times higher in children eating conventionally farmed fruits and vegetables compared with those eating organic food.[4]

According to the U.S. Department of Health and Human Services, organophosphate pesticides (OP) are now found in the blood of ninety-five percent of Americans tested. OP levels are twice as high in blood samples taken from children than in adults. Exposure to OPs is linked to hyperactivity, behavior disorders, learning disabilities, developmental delays, and motor dysfunction. OPs account for half of the insecticides used in the United States.[5]

The U.S. Centers for Disease Control reports that one of the main sources of pesticide exposure for U.S. children comes from the food they eat.[6]

The U.S. Department of Agriculture strictly prohibits mixing different types of pesticides for disposal due to the well-known process of the individual chemicals combining into new, highly toxic chemical compounds. There are no regulations regarding pesticide mixture on a consumer product level even though, in a similar manner, those same individual pesticide residues interact and mix together into new chemical compounds when conventional multiple ingredient products are made. Sixty-two percent of food products tested contain a measurable mixture of residues of at least three different pesticides.[7]

Currently, more than 400 chemicals can be regularly used in conventional farming as biocides to kill weeds and insects. For example, apples can be sprayed up to sixteen times with thirty-six different pesticides. None of these chemicals are present in organic foods.[8]

More than 300 synthetic food additives are allowed by the FDA in conventional foods. None of these is allowed in foods that are USDA certified organic.

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THE CLIMATE CRISIS AT THE END OF OUR FORK

By Anna Lappé

Anna Lappé is a national best-selling author and public speaker known for her work on sustainable agriculture, food politics, and social change. Named one of *Time*'s Eco-Who's Who, Anna has been featured in *Gourmet*, *Food & Wine*, *The New York Times*, *Delicious Living*, and *O Magazine*, among many other outlets.

With her mother Frances Moore Lappé, Anna leads the Cambridge-based Small Planet Institute, a collaborative network for research and popular education, and the Small Planet Fund, which has raised more than half a million dollars for democratic social movements worldwide, two of which have won the Nobel Peace Prize since the fund's founding in 2002.

Anna's first book, *Hope's Edge: The Next Diet for a Small Planet* (Tarcher/Penguin, 2002), cowritten with Frances Moore Lappé, chronicles courageous social movements around the world addressing the root causes of hunger and poverty. Winner of the Nautilus Award for Social Change, *Hope's Edge* has been published in several languages and is used in classrooms across the country. She is also the coauthor of *Grub: Ideas for an Urban Organic Kitchen* (Tarcher/Penguin, 2006) with eco-chef Bryant Terry and is at work on her third book, *Eat the Sky* (Bloomsbury, 2010), about food, farming, and climate change.

Anna holds an MA in economic and political development from Columbia University's School of International and Public Affairs and graduated with honors from Brown University. From 2004 to 2006 she was a Food and Society Policy Fellow, a national program of the W. K. Kellogg Foundation. She lives in Fort Greene, Brooklyn, where she visits her local farmers' market as often as she can.

We could hear audible gasps from the two dozen New York state farmers gathered at the Glynwood Center on a cold December day in 2007 when NASA scientist Cynthia Rosenzweig, one of the world's

leading experts on climate change and agriculture, explained the slide glowing on the screen in front of us.

The Glynwood Center, an education nonprofit and farm set on 225 acres in the Hudson Valley, had brought Rosenzweig to speak to area farmers about the possible impact of climate change on the region. Pointing to an arrow swooping south from New York, Rosenzweig said: "If we don't drastically reduce greenhouse gas emissions by 2080, farming in New York could feel like farming in Georgia.

"It was all projections before. It's not projections now—it's observational science," said Rosenzweig. We are already seeing major impacts of climate change on agriculture: droughts leading to crop loss and salinization of soils, flooding causing waterlogged soils, longer growing seasons leading to new and more pest pressures, and erratic weather shifting harvesting seasons, explained Rosenzweig.

When people think about climate change and food, many first think of the aspect of the equation that Rosenzweig focused on that day—the impact of climate change on farming. But when it comes to how the food system impacts global warming, most draw a blank.

Challenged to name the human factors that promote climate change, we typically picture industrial smokestacks or oil-thirsty planes and automobiles, not Pop-Tarts or pork chops. Yet the global system for producing and distributing food accounts for roughly *one-third* of the human-caused global warming effect. According to the United Nation's seminal report, *Livestock's Long Shadow*, the livestock sector alone is responsible for eighteen percent of the world's total global warming effect—more than the emissions produced by every plane, train, and steamer ship on the planet.[1]

Asked what we can do as individuals to help solve the climate change crisis, most of us could recite these eco-mantras from memory: Change our light bulbs! Drive less! Choose energy-efficient appliances! Asked what we can do as a nation, most of us would probably mention promoting renewable energy and ending our addiction to fossil fuels. Few among us would mention changing the way we produce our food or the dietary choices we make.

Unfortunately, the dominant storyline about climate change—its biggest drivers and the key solutions—diverts us from understanding

how other sectors, particularly the food sector, are critical parts of the *problem*, but even more importantly can be vital strategies for *solutions*.

If the role of our food system in global warming comes as news to you, it's understandable. Many of us have gotten the bulk of our information about global warming from Al Gore's wake-up call *An Inconvenient Truth*, the 2006 Oscar-winning documentary that became the fourth-highest grossing nonfiction film in American history.[2] In addition to the record-breaking doc, Gore's train-the-trainer program, which coaches educators on sharing his slideshow, has further spread his central message about the threat posed by human-made climate change. But Gore's program offers little information about the connection between climate change and the food on your plate.

Mainstream newspapers in the United States haven't done a much better job of covering the topic. Researchers at Johns Hopkins University analyzed climate change coverage in sixteen leading U.S. newspapers from September 2005 through January 2008. Of the 4,582 articles published on climate change during that period, only 2.4 percent addressed the role of the food production system, and most of those only peripherally. In fact, just half of one percent of all climate change articles had "a substantial focus" on food and agriculture.[3] Internationally, the focus hasn't been much different. Until recently, much of the attention from the international climate change community and national coordinating bodies was also mostly focused on polluting industries and the burning of fossil fuels, not on the food sector.

This is finally starting to change. In the second half of 2008, writers from *O: The Oprah Magazine* to the *Los Angeles Times* started to cover the topic, increasing the public's awareness of the food and climate change connection. In September 2008, Dr. Rajendra Pachauri, the Indian economist serving his second term as chair of the United Nations Intergovernmental Panel on Climate Change, made a bold statement about the connection between our diet and global warming. Choosing to eat less meat, or eliminating meat entirely, is one of the most important personal choices we can make to address climate change, said Pachauri.[4] "In terms of immediacy of action and the feasibility of bringing about reductions in a short period of time, it clearly is the most attractive opportunity," said Pachauri. "Give up meat for one day [a week] initially, and decrease it from there."[5]

Why does our food system play such a significant role in the global warming effect? There are many reasons, including the emissions created by industrial farming processes, such as fertilizer production, and the carbon emissions produced by trucks, ships, and planes as they transport foods across nations and around the world. Among the main sources of the food system's impact on climate are land use changes, especially the expansion of palm oil production, and effects caused by contemporary agricultural practices, including the emissions produced by livestock.

THE LAND USE CONNECTION

Let's look at land use first. A full eighteen percent of the world's global warming effect is associated with "land use changes," mostly from the food system.[6] The biggest factors are the destruction of vital rainforests through burning and clearing and the elimination of wetlands and peat bogs to expand pasture for cattle, feed crops for livestock, and oil palm plantations, especially in a handful of countries, Brazil and Indonesia chief among them.[7]

What do Quaker Granola Bars and Girl Scout Cookies have to do with the climate crisis?[8] These processed foods—along with other popular products, including cosmetics, soaps, shampoo, even fabric softeners—share a common ingredient, one with enormous climate implications: palm oil.[9] As the taste for processed foods skyrockets, so does the demand for palm oil, production of which has more than doubled in the last decade.[10] Today, palm oil is the most widely traded vegetable oil in the world, with major growth in the world's top two importing countries, India and China.[11]

As oil palm plantations expand on rainforests and peat lands in Southeast Asia, the natural swamp forests that formerly filled those lands are cut down and drained, and the peat-filled soils release carbon dioxide and methane into the atmosphere. (Methane is a key greenhouse gas with twenty-three times the global warming impact of carbon dioxide.) In a recent study, researchers estimate that producing one ton of palm oil can create fifteen to seventy tons of carbon dioxide over a twenty-five year period.[12]

Three of the world's biggest agribusiness companies are major players in the palm oil market, which is concentrated in two countries—Malaysia and Indonesia—where in 2007, forty-three percent and forty-four percent of the world's total palm oil was produced, respectively.[13] Wilmar, an affiliate of the multinational giant Archer Daniels Midland, is the largest palm oil producer in the world;[14] soy behemoth Bunge is a major importer of palm oil into the United States (although at the moment it doesn't own or operate any of its own facilities);[15] and grain-trading Cargill owns palm plantations throughout Indonesia and Malaysia.[16] These three companies and others producing palm oil claim that guidelines from the Roundtable on Sustainable Palm Oil (RSPO), established in 2004 by industry and international nonprofits, ensure sustainable production that minimizes the destruction of forest and peat bogs as well as deleterious effects on the global climate.[17]

However, some environmental and human rights groups argue that loopholes in the Roundtable's regulations still leave too much wiggle room. Says Greenpeace, "The existing standards developed by the RSPO will not prevent forest and peat land destruction, and a number of RSPO members are taking no steps to avoid the worst practices of the palm oil industry."[18]

We also know from new data that palm plantation expansion on peat land is not slowing. According to Dr. Susan Page from the University of Leicester, deforestation rates on peat lands have been increasing for twenty years, with one-quarter of all deforestation in Southeast Asia occurring on peat lands in 2005 alone.[19]

The other side of the land use story is deforestation driven by the increased production of livestock, expanding pasture lands and cropland for feed. In Latin America, for instance, nearly three-quarters of formerly forested land is now occupied by pastures; feed crops for livestock cover much of the remainder.[20] Globally, one-third of the world's arable land is dedicated to feed crop production.[21] Poorly managed pastures lead to overgrazing, compaction, and erosion, which release stored carbon into the atmosphere. With livestock now occupying twenty-six percent of the planet's ice-free land, the impact of this poor land management is significant.[22]

Raising livestock in confinement and feeding them diets of grains and other feedstock—including animal waste by-products—is a relatively

recent phenomenon. In the postwar period, intensification of animal production was seen as the path to productivity. As livestock were confined in high stocking densities often far from where their feed was grown, a highly inefficient and environmentally costly system was born.

As a British Government Panel on Sustainable Development said in 1997, "Farming methods in the last half century have changed rapidly as a result of policies which have favored food production at the expense of the conservation of biodiversity and the protection of the landscape."[23] Despite these environmental costs, confined animal feeding operations (CAFOs) spread in the 1960s and 1970s into Europe and Japan and what was then the Soviet Union. Today, CAFOs are becoming increasingly common in East Asia, Latin America, and West Asia.

As the largest U.S.-based multinational meat companies, including Tyson, Cargill, and Smithfield, set their sights overseas, the production of industrial meat globally is growing.[24] In addition, the increasing supply of meat in developing countries flooded with advertising for Western-style eating habits is leading to a potential doubling in demand for industrial livestock production, and therefore feed crops, from 1997–1999 to 2030.[25]

Although the shift from traditional ways of raising livestock to industrial-scale confinement operations is often defended in the name of "efficiency," it's a spurious claim. As a way of producing edible proteins, feedlot livestock production is inherently inefficient. While ruminants such as cattle naturally convert inedible-to-humans grasses into high-grade proteins, under industrial production, grain-fed cattle pass along to humans only a fraction of the protein they consume.[26] Debates about this conversion rate abound. The U.S. Department of Agriculture estimates that it takes seven pounds of grain to produce one pound of beef.[27] However, journalist Paul Roberts, author of *The End of Food*, argues that the true conversion rate is much higher. While feedlot cattle need at least ten pounds of feed to gain one pound of live weight, Roberts states, nearly two-thirds of this weight gain is for inedible parts, such as bones, other organs, and hide. The true conversion ratio, Roberts estimates, is twenty pounds of grain to produce a single pound of beef, 7.3 pounds for pigs, and 3.5 pounds for poultry.[28]

The inefficiency of turning to grain-fed livestock as a major component of the human diet is devastating in itself, especially in a world where

nearly one billion people still go hungry. But now we know there is a climate cost as well. The more consolidation in the livestock industry—where small-scale farmers are pushed out and replaced by large-scale confinement operations—the more land will be turned over to feed production. This production is dependent on fossil fuel–intensive farming, from synthesizing the human-made nitrogen fertilizer to using fossil fuel–based chemicals on feed crops. Each of these production steps cost in emissions contributing to the escalating greenhouse effect undermining our planet's ecological balance.

THE AGRICULTURE CONNECTION

One reason we may have been slow to recognize the impact of the food system on climate change may be a certain "carbon bias." While carbon dioxide is the most abundant human-made greenhouse gases in the atmosphere, making up seventy-seven percent of the total human-caused global warming effect, methane and nitrous oxide contribute nearly all the rest.[29] (Other greenhouse gases are also relevant to the global warming effect, but are currently present in much smaller quantities and have a less significant impact.)[30] Agriculture is responsible for most of the human-made methane and nitrous oxide in the atmosphere, which contribute 13.5 percent of total greenhouse gas emissions, primarily from animal waste mismanagement, fertilizer overuse, the natural effects of ruminant digestion, and to a small degree rice production.[31] (1.5 percent of total emissions come from methane produced during rice cultivation).[32]

Though livestock only contribute nine percent of carbon dioxide emissions, the sector is responsible for thirty-seven percent of methane and sixty-five percent of nitrous oxide.[33] Here again, recent changes in agricultural practices are a significant factor. For centuries, livestock have been a vital part of sustainable food systems, providing muscle for farm work and meat as a vital protein source. Historically, properly grazed livestock produced numerous benefits to the land: hooves aerate soil, allowing more oxygen in the ground, which helps plant growth; their hoof action also presses grass seed into the earth, fostering plant growth, too; and, of course, their manure provides natural fertilizer. Indeed, new self-described "carbon farmers" are developing best management practices to

manage cattle grazing to reduce compaction and overgrazing and, mimicking traditional grazing patterns, increasing carbon sequestration in the soil.[34]

But modern livestock production has steered away from these traditional practices toward the industrial-style production described above and to highly destructive overgrazing. In sustainable systems tapping nature's wisdom, there is no such thing as waste: manure is part of a holistic cycle and serves to fertilize the same lands where the animals that produce it live. In CAFOs, there is simply too much waste to cycle back through the system. Instead, waste is stored in manure "lagoons," as they're euphemistically called. Without sufficient oxygenation, this waste emits methane and nitrous oxide gas. As a consequence of industrial livestock production, the United States scores at the top of the world for methane emissions from manure. Swine production is king in terms of methane emissions, responsible for half of the globe's total.[35]

The sheer numbers of livestock exacerbate the problem. In 1965, eight billion livestock animals were alive on the planet at any given moment; ten billion were slaughtered every year. Today, thanks in part to CAFOs that spur faster growth and shorter lifespan, twenty billion livestock animals are alive at any moment, while nearly fifty-five billion are slaughtered annually.[36]

Ruminants, such as cattle, buffalo, sheep, and goats, are among the main agricultural sources of methane. They can't help it; it's in their nature. Ruminants digest through microbial, or enteric, fermentation, which produces methane that is then released by the animals, mainly through belching. While this process enables ruminants to digest fibrous grasses that we humans can't convert into digestible form, it also contributes to livestock's climate change impact. (Enteric fermentation accounts for twenty-five percent of the total emissions from the livestock sector; land use changes account for another 35.4 percent; manure accounts for 30.5 percent.)[37]

In addition to the ruminants' digestive process, emissions from livestock can be traced back to the production of the crops they consume. Globally, thirty-three percent of the world's cereal harvest and ninety percent of the world's soy harvest are now being raised for animal feed.[38] Feed crop farmers are heavily dependent on fossil fuels, used to power the on-

farm machinery as well as used in the production of the petroleum-based chemicals to protect against pests, stave off weeds, and foster soil fertility on large-scale monoculture fields. In addition, these crops use up immense quantities of fertilizer. In the United States and Canada, half of all synthetic fertilizer is used for feed crops.[39] In the United Kingdom, the total is nearly seventy percent.[40] To produce this fertilizer requires tons of natural gas; on average 1.5 tons of oil equivalents are used up to make one ton of fertilizer.[41] Yet in the United States, only about half of the nitrogen fertilizer applied to corn is even used by the crop.[42] This needless waste is all the more alarming because nitrogen fertilizer contributes roughly three-quarters of the country's nitrous oxide emissions.

Erosion and deterioration of soils on industrial farms is another factor in the food sector's global warming toll. As industrial farms diminish natural soil fertility and disturb soil through tillage, soil carbon is released into the atmosphere.[43] Because industrialized agriculture also relies on huge amounts of water for irrigation, these farms will be more vulnerable as climate change increases drought frequency and intensity and decreases water availability. Globally, seventy percent of the world's available freshwater is being diverted to irrigation-intensive agriculture.[44]

THE WASTE AND TRANSPORTATION CONNECTION

The sources of food system emissions on which we've focused so far—including land use changes and agricultural production—are responsible for nearly one-third of the total human-made global warming effect. That's already quite a lot, but other sectors include emissions from the food chain, including transportation, waste, and manufacturing.

For example, 3.6 percent of global greenhouse gas emissions come from waste, including landfills, wastewater, and other waste.[45] The food production system contributes its share to this total. After all, where does most of our uneaten food and food ready for harvest that never even makes it to our plates end up? Landfills. Solid waste, including food scraps, produces greenhouse gas emissions from anaerobic decomposition, which produces methane, and from carbon dioxide as a by-product of incineration and waste transportation.[46]

An additional 13.1 percent of the emissions that contribute to the global warming effect come from transportation, toting everything from people to pork chops.[47] The factory farming industry, in particular, demands energy-intensive shipping. CAFOs, for example, transport feed and live animals to feedlots and then to slaughter. Then the meat must be shipped to retail distribution centers and to the stores where it is sold to us consumers.

Americans, in particular, import and export a lot of meat. In 2007, the United States exported one 1.4 billion pounds of beef and veal (5.4 percent of our total production of beef)[48] and imported 3.1 billion pounds of the same.[49] One could argue that a lot of that transport is unnecessary from a consumer point of view and damaging from an environmental point of view.

Globally, international trade in meat is rapidly accelerating. As recently as 1995, Brazil was exporting less than half-a-million dollars' worth of beef. A little more than a decade later, the Brazilian Beef Industry and Exporters Association estimates the value of beef exports could reach $5.2 billion and expects revenues of $15 billion from beef exports by 2013.[50]

All of these billions of pounds of meat being shipped around the world add significantly to the carbon emissions from transportation. So do the Chilean grapes shipped to California, the Australian dairy destined for Japan, or the Twinkies toted across the country—all the meat and dairy, drinks, and processed foods shipped worldwide in today's globalized food market.

THE ORGANIC SOLUTION

The globalized and industrialized food system has not only negative health consequences—think of all those Twinkies, that factory-farmed meat, and that chemically raised produce—but a climate change toll as well. But the news is not all bad. Once we gaze directly at the connection between food, farming, and global warming, we see plenty of cause for hope.

First, unlike many other climate change conundrums, we already know many of the steps we can take now to reduce carbon emissions

from the food sector. For instance, we know that compared with industrial farms, small-scale organic and sustainable farms can significantly reduce the sector's emissions. Small-scale sustainable agriculture relies on people power, not heavy machinery, and depends on working with biological methods, not human-made chemicals, to increase soil fertility and handle pests. As a result, small-scale sustainable farms use much fewer fossil fuels and have been found to emit between one-half and two-thirds less carbon dioxide for every acre of production.[51]

We also are just beginning to see results from long-term studies showing how organic farms create healthy soil, which has greater capacity to store carbon, creating those all-important "carbon sinks."[52] By one estimate, converting 10,000 medium-sized farms to organic would store as much carbon in the soil as we would save in emissions if we took one million cars off the road.[53]

We're closer than ever to global consensus about the direction in which we need to head. In April 2008, a report on agriculture initiated by the World Bank, in partnership with the United Nations and representatives from the private sector, NGOs, and scientific institutions from around the world, declared that diverse, small-holder sustainable agriculture can play a vital role in reducing the environment impacts of the agriculture sector.

The result of four years of work by hundreds of scientists and reviewers,[54] the International Assessment of Agricultural Science and Technology for Development (IAASTD) calls for supporting agroecological systems; enhancing agricultural biodiversity; promoting small-scale farms; and encouraging the sustainable management of livestock, forest, and fisheries, as well as supporting "biological substitutes for agrochemicals" and "reducing the dependency of the agricultural sector on fossil fuels."[55] A civil society statement timed with the report's release declared that the IAASTD represents the beginning of a "new era of agriculture" and offers "a sobering account of the failure of industrial farming."[56] Said Greenpeace, the IAASTD report recommends a "significant departure from the destructive chemical-dependent, one-size-fits-all model of industrial agriculture."[57]

(Not everyone involved in the process was happy with the final report, which was signed by fifty-seven governments.[58] Chemical giant and agricultural biotechnology leaders Syngenta and Monsanto, for instance,

refused to sign on to the final document. No public statements were given at the time.[59] But in an interview, Syngenta's Martin Clough told me, "When it became pretty evident that the breadth of technologies were not getting equal airtime, then I think the view was that there was no point in participating. It's important to represent the technological options and it's equally important to say that they get fair play. That wasn't happening."[60])

Despite the chemical industry holdouts, there is also consensus that sustainable farming practices create more resilient farms, better able to withstand the weather extremes of drought and flooding already afflicting many regions as a result of climate change. In other words, mitigation *is* adaptation. Because organic farms, by their design, build healthy soil, organic soils are better able to absorb water, making them more stable during floods, droughts, and extreme weather changes. In one specific example, conventional rice farmers in a region in Japan were nearly wiped out by an unusually cold summer, while organic farmers in the same region still yielded sixty to eighty percent of their typical production levels.[61]

In ongoing studies by the Pennsylvania-based Rodale Institute, organic crops outperformed nonorganic crops in times of drought, yielding thirty-five to one hundred percent more in drought years than conventional crops.[62] Visiting a Wisconsin organic farmer just after the major Midwest flooding of the summer of 2008, I could see the deep ravines in the surrounding corn fields caused by the recent flooding, while I spent the afternoon walking through a visibly unscathed biodiverse organic farm.

Encouraging sustainable agriculture will not only help us reduce emissions and adapt to the future climate chaos, it will have other beneficial ripples: addressing hunger and poverty, improving public health, and preserving biodiversity. In one study comparing organic and conventional agriculture in Europe, Canada, New Zealand, and the United States, researchers found that organic farming increased biodiversity at "every level of the food chain," from birds and mammals, to flora, all the way down to the bacteria in the soil.[63]

Finally, we know that shifting toward sustainable production need not mean sacrificing production. In one of the largest studies of sustainable agriculture, covering 286 projects in fifty-seven countries and including 12.6 million farmers, researchers from the University of Essex

found a yield increase of seventy-nine percent when farmers shifted to sustainable farming across a wide variety of systems and crop types.[64] Harvests of some crops such as maize, potatoes, and beans increased one hundred percent.[65]

Here's the other great plus: we all have to eat, so we can each do our part to encourage the shift to organic, sustainable farming every time we make a choice about our food, from our local market, to our local restaurants, to our local food policies.

I was recently talking with Helene York, director of the Bon Appétit Management Company Foundation, an arm of the Bon Appétit catering company, which serves eighty million meals a year at four hundred venues across the country. York has been at the forefront of educating consumers and chefs about the impacts of our culinary choices on climate change, including leading the charge of the foundation's "Low Carbon Diet," which has dramatically reduced greenhouse gas emissions associated with their food. She summed up the challenge of awakening people to the food and climate change connection this way: "When you're sitting in front of a steaming plate of macaroni and cheese, you're not imagining plumes of greenhouse gases. You're thinking, dinner."

But the truth is those plumes of gases are there nonetheless, in the background of how our dinners are produced, processed, and shipped to our plates. Thankfully, more and more of us eaters and policymakers are considering the climate crisis at the end of our fork and what we can do to support the organic, local, sustainable food production that's better for the planet, more pleasing to the palette, and healthier for people too.