



Innovation & entrepreneurship driving food system transformation

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ABSTRACT

The current industrialized food system that is the predominant model of production in the United States and increasingly in other regions of the world has been recognized as a major contributor to greenhouse gas emissions, public health crises, environmental and soil health degradation, animal welfare abuses, labor crises and more. This article describes the evolution and design of food systems over time and the current assessment that a new system is required that focuses on planetary health and the health and well-being of humans and animals. The article describes the growth in entrepreneurship in the food system today and concludes that innovation is in need of increased support in order to advance a new operating system for how we grow, produce and distribute food.

1. Introduction: current U.S. food system challenges & drivers of change and solutions

The range of pressing health, social and environmental challenges associated with the current food system in the United States (and increasingly world-wide) have become alarmingly clear. Recent scientific reports and numerous media headlines make clear that the time is long overdue to address in a fundamentally different way the cross-cutting problems in our food production, distribution and consumption related to climate change and food security, rising obesity and other metabolic disease rates related to food, inadequate access to healthy food, degraded soil health and much more [1].

According to Olshansky, et al., the life span of the next American generation may for the first time in US history be shorter than their parents [2]. Persistent food insecurity during infancy and early childhood has been associated with a greater likelihood of obesity in children aged two through five [3]. There are a number of other critical issues requiring immediate redress across the social and environmental spectrum. For example, 95% of our food is grown in topsoil. Yet, according to the UN's Food and Agriculture Organization (FAO), a third of the world's topsoil has already been degraded — due to chemical-heavy farming, deforestation, and global warming — leaving only an estimated 60 years of topsoil remaining on Earth [4]. The recent Intergovernmental Panel on Climate Change (IPCC) Special Report identifies current agricultural practices as significant contributors to climate change [5].

Soil erosion is a natural process that has been dramatically accelerated through intensified industrial agriculture. There are proven

techniques that can mitigate soil erosion that also enable soils to regain productive capacity, including but not limited to reducing or eliminating tillage, planting a diverse array of crops including cover crops [6].

According to Kaiser Permanente, 20–40% of all U.S. healthcare spending is devoted to treating metabolic diseases caused by poor diet, driven in part by the prevalence of heavily processed foods, as well as the lack of accessibility and affordability of fresh, healthy foods. These matters comprise only a fraction of the challenges we face due to the perpetuation of our current food system. Advocates for sustainable agriculture, smallholder farms, public health, climate change, justice and fairness in the labor segment of the industry have been raising awareness about the need to think differently about how we grow, produce and distribute food since the advent of industrialized agriculture. A very small sampling of those efforts includes: Diet for a Small Planet which was written in 1971 by Frances Moore Lappé [7]; Fatal Harvest: The Tragedy of Industrial Agriculture published in 2002 [8]; Food Politics: How the Food Industry Influences Nutrition and Health published in 2002 by Marion Nestle [9].

In recent years, these and many other problems associated with our food system have resulted in an increase in activity on the part of food and agriculture industry leaders, policymakers, different types of investors and an increasingly concerned public demanding healthier and more transparently and sustainably produced food. These problems have also resulted in a wide range of entrepreneurial efforts that are attempting to solve for many different problems related to our food system. These include technological innovations addressing the constraints of our planet's productive capacity, the health outcomes

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associated with our current food system, inequitable access to healthy food, inefficiencies in our food production system that result in wasted food, food safety challenges, transportation and logistics issues and much more.

This current activity marks a significant shift in redefining and reshaping the operating system of how we grow, produce and distribute food. The history of humanity's food systems is marked by several such significant shifts – each containing aspects of the prior system while leveraging advances in science, technology and other research to advance an entirely new system. Simply put, for the sustained wellbeing of our planet and its people, we need a new and better food system. Each major food system change over time has been driven by innovation and this current shift is no exception.

Each system has been designed and optimized for a particular set of characteristics and the efforts underway today indicate a shift towards a system that is built for planetary health and the health of all living beings. A recent announcement by the CEO of PepsiCo that recognizes their role as a company that needs to help create a more sustainable world is but one example [10]. We also see policy shifts reacting to the challenges, such as California's investment of millions of dollars in the health of its soils [11].

2. History of human food systems [12]

Humanity's first food system, Food System 1, goes back as long as the species, hundreds of thousands of years, at least. This is commonly referred to as the hunter-gatherer approach to food. The range of diets that humans consumed as they evolved includes a range of wild animals and plants growing in various bio-regions around the planet [13].

This system appears to have served humans really well until about 12,000 years ago. While it is not clear what need humans were solving for at the time of the transition, it is evident that humans were at this point driven to move away from a nomadic lifestyle to one of settlement and the early development of agriculture, which defines the next food system, Food System 2 [14].

Then, over time, based on the apparent need for “better” food, humans learned that they could select for desirable traits in both plants and animals. This allowed us to optimize food production for flavor, adapt to varying climates, and protect against pests. Selecting for flavor was actually quite important because human taste buds are one of the best sensors of nutrients [15]. This system was Food System 3 and is best represented by the work of Gregor Mendel in the mid-nineteenth century [16].

Then, following the end of World War II, the United States in particular had the need to put large ammonia production plants that were previously used to produce explosives to other purposes. We also found enormous efficiencies in petroleum-based agriculture both to produce fertilizers and pesticides as well as to enable huge labor efficiencies with petroleum-based farm equipment. It was during this period that we selected plants for yield, including pest resistance, and no longer for flavor. This was our next food system (Food System 4).

Finally, and only in the last thirty to forty years, based on the need and desire for increased efficiency, have we shifted to a food system that is optimized for shelf life, convenience and logistics. This system has also been adept at maximizing the economics for market participants with the power to drive the system in their favor, including the vertically integrated animal protein producers, the commodity producers, and the distributors of processed foods. This system has historically marginalized the actual growers, ranchers and producers of food as far as their ability to capture value from the system. The increasing consolidation and commodification within Food System 5 has limited consumers' ability to make purchasing decisions that are aligned with values-based procurement [17].

Several additional challenges have emerged from this paradigm including, but not limited to, processed foods that are devoid of nutrients, minerals, and other essential elements necessary for human

health. Flavor of food is assumed to be an added element introduced at the processing stage. Because flavor is managed separately from food production, the nutrients that produce the flavor our taste buds evolved to detect have been largely ignored. This is why many foods today lack the nutrients humans need to thrive.

Another desired characteristic for uniformity and pristine cosmetic appearance has also created an enormous problem in the amount of food that is wasted in the United States – recent estimates are that over 63 billion pounds of food are wasted per year. This waste is also driven by inefficiencies in the supply chain and the lack of transparency in the system [18].

In the drive towards maximum efficiency and productivity we have also compromised some key aspects of humane treatment, respect and welfare of the people and animals connected to our food production system. Farmers, farm workers and food service industry employees remain largely unseen and undervalued resulting in increased inequity and lack of parity for these critical stakeholders in how food is produced, delivered and consumed.

Another attribute that Food System 5 is optimized for is convenience [19]. Perhaps more than any other country on Earth, United States consumers are infatuated with convenience which has compromised our health. Of course, there are many pressures and stresses around making time for all the things US consumers want and need to do, many people work multiple jobs, etc. so it is evident why convenience has become so valued.

Convenience does work well with cost efficiency in the supply chain, but the nutrient density and general healthfulness of foods ends up being severely compromised [20]. For over half a century, industry leaders have measured the system's success by its ability to optimize efficiency. To that end, the current food production process packs in calories, maximizes yield, and extends shelf life, delivering food to the masses with the utmost convenience. However, the effects of such convenience are flying largely under the radar of general supplier, policymaker, and consumer consciousness.

While all these food systems still exist somewhere in the world, the fifth food system is the dominant one in the United States today, although early indications are that this system is both being exported to other rapidly industrializing countries as well as beginning to be challenged in the United States as consumers seek ever fresher, more healthful and sustainably grown food [21].

3. The birth of a new food system

The time has clearly come to reinvent our current food system and bring into existence humanity's sixth food system – one that is optimized for the integrated and holistic priorities of planetary and human health. This system will necessarily consider the inter-relationships between all stakeholders in the food system and will include a holistic perspective on the vibrancy of farms, sustainable ecosystems, healthy communities and justice and fairness – the aspects and elements of food production that have been ignored in Food System 5.

As discussed, the current industrial food system, Food System 5, has created a host of significant challenges. These externalities have not been captured by the dominant market players and have not been effectively integrated into public policies that either price the impacts of this system fairly, or limit the ability of the environmental, physical or social externalities to be created in the first place. In recent years we have seen an emergence of efforts to accurately determine the “true cost of food” and to identify which actors should bear those true costs. In the current framework, polluters and those who are contributing to the range of social and environmental problems outlined above are not penalized for their actions or inactions. New frameworks are emerging that are designed to “...translate invisible resources into a common currency for strategic decision-making on impact and dependencies that affect overall value creation.” [22] One framework garnering global attention is the TEEBAgrifood Initiative which seeks to provide a

comprehensive economic evaluation of the “eco-agri-food systems” complex, and demonstrate that the economic environment in which farmers operate is distorted by significant externalities, both negative and positive, and a lack of awareness of dependency on natural, human and social capital [23].

As we move into this new system, scores of articles will appear across different verticals touting the food trends to watch in the coming months and years. The food industry should resist these temporarily alluring tendencies and focus instead on how to collectively find solutions to the problems perpetuated by our current food system. It is vital that we invest in solutions that differ substantially from the recent tendency of multinational companies and entrepreneurial ventures that has maintained rather than elevated the existing food system. In a race to place trending products — such as “gut-healthy foods,” protein alternatives, or a “healthier” version of an established brand — on grocery store shelves, the focus largely remains currently on immediate consumer satisfaction rather than mindful process and product sustainability.

Many companies entering the food industry don't consider the negative impacts of the drivers behind their practices — e.g., the manner in which their ingredients are grown, the stakeholders in their supply chain, how the ingredients are manufactured into products, and then packaged and distributed to consumers — nor how these new products are actually reinforcing the very system their contemporary notions would seem to renounce. If we focus on trends, we can miss opportunities for transformation and can end up developing solutions that, while possibly good in their intent, can also generate more problems. Focusing on trends also creates an environment in which investors, entrepreneurs, and consumers think there are simple solutions to complex problems.

We need to be thinking more broadly about the opportunities in food and agriculture that embrace new operating systems for how we grow, produce, and distribute food. It is not enough to focus on one element; we need to more broadly consider the implications of the entire food value chain on human and planetary health. Focusing on narrow trends exacerbates the lack of holistic thinking that has defined our current food system.

4. How we can start filling the gaps

The overarching goal in creating a new food system is to generate long-term changes that will have far-reaching benefits across all sectors. Evolving away from intensive farming practices, for instance, could create multiple positive effects across the entire ecosystem — saving the topsoil, mitigating climate change, and improving overall human health and health of farmers and farmworkers. Making such changes in widely accepted agricultural practices, however, takes a collaborative and comprehensive approach.

We need leadership to fill the gaps in knowledge that exist between industry leaders, policymakers, producers, manufacturers, and consumers. We must also work to develop tools and technologies that can adapt from current systems and/or support transitions consistent with the proposed changes. There is also a need to collectively harness a more conscious, holistic approach to food chain management that considers the inter-relationships between the people and parts at each level and how they can not only be improved — but transformed. Efforts are underway to determine the means by which the industrial production paradigm can be replaced by a more regenerative one. Regenerative agriculture is a conservation and rehabilitation approach to food and farming systems. It focuses on topsoil regeneration, increasing biodiversity, improving the water cycle, enhancing ecosystem services, supporting biosequestration, increasing resilience to climate change, and strengthening the health and vitality of farm soil. Practices include recycling as much farm waste as possible and adding composted material from sources outside the farm [24].

5. The time for action is now

Moving away from trends toward true transformation takes support, commitment, and intentional leadership from a broader set of stakeholders — academic researchers, investors, entrepreneurs, and philanthropists, as well as industry leaders, consumers, and big and small businesses. Entrepreneurs, for example, can drive the system's evolution by crafting their innovations to consider their impact on the entire system: potential economic shifts, global finance, individual health, education, and beyond.

Ultimately, the changes that we need to focus on in food and agriculture are much bigger than what's currently trending. We need to rethink from the ground up about crop development and growth, distribution and consumption, and the comprehensive impacts on human health and the environment. Working holistically and collectively towards growing a new standard for our food system, rather than following the trends, will create the necessary metrics for success across the industry that will help save our planet and its people.

6. Entrepreneurs driving change and creating Food System 6

The recent influx of innovation and entrepreneurship into the food system is a signal that system change is afoot. The increase in focus and attention around food system issues across numerous academic institutions has certainly informed and influenced this new crop of business builders [25]. Other macro trends are driving this innovation as well including corporations recognizing there are other stakeholders impacted by their businesses aside from shareholders [26]. These entrepreneurs are in need of a wide range of support as they build and scale their solutions. These entrepreneurs are challenging conventional practices across the entire food and agriculture value chain and building value aligned with both planetary capacity as well as consumer demand.

The proliferation of prizes, competitions, incubators, accelerators and other support structures are all indications that the market is shifting [27]. Challenges remain for those innovators and entrepreneurs who are attempting to disrupt legacy players in the food and agriculture industry, of course, but these entrepreneurs' innovative solutions that are more in line with planetary resources and consumer preference are in high demand by the dominant industrial players. Architecting our new food system will require carefully constructed collaboration between larger incumbent companies and smaller companies that does not dilute or diminish entirely the intrinsic value the innovators are creating.

These entrepreneurs are in need of support systems and multiple forms of investment from aligned entities in order to support maintaining their companies' value as they grow. Investment in these entrepreneurs is growing globally and will undoubtedly increase as the new elements of the food system evolve and iterate [28].

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