wider spectrum of expectations for quality?

How can you invite eaters into the innovation process and leverage your scale to help them meet their aspirations?

What other expertise could you contribute to help eaters understand how their purchases impact the food system?



"We are alive at a time when huge systems—industrial, infrastructural—are being remade, and I think it's our responsibility as we make choices both commercial and civic—it's just a light responsibility, don't stress—to extrapolate forward, and ask ourselves: Is this a system I want to live inside? Is this a system fit for humans?"

Robin Sloan,
writer for *The Atlantic*

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FOOD

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