FOOD & CLIMATE

CONNECTING THE DOTS, CHOOSING THE WAY FORWARD

CENTER FOR FOOD SAFETY

MARCH 2014

ABOUT CENTER FOR FOOD SAFETY

CENTER FOR FOOD SAFETY (CFS) is a non-profit public interest and environmental advocacy membership organization established in 1997 for the purpose of challenging harmful food production technologies and promoting sustainable alternatives. CFS combines multiple tools and strategies in pursuing its goals, including litigation and legal petitions for rulemaking, legal support for various sustainable agriculture and food safety constituencies, as well as public education, grassroots organizing and media outreach.

ABOUT CFS'S COOL FOODS CAMPAIGN

Addressing climate problems with food solutions, CFS's Cool Foods Campaign is harnessing the energy of the Food Movement to build a new constituency for climate action. Grounded in a set of climate-friendly principles, the Cool Foods Campaign empowers the public to engage in a positive, proactive way with an issue that can be overwhelming. Active on social media, Cool Foods meets and motivates consumers where they congregate to consider the climate impacts of everyday food choices. In the process, the Campaign brings parents and young people to the table at the nexus of food and climate. Cool Foods also works to promote organic practices that build soil health while creating vital reservoirs to store excess carbon.

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EXECUTIVE SUMMARY

Irreversible damage to agriculture—and hence food production—could create widespread scarcity, economic disruption, and social unrest, with grave consequences for global food security.

CLIMATE CHANGE THREATENS the inherent relationship between food and climate and "has the potential to damage irreversibly the natural resource base on which agriculture depends."[1] Irreversible damage to agriculture—and hence food production—could create widespread scarcity, economic disruption, and social unrest, with grave consequences for global food security.*[2]

This report strives to communicate the urgency to address climate change by reviewing basic parameters and thresholds necessary for food production. It lays out a range of climate change impacts such as drought and temperature increases and examines their actual and potential impacts on various crops. It then examines two competing systems of food production—industrial and organic—each with varying degrees of impact

* *Food security is defined as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." Note that the ability to grow and produce food is assumed.*

on climate change as well as varying capacity for resilience in the face of escalating climate-related shocks.

The public needs to recognize that the industrial food system externalizes many of its social and environmental costs and relies heavily on fossil fuel inputs for food production. This dominant system emits greenhouse gases (GHGs) in the processing, packaging, transport, refrigeration, and retail stages while also contributing to deforestation, land-use changes, water contamination, and waste. While standard estimates attribute 15 percent of GHGs to agriculture, taken in the aggregate, the global food system is, in fact, "responsible for around half of all global GHGs."[3]

Meanwhile, not only does organic agriculture use 30-50 percent less energy than comparable industrial systems,[4] the benefits of an organic food system extend well beyond issues related to food production. Working in concert with powerful natural systems, regenerative, organic and agroecological agriculture has tremendous, untapped potential to strengthen food security while adapting to climate uncertainties and mitigating agriculture's disturbances to the earth's climate system.

Working in concert with powerful natural systems, regenerative, organic and agroecological agriculture has tremendous, untapped potential to strengthen food security while adapting to climate uncertainties and mitigating agriculture's disturbances to the earth's climate system.

While our current climate trajectory is daunting, a future defined by food insecurity and climate chaos is not inevitable. We can still alter our course by, among other things, focusing on rebuilding soil organic matter which presents a large-scale, low-cost opportunity to take carbon out of the atmosphere.

For too long, climate change has been an abstract concept. It is time to make the climate story concrete, and ensuring global food security is both an opportunity and a mandate to act on behalf of climate stability.

Acting on climate change requires that government policymakers, farmers, businesses, researchers, and the public understand the inherent connections between differing food production systems and the exacerbation or mitigation of climate instability. It also necessitates that we transition away from our toxic, chemical-dependent industrial food system, and that we create the political will to bring to scale practices that enhance natural systems. The choices society makes *now* will create the conditions for future agricultural resiliency (or not) and food security for successive generations.

PART ONE: CONNECTING THE DOTS

Whether or not we choose to acknowledge it, the economies that we create are embedded in the natural economy.

CLIMATE CHANGE: EXCEEDING LIMITS

FOR DECADES industrial economies have disregarded the earth's biological limits and operated under the assumption that the basis for wealth lies outside of nature's life-supporting structures. Yet, "whether or not we choose to acknowledge it, the economies that we create are embedded in the natural economy."[5] As Wes Jackson, founder of The Land Institute, explains, "The only true economies are nature's ecosystems."[6] Our collective disregard for the environment as a finite, interconnected system with non-negotiable limits has allowed us to disrupt the very balance of the climate cycle that governs our planet. This phenomenon, referred to interchangeably as global warming, climate change, and increasingly as the climate crisis, is caused by the buildup of heat-trapping gases in the earth's atmosphere. These "greenhouse gases," which include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), result from a variety of human or anthropogenic activities, including agriculture.

In 2013, atmospheric concentrations of CO_2 surpassed 400 parts per million (ppm), a level not seen in 2 to 3 million years.[7] This grim milestone exceeds by 50 ppm the 350 ppm level that scientists have identified as the safe upper limit of CO_2 in the earth's atmosphere.[8] In practical terms, carbon dioxide and other greenhouse gases are causing global temperatures to rise. The evidence is unequivocal: 97 percent of the world's climate scientists agree that climate change is very likely driven by anthropogenic causes.[9] As more heat is trapped in the atmosphere, the energy from that heat powers extreme weather in all directions—more extreme heat and more extreme cold; prolonged droughts and more intense rain; and more forceful storms, all of which contribute to climate instability.

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REQUIREMENTS FOR FOOD PRODUCTION

Growing food depends on a stable climate, and for the past 10,000 years humans have relied upon relative climate stability for successful food production. Crops have specific climatic and environmental requirements that may include temperature, chill hours, rainfall, humidity, and soil types. These parameters dictate the range in which a specific crop has the potential to grow. For example, maple trees require oscillating temperatures, including freezing nights to produce the sap that is harvested as maple syrup. A necessity for some crops, cold is a limiting factor for others like citrus and avocados, which favor warmer climates. While wheat grows best in a dry, mild climate, cocoa beans, used to make chocolate, thrive in tropical areas. As climate change shifts these climatic ranges, both gradually and suddenly, over time, farmers will be challenged to maintain the level and quality of food production necessary to feed a burgeoning global population.

CLIMATE CHANGE MANIFESTATIONS

Humans have altered the earth's ecosystems, including the planet's chemistry, to such an extent that many believe we've entered a new geological epoch. Called the Anthropocene (*anthropo* for human, *cene* for era), this new era reflects a planet (and its climate) transformed by humanity.[10] Nowhere is this profound change more evident than in extreme weather events. These weather extremes often exceed the natural limits crops are able to tolerate and still produce food, jeopardizing livelihoods, food production, and ultimately global food security. Lester Brown, who has forecast global trends for decades, warns that we must be mindful of global food reserves, particularly grains:

> Ever since agriculture began, carryover stocks of grain have been the most basic indicator of food security. The goal of farmers everywhere is to produce enough grain not just to make it to the next harvest but to do so with

While scientists are reluctant to link climate change to specific extreme weather events, climate change is indeed shifting the conditions, most notably temperature and moisture, under which storms are created, and in many cases this increases the frequency and intensity of climate phenomena.

a comfortable margin…The world is now living from one year to the next, hoping always to produce enough to cover the growth in demand.[11]

Further warnings are forthcoming: According to the 5th Assessment Report (known as "AR5"), the United Nation's International Panel on Climate Change (IPCC) expects climate change to cause global food production to fall by two percent per decade for the rest of the century.[12]

Extreme Weather

Drought, floods, tropical cyclones, hurricanes, heat waves, and unseasonable frosts are some examples of extreme weather, driven by climate change, that damage or destroy food production. The 2013 U.S. National Climate Assessment warns that "the rising incidence of weather extremes will have increasingly negative impacts on crop and livestock productivity because critical thresholds are already being exceeded."[13]

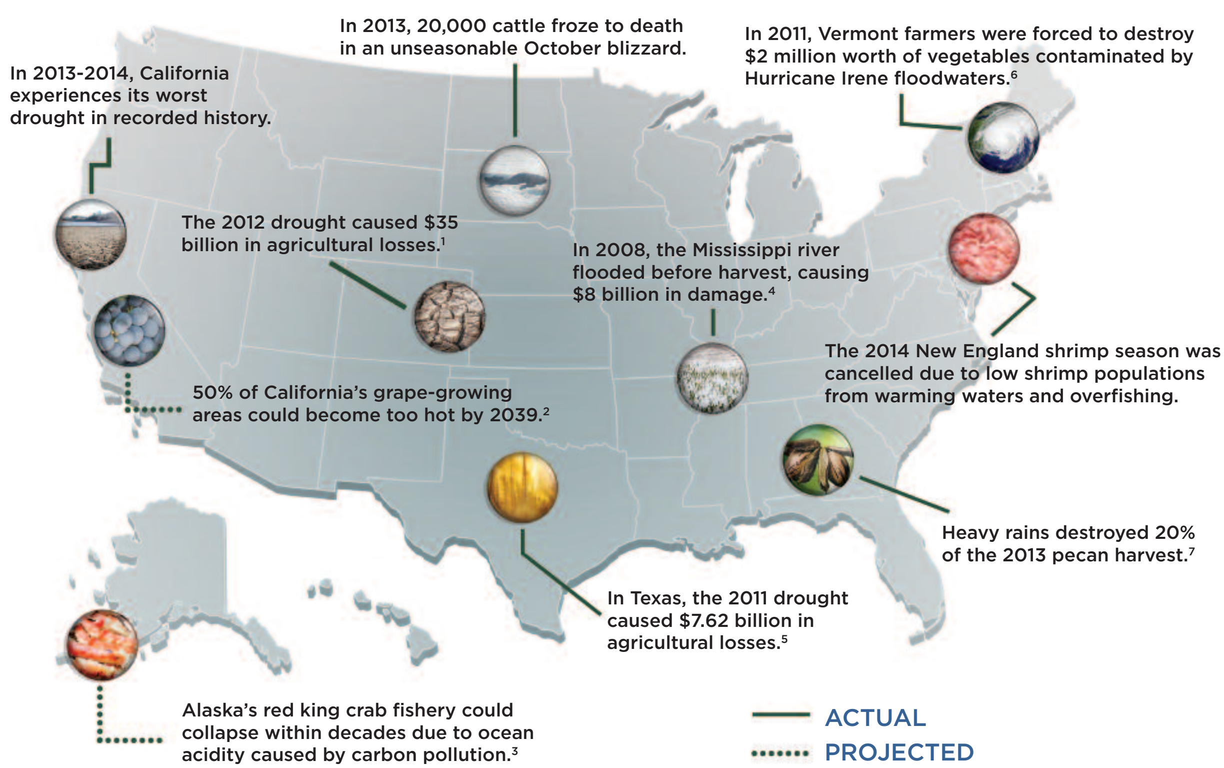
Topography, regional weather systems, proximity to large bodies of water, and local land-use changes are among the factors that influence a region's response to climate disruption.[14] While scientists are reluctant to link climate change to specific extreme weather events, climate change is indeed shifting the conditions, most notably temperature and moisture, under which storms are created, and in many cases this increases the frequency and intensity of climate phenomena.[15]

Droughts and heat waves in 2012 in the U.S. alone affected approximately 80 percent of agricultural land,[16] creating an estimated $30 billion in damages.[17] The last few years have brought, among other billion-dollar climate-related disasters: historic flash flooding in Colorado (September 2013), Hurricane Sandy in the Northeast (October 2012), unprecedented wildfires in the West (June 2012, May 2011), and widespread flooding along the Mississippi River (May 2011). Most recently, California, which produces nearly half of the nation's fruits and vegetables, is experiencing the worst drought in its 153 history. (2013-2014)

Shifting Weather Patterns

Meanwhile, climate change is causing earlier springs and warmer winters, facilitating the proliferation and higher survival rates of pathogens and parasites. Warming temperatures are also leading to a northern migration of invasive species and will likely increase the incidence and severity of diseases on crops and domestic animals. Shifting variations in warming and rainfall will also affect the spatial and temporal distribution of agricultural diseases, exposing crops to new pathogens.[18]

FIGURE 1: CURRENT & PROJECTED IMPACTS OF CLIMATE CHANGE ON FOOD PRODUCTION



Deluge and Drought

The planet's delicate water cycle is highly dependent on relative temperature stability. Under increased temperatures, the rate of evaporation and evapotranspiration*[19] of water is accelerated, removing valuable moisture from surface waters and plants and allocating the water elsewhere through rainfall. Under projected climate change scenarios, rainfall is expected to increase in areas with already high annual precipitation, while arid areas are expected to receive even less rainfall.[20] In many regions, precipitation events will become more intense by early 21st century,[21] while periods of prolonged, acute drought are expected to increase by late 21st century.[22] The implications of water scarcity for agriculture (crops and livestock) are immediate, and can result in price hikes and food shortages.

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* *"Evapotranspiration" is the process of transferring moisture from the earth to the atmosphere by evaporation of water and transpiration from plants.*

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Rising Temperatures

According to the IPCC's AR5, "1982-2012 was *likely* the warmest 30-year period of the last 1,400 years,"[23] and global average temperatures will continue to increase through 2100.[24] In addition to overall average temperature increase, heat waves are very likely to increase in both frequency and duration.[25]

Pollinators, including bees and butterflies, are sensitive to temperature extremes. Insect pollinators pollinate one-third of the total food produced in the United States.[26] Preliminary research suggests that increased temperatures can alter pollinator activity levels at important times of the growing season.[27]

It is very likely that globally the number of cold days and nights has decreased and the number of warm days and nights has increased.[28] Crops exposed to high night-time temperatures are vulnerable to greatly reduced yields, reduced quality, and an increased risk of total crop failure. Those effects have already been observed across the American Corn Belt when "corn yields were affected by high nighttime temperatures in 2010 and 2012."[29] Increased nighttime temperatures may have even more significant impacts on crops requiring a certain number of chill hours (i.e., temperatures below 45° Fahrenheit or 7° Celsius). Many nuts and fruits, including stone fruits like peaches and plums, require anywhere from 200 to 1200 winter chill hours for proper setting of fruit.[30] In areas like the Central Valley of California, the most important fruit and nut producing region of the U.S., climate models predict that up to two-thirds of chill hours will be lost by 2100.[31]

While earlier climate studies suggested that climate change brings potential net benefits for food production due to increased amounts of carbon dioxide and warmer temperatures, scientists now challenge those assumptions. The IPCC AR5 report, for example, cites a large body of new research that demonstrates how sensitive plants are to heat waves.[32]

All plants, and subsequently human life, depend on the process of photosynthesis. Humans and other animals cannot use sunlight directly as a source of energy, and obtain energy by eating plants or by eating other animals that have eaten plants. Creating energy from carbon dioxide and sunlight, photosynthesis is optimal between 68° and 95° Fahrenheit (20–35° C).[33] Past the 95-degree threshold, plants lose some of their ability to photosynthesize and at 104° F, (40° C) photosynthesis may cease entirely.[34] "At such elevated temperatures, plants go into thermal shock."[35] Not only do we depend on plant photosynthesis for food, but photosynthesis is one of the planet's primary mechanisms for removing CO_2 from the atmosphere.

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Vulnerability and Complacency

Crops and livestock provide 90 percent of the world's total caloric intake, with world fisheries (including marine, inland, and aquaculture) providing the remaining 10 percent.[36] While there are more than 50,000 edible plant species in the world, only a few hundred contribute significantly to current food supplies. According to the Food and Agriculture Organization of the United Nations (FAO), just fifteen crop plants provide most of the world's food energy intake, with rice, corn (or maize), and wheat making up two-thirds of this total.[37]

Feeding almost half of humanity and supplying more than 20 percent of human calories, rice is arguably the world's most important staple food. Grown predominantly by smallholder farmers, the majority of rice farms are smaller than two hectares. To buffer against the effects of climate change, farmers in more than fifty countries, including the Philippines, are turning to a system of rice intensification (SRI). This crop management approach can reduce water requirements, increase yields, and reduce agrochemical inputs.[38]

Nevertheless, despite mitigation efforts, millions of farmers who depend on subsistence agriculture remain defenseless in the face of extreme weather. "Super Typhoon"

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Haiyan/Yolanda that devastated the Philippines in November 2013 provides a sobering example of smallholder vulnerability. The Category-5 typhoon killed over 6,000 people, displaced 4.1 million, and damaged more than 63,200 hectares (156,170 acres) of rice crops. Recognizing that hunger would be widespread in future months if the December/January planting seasons were missed, the FAO and partners quickly mobilized to provide rice seeds for an estimated 35,000 farmers.[39]

While millions of people struggle with subsistence, millions of others are divorced from the origins of food they eat every day and may give little to no consideration to the fact that climate change has the potential to disrupt their food supplies. Centralized production, processing, and distribution channels have packaged convenience, but have separated people from food production, resulting in a loss of place-based knowledge and complacency toward food security.

PART TWO: CHOOSING THE WAY FORWARD

As Dr. Vandana Shiva has noted, "the beauty of being human is we can choose our paths."[40] The choices we make going forward will be critical and ultimately could mean the difference between food security and food insecurity.

The industrial food system externalizes much of its true costs by passing them on to society and the environment. These costs stem from the system's reliance on temporary chemical "fixes," and include adverse public health impacts, contamination of ground and surface water, soil degradation and erosion, and biodiversity loss.

THE INDUSTRIAL FOOD SYSTEM

Undermining Ecosystems and Climate Resiliency

The industrial food system externalizes much of its true costs by passing them on to society and the environment. These costs stem from the system's reliance on chemicals and include adverse public health impacts, contamination of ground and surface water, soil degradation and erosion, and biodiversity loss.

In a 2008 letter to then President-Elect Obama, author Michael Pollan highlighted the inefficiency of the 20th century's industrialization of agriculture and how it has:

The expansion of industrial monoculture plantations for commodity food crops like soy, sugarcane, and palm oil is driving deforestation as well as the destruction of savannas and wetlands. Taken together, deforestation and land-use changes account for 15 to 18 percent of global greenhouse gas emissions.

> increased the amount of greenhouse gases emitted by the food system by an order of magnitude; chemical fertilizers (made from natural gas), pesticides (made from petroleum), farm machinery, modern food processing and packaging and transportation have together transformed a system that in 1940 produced 2.3 calories of food energy for every calorie of fossil-fuel energy it used into one that now takes 10 calories of fossil-fuel energy to produce a single calorie of modern supermarket food.[41]

As climate activist Bill McKibben has observed, "The entire industrial food system essentially ensures that your food is marinated in crude oil before you eat it."[42]

Agriculture's overall greenhouse gas emissions are generally recognized to comprise 11 to 15 percent of global emissions. But this figure is comprised primarily of emissions from fertilizers and pesticides, and does not account for the many *off-farm* sources of greenhouse gases generated by the food system as a whole. To get a more accurate picture, the organization GRAIN has done a full assessment that includes off-farm contributors, finding that:

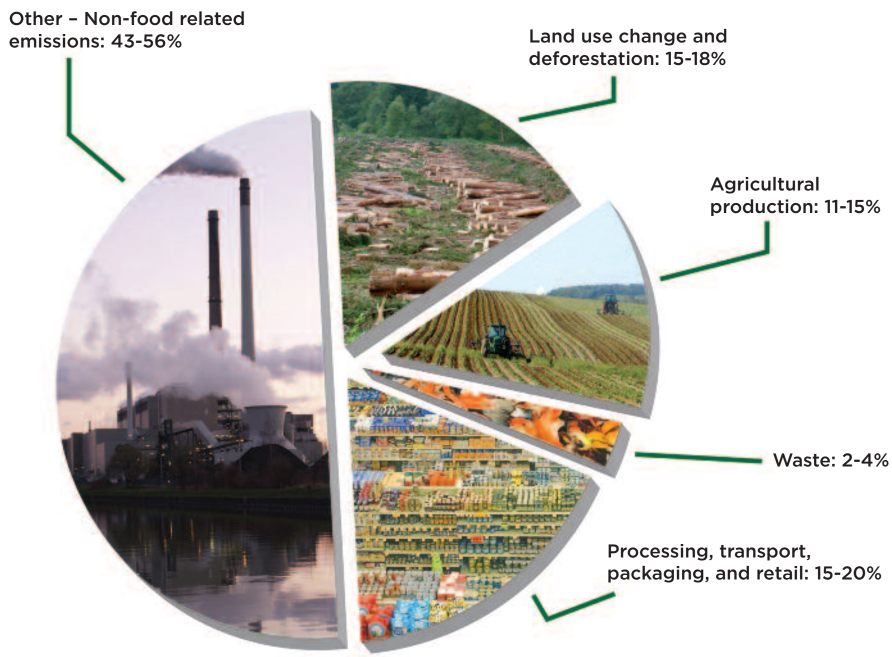
- The expansion of industrial monoculture plantations for commodity food crops like soy, sugarcane, and palm oil is driving deforestation as well as the destruction of savannas and wetlands. Taken together, deforestation and land-use changes account for 15 to 18 percent of global greenhouse gas emissions.
- Processing, packaging, transportation, refrigeration, and retail energy use contribute an additional 15 to 20 percent of global emissions.
- Vast amounts of food waste produce another 2 to 4 percent, much of it in the form of methane gas oozing from landfills.

GRAIN concludes that, in the aggregate, the industrial food system is responsible for "between a low of 44 percent and a high of 57 percent" of anthropogenic greenhouse gas emissions.[43] Ironically, these unbridled emissions contribute to conditions that directly undermine society's ability to meet future food security needs.

Factory Farms and Nitrogen Fertilizers

Concentrated animal feeding operations (CAFOs, or factory farms) and synthetic nitrogen fertilizers stand out for their especially egregious contributions to climate change. In recent years industrial livestock production has expanded at twice the rate of traditional mixed farming systems and at six times the rate of grazing systems.[44] Worldwide, billions of animals—including poultry, hogs, and cattle—are raised on factory farms.[45] Whereas manure from grazing livestock can enhance soil fertility, manure from CAFOs is stored in "lagoons" where it releases methane (CH_4), a GHG 21 times more potent than CO_2, into the atmosphere. Additionally, while all ruminant

FIGURE 2: CONTRIBUTION OF THE GLOBAL FOOD SYSTEM TO TOTAL GHG EMISSIONS



Source: GRAIN

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animals generate methane through digestion, EPA studies show that corn and soybean-fed livestock raised in CAFOs produce more methane than grazing livestock.[46] Currently 35 percent of global cereal production (including corn and soy) is used for animal feed.[47] This is grown using synthetic nitrogen fertilizers, over half of which is lost through groundwater leaching or released as nitrous oxide (N_2O) into the atmosphere.[48] This is significant because N_2O is a greenhouse gas 310 times more potent than CO_2, and in the U.S. 69 percent of it comes from agriculture.[49]

Biotechnology and Pesticides

Meanwhile, a pillar of the industrial system, the pesticide and biotechnology industry alleges that new advancements in agricultural technology, including genetic engineering, are the solution to both global food security and resiliency. New genetically engineered (GE) crops like drought-tolerant corn[50] and others under development, such as salt-tolerant rice,[51] "biofortified" sorghum,[52] and bacteria-resistant bananas,[53] are being hailed as the innovations necessary to achieve food security. And, while highly sophisticated marketers tout the supposed benefits of future GE products, they omit the true costs already associated with the available GE crops.

Biotechnology firms have developed a handful of GE commodity crops that produce pesticides and/or withstand direct application of herbicides. These two traits account for virtually 100 percent of global biotech crop acreage.

In fact, despite a quarter century of promises and over 15 years of commercialization, the agricultural biotechnology industry has failed to provide any concrete advancement in regards to increasing crop yields,[54] reducing world hunger, ameliorating global malnutrition, or combating climate change.

Instead, biotechnology firms have developed a handful of GE commodity crops that produce pesticides and/or withstand direct application of herbicides. These two traits account for virtually 100 percent of global biotech crop acreage.[55] In the U.S., the vast majority of these are resistant to a single herbicide, glyphosate, which is the active ingredient in Monsanto's herbicide Roundup. Altogether, GE crops, made by chemical companies, were responsible for the 527 million pound increase in herbicide use in the U.S. from 1996-2011.[56]

In summary, far from offering any climate solutions, the industrial and biotechnology models consistently underestimate the complexity of ecosystems by employing quick chemical fixes. In so doing, plant biotechnology increases crop vulnerability by weakening ecosystems' natural ability to adapt to extreme weather.

ADDRESSING POPULATION GROWTH

The United Nations projects that, by 2050, global population will increase from its current 7.2 billion to over 9.5 billion.[57] Given this figure it seems logical to conclude that only increasing yields will avert catastrophe. Agribusiness exploits this line of thinking and incessantly uses the "feed the world" argument to promote its suite of biotech products.

Claims that GE crops can solve world hunger are, however, based on two fallacies. First, as explained, GE crops are pesticide-promoting technologies that do not increase yields or help fight hunger. The second fallacy is that the root of the problem is a global shortage of food. In reality, the world today produces more food per capita than ever before. In fact, enough food is produced to provide 4.3 pounds to every person,[58] every day; and yet hunger is widespread. The problem of world hunger *today* is "most attributable not to stocks that are too low or global supplies unable to meet demand, but to poverty."[59]

The problem of world hunger *today* is "most attributable not to stocks that are too low or global supplies unable to meet demand, but to poverty."

Widespread adoption of genetically engineered crops in some parts of the world could actually exacerbate rather than alleviate poverty, leading to an increase in hunger. Concern about food security is supported by recent experiences with GE crops in South America. In Argentina, massive plantations of Roundup Ready soybeans for export have replaced land that used to be farmed by many families and other workers growing food for local consumption.[60] Very few workers are needed to manage these herbicide-resistant crops, so people are displaced from their land and livelihoods. Similarly, in Paraguay, the area planted with soybeans (95% now GE) has nearly tripled since 1997, while per capita food production has declined.[61] Forty-five percent of the rural population is in poverty, and 90,000 rural people move to urban slums each year.[62] Thus, overall increases in production of genetically engineered commodity crops can indeed translate into more, not fewer, hungry people.

FOOD WASTE

Meanwhile, about one third (1.3 *billion tons*) of the food produced in the world goes to waste every year.[63] In developed countries, 40 percent of the waste occurs at the retail and consumer end, whereas in developing countries more than 40 percent of food losses occur due to inadequacies in processing, storage, and transport.[64] Clearly, there are many opportunities for structural improvement that would significantly reduce waste and its associated resource, labor, and climate costs.

The crux of our food security challenge lies in intelligently managing what we already produce while simultaneously designing food systems that are resilient to the mounting pressures of climate change. To that end, at the 2014 Global Forum on Food and Agriculture, the head of the United Nations Environment Programme called on producers to "shift to more sustainable patterns including greater respect for ecosystem services and less waste—in order to feed the world's rapidly increasing population by 2050."[65]

While food production is obviously a global issue, the contribution to both global food production and greenhouse gas emissions from the United States cannot be ignored, and deserves special attention here.

Despite years of presidential and Congressional debate and proclamations about the seriousness of climate change, the federal government has failed to take sufficient action to address the climate crisis. In fact, it took a U.S. Supreme Court case, *Massachusetts v. EPA*,[1] to finally force federal policymakers to acknowledge the need for mandatory regulation of greenhouse gas emissions. Moreover, Congress has not succeeded in passing laws to mitigate climate impacts and no federal climate legislation currently exists.

In his 2014 State of the Union Address, President Obama declared that the debate about climate change "is settled. Climate change is a fact. And when our children's children look us in the eye and ask if we did all we could to leave them a safer, more stable world, with new sources of energy, I want us to be able to say yes, we did."[2] But just days later the 2014 Farm Bill passed by the U.S. Senate granted massive, multi-million dollar subsidies to industrial producers, thus exacerbating climate change and undermining resilience.

Any plan that doesn't address the multiple sources of greenhouse gases attendant with the industrial food system is categorically ignoring what could be the single largest driver of global climate change.

We need government regulations and policies designed to reduce our reliance on fossil fuels and toxic chemicals, protect farm land, build soil health, and conserve fresh water while promoting on-farm resilience to weather extremes, protecting pollinators, and ensuring food security. To this end, we need the public to pressure elected officials to act on climate change.

CENTER FOR FOOD SAFETY'S CLIMATE LITIGATION

Center for Food Safety (CFS) has been a pioneer in addressing the impacts of climate change; the seminal U.S. Supreme Court climate change case, *Massachusetts v. EPA*, was based on a groundbreaking 1999 rulemaking petition authored and spearheaded by the International Center for Technology Assessment, a project of CFS. In that case, the Court ruled that the Environmental Protection Agency (EPA) has the authority under the Clean Air Act to regulate carbon dioxide and other greenhouse gases as pollutants.

The EPA has subsequently undertaken some rulemaking. Building on the *Massachusetts v. EPA* victory, in 2008 Center for Food Safety filed a legal petition requesting that the Council of Environmental Quality (CEQ) require federal agencies to consider and analyze climate change impacts in the environmental compliance documents they must write pursuant to the National Environmental Policy Act. CEQ has yet to respond to the petition.

[1] 549 U.S. 497 (2007).

[2] "FULL TRANSCRIPT: Obama's 2014 State of the Union Address." *The Washington Post*. The Washington Post, 28 Jan. 2014. Web. 10 Feb. 2014. <http://www.washingtonpost.com/politics/full-text-of-obamas-2014-state-of-the-union-address/2014/01/28/e0c93358-887f-11e3-a5bd-844629433ba3_story.html>.

ORGANIC AND AGROECOLOGICAL SYSTEMS

By fostering a set of conditions that tend to increase resiliency, organic farms are better equipped to endure ongoing climate-related stresses.

Ecosystem Health and Climate Resiliency

From a climate point of view organic and agroecological*[66] farming systems have several distinct advantages over industrial systems. First of all, due to the fact that synthetic pesticides and fertilizers are prohibited in organic and agroecological systems, they use as much as 50 percent less fossil fuel energy as industrial farms.[67]

Secondly, because organic and agroecological systems work within biological constraints and with natural cycles, they don't degrade natural capital, *i.e.* biodiversity, water, and soil. Effective biological management practices, including maintaining perennial shrubs and trees on farms, rotating crops, growing crops that support beneficial insects, and applying mulch to fallow fields, create conditions that make these farms attractive to a variety of life below and above ground. On average organic farms have 30 percent higher biodiversity, including birds, pollinators, and plants, than their mono-cropped industrial counterparts.[68] Additionally, the diversity of crop varieties grown on organic and agroecological holdings is typically in stark contrast to the vast monocultures that characterize industrial systems.

Moreover, by fostering a set of conditions that tend to *increase resiliency*, organic farms are better equipped to endure ongoing climate-related stresses. Research supports this claim. Comparative field trials of conventional and organic systems at the Rodale Institute in Pennsylvania found that organic yields were 31 percent higher during drought when compared to conventional.[69]

Because these systems are better for human health, ecosystem health, and climate health, a wide range of global experts within the scientific and human rights communities increasingly herald organic, agroecological systems as the only path for ensuring agricultural resilience. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report calls for placing an "increased importance to the multifunctionality of agriculture, accounting for the complexity of agricultural systems within diverse social and ecological contexts." This shift would "recognize farming communities, farm households, and farmers as producers and managers of ecosystems."[70]

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* *"Agroecology" the convergence of agronomy and ecology is defined as the "application of ecological science to the study, design and management of sustainable agroecosystems."*

There is a growing amount of research that organic and agroecological methods can match and at times significantly increase yields over conventional, industrial agriculture.

Organic agriculture is often dismissed as a viable solution for global food production due to the erroneous assumption that yields are greatly reduced in organic systems. On the contrary, there is a growing amount of research that organic and agroecological methods can match and at times significantly increase yields over conventional, industrial agriculture. The UN Special Rapporteur on the Right to Food cites a 2006 study, conducted in 56 developing countries, measuring the increased productivity of 12.6 million farms employing sustainable agriculture projects. The study found an average yield increase of 79 percent and an even more significant yield boost (116 per cent) for African farms.[71] Meanwhile, in industrialized countries, organic agriculture has been shown to equal the yields of conventionally grown crops.[72] Agroecological farms in developing countries also benefited substantially from organic methods as they do not require the expensive chemical and technical inputs relied upon in conventional agriculture.

The Soil Health Solution

The case for a *global shift* to organic and agroecological food production systems becomes even clearer when the role of soil in mitigating climate change is examined. While improving soil fertility is one of the underlying tenets of organic farming systems, soil is often underappreciated and regularly degraded by the chemicals associated with industrial practices. Yet, healthy soils provide numerous, invaluable services including processing waste, storing and filtering water, and even preventing disease.

Most importantly, healthy, living soils have an enormous capacity to store carbon. In fact, the amount of carbon stored in soil is roughly three times more than that stored in the atmosphere.[73] Because soil has been mismanaged, more than a third of the excess CO_2 that has been added to the atmosphere has come from the destruction of soils.[74] Squandering this precious, shared resource contributes to climate change, floods, and droughts while directly undermining our ability to grow nutritious food and be resilient in the face of this disruption. Record flooding in the U.K. underscores soil's inability to withstand punishing floods when soil organic matter has been compromised.[75]

Humans are altering the chemistry of where carbon is *stored*, and climate change is a manifestation of that alteration. Burning fossil fuels and clearing land converts stored carbon into CO_2. Releasing more CO_2 into the atmosphere than it can effectively absorb is causing the oceans to acidify and is contributing to the destruction of coral reefs and other marine ecosystems. Unlike the atmosphere and the ocean, however, soils *benefit* from increased levels of carbon.

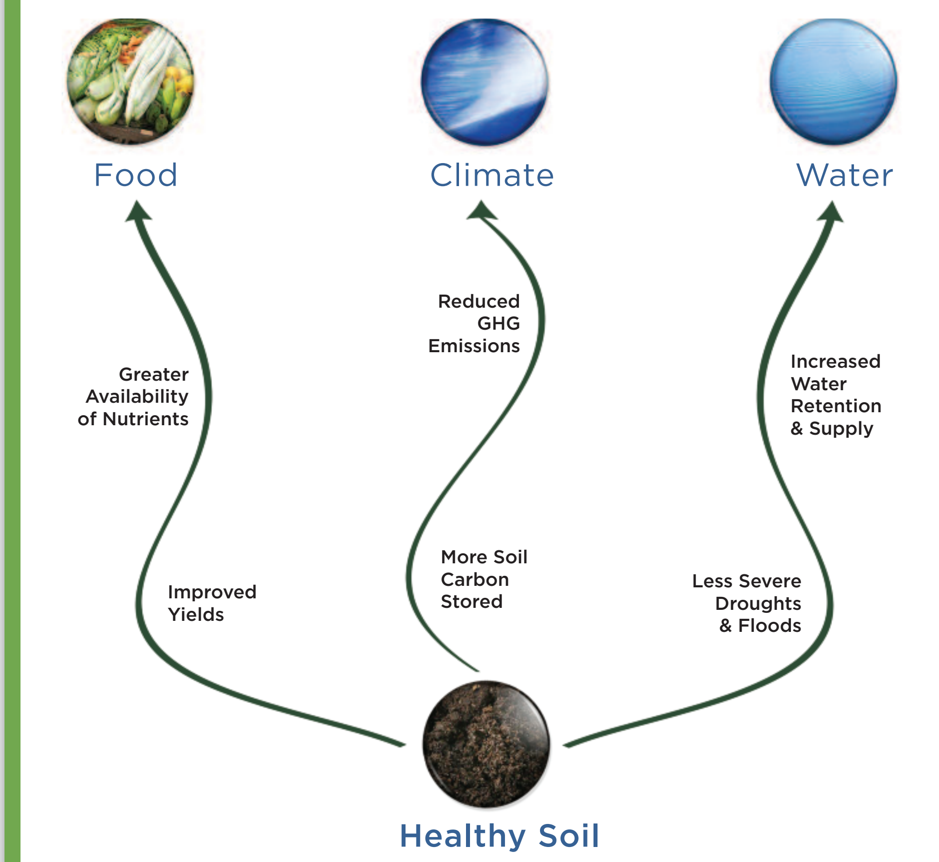
Adopting methods that build soil organic matter, and thus soil carbon, provide remarkable advantages for food production and climate resilience because soil carbon:

- Holds plant nutrients in place and provides food for beneficial microbes;
- Aids in water filtration and storage and regulates soil temperature;
- Binds heavy metals and pesticides (reducing toxic runoff); and
- Improves soil structure, preventing compaction and erosion.[76]

Because ecosystem components are interdependent, by degrading or improving one aspect of ecosystem health, the entire system can likewise be degraded or improved. Rebuilding soil organic matter pumps carbon dioxide into the soil in the form of soil carbon and creates an upward spiral of ecosystem health.[77] Making soil health a central goal of agricultural policies worldwide will be *essential* for achieving global food and water security and mitigating climate change. To this end, promising research by GRAIN has shown that if the right policies and incentives were in place world-wide, soil organic matter contents could be restored to pre-industrial agricultural levels within a period of fifty years. The continuing use of these practices would allow the offset of 24 to 30 percent of global annual greenhouse gas emissions.[78]

Making soil health a central goal of agricultural policies worldwide will be *essential* for achieving global food and water security and mitigating climate change.

FIGURE 3: THE SOIL - CLIMATE CONNECTION



CONCLUSION

Our path to ongoing food diversity, quality, and security must begin with widespread adoption of organic and agroecological agriculture methods as *the foundation* of food and agricultural production systems.

A FUTURE OF food insecurity and climate chaos is not inevitable. We have choices and can employ agricultural methods that will ensure an abundant and resilient food supply. But, we must act quickly before this narrow window of opportunity closes.

Our path to ongoing food diversity, quality, and security must begin with widespread adoption of organic and agroecological agriculture methods as *the foundation* of food and agricultural production systems. Not only are these best suited to rebuilding soil carbon by enhancing biological processes, but they also enhance the underlying conditions that allow ecosystem health to flourish.

In the end, it comes down to making a fundamental decision: do we, as consumers and producers, continue investing in an industrial system that contributes egregiously to climate change and degrades the natural ecosystems upon which our societies and economies are based? Or, do we instead choose to make the necessary investments in organic and related regenerative systems that will address many of the underlying causes of climate change while strengthening our ability to survive and prosper in a warming and volatile world? The choice is ours to make.

WHAT YOU CAN DO THREE TIMES A DAY

While global and national action is needed to address agriculture's significant role in the climate crisis, there are choices that each of us make daily, that can collectively help to address climate change *now*. In fact, every time you eat, you have an opportunity to connect the dots and choose the way forward:

There are choices that each of us make daily that can help to address climate change now. In fact, every time you choose what to eat, you have an opportunity to connect the dots and choose the way forward.

1. Eat fresh, unprocessed foods

Processed foods often contain genetically modified crops which, as we've seen, are designed to produce pesticides and / or withstand direct application of herbicides, taking an enormous toll on the climate. The "processing" that follows happens in large energy-intensive factories. In fact, processed food typically requires more energy to make than what we get back when we eat it! Additionally, processing and packaging go hand-in-hand, and although we've seen some important improvements, a lot of packaging remains unfriendly to the environment.

2. Buy local and in-season

The average conventional food product travels about 1,500 miles to get to your grocery store.[79] Buying local food at a farmers' market or farmstand gives you an opportunity to get to know your local farmers, learn how your food was grown and, unless you grow it yourself, it's the freshest food. By eating what's in season we put less stress on the earth to produce food at an unnatural time.

3. Choose organic foods

Not only are organic systems healthier for you and for the climate, they help build fertile soil—one of the most important components of farming and a vital ally in our race to stabilize the climate. Organic agriculture doesn't rely on synthetic fertilizers or toxic pesticides, which, as we know, are large contributors to climate change; are energy-intensive to manufacture; and release two of the most potent greenhouse gases—methane and nitrous oxide.

Not only are organic systems healthier for you and for the climate, they help build fertile soil—one of the most important components of farming and a vital ally in our race to stabilize the climate.

4. Eliminate industrial meat and dairy consumption; opt instead for pasture-raised products

Remember, animals raised in CAFOs are fed grain—mostly corn and soy—that is grown using a fossil-fuel intensive blend of fertilizers and herbicides. One hundred percent grass-fed, pasture-raised, and organic meat and dairy are more humane, better for our health, and, if properly managed, restorative for the environment. Grasslands, an important feed source for livestock, wildlife habitat, and storage of carbon and water, cover 70 percent of the earth's agricultural land.[80] They "hold significant potential for employing soil carbon sequestration strategies to help mitigate climate change."[81]

5. Reduce food waste and compost at home, at school, and at work

Food is the single largest component of municipal solid waste reaching America's landfills and incinerators. In a compost pile, food scraps decompose with the help of microorganisms, and the food eventually becomes healthy, carbon-rich soil. Unlike a compost pile, landfills are compacted so tightly that food waste decomposes without oxygen (anaerobically) and creates methane gas. Be climate-smart, start a compost pile today!

To learn more visit
www.centerforfoodsafety.org

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