

“In the face of climate change, it is increasingly urgent that we realign our diets to focus on health and environmental sustainability.”

# A Path to Sustainable Food Systems

JESSICA FANZO

Our food systems are a wonder of the modern world. They efficiently supply almost eight billion people. Annual deaths from famine fell below one million for the first time in the 2010s, and the prevalence of undernourishment has declined globally, albeit slowly, in recent decades. Many (but not all) people around the world now enjoy an unprecedented quantity, quality, and variety of food options.

However, the foods we eat also contribute to increasingly common and burdensome health problems. And although rates of hunger have been decreasing over the past 25 years, many people remain food insecure, not knowing when and from where their next meal will come. More than 690 million people still go to bed hungry every night.

More than 20 percent of children around the world are stunted—too short for their age—because of a lack of nutritious foods. Most of those children live in low- and middle-income countries. At the same time, more than 2 billion people suffer from obesity, including 40 million children under the age of 5. The increase in obesity worldwide is linked to a rise in chronic, noncommunicable, but potentially deadly diseases such as diabetes, heart disease, and cancer, which are overwhelming health systems. Without substantial dietary changes, human health will further decline.

Simultaneously, food systems are placing a growing burden on our planet's environment. Agriculture is responsible for 10 to 24 percent of global greenhouse gas emissions, which are increasing temperatures, changing precipitation patterns, and acidifying the oceans. Agricultural

production, in turn, is extremely sensitive to a changing climate, which will make it increasingly difficult to produce enough food for a growing population.

People's lifestyle choices are driving disastrous planetary changes, while many are suffering from the impacts of these changes. We are victims of our own actions in a destructive feedback loop. Transforming food systems in order to benefit human and planetary health is a way to escape that loop.

## CLIMATE INTERCONNECTIONS

Climate change affects every aspect of food systems. If it is not ameliorated, it is expected to cause a 2 percent decrease in food production every decade until 2050, and much more drastic declines after that. Meanwhile, practices within food systems affect essentially all environmental systems. Our diets are thoroughly intertwined with the environment.

The Anthropocene is the geological epoch now under way, in which humans have become the dominant influence on the planet, responsible for global warming, rising sea levels, animal and plant extinctions, and habitat loss. Agriculture, which now uses 37 percent of Earth's land and 70 percent of its freshwater supply, has been a major contributor to the environmental predicaments of the Anthropocene. It is the biggest source of nutrient runoff, causing algal blooms, dead zones, and acidification of the planet's freshwater and ocean ecosystems. These changes, along with the accelerated clearing of forests for agricultural use, have been factors in one of the most dire events of the Anthropocene: an ongoing mass extinction that has culled the number of species of mammals, birds, fish, reptiles, and amphibians by an average of 60 percent since 1970.

If we continue on this trajectory, the consequences for our food systems will be catastrophic.

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Continued deforestation to clear land for agriculture will cause the collapse of biogeochemical systems that affect oxygen levels for the entire planet. The biodiversity of plants, insects, and animals will be severely diminished, increasing the vulnerability of ecosystems important to food production and human life. Extreme weather events, food and water shortages, more diseases (including pandemics), and other climate-related problems are likely to skyrocket.

Changes in global temperature and precipitation levels caused by climate change are expected to reduce agricultural productivity and the nutritional content of certain crops. Crop diseases will increase in some parts of the world, as will losses due to pathogens infecting stockpiles of harvested grains. Combating these outbreaks will require more and better cold storage of food, which in turn will use more energy, fueling climate change, unless we shift rapidly to renewable energy resources. In any case, food will likely be in shorter supply, higher priced, and less affordable, especially for the poor, causing social unrest.

In the face of climate change, it is increasingly urgent that we realign our diets to focus on health and environmental sustainability. Purchasing and eating patterns at the individual and societal level must change. People will need to buy less food, and they will have to exercise greater food consciousness to reduce spoilage and waste. This may seem difficult, but we should not fear having to make these adjustments. To the contrary, adapting in these ways would improve health and well-being for everyone, as well as the odds that Earth will remain habitable for generations to come.

## DIMINISHING DIVERSITY

More intense focus on agricultural production in recent decades has spurred economic growth while also increasing food security in many regions of the world. Yet this shift has also compromised both nutritional and environmental health. Many of these negative effects stem from the model's uniformity.

Industrial agriculture typically causes a dramatic loss of genetic diversity in crops and farm animals. The food supply increases, but a select number of globally important staple foods (wheat, rice, maize, and sugar) make up the majority of the supply, supplemented by a few newer global

commodity crops, particularly soy, palm, sunflower, and rapeseed used for oils.

As these crops become more prevalent around the world, traditional staples such as sorghum, millet, rye, cassava, sweet potatoes, and yams have been marginalized. They have not disappeared—at least not yet—but in many places they are no longer eaten every day. Traditional diets formerly based on a single staple (for instance, rice in Southeast Asia) have changed over time to include other staples such as wheat and potatoes. The same is true for maize-based diets in Latin America, sorghum- and millet-based diets in sub-Saharan Africa, and so on around the globe.

Food supplies worldwide are much more uniform, and among crop species there are fewer varieties available today than a century ago. Colin Khoury, a crop diversity specialist at the International Center for Tropical Agriculture in Colombia, has argued: “If we are what we eat, then it seems that over the last half-century people around the world have become much more the same type of human being—globalized people eating globalized foods.”

Industrial agriculture is resource-intensive and a major contributor to the world's greenhouse gas emissions. It exacerbates land degradation and relies on high inputs of energy, fertilizer,

pesticides, and water. Even though the common practice of monocropping can increase yields, it can also, in certain contexts, damage biodiversity and upset ecosystems. A more diversified form of agriculture could provide more resilience and protection against disaster, but the time and costs needed to rebuild soil health and fertility often dissuade farmers from taking this route.

Evidence suggests that despite increased yields, production of the world's major crops, such as maize, rice, wheat, and soy, has already begun to stagnate. It is possible that crop productivity can be increased only up to a certain point, after which new techniques are necessary for a boost. And future agricultural expansion will be curbed by urban sprawl. It is expected that urbanization will result in the loss of approximately 2 percent of global croplands by 2030. About 80 percent of that cropland loss will take place in Asia and Africa. These are all reasons to move away from industrial farming, or at least to rethink intensification efforts, in order to better support human and environmental health.

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## VICIOUS CYCLES

Human alterations to the climate are already producing dire consequences. Under the most optimistic scenarios, 1.2 billion people will reside outside the comfortable “climate niche” in which humans have thrived for at least 6,000 years. This, along with rising seas inundating coastal areas, will cause people to migrate to more livable places on the planet, increasing population pressure in some parts of the world.

Regions will not suffer equally from climate change. In some areas, such as the Andes and East African highlands, growing seasons may expand. The production of cassava is projected to increase with climate change because cassava plants (which produce edible roots and leaves, a staple crop for many Africans) thrive in warmer temperatures and with higher carbon dioxide levels. In most of the global South, however, particularly in equatorial regions, climate change is expected to decrease yields of various crops and make it more difficult to produce many foods.

Cyclone Idai, considered one of the worst climate-related disasters in the Southern Hemisphere to date, caused widespread food insecurity when it hit Mozambique in 2019. The number of once-rare climate-related disasters is expected to rise with every incremental increase in the global temperature level, as the Intergovernmental Panel on Climate Change warned in August 2021. The consequences for humans, their homes, and their food security and diets will be graver than ever.

Climate change is a long-term shock to food systems. Some experts argue that extreme weather events such as heat waves, droughts, flooding, and cold spells can lead to devastating failures of major crops, including wheat, maize, soy, and rice. The risk of extreme weather events occurring simultaneously in many growing regions is increasing because of climate change. Such “multiple breadbasket failures” are likely to occur in the next two decades, compromising food access for billions of people.

Most of the world’s acute hunger and undernutrition occurs not due to conflicts and natural disasters, but during annual “hunger seasons”—the times of year when the previous harvest’s stocks have dwindled, food prices are high, jobs are scarce, and rainfall is unpredictable. The frequency and intensity of seasonal hunger is expected to increase with climate change and to be especially severe in Africa south of the Sahara.

Such effects will be most dire in areas where agriculture is rainfed and rains are highly seasonal.

Maintaining, much less expanding, agricultural production will become increasingly difficult in the face of hotter temperatures, a more limited water supply, and acidification of soils and oceans. Heat-stressed plants are more susceptible to disease, which could lead to smaller yields and greater use of agrochemicals for pest control. Some pest populations are expected to flourish in warmer temperatures and migrate to new, higher latitudes.

Agricultural production involves a feedback loop with the environment. It contributes to ever-increasing climate change, which in turn drives intensified production to meet global food demand. Fossil fuels are one component of this feedback loop. They are used to produce fertilizers, pesticides, and other synthetic agrochemicals, which drive up crop yields but also contribute to groundwater contamination, soil acidification and biodiversity loss, and buildup of chemicals in waterways and on land to levels that can be toxic to humans and animals.

The use of pesticides in agriculture compounds the downward spiral of dwindling crop diversity. Pesticides have reduced the numbers and diversity of species of pollinators such as bees, bats, and butterflies, which play vital roles in crop production. Climate change poses another huge threat to these and other insects that help keep ecosystems in balance.

Such adverse outcomes could lead to lower crop yields in the long run, which in turn will prompt even more chemical use to increase productivity. This vicious cycle will be incredibly challenging to break.

Beyond its effects on diversity, intensive agriculture also contributes to erosion and the degradation of soil quality, which has already resulted in the abandonment of roughly one-third of the world’s arable land. The south-central United States experienced the dire consequences of poor soil conservation practices in the 1930s with the Dust Bowl, which deepened the Great Depression and forced 2.5 million people to migrate across the country. Increased use of techniques to reduce soil erosion, such as no-till methods and cover crops, will be necessary to avoid repeating such catastrophes and meet global food demand.

## NUTRITIONAL DEFICIENCIES

Industrialized agriculture aims to meet nutritional needs by combining highly specialized and

productive farming with trading systems that allow consumers to buy a variety of foods. But the diversity of choice delivered by international trade has mainly benefited wealthy consumers in high-income countries. Meanwhile, substandard infrastructure and broken or inadequate value chains have forced poor people in low-income countries to rely on staple crops that are insufficient to meet their nutritional needs.

Climate change also threatens the nutritional quality of food. Elevated levels of atmospheric carbon dioxide can increase photosynthesis and plant growth. But it can also reduce the nutritional value of some crops, especially wheat, rice, potatoes, soy, and peas. Samuel Myers, the director of the Planetary Health Alliance at Harvard University, has shown that productivity gains may offset the yield-decreasing impact of climate change, but the harvested crops will typically contain less protein, iron, and zinc, essential nutrients for human health.

Of the more than 50,000 edible plant species on Earth, people throughout human history have used roughly 7,000 of them as food sources, along with a wide variety of animals and other organisms, including fungi, algae, yeasts, and bacteria. But over the past century, primarily by conscious choice, humans have driven the diversity out of agricultural systems. Just 15 crops now account for 90 percent of the world population's caloric demands. And only three staple crops—rice, maize, and wheat—account for two-thirds of global food-energy intake.

A century ago, commercial seed houses offered hundreds of varieties of crops that provided nutritional diversity, risk reduction, and climate adaptability. Now, farmers face pressure to stop saving seeds, which has caused a loss in such heirloom varieties. Today, the United Nations Food and Agriculture Organization reports that the world's agricultural landscape is dominated by only 12 species of grain crops, 23 species of vegetable crops, 35 species of fruit and nut crops, and 5 animal species (not including fish). Globally, 75 percent of agricultural land is devoted to growing those 12 grains.

It is not only the diversity of crops that matters, but the variety of species of individual crops as well. In India, for example, more than 80,000 varieties of rice were once cultivated, but that number has now fallen to just several hundred. Similarly,

the United States has largely shifted to monocultures of corn and soy, with the great majority of farms producing the same varieties of the same crops. This creates incredible risk not only from a nutritional perspective, but also from a climate standpoint. As with an investment portfolio, it pays to diversify—a hard-earned lesson of the Irish Potato Famine.

Many factors have contributed to the decline in diversity, including replacement of human labor with machinery and investments in the breeding and distribution of high-yielding major crops as an economic development strategy. Agriculture subsidies dedicated to a narrow range of crop commodities have further reduced diversity. This trend toward homogeneity in the global food supply also heightens interdependence among countries for access to vital food imports, which can be vulnerable to supply chain disruptions.

### SMALL FARMS IN PERIL

As farm sizes increase, the nutrient content of crops typically diminishes with the loss of diversity.

Smaller farms with more agrobiodiversity often introduce a broader array of nutrients (particularly micronutrients) into the food supply than large farms. As sustainable food systems expert Mario Herrero says, “Small and

medium holder farmers are providing a monumental ecosystem service. They're the stewards of the nutrients and biodiversity for the world.”

Despite their value to global ecosystems, smallholder farms—generally defined as less than 2 hectares (about 5 acres), but sometimes as up to 10 hectares—are the farms most vulnerable to the effects of climate change. They also are the most disenfranchised from the global financial system. Many smallholder farmers, especially women, struggle to rise above subsistence levels. They often lack access to credit, technical support, and markets while enduring the volatility of global commodity prices.

Subsistence farmers try to eke out a living by growing crops to send to market, hoping to have enough left over to feed their families. Unfortunately, they often fail because of droughts, unpredictable rains, lack of mechanization or other technology to support a small business, and lack of infrastructure (sometimes even roads) to get their crops to distant markets. Even with the odds

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these farmers face, their land still accounts for 30 percent of all food commodities in their regions.

Globalization has intensified costly regulatory burdens and downward price pressures for farmers of all sizes (though during the COVID-19 pandemic, food prices have risen and were about 30 percent higher in July 2021 than they were a year earlier). But half of the hungry people in the world are dependent on small-scale farming communities. And nearly one billion people who derive their livelihoods primarily from agriculture will bear the brunt of large-scale environmental disruptions in the near future. Climate change may force smallholders to abandon their own farms to seek more secure food sources and livelihoods.

## HOLISTIC POLICIES

Transforming global food systems will require changes at two broad levels: in the policymaking arena and in the realm of individuals' actions. Policies should help ensure that all people have access to safe, healthy, affordable food; that farmers and workers are supported; that animals are treated humanely; that air, water, and land are protected for future generations; and that climate change is mitigated.

These goals are not achieved by current food policies in the United States—or anywhere else. Not a single nation has a holistic food system policy designed to improve human nutrition and well-being while protecting the environment. Many countries have agriculture policies, dietary guidelines, or climate change policies, but what's lacking is an effort to bring those policies together in a coherent, all-encompassing strategy that addresses the entirety of food systems. In fact, the goals of different sets of policies are sometimes contradictory.

One of the most important steps that governments can take to improve public health and sustainability within food systems is to promote agricultural diversity. Ministries of agriculture can enhance biodiversity and nutrition by increasing access to a wider array of seed varieties and livestock breeds that are resilient to weather conditions, pests, and diseases. Governments should also support farmers' groups, community-based organizations, and social movements that encourage diversification and offer agricultural extension services. The use of cover crops, crop rotation, manure, and appropriately applied fertilizers can improve soil quality and potentially enhance the nutritional content of foods.

In food systems that are not yet highly modernized, strategies should focus on basic improvements to storage and transportation infrastructure to ensure the safety of perishable foods from farm to consumer. In more modernized food systems, innovative and sustainable technologies for storage and distribution should be developed and implemented. Satellite technologies allow shippers and carriers to monitor the quality of their cargo and shorten delivery times. Wider adoption of these practices could reduce spoilage, improve food safety, and increase profits.

The COVID-19 pandemic has sparked debates about supply chains. Disruptions during global lockdowns caused food shortages. Shorter supply chains and alternative retail infrastructures can provide accessible and affordable alternatives to mass retail outlets, which may be hard for some consumers to reach. Networks and micro-hubs of food producers could increase market access and limit food loss. Governments can support local food by repurposing infrastructure in cities to favor farmers' markets, mobile food trucks, and community food centers.

Changing food environments to promote healthier, sustainable food choices will require action in many other policy areas, including regulation of advertising and sales tactics; food provisioning in institutional settings, such as schools; and economic incentives and disincentives, such as retail subsidies and taxes. A step as simple as requiring more informative nutrition labels can help both consumers and food producers. It would encourage healthier individual choices and guide the food industry to reformulate products with more nutritious ingredients and less environmental impact.

## FISCAL NUDGES

Policymakers can create strong fiscal incentives to shape the actions of those responsible for our food systems. Trade agreements, tax policies, and subsidies must all better align with policies that promote healthy and sustainable diets. Corporate goodwill and voluntary measures are not enough. While there are some exceptions in the food and beverage industry, transgressions against public health, environmental, and climate goals remain common. Only governments have the necessary legitimacy to establish a fiscal framework that puts diets on a healthier and more sustainable track.

Shifting agriculture subsidies toward crops that would contribute to healthy diets, such as fruits,

vegetables, nuts, and legumes, could be a game changer for farmers and the consumers of their harvests. Local or national governments could institute tax incentives to motivate producers and retailers to engage in healthier and more sustainable practices. They could tax fertilizer, which might encourage farmers to switch to more organic approaches.

Governments could also provide incentives to street vendors to use healthier ingredients, as the authorities in Singapore did. They could offer tax breaks or financial incentives for retailers that sell healthy foods. Or they could adjust sales tax rates to incentivize a shift toward more nutritious food products by consumers.

Efforts in some cities to encourage corner stores to stock healthy, fresh foods have increased purchases of these options while generating higher profits. New York City's Healthy Bodega program has linked stores offering healthier foods to the federal Supplemental Nutrition Assistance Program, allowing low-income consumers to use the food-purchasing aid to stock up. The local production and sale of healthy foods, as well as direct sales at farmers' markets and farms via Community Supported Agriculture programs, offer important economic and social benefits to farmers, consumers, and communities, particularly in neglected neighborhoods.

More ambitiously, a greenhouse gas emissions tax on foods, based on the amount of emissions generated by their production, could be a powerful health-promoting climate policy. The tax revenue could be used to subsidize healthier foods or to fund health care programs. Other tax policies that could be considered in order to improve health and sustainability include levies on the food and beverage industries for water use, meat, sugar, and pollution. One model for this is a proposal for a carbon tax on fossil fuel extraction, with the revenues to be distributed equally among all citizens.

## CALORIE COUNTING

Responsibility for health and sustainability should not be the burden solely of individual citizens. Yet what we eat and what policies we support can shape food systems and the food supply. Individual actions can contribute to much larger social movements that collectively shift the food agenda.

Transitioning to healthy and sustainable diets is not easy. It requires knowledge, will, and persistence. But a quality diet not only improves human health; it also protects the environment.

We must determine how to meet the world's caloric and nutritional needs while minimizing further harm to the planet and ensuring that farmers have the support they need to adapt to a changing climate. Three measures in particular could go a long way toward improving both human and environmental health.

First, we need to end consumption of calories in excess of what the body expends every day. According to the US Department of Health and Human Services, this is 1,600 to 2,400 calories for adult women and 2,000 to 3,000 for adult men. Moderate consumption entails eating to satisfy but not to exceed energy and nutrient requirements for growth, physical activity, and bodily repair. Reducing excess caloric intake typically averts the health risks associated with obesity, while placing less demand on finite supplies of food.

Second, we need to avoid unhealthy, highly processed foods. That could prove to be a challenge, especially in high-income, industrialized countries, where nearly everything has been processed to some extent. The foods to avoid are those that include ingredients rarely or never used in home kitchens.

Third, individuals in middle- and high-income countries need to reduce their consumption of animal-source foods, especially beef. Cattle produce large amounts of methane, a toxic greenhouse gas that contributes significantly to global warming. Raising livestock also contributes to deforestation and biodiversity loss.

While most people in high-income countries consume far more meat than they need, most people in low-income countries do not have enough animal-source foods. In low-income countries, the aim should be to facilitate enough meat consumption to fulfill nutritional needs. That means improving supply-chain infrastructure and subsidizing prices to ensure that these foods are more accessible and affordable. Middle-income countries, for their part, should aim to prevent meat consumption from reaching excessive levels.

A growing world population will require more food. At the same time, climate change will make it increasingly difficult for farmers to feed that

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population. Our current systems focus on cheap, abundant food that can be produced as quickly as possible while generating ample profit margins for industries that dominate the marketplace, leaving many smallholders behind.

Urbanization is encroaching on remaining open spaces, and the average age of farmers is hitting 60 (among those surveyed). This raises the question: *Who will feed us?* And who would want to be a farmer with climate change barreling down on us?

Weathering climate change will require much more sustainable approaches. Preventing catastrophic collapses of global food systems demands an all-hands-on-deck approach. On both individual and systemic levels, we need to be bolder. Our world is changing rapidly; there is no time to let problems fester.

Governments need to make decisions now and be less risk averse. There is much evidence already available about how to improve food systems and diets while pursuing climate adaptation and

mitigation. Strategies exist to address all these challenges simultaneously. But for such approaches to be effective, governments must commit to and invest in change.

The private sector also has to participate and develop partnerships with other sectors to improve public health and environmental sustainability. Consumer awareness needs to increase. Young innovators should be encouraged to bring new ideas to the table. And citizens need to vote for leaders who will foster global cooperation and goodwill.

No single country can address climate change or steer food systems in the right direction by itself. Every country has some form of malnutrition, and each will struggle with climate change, some more than others. These are collective global issues that call for a collective response. While the challenges may seem daunting, cooperation can help food systems adapt to rescue both planetary and human health. ■