WHITE PAPER

Cornell Food Systems Global Summit

Implications of Taking a Systems Approach

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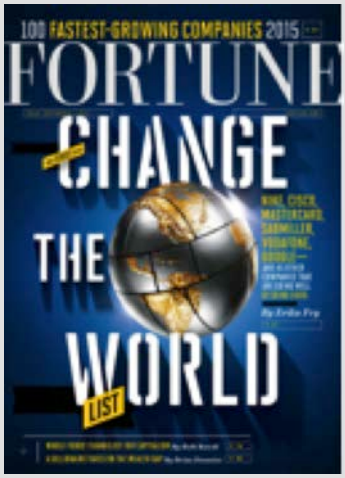
Introduction

The challenges of feeding a population are often discussed separately from those of properly nourishing an individual. But as these challenges intensify under pressures including population growth and global climate change, it is quickly becoming apparent that action at the level of food systems is necessary to fulfill this two-pronged responsibility.

Reactions to the issue of drought in California exemplify this shift in thinking. News stories about the perils of buying almond milk abounded, weighing the individual nutritional benefits of almond milk against the cost of growing a crop with such high water demands in drought-stricken California. Food businesses teamed up with scientists and engineers to implement water-saving technologies. The government offered rebates to individuals who adopted water-saving practices such as growing desert plants in lieu of a lawn.

"All of these groups are talking about



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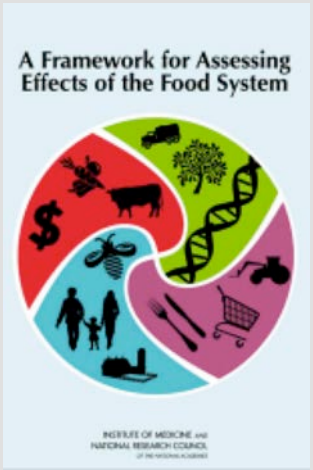

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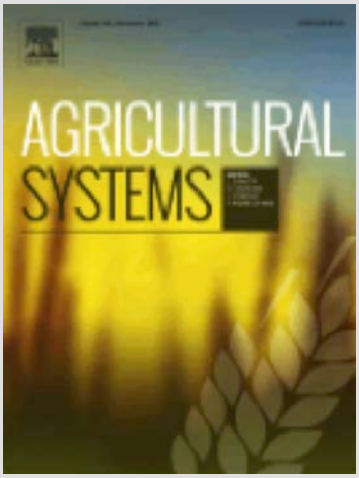

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systems intelligence, systems thinking, systems modeling —I think the time is now.

It's not that the approach is brand new. But applying it through the food system has really come into its own."

— Julie Stafford
Industry Liaison Officer
CIFS Industry Partnership Program

*Image credits: Fortune Magazine, September 1, 2015 Issue, www.fortune.com
The National Academies Press, "A Framework for Assessing Effects of the Food System" (2015)
Agricultural Systems, Elsevier, Editors: S. Dogliotti, C.F. Nicholson, D. Rodriguez, F. Penning de Vries

The extraordinary pressure the drought imposed naturally brought about change at the level of food systems, but the food industry has the chance to reap the benefits of systems strategies before the situation becomes this dire worldwide. Enormous power lies in our immensely complex food system—the power to integrate cutting-edge technologies into consumers' daily lives, to fight the burden of disease by creating and promoting healthy products, to lead the charge in combating global climate change, and to build thriving businesses in the process. Harnessing that power demands an approach that encourages food industry stakeholders to identify opportunities for creating strategic partnerships to better leverage resources and to predict unintended consequence that may not be apparent from the perspective of a single food system component.

As Malden Nesheim, professor of nutrition emeritus and provost emeritus at Cornell University, emphasized at the 2015 Cornell Food Systems Global Summit, "if you push a button in one part of the food system, something pops out somewhere else." That something could be anything from the ecosystem-destroying algal blooms that fertilizer use upstream creates to biofuel made from waste produced upstream in the system.[i] Without looking at the system as a whole, it is too easy to miss unintended consequences before they cause damage and to neglect opportunities for growth and streamlining while inefficient practices become deeply entrenched.

From *Fortune* magazine to federal policy approaches, an unprecedented alignment around the concept of a systems approach is igniting change across food industry sectors. Transforming food systems with such an approach will require not only a shift in thinking, however, but full adoption of technological tools for data collection and methodologies by which to analyze data from local to international levels. The challenge now is to keep this momentum going so that everyone from food industry workers to consumers to other species endangered by food-related practices can benefit from smart, systems-level strategies.

The Cornell Institute for Food Systems Industry Partnership Program is a public-private partnership that expands and enhances engagement of Cornell University faculty and staff with industry scientists, engineers, and business leaders throughout the food system. This interdisciplinary institute fosters communication between Cornell scientists and industry partners to directly address important challenges in the food industry.

The Institute focused its 2015 Conference on "Implications of Taking a Systems Approach". This white paper reflects the information and ideas presented by speakers throughout the Summit.

From Problems to Profits
The Need For A Systems Approach

If there is anything that people across all food sectors can agree upon it is that the challenges facing food systems are immense. Food systems must simultaneously satisfy consumer demands that constantly change and expand, provide a thriving economy for food industry workers, and operate sustainably to protect the environment. Strategic resource allocation will be key to overcoming these challenges. Embracing a systems approach can help food systems develop innovative strategies that harmoniously support businesses, consumers, and a healthy environment.

Better business practices

A systems approach can help businesses across the food industry turn costly problems into lucrative opportunities. With the explosion of data-collecting technologies available today, collecting data and distilling insights to guide strategy development is feasible on an extraordinary scale. The objective is not simply to gain more insights. It is to leverage them across the entire food in order to gain new insights of an entirely different character. With a systems approach comes new opportunities to predict problems before they arise and to predict opportunities that may have otherwise gone unnoticed.

Figure 1 A dairy cow and her calf. (Source: UBC Animal Welfare Program)

UNCOVERING OPPORTUNITIES FOR IMPROVEMENT

When a consumer takes food off the grocery store shelf, that product has already moved through most of the food system. In this pivotal moment, the consumer's opinions and behaviors have the potential to reach all the way across the food system and influence practices at the farm. Studies show, for example, that good treatment of cows is vital to citizens' perspective of dairy farming—and that educating them about dairy farming does not appear to change their minds about certain practices. In fact, evidence suggests that they become less likely to believe that dairy cows have a good life once they are educated, as issues that they were not aware of come to light.

Investigating consumer attitudes through scientific studies can help us identify which types of practices fail to resonate with societal values and provide us the reasons behind citizens opinions. When asked for their opinion about separating cows from their

calves at birth—a practice that is little-known outside of the dairy industry—the general public was largely opposed, explained Marina von Keyserlingk, Professor of Animal Welfare at the University of British Columbia. Participants surveyed contended that that the industry can and should accommodate cow-calf pairs instead of separating them, a practice that they found emotionally stressful, unnatural, and unhealthy for the calf and cow.[ii] Listening to consumer opinions is critical simply because they have the power to swiftly undermine business, even if their ideas are not the most practical from a purely business perspective.

In the case of cow-calf separation, some evidence suggests that changing this practice could earn the dairy industry more than stronger consumer trust. Dairy farmers do have a reason for separating cows and calves and part of the reason is the belief that this will maintain health of both calves and cows through minimizing the opportunity of cross contamination of contagious organisms.

Figure 2 Generic "Made in PA" state logo, designed as part of a campaign to promote locally sourced foods to stimulate local economies and limit environmental damage. A systems approach reveals that the issue is not as simple as this campaign would suggest, however.
(Source: "Should We Regionalize Fluid Milk Consumption?: System Impacts" — Chuck Nicholson, Adjunct Associate Professor, Charles H. Dyson School of Applied Economics and Management, Cornell University)

By providing each calf with only a portion of the milk it would get from its mother, the industry was focused on maximizing return on investment from milk production. This may seem logical, yet recent scientific work has challenges this practice. Calves that are provided nutrients early on in life from milk or milk replacer at levels more similar to what they would receive from the cow grow faster, leading to enhance lifetime productivity as mature animals. A study involving over 1,200 calves showed that calves produced more than 1,500 pounds more milk in their first lactation for each additional pound gained per day during the milk feeding period. For comparison, traditional genetic selection for milk production yields only about 200 pounds more milk per lactation.[iii]

"We don't actually have a system on the farm that allows us to capture something like this—the data systems are missing."

— Michael Van Amburgh, Professor, Department of Animal Science, Cornell University

A systems perspective can point to opportunities like this—when revisiting the reasoning behind traditional practices has benefits across the system. Without a way to capture and scientifically analyze data on these practices, however, dairy farmers can easily miss out on insights such as those gleaned from studies of cow-calf pairs. Increased communication among academic experts, dairy producers, and the citizens

who buy products is a key element of systems approaches. It is a way to both reveal unintended consequences and facilitate the development of practical science-based solutions.

AVOIDING UNINTENDED CONSEQUENCES

A well-informed systems approach can also help businesses and policymakers avoid unintended consequences that might otherwise go undetected because of their counterintuitive nature. As an example, many consumers will pay a premium for local food because they view it as healthier, lower cost, better for the environment, and better for the local economy. Pennsylvania even has a statewide program called 'PA Preferred' that is designed to promote locally-sourced foods such as fluid milk. Despite conventional wisdom about the effects of localization on food systems, studies that take into account the entire system show that sourcing fluid milk locally can actually increase the total miles traveled by fluid milk and have other negative environmental outcomes.

The key is understanding that farm milk is a limited resource in a food system, just as nitrogen and water are limited resources in an ecosystem. Without looking at the system as a whole, it is difficult or even impossible to predict the consequences of changing the uses of farm milk in a given geographic area. Milk and its components are used in many dairy products such as ice cream, yogurt, whey, cheese, and butter. Taking away a larger portion for consumption as fluid milk means that less milk is available for use in other products. Defining 'local' as 'within the same state' (as does the U.S. Department of Agriculture) can also affect distances traveled, especially for a state with boundaries like New York for which milk supplies in other states can be closer. Using state-based boundaries of localization resulted in an 11% increase in total miles traveled by fluid milk in New York and a 2% increase in total miles traveled by all dairy products in the Northeast. Localization also increased costs and greenhouse gas emissions for dairy products in the Northeast.[iv]

USING SYSTEMS INSIGHTS TO GUIDE INNOVATION

The upshot of these dairy cases is not that local food is bad or that businesses must always give in to consumer opinions. Rather, it is that a systems approach is key to achieving the benefits desired in food systems while minimizing consequences. So what is a business to do if a systems analysis reveals that its plans to go local are not actually more environmentally friendly or that consumers are not satisfied with a particular aspect of its products?

Using systems insights to inform strategies is a powerful path to true innovation. As it turns out, local produce can also end up being less environmentally friendly than

imported produce, in terms of CO_2 per pound of product. Field-grown lettuce transported 2,500 miles to New York, for example, costs 0.7 pounds of CO_2 per pound of lettuce, whereas locally grown greenhouse lettuce costs 2 pounds of CO_2 per pound of lettuce. This is because heating and lighting a greenhouse year-round can consume a staggering amount of energy.

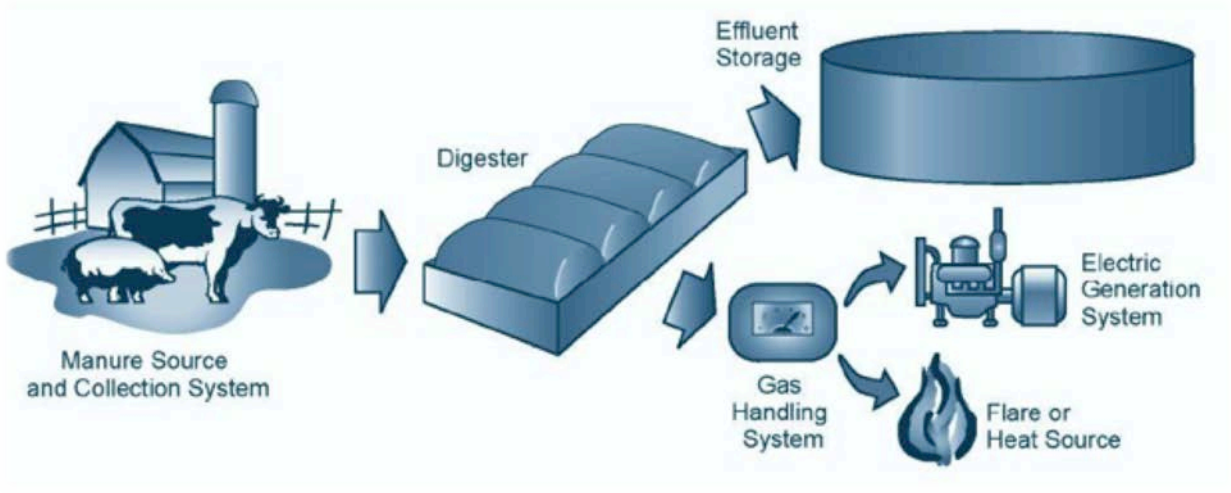

Figure 3 An example of an electric generator system powered by a waste digester. (Source: "A Systems Approach is Needed to Catalyze a Sustainable, Year-round, Locally-grown Produce Industry in the Northeast" by Neil Mattson, Associate Professor, School of Integrative Plant Science Horticulture Section, Cornell University)

The energy demands of local produce are not insurmountable for a strategically designed system, however. A dairy with 850 milking cows could provide enough heat via manure digesters to run 100 acres of greenhouses year-round. If the farms that own New York's 600,000 dairy cows were to install such systems, those greenhouses would produce about 100 million pounds of lettuce yearly. That would satisfy a substantial 42% of the state's lettuce demand.[v]

An environmentally friendly local product is only valuable if consumers will pay for it, of course. Ensuring this can be a challenge, but one that a systems approach can also help to solve. While consumers are generally willing to pay for and like the taste of fresher broccoli, for example, they are still heavily influenced by the way produce looks. For east coast broccoli growers, this presents a problem because east coast broccoli often looks different than its western counterpart.

By surveying consumers to gauge their preferences in tandem with rigorous plant breeding work, east coast broccoli can now use broccoli varieties that are well adapted to eastern conditions, look more like western-grown broccoli, and taste just as good as imported western-grown broccoli. They also implemented clever marketing strategies to give their broccoli an additional boost (Figure 4). Addressing all of these factors that

influence the viability of eastern-grown broccoli at various points in the food system is giving local broccoli the edge that it needs to be competitive in a market where western-grown broccoli is also available.[vi]

Figure 4 Marketing local broccoli in Brooklyn. (Source: "Is Regionalizing Broccoli Value Chains a Good Strategy for the Northeast" — Miguel Gomez, Associate Professor, Charles H. Dyson School of Applied Economics and Management, Cornell University)

Sustainable global food systems

At this point, it is clear that it is in everyone's best interest to be mindful of how their choices affect the environment. Food systems are complex and expansive, often extending to global scales. Unfortunately, they are also often major sources of environmental damage. As such, the food industry is poised to become a leader in achieving the global goal of keeping our environment—and the peoples who live in it—healthy. Leveraging knowledge gathered from across sectors through a systems approach can give food systems the power to curtail unintended consequences for both businesses and our global environment.

THE CLIMATE-CHANGED KITCHEN

A changing climate means a changing kitchen. Global temperatures have increased by 1.5°F overall so far, and the food industry is already feeling the effects. Coffee production in Costa Rica is off by about 30 percent, avocado production in California is expected to be down by 40% by 2040, lobster production has moved 50 miles north off the coast of Maine because of rising ocean temperatures—and the list goes on.

Supply chains are changing as a result of climate change. So far, those working in the food industry have largely been able to revise their supply chains to make up for these changes so that they are more or less imperceptible to consumers. But if this trend continues, that is likely to be more challenging.

That's why the Cornell Institute for Climate Change & Agriculture was founded. The Institute aims to raise the profile of the challenges that climate change poses and to craft strategies for facing these challenges that integrate insights from farmers and producers. Their plan of attack involves implementing climate smart-farming to help farmers adapt to the changes as well as reduce their carbon footprint, and supply chain risk assessment to minimize future environmental damage. This will entail developing and using new management decision tools to reduce losses from unexpected frost

events, to help estimate crop growth and maturity under warmer conditions, and reduce heat stress on dairy cattle. But changes must also occur beyond the farm. Given more risk and volatility globally the food industry should also consider technology for conservation, investing in suppliers to ensure productivity and resiliency, and researching and developing new ingredients. In other words, tackling climate change is going to require system-wide changes in food industry practices.[vii]

THE UGLY TRUTH OF FOOD WASTE

Between the many studies that have revealed alarming side effects of fertilizer and pesticide use, droughts that have raised concern over agricultural water use, and the sheer amount of land that is used to grow food, it is clear that environmental issues and food system issues go hand-in-hand. This makes it all the more appalling that after all of the land and energy and other environmental sacrifices made for farming, we throw away 40 percent of our food. As United Technologies Chief Sustainability Officer John Mandyck lamented, "it's hard to imagine a more inefficient system for the one thing we need to sustain the human race."

The numbers are staggering. Yearly, 1.3 billion tons of food go to waste while 1 in 9 people go hungry. The world produces enough food to feed 10 billion people, yet fails to meet the food needs of its current population of 7 billion. The carbon footprint of wasted food is 3.6 billion metric tons of CO_2 per year.

"The low hanging fruit for climate change is literally rotting in front of us."

— John Mandyck, Chief Sustainability Officer, United Technologies

Even so, that low hanging fruit is out of reach if the food industry doesn't raise itself up through a systems approach. Mandyck stressed that a lot of food is lost in long distribution chains—a systems-level problem that better refrigeration can do much to minimize. Refrigeration is the number one way to extend food life, but the infrastructure for optimal cold chains is not in place in many nations. It is critical, according to Mandyck, that emerging economies adopt sustainable cold chain technologies to the level that developed countries have so that the travesty of hunger amidst food waste can at last come to an end.

Figure 5 A French supermarket Intermarché is teaching consumers how to love "ugly" produce through their fun and informative Inglorious Fruit campaign launched in (Source: http://itm.marcelww.com/inglorious/)

A systems approach means engaging consumers in solving these problems as well. Many of us shop with our eyes rather than a plan and refuse to buy perfectly edible produce due to aesthetic imperfections. The food industry can do its part to encourage these individual actions by launching consumer campaigns. Already, the European Union has been a leader in this field (Figure 5).[viii]

THE TRANSPORTATION ABOMINATION

More people are killed by vehicle emissions than traffic accidents. While rubbernecking at an accident is common, the very real harm of vehicle emissions does not cause such a spectacle. But those who take the time to look will find that the vehicle emissions pose a serious threat—and emissions from food transportation vehicles contribute significantly to this danger, according to Oliver Gao, associate professor of civil and environmental engineering at Cornell University.

Diesel particle shorten 21,000 American lives each year. Current food systems typically rely on diesel trucks to transport products, and diesel tractors as tools in producing those products. Diesel engines have become so popular because they last longer, but this benefit comes at the expense of human and environmental health. The example of

Hunts Point in the South Bronx illustrates this all too well. Hunts Point is the world's largest food distribution center, with more than 13,000 diesel trucks rolling in each morning. The area's skyrocketing asthma rates of 21 to 23 percent are no coincidence.

Vehicles powered by diesel engines are so entrenched in food systems that a systems approach is absolutely necessary to successfully remove them from the equation. Though translating food miles to greenhouse gas emissions is relatively simple, calculating the diesel particulates produced is more difficult. Phenomena such as the counterintuitive "ozone weekend effect," which refers to observed increases in ozone as traffic decreases, underscore the importance of leveraging scientific perspectives to inform business practices. Before potential solutions such as vegetable oil power are implemented on a large scale, insights from across the system must be taken into account.[ix]

Why Now?

Technologies for gathering and sharing information are critical tools for crafting systems strategies. Strengthening connections between the components of a system, regardless of location, is now easier than ever thanks to digital communication devices. But a systems approach in the 21st century is not simply about creating more connections—it is about using information to identify trends, predict outcomes, and enable the creation of connections that maximize impact.

Our Modern Mission
A Systems Approach in the 21st Century

Embracing a systems approach means both strengthening existing connections and forging new connections between elements of the food system. The rise of the Internet and mobile devices has transformed the way people interact with one another on a daily basis, making it easier than ever to connect with whomever, whenever. It is time for the food industry to harness the power of the hyper-connected digital lifestyle that many of its consumers have already adopted.

This mission is two pronged. One arm entails harnessing the power of new technologies to enhance communication between components of the food system and collect data on the actions of those components. The other focuses on creating proper infrastructure for utilizing those communication methods and data, which can manifest in anything from partnerships between academia and industry to apps for mobile devices. A modern systems approach requires attention to both.

Figure 6 A systems approach in the 21st century is not just about capturing data from consumers and production processes, but also about using digital tools as a means of communication with consumers (Source: https://twitter.com/Wegmans)

A feast of data

Big data is perhaps the most powerful product of the digital age. At IBM, the theme of big data has been magnetic, according to Robin Lougee of IBM Research. Virtually every industry has a use for big data, and Lougee expects that it will be spectacularly disruptive in a variety of industries. The food industry is certainly among them, as big data has fundamental implications for driving insights for food systems that could translate into huge opportunities.

“Data is disrupting entire industries and that disruption is already happening in food and agriculture”

— Robin Lougee, Consumer Products, Business Solutions and Mathematical Sciences at IBM Research

It is well known by now that the digitalization of many tasks throughout our businesses and personal lives has resulted in an explosion of data. Lougee emphasized that despite the value of data, 90 percent of the data created over the last 10 years was never captured or analyzed. It is critical for food systems to implement effective strategies for capturing data and extracting insights from data now.[x]

The ability to capture high resolution satellite imagery of farmland, install sensors that collect data on the quality of fruits as they develop, monitor the water usage of vines, and create detailed yield maps that integrate detailed geospatial information has been exciting for Nick Dokoozlian, vice president of Viticulture, Chemistry and Enology at E&J Gallo winery. Yet he too points out that our ability to collect data far exceeds our ability to interpret the data into useful information.” One of the primary challenges with precision agriculture is determining which data are most relevant for improving management decisions. Dokoozlian found that partnerships with academic institutions allowed the company to make the most out the mountains of data it had accumulated.[xi]

This pairing of agricultural methods and data collection represents a way to update traditional practices. But much of the excitement about big data is centered on completely new opportunities that combine big data with other new

SYSTEMS STRATEGY

Rapid communication in response to recalls

When there’s a recall, it’s all hands on deck, priority until resolved, explained Jeanne Colleluori of Wegmans Food Markets. By strategically gathering phone data through their Shoppers Club as well as putting out alerts through their website and Twitter account—which has more than 100K followers (Figure 6)—Wegmans is now able to warn their customers about recalls more efficiently than ever. Furthermore, strong communication between components of the food system is critical to alerting food sellers to the problem in the case of a recall.

Telling customers about recalls can be difficult, especially when the products are intended for consumption by children or pets. But Wegmans has found that taking advantage of today’s powerful communication tools can help to assure customers that the company is truly concerned about their safety and taking all possible actions to protect their health. While there will always be some angry responses, Colleluori said, the more common response is along the lines of “my gosh, I had no idea” and “thank you.”

technologies. Metagenomics—the study of all of the genetic information in an environmental sample, such as material from the gut of a cow—presents such an opportunity. Since metagenomic samples typically include an array of microbial species, metagenomic sequencing can generate enormous amounts of data that can be used in a variety of innovative ways.

One particularly exciting opportunity is the use of metagenomic data for predictive analytics, which is the practice of using data to identify likely outcomes before they happen. It will be like giving workers across the food supply chain microscopic cameras that will help them understand what is coming into their business to answer questions such as, "is this normal or does it deviate from the norm? And if it does deviates from the norm, is the difference problematic or not?" With these insights, it is possible to change a situation before it arises—an ability that will have major positive economic and social impact, and can be lifesaving when applied to food safety.

Imagine a store receives a shipment of meat from its supplier that has supposedly been refrigerated properly. But on the way there, the driver did not notice a blip on the screen, and the food was in danger of spoilage. Even if the food is not yet showing noticeable signs that it has been compromised, Lougee and her team at IBM hypothesize that the communities of bacteria living on the food will be a little different from that of the same product when it is normally refrigerated. By analyzing the metagenomic data, she reasoned, the food industry can detect events where workers simply “don’t know what they don’t know.” This and other work is part of the *Consortium for Sequencing the Food Supply Chain*, which IBM and Mars, Inc. created in partnership in January 2011 and recently joined by Bio-Rad. While initially focused on food safety, the efforts will be foundational to other important areas of concern including food traceability, food fraud, food spoilage, and probiotics.

The Internet of Things, or IoT, has become another tech buzzword in recent years. As the name suggests, IoT refers to the embedding of sensors and other electronics in objects to allow them to collect and exchange data. Such technology has a huge opportunity for use in agriculture for monitoring the complex environment on the farm with IoT-enabled gates, livestock collars, and more, Lougee contended. Currently, IBM is working with farmers in Kenya to help them remotely monitor and manage their operations in the countryside. The project, which is currently in trials, uses IoT-enabled sensors to monitor water tank levels, the amount of moisture in the soil, and the performance of irrigation equipment, in addition to infrared cameras, to provide insights to farmers via a smartphone app.[xii]

The challenge as food systems move into the future will not be just collecting data, but doing so with a strategic plan for using computers to extract meaningful insights from that data.

Personal portions of data

Now that most people are walking around essentially instrumented with smart phones and other mobile devices, data has become more personalized as well. This too presents a major opportunity for the food industry, especially considering that so much of a consumer's interaction with food now happens digitally through services such as Yelp for reviewing, Seamless for ordering, and even Instagram for sharing the experience of food.

Figure 7 Logo for the Pushcart app. (Source: www.smalldata.io)

All of this generates data that food businesses can use to generate better product recommendations and that consumers can use to manage their eating habits. With this in mind, Deborah Estrin, professor of computer science at Cornell Tech, is developing apps that build recommendation and personalization engines and techniques that take in multiple sources of data from an individual, build models that take into account what others like them might do, and in particular that take into account that an individual can receive even more direct recommendations and feedback on what they are doing by virtue of this data that they essentially generate passively.

Pushcart is one of the prototype apps that Estrin and her team have created. A consumer can sign up with Pushcart so that all email receipts from online grocery shopping automatically get forwarded to Pushcart's nutritionists, who then evaluate those grocery purchases and suggest swaps. For example, the nutritionist might suggest that you substitute strawberries for that strawberry ice cream next time. Apps like Pushcart represent a way to use data that is already within food systems to strengthen system connections, in this case closing the feedback loop between individual consumers and nutritionists.[xiii]

Integration Yields Innovation
Systems Approaches in Practice

A systems approach is more than just a concept. Businesses throughout the food industry have already been practicing systems approaches, and reaping the rewards. The connections within the food system are complex, but an understanding of these connections and how they can be leveraged holds immense power (Figure 8). From the packaging facility to the farm, systems thinking has proven to be effective at both fostering innovation and avoiding unintended consequences.

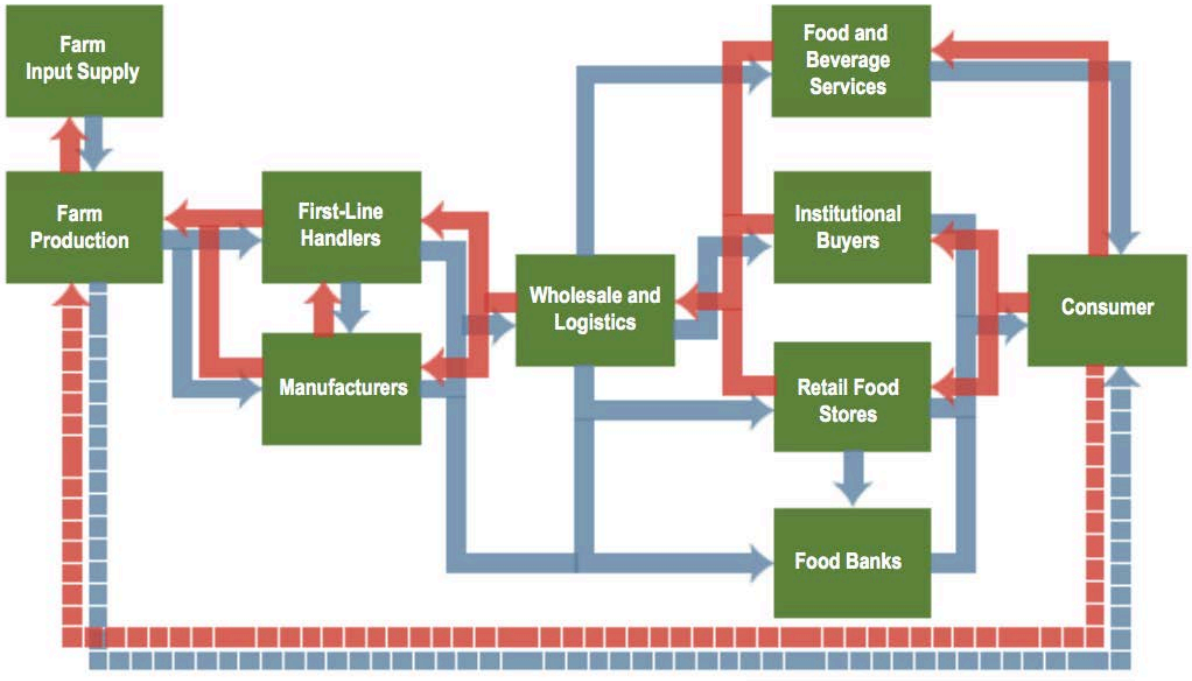

Figure 8 Food system schematic developed by Malden C. Nesheim, Maria Oria, and Peggy Tsai Yih in collaboration with the Committee on a Framework for Assessing the Health, Environmental, and Social Effects of the Food System, Food and Nutrition Board, Board on Agriculture and Natural Resources, Institute of Medicine, and National Research Council. (Source: A Framework for Assessing Effects of the Food System, ISBN: 978-0-309-30780-2, DOI: 10.17226/18846)

"Convergence thinking engages approaches to problem solving that transcend disciplines and integrate knowledge."
— Dr. Norman R. Scott, professor emeritus, Biological & Environmental Engineering, Cornell University

A systems perspective goes hand-in-hand with convergence thinking, the application of insights and approaches from disciplines that may seem at first to have little in common.

Whether introducing a new design, cutting-edge technology, or making any major decision, approaching the situation from a systems perspectives can help businesses arrive at the best possible decision or series of decisions.

Packages of system success

Too many people think of packaging as the final step in food production, notes Lora Spizzirri, an independent Food and Beverage consultant. Rather than design packaging to accommodate the finished product, she believes companies should develop packaging that works synergistically with the product and the system through which it is created and delivered to consumers.

"What if you actually began with the package and used it to drive product innovation?"

— Lora Spizzirri, Packaging Innovation Consultant, quoting Peter Clarke, CEO and founder at Product Ventures

The stand-up spouted pouch (Figure 9) is a favorite example of Spizzirri's, a Research and Development veteran who has worked extensively on iconic brands such as Philadelphia™, Oscar Mayer™, and Kraft Mac N Cheese™. Consumers perceive the pouch's contents as fresher and less processed, a quality that adds value. It also has significant supply chain efficiencies because it takes less energy to convert resin into a flexible pouch than a bottle, and the unfilled pouches take up far less space during transportation.

Figure 9 Stand-up spouted baby food pouches are one of many examples of packaging innovation that impacts many parts of the food system. (Source: Parenting Patch | Wikimedia Commons)

Additionally, the fact that millennials are feeding their toddlers from spouted pouches suggests that current aversions to consuming food from pouches will dissipate. Understanding macro trends such as this can help businesses in the food industry stay on the cutting edge of packaging innovation.

If you solve a real problem for consumers, Spizzirri emphasized, then they will pay a premium. Pre-cut lettuce, for example, is a packaging innovation that many consumers now take for granted. Consumers like the controlled portion and re-sealable package,

which also extends shelf life and allows branding of what was once a commodity product.

The success of ultra-convenient design of K-cups for Keurig coffee systems and the aesthetically appealing design of Method soap bottles also prove that packaging can add value to a product.

Design has proven over and over again that it sells. For example, the aesthetically appealing design of Method soap bottles proves that packaging design can add value to a product. A study by the Design Management Institute showed that a $10,000 investment over the past 10 years in index of design-centric companies would have yielded returns 219% greater than the S&P 500 Index. To design successful packaging, Spizzirri recommends paying more attention to what consumers do than to what they say—observations in their homes tend to prove more valuable than focus group discussions.

But Spizzirri warned that decisions made early on in the engineering process, such as the selection of raw materials, is going to affect every step of the supply chain.[xiv] Approaching packaging design with the entire system in mind is critical to creating successful packages.

Agricultural advantages to systems thinking

The farm is a system, regardless of whether one looks at it from a systems perspective or not. When Craig Yunker of CY Farms looks back on how his operation has changed over the past several decades, he notes that the

SYSTEMS STRATEGY

Integrating new technologies into food systems: High Pressure Processing

"When developing an HPP product, the first question you should ask yourself is why am I using HPP? If you ask yourself that question in the beginning, it's going to set the stage for the rest of the ingredients that you bring into it."—Joyce Longfield, Applications & Regulatory Specialist, North America, Hiperbaric

High pressure processing, or HPP, is a technique that uses cold water pressure as a method of bacterial reduction for shelf life extension and food safety. It's an exciting new technology that keeps food raw and fresh, but as applications and regulatory specialist at the HPP company Hiperbaric, Joyce has seen the consequences of introducing this new technology into production practices without first evaluating the implications at a systems level.

HPP has minimal impact on browning enzymes, for example, so if you don't process this product appropriately to remove the air during the blending, then it could still brown over time. Packaging is another key consideration—the uniform pressure of HPP requires flexible packaging, which has downstream implications for shipping and shelving at the store.

shift towards looking at systems and synergies was not so deliberate. Rather, it was a natural way to maximize efficiency, profits, and productivity.

Rotating soybean and corn crops with vegetables, for example, has long been known as a great way to boost the fertility of a field. The catch is that the farmer needs a market for the crops planted to increase fertility. Yunker solved this problem by designing a system that incorporates outlets for each of these crops: some go to the processing industry, some to fresh markets, and some go to the farm's 4,000 head feedlot. The result is a tight, efficient, system in which there is little waste and more profit.

“What we’re seeking is a balance of resource allocation that can maximize the synergies between the businesses, take advantage of inputs and outputs from those pieces, and can yield more as a whole than the sum of its parts.”
— Craig Yunker, Managing Partner, CY Farms & Batavia Turf

Integrating with the local and regional community is another way to expand a farm's system with new and profitable synergies. Pairing the dairy replacement facility at CY Farms, which only uses female calves, with a nearby veal operation, which only needs male calves, is one synergy that Yunker has built into his system to make the most of its byproducts. Another is a using their Batavia Turf operation that provides a market for the compost the farm produces as a result of its primary practices.[xv]

At E&J Gallo winery in California, grape growers have increased efficiency through similar systems thinking, but with a technological twist. By partnering with scientists at Cornell and Carnegie Mellon universities, E&J Gallo was able to take advantage of grape cluster imaging sensors and geospatial mapping technology to build real-time yield estimates of vine yields. To help them mitigate the challenges of the California drought, they also teamed up with IBM scientists to collect data on how much water was used and where. in their vineyards. They found that this could vary as much as 100% or more among grapevine in the same vineyard row. Previously, they had provided each plant with the same amount of water, but this knowledge allowed them to distribute this precious resource more efficiently.

Whereas in the past grape growers like those at E&J Gallo farmed their vineyards at the whole-block level, today they can use geospatial technologies to optimize practices for individual vines. These are just a few examples of the opportunities afforded by the fact that today, “when standing out in the field we can link an almost unlimited amount of data to that specific graphic coordinate,” according to E&J Gallo’s Nick Dokoozlian. By adopting a systems approach, businesses in the food industry can identify the best connections to forge with other food system elements and the right tenchnology to implement.[xvi]

A First-Class Future for Food Systems
Training the Next Generation

To properly address the challenges that lie ahead, the diverse components of the food system must come to view one another as partners working toward the shared goal of an efficient, sustainable, thriving food system that is greater than the sum of its parts. Opportunities for synergy have always existed within food systems, but the skills to identify these opportunities, let alone to act upon them, have been lacking. Arriving at a systems approach often takes the wisdom of experience, and there is no time to waste.

Without exposure to the big picture of the food system, it is easy to inadvertently limit one's perspective to a particular element—to start where one already is in the system and slowly zoom out. The Cornell Institute for Food Systems hopes to give young people a head start with their new Food Systems Fellowship by providing them with a broad view of the food system so that they can zoom in to their future careers.[xvii]

"Our goal is to create the right talent, to show these bright young women and men all that they can do within the system."
— Michael Kreher, Director of Strategic Business Development, Kreher's Farm Fresh Eggs

The program is designed to offer a classroom education taught from a broad, real-world perspective. Interns will be immersed in agriculture, food processing, and agribusiness management for several weeks at a time as a way to translate these lessons into tangible experiences. Students will see how supplies move through the food system from farm to fork. In the process, they will gain much-needed exposure to the variety of career paths within the food industry.

Anyone who has spent time with the ambitious young people gearing up to enter the food industry realizes that they already have the drive needed to take on the food system's greatest challenges, but are at varying stages of developing their practical knowledge of the food system. Michael Kreher summed it up well during his closing remarks at the Summit: "The leaders of tomorrow want to solve big problems, and we can show them how to do it."[xviii]

Endnotes

[i] "Opening Remarks" — *Malden Nesheim, Professor Emeritus and Provost Emeritus, College of Human Ecology, Cornell University*

[ii] "Innovation through Interconnection: Maximizing Feedback Impact" — Marina von Keyserlingk, *NSERC Industrial Research Chair and Professor, Animal Welfare, University of British Columbia*

[iii] "Innovation through Interconnection: Maximizing Feedback Impact" — David Barbano, *Professor, Department of Food Science, Cornell University;* Michael Van Amburgh, *Professor, Department of Animal Science, Cornell University;* Marina von Keyserlingk, *NSERC Industrial Research Chair and Professor, Animal Welfare, University of British Columbia*

[iv] "Should We Regionalize Fluid Milk Consumption?: System Impacts" — Charles Nicholson, *Adjunct Associate Professor, Charles H. Dyson School of Applied Economics and Management, Cornell University*

[v] "A Systems Approach is Needed to Catalyze a Sustainable, Year-round, Locally-grown Produce Industry in the Northeast" — Neil Mattson, *Associate Professor, School of Integrative Plant Science Horticulture Section, Cornell University*

[vi] "Is Regionalizing Broccoli Value Chains a Good Strategy for the Northeast" — Miguel Gomez, *Associate Professor, Charles H. Dyson School of Applied Economics and Management, Cornell University*

[vii] "The Impact of Climate Change on our Interconnected and Interdependent Food Supply" — Michael Hoffmann, *Executive Director, Cornell Institute for Climate Change and Agriculture, Cornell University*

[viii] "Sustainable Urbanization: The Future of Food" — John Mandyck, *Chief Sustainability Officer, United Technologies*

[ix] "Environment and Health Externality of Food Supply Chains—From Transportation to Air Pollution and Public Health" — Oliver Gao, *Associate Professor, Civil and Environmental Engineering, Cornell University*

[x] "Big Data Throughout the Food System: Driving Decisions, Designing the Future" — Robin Lougee, *Consumer Products, Business Solutions and Mathematical Sciences at IBM Research*

[xi] "Integrated Systems: Solving the Productivity Challenge for Agriculture" — Nick Dokoozlian, *Vice President, Viticulture, Chemistry and Enology, E&J Gallo*

[xii] "Big Data Throughout the Food System: Driving Decisions, Designing the Future" — Robin Lougee, *Consumer Products, Business Solutions and Mathematical Sciences at IBM Research*

[xiii] "Personalizing Nutritional Recommendations with Small Data" — Deborah Estrin, *Professor, Computer Science, Cornell Tech*

[xiv] "The Untapped Potential of Packaging in Food Systems" — Lora Spizzirri, *Packaging Innovation Consultant*

[xv] "A Systems Approach to Production Agriculture" — Craig Yunker, *Managing Partner, CY Farms & Batavia Turf*

[xvi] "Integrated Systems: Solving the Productivity Challenge for Agriculture" — Nick Dokoozlian, *Vice President, Viticulture, Chemistry and Enology, E&J Gallo*

[xvii] "Closing Remarks for Today and the Future" — Michael Kreher, *Director of Strategic Business Development, Kreher's Farm Fresh Eggs*

[xviii] "Closing Remarks for Today and the Future" — Michael Van Amburgh, Professor, Department of Animal Science, Cornell University

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