

Chapter 1.1

Ten Forces Shaping the Global Food System



Source: Columbia SIPA



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“The wealth of the nation is its air, water, soil, forests, minerals, lakes, oceans, scenic beauty, wildlife habitats and biodiversity... that’s all there is.”

Gaylord Nelson (1916– 2005) Governor of Wisconsin, United States Senator and founder of Earth Day

Key messages

This chapter provides a general introduction to this book, and adumbrates many topics that are found in the following pages. It focuses on ten forces which have a pivotal influence on the global food system. These may be summarized as follows.

- **The degradation of natural resources:** Sustainable intensification of *existing* agricultural land will be essential if we are to meet growing population demands for food and better nutrition.
- **Climate change:** Climate-Smart Agriculture (CSA) is essential for managing landscapes in order to achieve increased productivity, enhanced resilience and reduced greenhouse gas emissions. Climate Smart *Food Systems* goes beyond CSA to incorporate dietary choices, food losses and waste, processing and packaging, and transport infrastructure.
- **Urbanization:** In the face of growing urbanization, our food system networks will have to change to ensure that food is accessed in an equitable way that crosses geopolitical boundaries.
- **Globalization:** Food commodities are moving across international borders at unprecedented levels and are changing food consumption patterns all over the world.
- **Consumer behavior:** Consumers are increasingly being asked to make complex choices about the food they eat. Providing them with useful information and better skills can shift consumer demand in the direction of healthier eating patterns.
- **Culture and tradition:** Food systems continually shape our culture and traditions and vice versa. The food environment around us is altering how we make food choices and how we access, prepare and consume food.
- **Government policies:** Sound government policies are necessary to enable a productive, sustainable and equitable food system, and getting policies right involves a tricky balance.
- **Conflict and fragile states:** Conflict creates unstable food systems. There is a critical need to enhance food security resilience through policies and programs that link immediate hunger relief interventions with a long-term strategy for sustainable growth.
- **Technology innovation:** Technology continues to create opportunities to improve the productivity and sustainability of the food system. Perhaps the most exciting and most controversial technological innovation is biotechnology, specifically genetically modified organisms (GMOs).
- **Sustainability:** The adoption of the Sustainable Development Goals (SDGs) by all nations will provide a powerful framework that will guide decision-making on policies and budgets by governments, private sector, and civil society to 2030. These goals hold the potential to set the global food system on a more sustainable path.

21 **1. The degradation of natural resources**

The productivity and sustainability of our global food system depends on the state of earth's natural resources: soil, water, climate, and biodiversity, both terrestrial and aquatic. Humans survive and prosper by manipulating these most fundamental resources to produce food through farming, animal husbandry and fisheries. But our food system is emerging as a major contributor to the breaching of our planetary boundaries that define "a safe operating space for humanity."¹

Twelve thousand years ago, at the dawn of the Neolithic Era, the human population, comprising mainly hunters and gatherers, was probably no more than 10 million. In 2015, our planet struggles to nourish 7.3 billion people, with the daunting prospect of provisioning 9.5 to 13.3 billion inhabitants by the end of the century, according to recent UN estimates. The changes launched with the Industrial Revolution have brought unprecedented advances in science, technology and longevity. Agriculture now occupies 38% of the world's terrestrial surface. But the wider ecological consequences of human activity on our food system are becoming clearer and more troubling.

Agricultural land is being degraded through deforestation, soil erosion, nutrient depletion, salinization, waterlogging, overgrazing, desertification, and industrial pollution. Across Asia, Africa and Latin America, forests continue to make way for agriculture in response to population and income growth. Nutrients essential for plant growth are lost through erosion and extraction without replenishment. Seventy percent of freshwater extraction is allocated to agriculture. Water is being removed from the earth's surface and also from aquifers at an unsustainable rate. Our rivers, lakes and

oceans are being overfished and polluted. Global biodiversity – the genetic foundation of our food system – is in retreat. Species and genotypes are becoming extinct at an alarming rate. And now, the earth's seemingly unique climate – which supports our agriculture, forests and fisheries – is threatened with catastrophic warming through the apparently inexorable increase in greenhouse gas (GHG) emissions.

Natural resource degradation adversely affects all four dimensions of food and nutritional security: availability, access, utilization, and stability. Reduced crop and animal productivity and depleted aquatic resources diminish local availability and access through higher prices. The poor are most affected, as a greater share of their income goes to buy food. They reduce consumption and shift to lower-cost products, often with adverse nutritional consequences. The inherent nutritional quality of food can be reduced by lower nutrient content and the accumulation of toxins. Reduced diversity of available and accessible food can also result in low-quality diets. Declining water quality, including fecal contamination, leads to diarrheal disease and the inability to utilize the nutrients from food. Climate change and variability affect the stability of food and nutrition security.

Halting and reversing natural resource degradation are essential for improving the world's nutrition. It is widely agreed that further expansion of the land frontier through deforestation must be avoided. Thus, sustainable intensification of *existing* agricultural land – producing more food, more efficiently, and with less damage to the environment – will be essential if we are to meet growing population demands for food and better nutrition.

Desertification, exacerbated by climate change, is threatening the livelihoods of pastoralist communities in northern Kenya and across Africa. Source: Jess Fanzo



2. Climate change

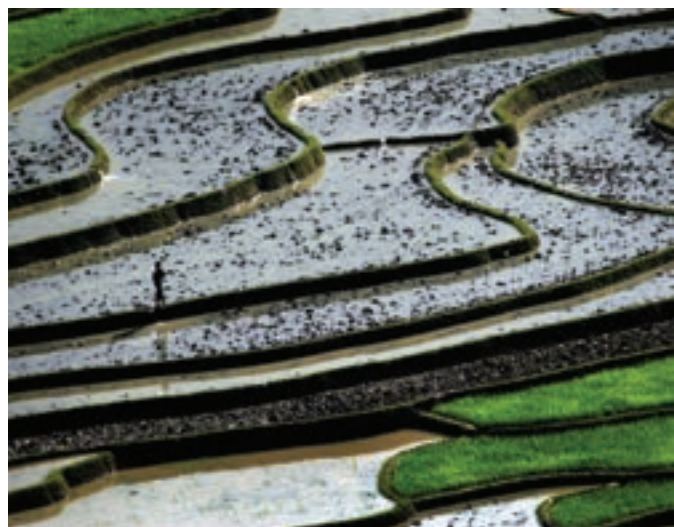
The evidence is clear. Human activity, primarily through unrelenting fossil fuel consumption, ongoing clearing of forests, and food production, is changing the earth's climate. Increased GHG emissions from these actions are causing temperatures to increase, in turn, resulting in extreme and harmful conditions such as heat waves, typhoons, droughts, floods, and rises in the sea level. These conditions put populations at greater risk of food and nutritional insecurity. Broad consensus has been reached on the importance of a “2°C guardrail” to protect the planet from the most dire consequences. More recent analysis suggests this “guardrail” will not be enough to avoid catastrophic rises in the sea level.

Our climate is one of our natural resources. It makes the earth unique among all known planets. It is a fundamental building-block of the food system, providing temperatures and rainfall favorable to the management of farming systems that meet our nutritional requirements. Even with the more conservative estimates concerning climate change, we can expect disruptions of the food system, which will cause greater instability of food production and distribution and will result in shortages, price increases, periodic price spikes, unplanned migrations, and refugee emergencies. At the same time, agriculture, forestry and related land uses are major contributors to GHG emissions.

Climate change is also likely to exacerbate degradation of other natural resources, including our land, water and genetic resources. These trends will place unprecedented stress on the ability of the global food system to ensure a state of food security, defined by the World Food Summit in 1996 as: “when all people at all times have physical and economic access to sufficient, safe, and nutritious food to maintain an active and healthy life.” Climate change threatens to undermine much of the progress achieved over the past 50 years. The world's poor, who are already most vulnerable to food insecurity and undernutrition, will be hardest hit.

3. Urbanization

Major economic and demographic transitions have had significant impacts on health outcomes of the global population, including fertility and mortality rates as well as disease patterns and health outcomes. Parallel to these transitions, diets, physical activity and body composition have also shifted. This phenomenon is also known as the nutrition transition. One of the main drivers of this nutrition transition is urbanization, which is an integral part of a broader structural transformation that has been long observed in Asia and Latin America and is rapidly emerging in Africa. People are leaving behind their rural livelihoods



Rice terraces in northern Vietnam: worldwide, 70% of freshwater extraction is allocated to agriculture.
Source: International Rice Research Institute.

In response to the growing challenge of global climate change, there has been increasing attention to developing and promoting food systems that both reduce GHG emissions and decrease vulnerability to a changing, more variable climate. The World Bank, FAO and the CGIAR all highlight the need for “Climate-Smart Agriculture” (CSA) as an approach to managing landscapes to achieve increased productivity, enhanced resilience and reduced GHG emissions. This concept should extend to Climate Smart *Food Systems* by applying a value-chain approach which ensures that broader economic, social and environmental objectives are met in anticipation of climate change. This approach goes beyond CSA to incorporate dietary choices, food losses and waste, processing and packaging, and transport infrastructure. Thus, the design and deployment of Climate Smart Food Systems will require a multisector and multistakeholder approach.

and moving to urban centers. This expanded population growth within urban environments is putting increasing pressure not only on the planet and our global food system, but also on where people are able to get work, and how they live.

Globally, more people live in urban areas than in rural areas, with 54% of the world's population residing in urban areas as at 2014. In 1950, 30% of the world's population was urban, and by 2050, an estimated 66% will be urban. Africa and Asia remain rural, with 40% and 48% of their populations living in urban areas. This will change in the coming decades, with both regions urbanizing faster than other regions of the world. By

2050, 56% and 64% respectively will be urban. Just three countries together – India, China and Nigeria – are expected to account for 37% of the projected growth of the world's urban population between 2014 and 2050.

Urbanization is affecting food supply and demand in both positive and negative ways. While it is thought that increased urbanization displaces arable land needed for agriculture, the relationship between urban populations and rural producers is more complex. More and more people live in cities: they have relatively sedentary occupations and lifestyles, and often have higher disposable incomes. The lifestyles of urban consumers will increasingly dictate what food is grown by producers and how that food is traded, processed, distributed, and marketed. City dwellers will increasingly want access to a greater diversity of foods including meat, dairy products and convenient, ultra-processed foods. On the supply side, economic growth and global trade will change the way food is produced, processed and sold, creating new markets for rural producers. The rapid transformation of the food retail sector – the so-called supermarket revolution – is being observed in virtually all parts of the developing world.

Not all movement to urban centers has a positive influence on nutrition and wellbeing. Currently, a quarter of the world's inhabitants live in slums or poorly constructed shantytowns.² Limited access to social services, safe and nutritious food, and poor public health infrastructure leaves shantytown populations at high risk of both communicable and non-communicable diseases. These shifts will require delicate decisions as to how much quality food should be produced, what type, where, and how. Nutrition outcomes will surely be affected in the absence of proper planning, infrastructure, and health and social services, and many of the lower- and middle-income countries lack these. Our food system networks will have to change to ensure that food is accessed in an equitable way that crosses geopolitical boundaries.

4. Globalization

Globalization describes a historical and ongoing process of integration of economies across countries through the trade of goods and services, along with flows of labor, investment and technology across national borders. Globalization may include broader considerations of culture, politics and the environment. Indeed, the Millennium Development Goals and the recently agreed Sustainable Development Goals allow us to extend the concept further to include global solidarity and partnership to end poverty and achieve more inclusive and sustainable societies. This section will focus on just two important manifestations of globalization that directly affect the food system: agricultural trade and land acquisition.

Economists are well known to welcome trade without distortions as a means of improving the efficiency of markets in delivering agricultural commodities and food at the lowest cost. The Doha Round of international trade negotiations launched by the World Trade Organization in 2001 has sought to reduce distortions in global agricultural trade caused by high tariffs and other barriers, export subsidies, and other forms of domestic support, and to enable increased global trade. Also known as the Doha Development Round, the negotiations were additionally intended to improve the trading prospects of developing countries. Progress towards agreement remains slow, with most countries retaining entrenched positions designed to either protect or advance their own trade.

Notwithstanding the ongoing inefficiencies of global agricultural trade, food commodities are moving across international borders at unprecedented levels. The most obvious impacts are lower prices in importing countries of many internationally traded commodities (e.g., chicken exports from Brazil) and increased domestic prices of new, internationally traded commodities (e.g., quinoa produced in Peru). These trends are changing food consumption patterns all over the world, with mixed results.

The case of quinoa, an ancient, nutrient-rich grain, is illustrative of a new commodity on the international market. Peru was forecast to export 40,000 MT of quinoa (valued at US\$180 million) in 2015 to become the world's leading exporter of this commodity. With growing demand from international markets, quinoa production more than doubled in Peru between 2011 and 2014, mainly through an increase in yield per hectare. While farmers have benefited from increased international demand, the impact of more expensive quinoa on domestic consumption and its dietary consequences remains a concern, although it is not yet fully understood.

Since the global food crisis of 2007–08, there has been rising interest in the transnational acquisition of agricultural land. Governments of some food-importing countries have sought to improve their food security by investing in land beyond their borders. Corporations and other private investors have seen the rising prices of agricultural commodities as an opportunity to invest in, and develop, agricultural land in land-rich regions such as Africa, Latin America and Central Asia. Advocacy groups, civil society organizations and academics have claimed that such investments have often resulted in the displacement and inadequate compensation of traditional owners, the corruption of proceeds from sale or lease of land, human rights violations, and environmental degradation. The Land Matrix Global Observatory, an independent global land monitoring initiative that promotes

transparency and accountability in land investment, estimates that transnational acquisitions totaling 38 million hectares have been recorded in 1340 deals initiated since 2000. The impact of these transactions on food security, nutrition and poverty remains unclear.

5. Consumer behavior

Changing demographics, incomes, lifestyles, and preferences influence demand for specific foods. Overall, global diets are shifting towards higher-quality, nutrient-dense products such as meat, dairy products, and oils – but also towards more processed foods. This demand does not always equate to healthy decisions for people or the environment.

While consumers have come to exercise a more prominent role in the modern food system, they are not fully informed as to how it works, the foods it produces, and the environmental footprint it creates. They are also not sufficiently informed as to what constitutes a healthy diet.

There are exceptions. Many consumers are still poor and lack the resources to access higher-quality diets. Instead, they can only purchase what would be considered less healthy options – processed foods, high in sugar and fat, with high energy content for every dollar spent. In much of the world,

the cost of even basic diets which meet mainly caloric needs exceeds daily wages, on account of escalating food prices. Unfortunately daily consumption of this low-quality, high-energy diet increases the risk of obesity and of the chronic, non-communicable diseases associated with being overweight.

Consumers are increasingly articulating their preferences for foods they want to consume, and there is growing interest – especially in high-income settings – in consuming healthier diets. At the same time, however, many consumers are also becoming increasingly remote from the production of food, mainly on account of urbanization. The growing scientific complexity of food production and processing has placed greater burdens on consumers, who often lack the knowledge to understand nutritional or food sciences. Concomitantly, new information about diet and health is continually being released by the media for consumers to decipher. This often cryptic and contradictory information has left many consumers confused as to what comprises a healthy diet, and what foods they should eat. Yet consumers are increasingly being asked to make choices concerning complex issues regarding the nutritional content and health-giving properties of food.

Providing consumers with useful information and better skills that allow them to choose healthier foods can help influence consumer demand in a healthier direction. This



Processed and packaged foods compete for space at a food stall in Kathmandu, Nepal.

Source: Jess Fanzo

behavioral shift may affect what is in the food supply. Educating consumers about commercial agriculture and enhancing the public's understanding of food production methods may have long-term benefits in maintaining consumer confidence. Food labeling, informative health statistics on menus, nutrition literacy programs, cooking classes at school and work, and useful dietary guidelines can all help here. Furthermore, price incentives for healthy foods in underserved areas, health-related food taxes, and stricter regulation on advertising junk food to children can help consumers make healthier choices.

6. Culture and tradition

Culture is inherent in *agriculture*. Because food is the product of agriculture, food serves as a powerful expression of how we tie ourselves to the land and preserve our social traditions. The types of foods we consume, the preparation and cooking practices involved, and the way we eat those foods all articulate who we are and why we eat as we do. Food systems are consistently shaping our culture and traditions and vice versa.

Taste, health, social status, cost and resources all influence which foods we choose to eat, but culture and tradition are also key factors. Embedded in tradition and culture are

social events and gatherings, holiday traditions, special occasions, and religious or ritual observances that call for particular foods. This can be both positive and negative. On the positive side, food choice can be deeply personal and can often hinge on our ideals, sense of identity and habits. Food itself is central to our sense of identity, often showing the geography, diversity and hierarchy of a certain culture.

Food taboos can influence health and nutrition outcomes, and are practiced among most human societies. Some religions define certain food items as appropriate for human consumption and others less so. Dietary restrictions and rules may govern particular phases of the lifespan. Many of these taboos occur during pregnancy and lactation, including appropriate food intake, energy-expending activities, and food restrictions. Cultural perceptions of food behavior and activity can have significant impacts on women's lives and their food security and nutritional status.

The food environment around us is changing how we make food choices and how we access, prepare and consume food, including the ever growing influence of supermarkets but also of restaurants, vending machines, small kiosks, *bodegas*, and corner stores. Half a century ago, most food was grown for household consumption by smallholder farmers living in

Because food is the product of agriculture, food serves as a powerful expression of how we tie ourselves to the land and preserve our social traditions. Source: Mike Bloem



rural areas. Food was also purchased at small, local markets. With globalization, there is a growing trend whereby more and more food purchased by consumers has traveled longer distances and is purchased in supermarkets. These changing purchasing patterns have been influenced by rapid urbanization, income growth, and the expansion of modern retailers, processors and distributors. Additionally, more and more households are moving out of rural areas into urban centers, where they utilize modern supermarkets and are changing the cultures and traditions around food, sometimes both positively and negatively.

7. Government policies

Governments can affect the productivity and sustainability of food systems at all levels: local, national and global. Policies on regulations, subsidies, and taxes can shift the investment decisions of all participants along the food value chain, including producers, processors, traders, and consumers. Government policies and related budget allocations in infrastructure, procurement, research, and public information can similarly alter the priorities of these stakeholders.

In developing countries, governments have long been concerned with price stability and its impact on social stability. Rice economies in Asia have sought to buffer their domestic prices from price instability in the world market, although this has often come at a high cost and at a disadvantage to domestic producers. During the food crisis of 2007–08, some governments – with the intention of protecting their consumers – closed their borders, exacerbating fears and contributing to the price spike that plunged millions of people into food insecurity and poverty.

Many governments have advocated policies that support improvements in agricultural productivity. The Asian Green Revolution is viewed by many as a triumph of supportive government policies in the form of research and extension investments, rural credit, input subsidies, commodity price support, and infrastructure investments, mainly in irrigation and transport. For more than a decade, similar policies have been promoted by African governments, and their impact is now becoming apparent.

Whether in rich or poor countries, governments make policies and investment choices with a view to the consequences on their *own* sustainability. Democratically elected governments with vocal and influential rural constituents are reluctant to remove historical policy support, as seen with the case of agricultural subsidies in the United States, Europe and Japan. The US Government

Accountability Office estimates that agricultural subsidies and insurance cost its taxpayers some US\$20 billion annually. Benefits accrued to politically influential agribusiness corporations and large-scale farmers have prevented any meaningful reform of these programs until recently. In Malawi, the government of President Bingu wa Mutharika boosted corn production in 2005 with a fertilizer subsidy, leading to national food security *and* a resounding re-election in 2009. Food can be a highly politicized commodity.

Governments and businesses must work in harmony to create synergies that bring benefits to producers and consumers alike. For example, the Alliance for a Green Revolution in Africa (AGRA) is creating value by building the governance and management capacity of small and medium-sized enterprises and farmer groups while at the same time building institutions that promote market efficiency and regional trade. To provide a more equitable food system, such policies must be coupled with social safety nets so as to ensure that the poorest consumers are food- and nutrition-secure.

Another area where governments influence the food system is through national dietary guidelines, which by their nature change over the course of time. The Dietary Guidelines for Americans provide the basis for federal food and nutrition policy and education initiatives, aiming to foster healthy eating habits and reduce the incidence of nutrition-related chronic diseases. First released in 1980, the Guidelines are updated and published every five years in a joint effort of the US Department of Health and Human Services and the US Department of Agriculture. Many countries have similarly established national guidelines that reflect the science on food and diets, while adapting to local culture and food availability. The establishment and dissemination of evidence-based dietary guidelines is an essential component of an effective national food and nutrition strategy which, in turn, influences the food supplied in schools, military institutions, hospitals, and government food assistance programs. It also affects the way the food industry formulates its food products.

It is evident that sound government policies are necessary, but not sufficient, for enabling a productive, sustainable and equitable food system. Governments operate within complex and context-specific political economies with a wide range of consequences. Professor Peter Timmer argues that “there is scope for more or less government involvement, depending on institutional capacity and the willingness of citizens to be taxed to pay for it, but ‘none’ has never been the right answer,”³ He concludes that getting policies right is “a tricky balance that requires constant analysis, experimentation and learning.”

27 8. Conflict and fragile states

The food system can serve as a lens through which to view the most important problems of society. One of these is conflict and violence and the many fragile states that are climbing out of war and genocide.

Countries and areas in protracted crisis are “environments in which a significant proportion of the population is acutely vulnerable to death, disease and disruption of livelihoods over a prolonged period of time.”⁴ Areas in protracted crisis and fragile states have some commonalities, including competition for natural resources, poor governance, inadequate access to nutrition, health and social services, dysfunctional institutions, loss of assets, food insecurity that impacts livelihoods, and persistent hunger.

The trigger for violent conflict or crisis may be natural, such as a prolonged drought, or economic, such as the change in price of a country’s major staple or cash crop. Whatever the reason, these crises are both causes and effects of food insecurity and inadequate or inequitable access to assets. As well as being a consequence of conflict, food insecurity can of itself lead to conflict. Environmental scarcities and food insecurity do not always lead to conflict, but can escalate situations into violence. Most of the countries currently experiencing conflict are classified by FAO as “low-income food deficit,” and have high burdens of undernourishment and high numbers of stunted children.

Conflict impacts global food security as well. Geopolitical conflicts cross the borders of different food systems. Fragile and failed nation-states are often suffering under the repression of extreme poverty and are touched by war and strife. These fragile states influence, and are in turn influenced by, global market forces, and food security is often one of the first factors to be affected.

Food systems that are repeatedly put under stress by conflict tend to move from predictable food value chains to instability and volatility. Violent, armed conflict can lead to the destruction of crops, livestock, land, and water systems, as well as disruptions in infrastructure such as roads and other transportation modalities, markets, and the human resources required for food production, processing, distribution, and safe consumption. Those participating or instigating war and conflict often use hunger as a weapon: “they use siege to cut off food supplies and productive capacities, starve opposing populations into submission, and hijack food aid intended for civilians.”⁵

The response mechanisms adopted by the international community – such as the UN Committee on Food Security’s

Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests – are disparate and generally ineffective to address conflict, protracted crisis and fragile states. There is a critical need to enhance food security resilience through specific policies and programs that link immediate hunger relief interventions with a long-term strategy for sustainable growth. This would include rebuilding local institutions and support networks, building the capacity of farmers to adapt and reorganize, providing recovery measures for rural livelihoods, and supporting vulnerable groups. But challenges remain. Most actions are short-term, with narrow analysis and responses. There is a need to think about short and long-term approaches at the same time, with a major objective being resiliency.

9. Technology Innovation

Innovation in agriculture arguably began with the first attempts to domesticate food crops more than 12,000 years ago. More formal efforts to improve farming methods probably began at the Rothamsted Estate in the southeast of England in the 1840s, when John Bennet Lawes initiated research into the effects of fertilizers on crop growth. This research, coupled with the first manufacture of artificial fertilizers, also at Rothamsted, provided the foundation for modern scientific agriculture. Important discoveries were being made in parallel in Germany by Justus Freiherr von Liebig, a professor at the University of Giessen who is today considered the founder of organic chemistry. Yields were improved further in the early 20th century with the development of the Haber-Bosch process that used atmospheric nitrogen to produce ammonia (the core ingredient of nitrogen fertilizer) supplying the most important nutrient for food production.

Driven by advances in crop breeding, most notably the development and commercialization of hybrid corn in the United States, plus the rapid mechanization of many traditionally manual agricultural processes, global food production grew at an unprecedented rate. But while corn and wheat yields increased in the first half of the 20th century, mainly in temperate climates, there was little progress in tropical environments, where populations were most rapidly growing. It was only the advent of the Green Revolution, led by the efforts of Norman Borlaug and MS Swaminathan that, at the very least, postponed Thomas Malthus’ 1798 predictions of “gigantic inevitable famine.” Cereal production more than doubled in Asia between 1970 and 1995, while the population increased by 60% and agricultural land increased by only 4%. Agricultural



Golden Rice, produced through genetic engineering, provides another option for tackling vitamin A deficiency.
Source: International Rice Research Institute.

technology in the form of new seed varieties, fertilizer, and irrigation had provided breathing space for the planet.

Technology continues to create opportunities to improve the productivity and sustainability of the food system. Precision agriculture draws on progress in information technology, including GPS and the use of drones, to manage fields more efficiently through greater sensitivity to crop needs and field characteristics, for example enabling fertilizer and water to be applied at appropriate rates, reducing waste and environmental damage. While mainly applied in industrial agricultural settings, these new technologies are yet to realize their potential for improving agricultural efficiency for smallholders in low-income countries. In Africa, the Bill & Melinda Gates Foundation is supporting efforts to better understand soil and landscape resources and improve their management using the recent advances in soil spectroscopy, spatial-temporal statistics, geospatial mapping, aerial imaging, and cloud computing. These new approaches are being applied by the Africa Soil Information Service across several countries.

Perhaps the most exciting and most controversial technological innovation to shape the food system is

biotechnology – specifically, genetically modified organisms (GMOs). Commercialized in the United States since 1996, GMOs have polarized communities within the global food system. For the most part, farmers have embraced genetically modified crops: a record 181.5 million hectares of biotech crops were grown across 28 countries in 2014, representing some 12% of global crop lands. Concerns about health and environmental risks appear to be waning as growing scientific evidence points to compelling economic, social and environmental benefits in most settings.

Research is showing potential for adaptation to climate change through genetic improvement to incorporate such traits as tolerance to heat, drought, submergence, and salinity. Biotechnology and other advanced breeding methods are also opening new frontiers for improvement in the nutritional quality of food e.g., Golden Rice to combat vitamin A deficiency, as well as vitamin A rich maize, high-zinc wheat, and high-iron pearl millet. These breeding methods complement important advances in the large-scale use of food fortification and micronutrient powders in combatting global malnutrition.

10. Sustainability

In 1972, the Club of Rome published “The Limits to Growth,” outlining the need for a “great transition...from growth to global equilibrium.”⁶ This landmark document warned of the trends in population, industrialization, food production, and resource depletion. But the authors argued that these trends were not inevitable and that it was possible to establish a more sustainable global equilibrium “so that the basic material needs of each person on earth are satisfied and each person has an equal opportunity to realize his individual human potential.”

The Brundtland Commission in 1987 defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” This “intergenerational” concept was adopted by the Rio Earth Summit in 1992 and has remained a dominant conceptual framework for sustainability to this day.

More recently, beginning with the UN World Summit on Sustainable Development in Johannesburg in 2002, the term “sustainable development” was reformulated by the international community to comprise three interdependent and mutually reinforcing pillars: economic growth, social inclusion, and environmental protection. This vision of sustainable development was reinforced through the Rio+20 Summit and indeed has provided the foundation of a new set of global development goals: the Sustainable Development Goals (SDGs).

The SDGs embody an important principle of universality. We are now all accountable for an improved quality of life, one that can be shared by all and sustained over time. SDG2 commits UN member states to “End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.” Among SDG2’s several targets are universally applicable commitments to end all forms of malnutrition by 2030, with an implication to address both undernutrition and overnutrition. SDG2 also calls on nations to fulfill the mandate of the Doha Development Round. Other SDGs address universally important needs to combat climate change, reduce food waste, and conserve terrestrial and marine resources.

International agreement on the SDGs will provide new impetus to rethink the way we produce, distribute and consume our food. From the outset, the SDGs have been criticized for their complexity and comprehensiveness. But a *sustainable* global food system will not be easy to achieve. There is no single sector or technology fix that provides a pathway to sustainability. Business as usual is not an option. And for the first time in history, there is a consensus that all of us will be held accountable for a shared development agenda and shared solutions that address food system issues in all countries and at all levels of income.

My personal view

Glenn Denning

Today’s food systems are a complex, dynamic product of many interacting forces. In one sense, the food we consume is a remarkable feat of technical ingenuity and environmental adaptation against the forces of nature and population. Thanks to farmers, pastoralists and fisher folk, we have skillfully manipulated our land, water, and genetic resources to *more or less* feed the planet. Advances in science and technology, especially over the past century, have held at bay the “gigantic inevitable famine” predicted by Thomas Malthus in 1798.

This tells only part of the story, however. Almost 800 million people continue to go hungry. Micronutrient deficiencies affect perhaps 2 billion. At the same time, we are faced with an epidemic of overweight and obesity that

is beginning to undermine past gains in longevity and quality of life. All of this is unfolding in a world that is rapidly urbanizing and globalizing, and in a bio-physical environment that is under stress from unrelenting population growth and the unsustainable exploitation of natural resources, while being at the same time increasingly subject to the effects of climate change.

There has never been a better time to think and act with sustainable development as our vision. The adoption of the SDGs by all nations in September 2015 provided us with a powerful yet challenging framework to guide decision-making on policies and budgets by governments, the private sector, and civil society to 2030. These goals hold the potential to set the global food system on a more sustainable path – one that meets the needs of present and future generations, while simultaneously ensuring that our food systems are economically viable, socially inclusive and environmentally sustainable.

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