Chapter Four – Today, Eating Fossil Fuels; How Will We Meet the Challenge Tomorrow?

North Americans' health care costs, our children's obesity, our own health, our insecurities about the future of energy, water and soil, our uncertainties about climate change and our anxieties over the loss of agricultural land are all related to accessing quality, affordable, nutritious food from reliable sources. The low-nutrient, low-quality "junk" food so many of us depend on is, literally, killing us. Yet the North American food system makes an average of 3,800 calories a day available to every person, more than one and a half times our average daily need.
https://web.archive.org/web/2016*/https://www.lloyds.com/lloyds/press-centre/press-releases/2015/06/food-system-shock

The origins of twenty-first-century agriculture can be traced back to the convergence of three things: the discovery and use of fossil fuels, the development of the internal-combustion engine and the invention of dynamite.

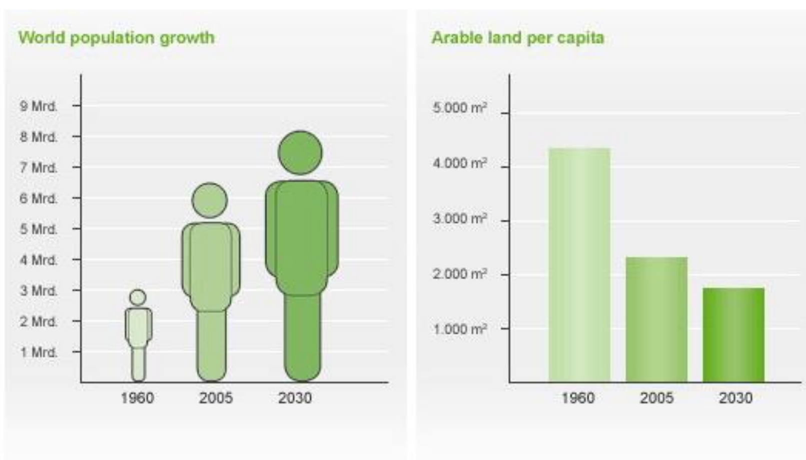
Henry Ford is credited with inventing the diesel-powered tractor in 1907. Its introduction rapidly replaced the clumsy, excessively heavy steam-powered tractors popular during the 1800s that often got stuck during springtime planting efforts, especially in already soggy bottomland. They routinely had to be hauled out by teams of horses. Ford's reasonably priced, lightweight, small, agile farm vehicles rarely got stuck, and the moment they hit the plowing fields they completely revolutionized the way agriculture was practiced, although they did not become widely used until the outbreak of World War I. Today, much of the tractors and other farming equipment in the United States are manufactured by the John Deere Company, headquartered in Moline, Illinois, but many companies make farm equipment worldwide. All use gasoline or diesel as their fuel of choice. It is no wonder, then, that farming consumes some 30 percent of all fossil fuel used in the United States?

Combine harvesters in 1902 and 2014. (Credit, top: Robert N. Dennis, New York Public Library. Credit, bottom: (cc-by) Martin Pettitt, via flickr.)

Wrapped into thick paper-covered foot-long sticks with a primer fuse and a percussion cap, dynamite could be safely shipped anywhere in the world. It rapidly became the explosive of choice for clearing land. Stumps that once required teams of draft animals and days of effort to pry them out of their rooted strongholds could now be removed from the forested landscape in less than a single day's work. Empty fields, once virgin woodland, were transformed into domesticated agricultural land. Plowed, then planted with crops like corn and sorghum, virtually any crop could bring in a profit in the early days of Midwest farming. The forest floor was rich in deep, black soil, an ideal situation for any crop species with a penchant for growing in a temperate zone.

"Until the end of the last Ice Age, around 11,000 B.C., all peoples on all continents were still hunter-gatherers. Different rates of development on different continents, from 11,000 B.C. to A.D. 1500, were what led to the technological and political inequalities of A.D. 1500. While Aboriginal Australians and many Native Americans remained hunter-gatherers, most of Eurasia and much of the Americas and sub-Saharan Africa gradually developed agriculture, herding, metallurgy and complex political organization. Parts of Eurasia, and one area of the Americas, independently developed writing as well. However, each of these new developments appeared earlier in Eurasia than elsewhere". Guns, Germs, and Steel: The Fates of Human Societies (Jared Diamond)

In contrast to the amount of arable land, which has varied widely through time and across civilizations, the amount of land needed to feed a person has gradually decreased over recorded history. Hunting and gathering societies needed 20 to 100 hectares of land to support a person (There are 2.47 acres in a hectare and 43,560 sq. ft. in an acre). The shifting pattern of cultivation that characterized slash-and-burn agriculture took 2 to 10 hectares of land to support a person. Later, sedentary agricultural societies used about a tenth as much land to support a person. An estimated 0.5 to 1.5 hectares of floodplain fed a Mesopotamian (Middle East, now largely desert). Over time, human ingenuity with fossil fuel derived fertilizers increased food production on the most intensively farmed and productive land so that today, with roughly 6 billion people and 1.5 billion hectares of cultivated land, it takes about 0.25 hectares to feed each person. The world's most intensively farmed regions use about 0.2 hectares to support a person. Increasing the average global agricultural productivity to this level would support 7.5 billion people. Yet by 2050 the amount of available cropland is projected to drop to less than 0.1 hectare per person. Simply staying even in terms of food production will require major increases in per hectare crop yields – increases that will require the very best of human ingenuity and of course, growth medium fertility.



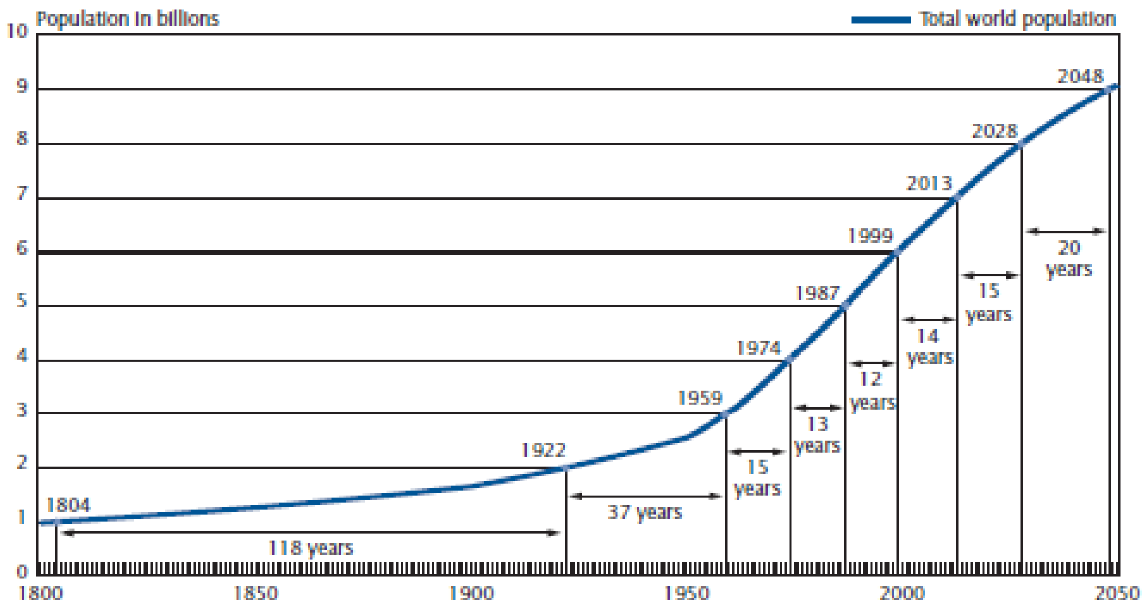
Source: FAO

Agricultural production needs to be substantially increased – by 60% – in the next four decades to meet the growing demand for food, according to the agricultural outlook for 2012-2021 published by the OECD and Food and Agricultural Organization of the United Nations. There will be a 5% increase (or 69 million hectares) in total arable land by 2050 (most often means wilderness lost), the report notes but 25% of current agricultural land is already "highly degraded".

Canada's soil is in crisis — and change is needed, says advocate Alberta Farmer Express

The biggest crisis facing Canadian agriculture is right beneath our feet. The various components of soil — organic matter, nutrients, water-holding capability, and amount of carbon — need to be in balance, and that's not happening, he argued. https://www.albertafarmexpress.ca/news/canadas-soil-is-in-crisis-and-change-is-needed-says-advocate/

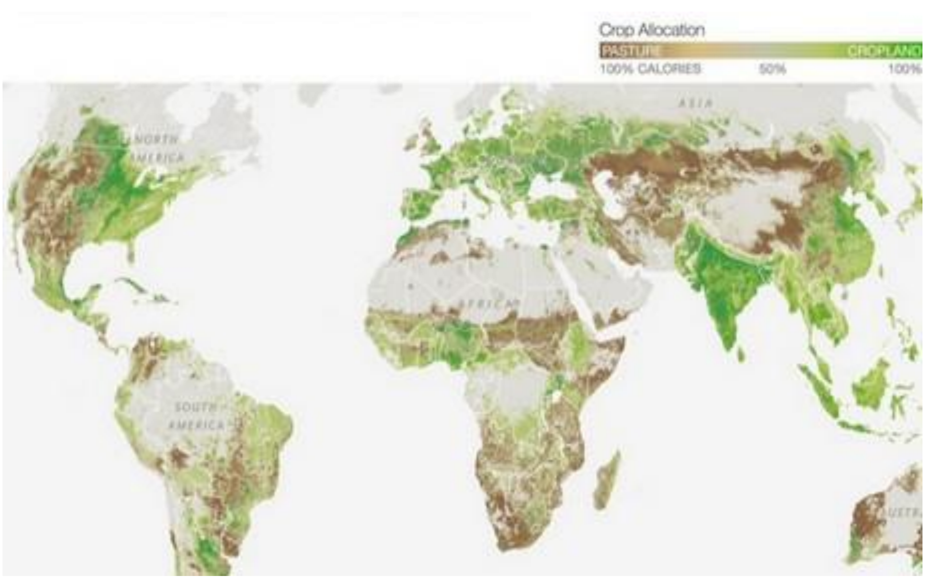
Figure 1.
Time to Successive Billions in World Population: 1800-2050
The sixth billion accrues to world population in record time!



Source: United Nations (1995b); U.S. Census Bureau, International Programs Center, International Data Base and unpublished tables.

Worldwide food production: running out of land

"We cannot increase food production by using more land for the agricultural sector," says National Geographic based on the map below.



National Geographic has started a special online project in which food production and the growing world population is central.

http://www.nytimes.com/2015/06/26/science/worlds-aquifers-losing-replenishment-race-researchers-say.html?_r=0 http://grist.org/climate-energy/our-alarming-food-future-explained-in-7-charts/

In the United States, each year, an area two thirds of a mile wide that would stretch from San Francisco to New York is converted by urban sprawl (see http://www.mercurynews.com/california/ci_29902724/americas-vanishing-west-california-losing-most-land-development). According the American Farmland Trust, more than 6 million acres of agricultural land in the United States were lost to development between 1992 and 1997 alone. Between 2002 and 2007, the United States lost another 3.2 million acres of farmland each year, mostly to development. The overall loss of farmland coincides with most professional planners' absence of interest in food ("farming is unprofitable"), even though it's an enduring necessity, as important as energy, air, water and shelter, all of which get a lot of planning attention and rightly so. Perhaps food is too obvious and has been too plentiful, for some, to bother to think about.

Driving this relentless onslaught on borderline farms is the irresistible lure of big money. The closer to the city, the higher the price of land. A farm that's worth $2,000 an acre for growing food or raising cattle can be worth 20 times that (it goes up with each zoning upgrade) when it's subdivided. A developer can make more money from turning an acre of farmland into housing than a farmer might profit from a lifetime of selling crop off that acre. Combine this financial bonanza with dwindling incomes for aging farmers, and the pressure to get rid of near-urban farmlands is firmly in place.

Ironically, the new taxes reaped by a city from a green field suburban development are illusory gains. The American Farmland Trust (AFT) studied scores of US counties and found that for every dollar of taxes raised by residential development, public costs were $1.16. By comparison, private working agricultural land and open space cost only 35 cents to service for every dollar of tax they generated. What the trust calls "working and other open lands" may generate less revenue than residential, commercial, or industrial properties, but such lands require little public infrastructure and few services. In nearly every one of more than 150 communities studied, farmland generated a fiscal surplus that helped offset the shortfall created by residential demand for public services. The only exceptions were where a community decided to pay for agricultural conservation easements. "Converting agricultural land to residential use should not be seen as a way to balance local budgets," the AFT study concluded.

"During the 1990's the American economy lost two acres of farmland every minute primarily to suburbanization" reports Jeff Rubin.

Indeed, we know that 2008 was an important milestone in the history of humankind: That was the year that the majority of the world population, for the first time, lived in urban centers.

https://www.zerohedge.com/news/2022-05-07/you-can-live-orwellian-nightmare-just-800-month

Surprising to most, little of Canada's huge land mass is suitable for agricultural use; even less is prime agricultural land. A great deal of population growth however occurs at the expense of this irreplaceable agricultural land. As global food shortages mount, when people are being urged to eat locally grown food to reduce energy expended on transport, and when erosion, salination, and desertification take an estimated 7% of the world's agricultural land out of production each year, Canada continues to turn some of its most fertile land into townhouses and strip malls.

This should not be news. In 1976, the Science Council of Canada reported that there was “less land suitable for agriculture in Canada than is generally realized”. Only 13% of land (294 m. acres) was judged suitable for agriculture. Of agriculture land, only 19% (55 m. acres) was prime (4% class 1; 15% class 2). Another 23% suitable for cultivation was capable of sustained production of common field crops (class 3), while 22% was marginal for field crops (class 4), and 24% was cultivated pasture (class 5).

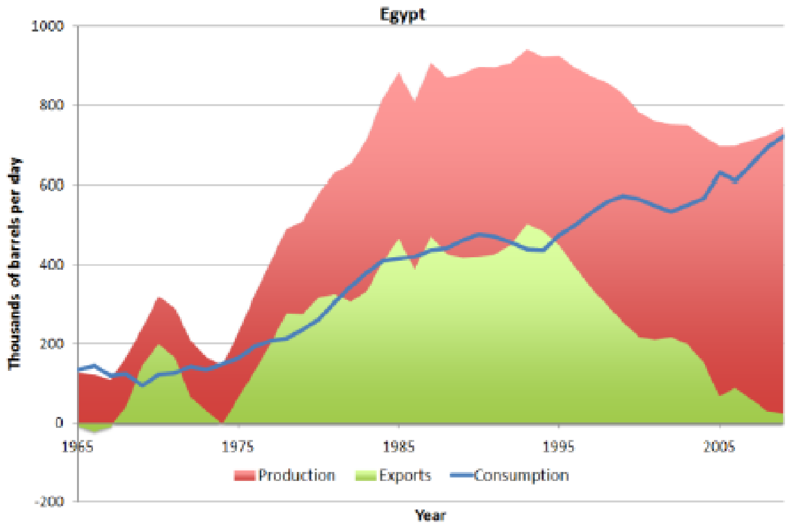
It is a grim picture of the decline in farmland, urban growth having made major in-roads into land with the best soils and climate. Southern Ontario and the Saint Lawrence Lowlands were in greatest jeopardy with half of the farmland lost to urban expansion coming from the best one-twentieth of Canada's arable land. The Report noted agricultural land cannot ever command the same prices for continuing agricultural use as it can for almost any urban-related use. It urged that the best agricultural land be designated exclusively for agricultural use, a recommendation seldom acted upon as prime land and wild and wetlands are devoured at a relentless pace. The extent of this loss was captured in a 2005 Statistics Canada report, based on census data and the Canada Land Inventory, and included the following:

- in 2001, there was another 14,300 sq. kms of urban land absorbed from agriculture use.
- the Niagara peninsula and Okanagan Valley fruit belts had lost farmland used to grow crops that cannot be grown elsewhere in Canada;
- as prime agricultural land diminished, demand for arable territory increased, forcing farmers to cultivate poorer quality soils.
- in 1971, urban areas occupied slightly less than 6% of Class 1 land in Ontario. By 2001, they occupied 11% of such land; in 1971, less than 2% of Alberta’s Class 1 land was urbanized a figure that is now more than 6%.

Below we compare Canadian and Egyptian statistical numbers because many in the world like to think the breadbaskets of the world are infallible to continuing to feeding the world without being aware of the ever connecting, numbers of risks, which suggest Canada could be far more likely to endure what Egypt already has, than we would care to give a second thought to.

Cdn. Population 1960 17.87 million

- Population 2012 33.9 million
- Growth rate 1.238% or 1,137 people daily.
- Water: 7% of the world's supply of fresh water but 60% of its water flows north to the Arctic Circle so where we use water by world standards we are average.
- Only 13% of land (294 m. acres / 118.9 m. Ha) was judged suitable for agriculture.
- Arable land per capita: 3.5 Ha
  - **Canada's exports of processed food products exceed imports by about 30%. In 2003, Canada exported $16.8 billion worth of processed food products and imported $12.6 billion.** http://www.statcan.gc.ca/pub/15-515-x/2004001/4064688-eng.htm



Compare Canada With Egypt

Egypt: ***The relentless math:***

- Population 1960: 27.8 million
  Population 2008: 81.7 million
  Current population growth rate: 2% per annum (a 35-year doubling rate)
  Population in 2046 after another doubling: 164 million
- Rainfall average over whole country: ~ 2 inches per year
  Highest rainfall region: Alexandria, 7.9 inches per year
  Arable land (almost entirely in the Nile Valley): 3%
  Arable land per capita: 0.04 Ha (400 m2)
  Arable land per capita in 2043: 0.02 Ha
  Food imports: 40% of requirements
  Grain imports: 60% of requirements

Oil production peaked in 1996
Net oil exports: Began falling in 1997, went negative in 2007
Cost of oil rising steeply
Cost of oil and food tightly linked

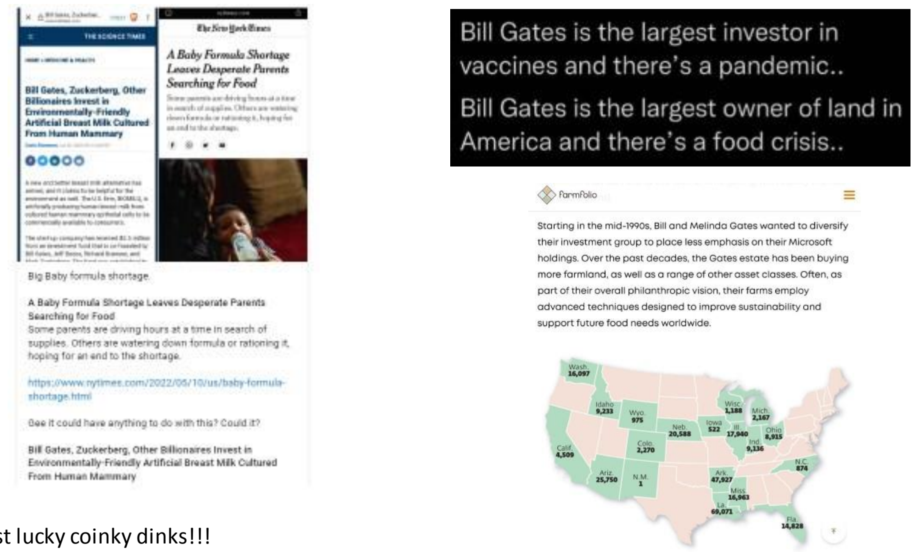
We will look at some statistics more granularly to perhaps bring things closer to where you live.

A land development study in Red Deer County, Alberta, came up with the following numbers: Residential development cost the county $1.81 for every $1.00 in tax revenue, compared to only 70 cents in costs for agricultural land.

It was thought stopping this long trend and bucking these market forces can only be done three ways: prevent farmers from selling to developers; prevent land from being developed; or have someone else (usually a public agency) buy and preserve the land. Land trusts have sprung up all over. The Southern Alberta Land Trust Society is an example; it was started by a group of ranchers in 1997 to buy conservation easements on ranch land. But currently we have multinational corporations and the wealthiest billionaires buying agricultural land like there is no tomorrow.

Three Large American Multinationals Bought 17 Million Hectares of Ukrainian Agricultural Land: Cargill, Dupont and Monsanto. Among the main shareholders of these three companies are Vanguard, Blackrock, Blackstone. **(www.australiannationalreview.com)**https://www.australiannationalreview.com/lifestyle/three-large-american-multinationals-bought-17-million-hectares-of-ukrainian-agricultural-land/

Billionaire-funded eco group quietly taking farmland out of production in rural America https://news.yahoo.com/billionaire-funded-eco-group-quietly-060014105.html



…just lucky coinky dinks!!!

https://www.shtfplan.com/headline-news/globalists-have-been-planning-to-starve-the-world-with-food-scarcity-since-at-least-2015

Bill Gates now owns 242 THOUSAND acres of US Farm Land see https://farmfolio.net/articles/why-is-bill-gates-investing-in-farmland-how-much-does-he-own/

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The sometimes-stormy success of the B.C. Agricultural Land Reserve served as a guide to Quebec's establishment of a similar commission in the late 1970s. It also informed the Ontario government's 2005 Greenbelt Plan to protect farmland and undeveloped land from urban expansion in the Golden Horseshoe (from the Niagara region in the south, to cities such as Toronto, Hamilton and Peterborough). Ontario's Greenbelt Plan prevents non-agricultural uses on lands designated as "prime agricultural areas" or "specialty crop areas." Encompassing 1.8 million acres, it is the largest and most diverse greenbelt in the world. But whereas perhaps BC led, we all too often lose sight of great wisdom.

Only about five percent of the massive province of B.C. is agricultural land, and only part of that has good soil. During the 1960s, we were losing between 4,000 and 6,000 hectares of arable land every year to development in the prime valley bottoms and river deltas. Urban intrusion onto agriculture land was particularly rampant in the lower Fraser River Valley, on the outskirts of fast-growing Metro Vancouver.

In 1973, the provincial government created the Agricultural Land Reserve (ALR), which stopped the building of subdivisions on land designated as agricultural. The government identified lands for agriculture based on the capability of the land, its current use, local zoning, and input from public hearings. Five percent of the province (4.7 million hectares) ended up in the reserve — lands deemed most critical for the province's food production, where non-agricultural uses would no longer be allowed.

In 2014 the Ministry of Agriculture estimated BC would need another 225,000 acres of irrigated farmland to produce a healthy diet for people just in B.C. in 2025 (meaning self-sustaining). What BC preserved with one policy in one department, they are preparing for a net loss with another policy from the energy department as they prepare to dam and flood thousands of food producing hectares on the Peace River with Site C. When they realize, more hydro-electricity was not a good trade–off for food production and ecology, we believe Site C will be seen as another terrible mistake – but connecting all these dots is difficult work. See http://www.cbc.ca/player/News/ID/1473324394/ Parks Canada says BC Hydro's two existing dams on the Peace River have damaged the "ecological integrity" of globally significant wildlife habitat downstream and that any environmental assessment of the planned Site C dam should include cumulative impacts but it's a case lost as Site C is a tragedy being played out.

In a written submission to a Joint Review Panel that held public hearings on the $7.9-billion mega-project, Parks Canada notes that downstream of the dams in northern Alberta lies Wood Buffalo National Park, a World Heritage Site that protects 80 per cent of the 5,000-square-kilometre Peace-Athabasca Delta.

The W.A.C. Bennett and Peace Canyon dams, built in 1967 and 1980, respectively, have altered the surface hydrology of the delta by reducing the magnitude and frequency of summer floods and "ice jam flood events," Parks Canada says. ... http://www.vancouversun.com/news/Parks+Canada+voices+concerns+about+downstream+impact+Site/9265004/story.html

Take an apple and pretend it is the Earth. Now, 75% of the world is water, so cut it in quarters and throw away 3 slices. Cut the remaining quarter in half and throw one chunk away because 50% of dry land is mountains, desert etc. Now cut the 12.5% you have left in half, because that land is too steep, rocky, or wet for food production. Less than the 6% of skin you have left has to grow all of the world's food. Only a small portion of that is Class 1.

Data from the World Bank shows that arable land per capita has been declining globally for 40 years. This has been true in most countries, especially the so called juggernauts of India and China. But we have compensated for that decline, with fertilizer. As Julian Cribb points out "billions of people would not be alive today, were it not for the invention of the industrial process for making nitrogen fertilizer from natural gas." This process consumes over 5% of the worlds natural gas production today and there is a great deal of competition for natural gas supply and I expect the result will inevitably be dramatic natural gas price increases from 2021 onward.

National Geographics Aug 2014 "Hunger In America" Excerpts:

"The topic turned to Clevelands lake effect which dumps about 68 inches of snow on the city each year. 'The kids must love all the snow days,' I joked. The room went silent. People exchanged glances. 'We try never to close the schools,' one man finally said. 'When we do, a lot of kids won't eat.'

Hunger in America doesn't look like the Dorothea Lange photos of hollow-eyed unemployed people during the Depression, but it is hunger even so. These days the hungry are often 'white, married, clothed, and suburban housed, even a bit over-weight,' writes Tracie McMillan…

'There is a hidden crisis', says Eric Gordon, chief executive officer for the Cleveland Metropolitan School District, where 45,000 free meals are served daily from kindergarden through 12th grade. 'If you take us out of the picture, there are a lot of kids who won't eat'. Our society, Gordon says, has chosen to ignore this reality…

In 2006 the U.S. government replaced "hunger" with the term "food insecure" (although I submit the victims would argue they remain hungry despite another new "politically correct" term has been put in place to what avail?) to describe any household where, sometime during the previous year, people didn't have enough food to eat. But whatever the name, the number of people going hungry has grown dramatically in the U.S. (and yes likewise Canada) *increasing to 48 million by 2012* (about 15% of the population) *– a fivefold jump since the late 1960's, including an increase of 57 percent since the late 1990's. Privately run programs like food pantries and soup kitchens have mushroomed too. In 1980 there were a few hundred food emergency programs across the country; today there are 50,000. Finding food has become a central worry for millions of Americans. One in six reports running out of food at least once a year.*

To witness hunger in America today is to enter a twilight zone where refrigerators are so frequently bare of all but mustard and ketchup that it provokes no remark, inspires no embarrassment. Here dinners are cooked using macaroni-and-cheese mixes and other processed ingredients from food pantries, and fresh fruits and vegetables are eaten only in the first days after the SNAP/food stamp payment arrives…

If you are really hungry, then how can you be – as many are – overweight? The answer is ' the paradox that hunger and obesity are two sides of the same coin' says Melissa Boteach, vice president of the Poverty and Prosperity Program of the Center for American Progress, 'people making trade-offs between food that's filling but not nutritious and may actually contribute to obesity.' For many of the hungry in America, the extra pounds that result from a poor diet are collateral damage – an unintended side effect of hunger itself.

The Canadian Diabetes Association warns that the economic burden of diabetes in Canada could escalate to nearly $17 billion by 2020, an increase of more than $10 billion from 2000. Nearly 10% of all Canadians risk getting or having diabetes by 2020.

Statistics Canada found that 26% of children aged 6 to 11 are overweight or obese. The percentage rises to 28% for Canadian teenagers and a staggering 61% for Canadian adults.

The largest grocery retailer in Canada is Loblaw. They are also the biggest private-sector employer in Canada. When their CEO, Galen Weston, spoke at the 2009 Global Politics of Food conference he cited soaring health care costs as a reason his stores are planning to be on the good side of the food revolution: "We're looking at unsustainable health care costs, 70% of them driven by behaviors, with diet a driving force in 75% of diseases." Americans spent almost $300 billion at supermarkets in the past year, with the #1 item being carbonated beverages, which clocked in at about $12 billion.

As the face of hunger has changed, so has its address. The town of Spring, Texas, is where ranchland meets Houston's sprawl, a suburb of curving streets and shade trees and privacy fences. The suburbs are the home of the American dream, but they are also a place where poverty is on the rise. As urban housing has gotten more expensive, the working poor have been pushed out. (See https://www.zerohedge.com/markets/falling-mortgage-rates-drive-9-jump-home-prices-70-us-unaffordable-average-worker)

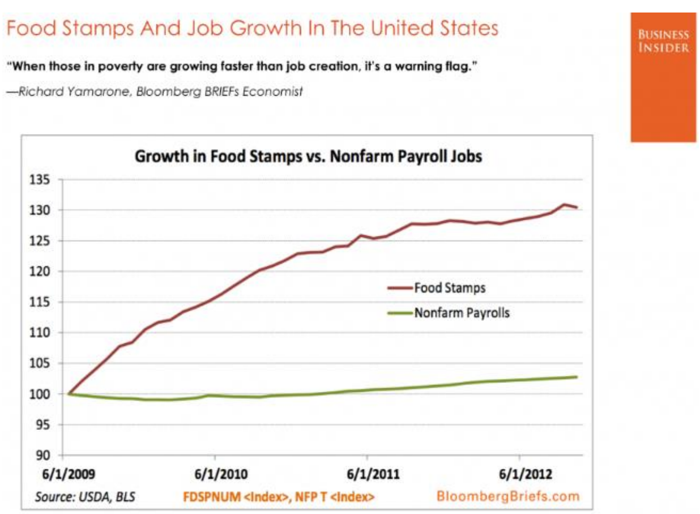
Today hunger in the suburbs is growing faster than in the cities, having more than doubled since 2007.

Yet in the suburbs America's hungry do not look the part either. They drive cars, which are a necessity, not a luxury here. Cheap clothes and toys can be found at yard sales and thrift shops, making a middle-class appearance affordable. Consumer electronics can be bought on installment plans, so the hungry rarely lack phones or televisions. Of all the suburbs in the country, northwest Houston is one of the best places to see how people live on what might be called a minimum-wage diet…

Of course, it is possible to eat well cheaply in America, but it takes resources and know-how that many low-income Americans don't have…

Those priorities are reflected at the grocery store, where the price of fresh food has risen steadily while the cost of sugary treats like soda has dropped. Since the 1980s the real cost of fruits and vegetables has increased by 24 percent. Meanwhile, the cost of non-alcoholic beverages – primarily sodas, most sweetened with corn syrup – has dropped 27 percent…

More than 48 million Americans rely on what used to be called food stamps, now SNAP: the Supplemental Nutritonal Assistance Program. In 2013 benefits totaled $75 billion, but payments to most households dropped; the average monthly benefit was $133.07 a person, less than $1.50 a meal…Who qualifies for SNAP? Households with gross incomes no more than 130 percent of the poverty rate."



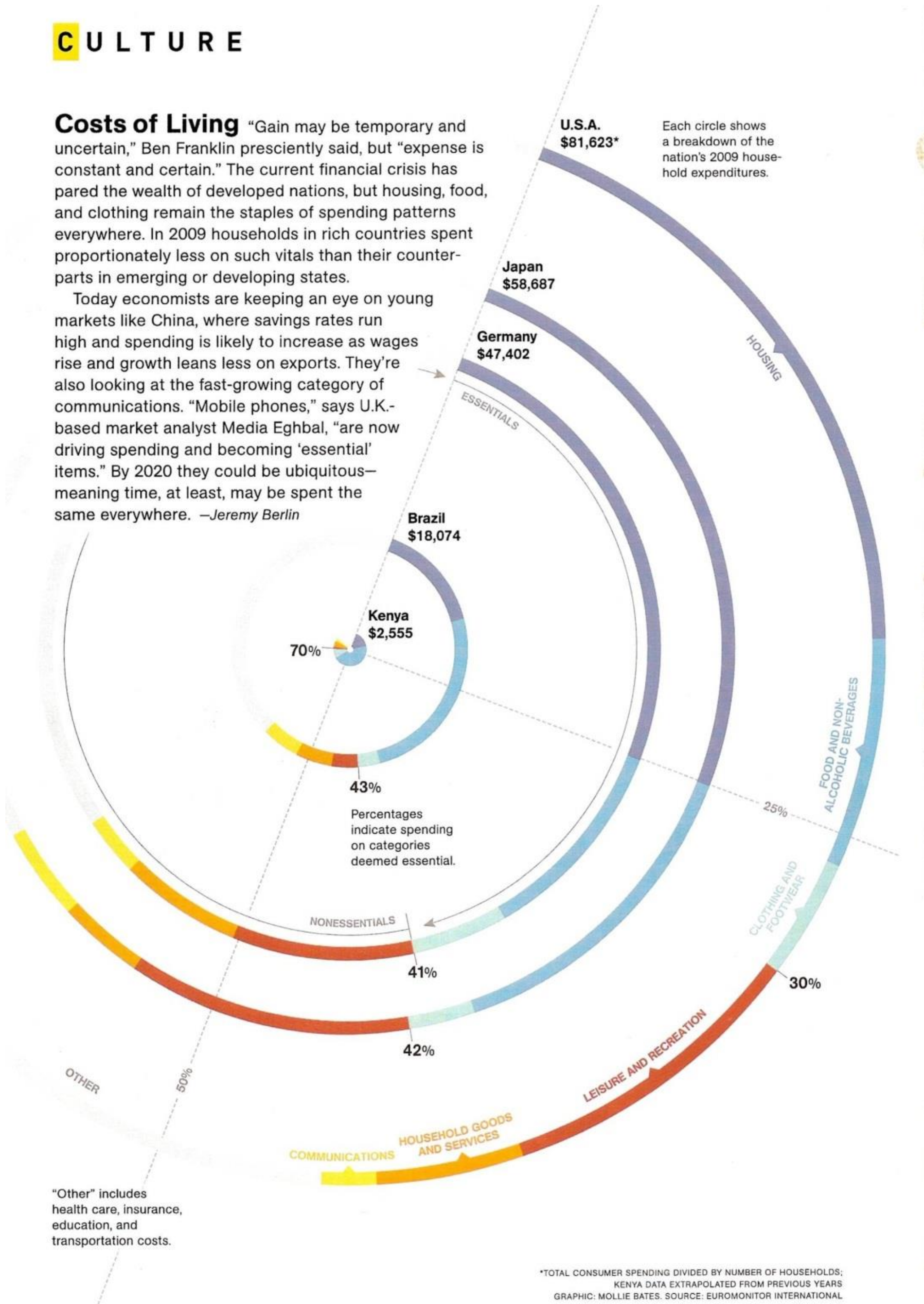
New research from the Urban Institute shows that the supply of housing for extremely low-income families, which was already in short supply, is only declining. In 2013, just 28 of every 100 extremely low-income families could afford their rental homes. That figure is down from 37 of 100 in 2000 — a 25 percent decline over a little more than a decade. http://www.citylab.com/housing/2015/06/every-single-county-in-america-is-facing-an-affordable-housing-crisis/396284/

Using data from the Census Bureau and the U.S. Department of Housing and Urban Development, researchers built an interactive map to illustrate the nationwide reach of the problem. In no county in the U.S. does the supply of affordable housing meet the demand among extremely low-income households. (Families who made no more than 30 percent of an area's median household income were considered "extremely low income.")

Oil use in food production has also delivered something many of us in our everyday lives take for granted — cheap food.

In the United States today, an average of 9.9 percent of disposable income is spent on food; 80 years ago, it was 25 percent. German consumers on average spend 10.9 percent of their disposable income on food at home, followed, among high-income countries by Japan (13.4 percent), South Korea (13.4 percent), and France (13.6 percent), and in middle-income countries by South Africa (17.5 percent) and Mexico (21.7 percent). China (28.3 percent) and Russia (36.7 percent) are seeing rapid decreases, but the percentage of income spent on food is still relatively high. India (39.4 percent) and Indonesia (49.9 percent) are among the highest when it comes to the amount of disposable income spent on food.

Only farming that nourishes Nature and supports biological activities, efficient use of water, climate, seeds, breeds and naturally developed soils — rather than industrial agricultural that creates deserted monotonous landscapes and relies on external energy — can guarantee food for all: now and in the future" — Laureates of the Right Livelihood Award, "Declaration for Living Change"



CULTURE

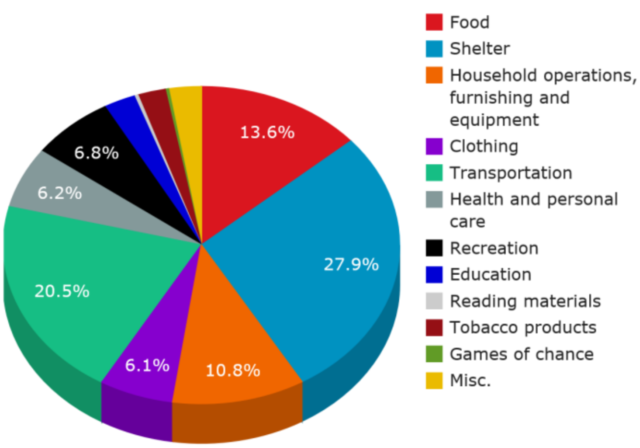
Costs of Living "Gain may be temporary and uncertain," Ben Franklin presciently said, but "expense is constant and certain." The current financial crisis has pared the wealth of developed nations, but housing, food, and clothing remain the staples of spending patterns everywhere. In 2009 households in rich countries spent proportionately less on such vitals than their counterparts in emerging or developing states.

Today economists are keeping an eye on young markets like China, where savings rates run high and spending is likely to increase as wages rise and growth leans less on exports. They're also looking at the fast-growing category of communications. "Mobile phones," says U.K.-based market analyst Media Eghbal, "are now driving spending and becoming 'essential' items." By 2020 they could be ubiquitous—meaning time, at least, may be spent the same everywhere. —*Jeremy Berlin*

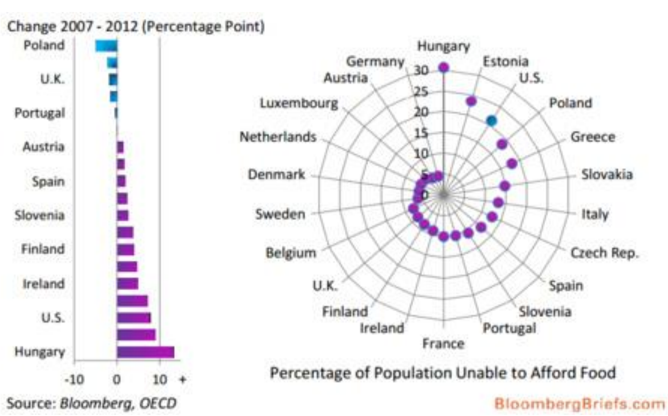
In Canada we spent 24% of our income on food in 1960 versus 11% in 2010. Only 3 years later food moved up to 13.6%.

Survey of household spending

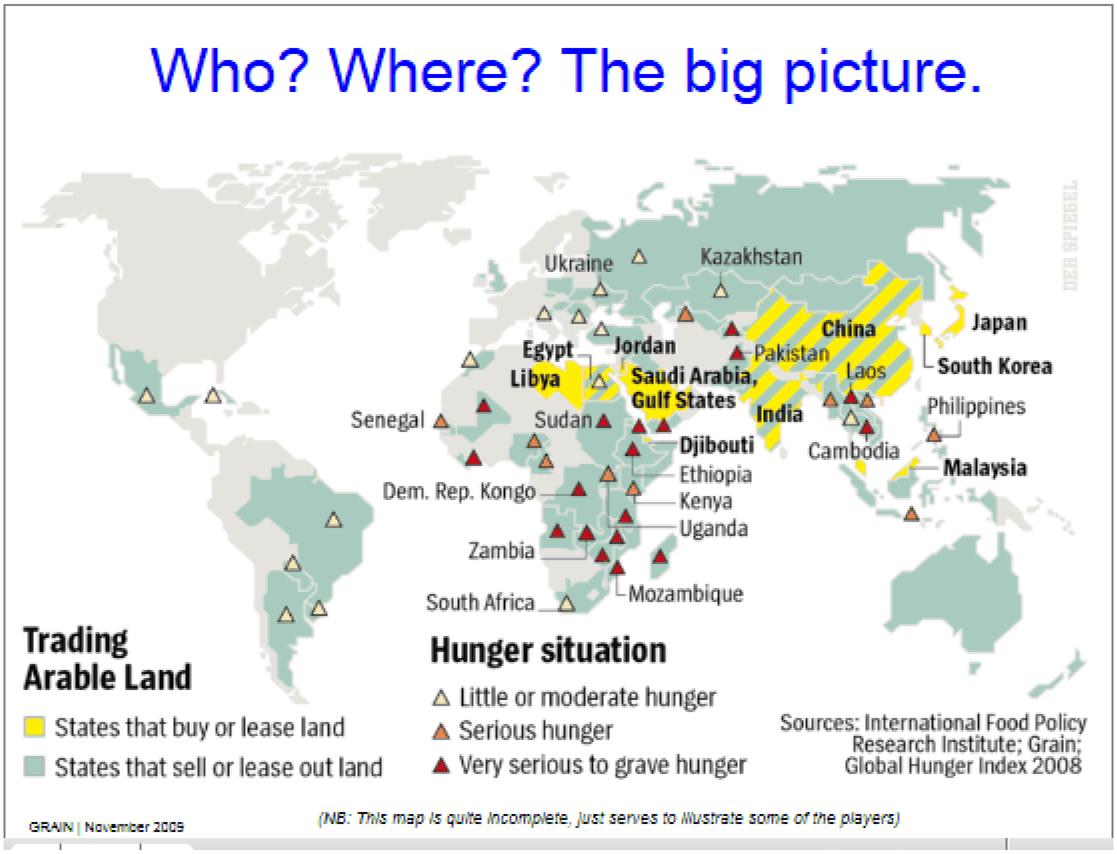
This is a breakdown of Canadian household spending in 2013, which amounts to an average of $58,592 per household. This includes money spent on goods and services but does not include income tax, insurance and pension contributions or gifts of money or charitable contributions.



Whenever I note that real median incomes in North America have not increased for decades, many people have a hard time believing it. Nevertheless, as John Adams famously proclaimed: “facts are stubborn things.” Indeed they are, and an article (https://www.bloomberg.com/opinion/articles/2015-04-10/the-u-s-middle-class-poorer-than-you-think) provides some disturbingly stubborn facts that must be admitted to and faced.



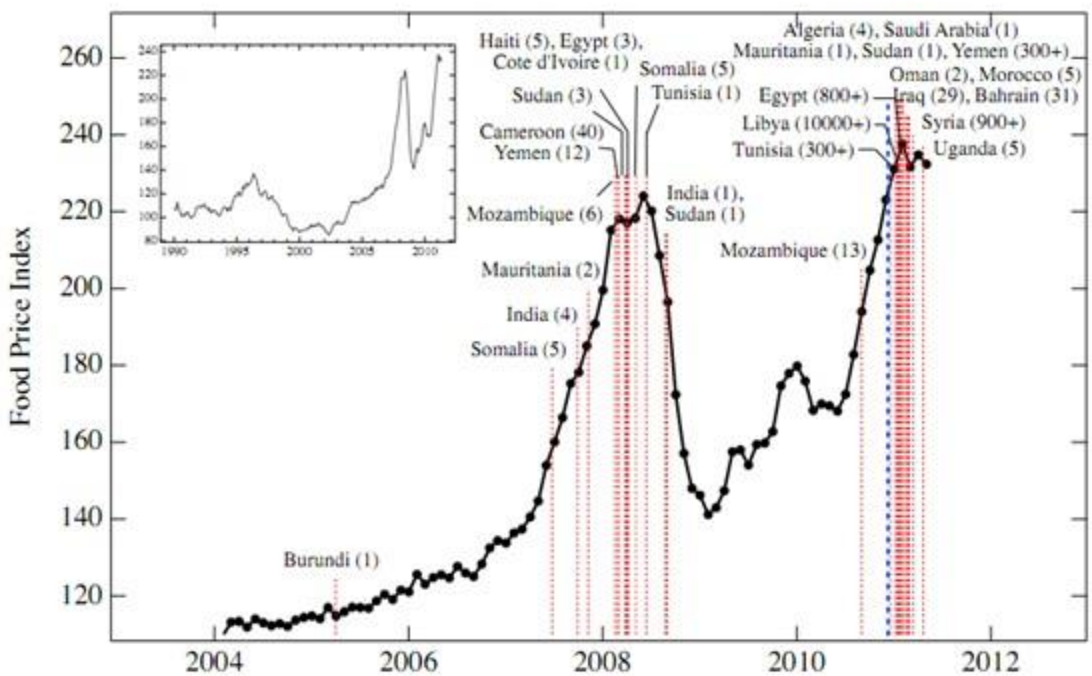
On the right, percentage of the population which cannot afford food, by country (on the left, change 2007-2012). Source : Bloomberg / OECD.



Globally, an estimated 963 million people — or about 15% of the world's population — were undernourished in 2008. In March of that year, riots broke out from Haiti to Bangladesh to Egypt as people were hit with annual price increases of 130% for wheat, 87% for soy, 74% for rice, and 31% for corn. Food shortages and price increases in 2009 sent another 75 million people into the ranks of the hungry.

Food Prices & Unrest Plotted

The MIT Technology Review the results of such price shocks: "The evidence comes from two sources. The first is data gathered by the United Nations that plots the price of food against time, the so-called food price index of the Food and Agriculture Organization of the UN. The second is the date of riots around the world, whatever their cause." Plot the data, and it looks like this:



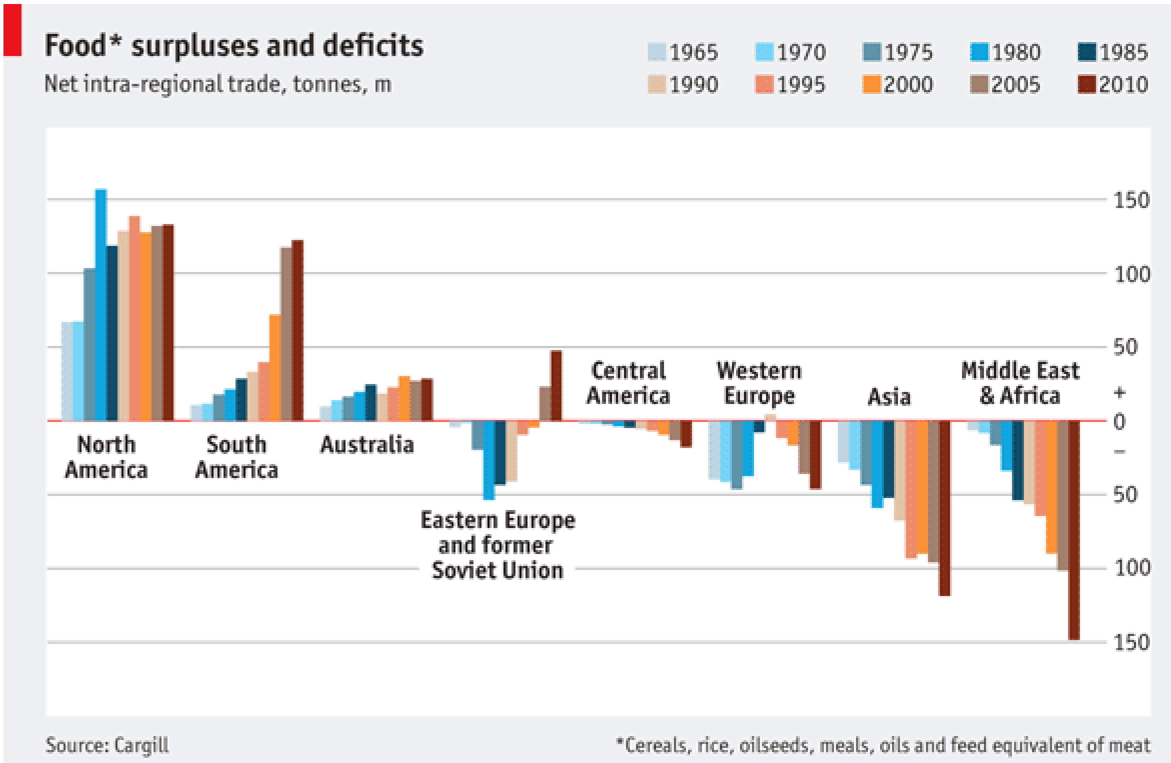
As George Monbiot stated "people do not riot for austerity", but "when they have nothing to lose, they lose it" adds Gerald Celente.

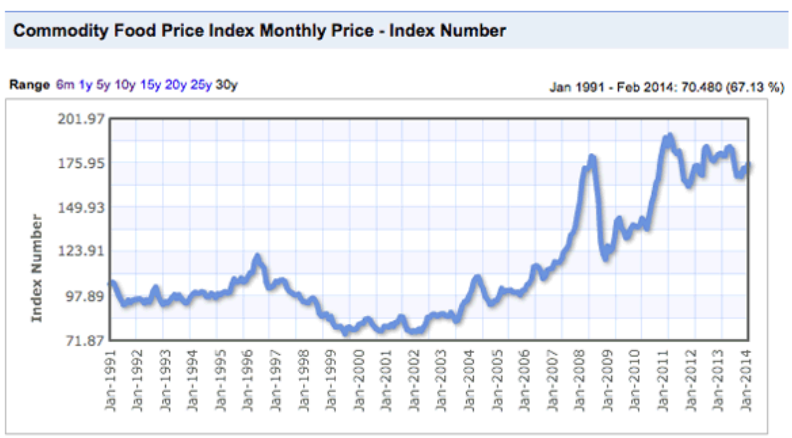
A drought in Russia in 2010 triggered a ban on wheat exports — part of a disturbing trend of food-producing nations protecting supplies for domestic needs. As the world's population keeps growing and consuming resources faster than they can be replaced, future food shortages and price hikes are inevitable. In 2010, the food price index hit record highs, and the United Nations' Food and Agriculture Organization estimates that food production will have to increase 70% by 2050 to feed a world population that's supposedly headed to 9.1 billion people (from 6.8 billion in 2010).

There are some that put forward the wealthiest almost always benefit from chaos (i.e. Ukraine is continually destabilized and the worlds largest multinationals buy up millions of acres of bread basket lands from formerly family farms)

World Sources of Food

According to Cargill, from 1965 until 2010 only North America, South America and Australia have produced ongoing surpluses of wheats, grains, rice and meals for export. All others, Russia, Europe, Asia, Africa and the Middle East have become importers.





Description: Commodity Food Price Index, 2005 = 100, includes Cereal, Vegetable Oils, Meat, Seafood, Sugar, Bananas, and Oranges Price Indices

In 2009–2010, Australia had its first year as a net importer of food — and that was before the Queensland floods of 2010 that ruined thousands of acres of agricultural land.

The changes in imports and exports reflect the shrinking land base for agriculture, as agricultural lands around city edges get turned into housing lots and pavement.

Although the United States rightfully prides itself as the breadbasket of the world, in 2006 — for the first time — the value of food imported into the United States exceeded the value of food exported from the United States.

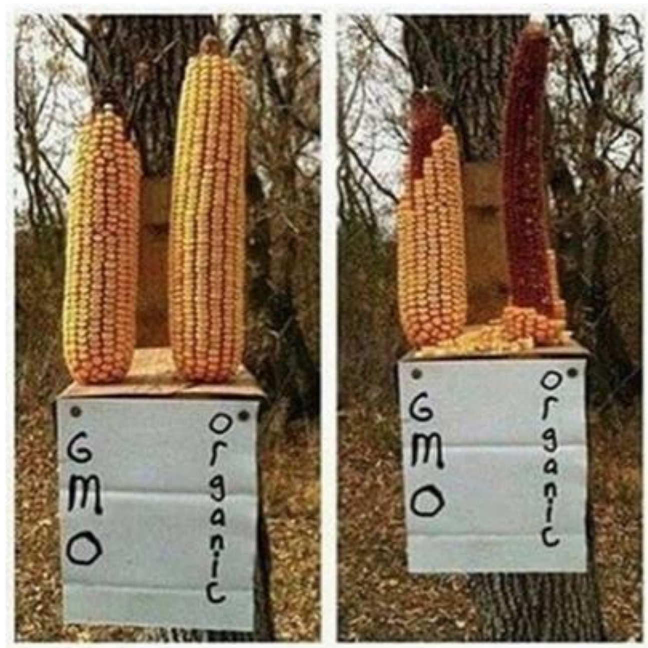
In the United States in 2009, almost 30% of the grain harvested went to ethanol distilleries to produce fuel for cars. That's enough food to feed 350 million people for a year. Who dreamt up that nightmare of a subsidized fuel policy and why!!

Science Prevented The Last Food Crisis. Can It Save Us Again?

Why GM crops will not feed the world

In a marked tipping point for rising global food prices Haiti's Prime Minister was ousted amid rice riots; Mexican tortillas have quadrupled in price and African countries were hit especially hard. According to the World Bank, global food prices rose a shocking 83 percent from 2005 to 2008. And for the world's poor, high prices mean hunger. In fact, the food crisis recently prompted University of Minnesota food experts to double their projection of the number of the world's hungry by the year 2025—from 625 million to 1.2 billion.

Many in the biotechnology industry (for obvious self-serving purposes) promote there is a simple solution to the global food crisis: genetically modified (GM or biotech) crops. Biotech multinationals have been in media blitz mode ever since the food crisis first made headlines, touting miracle crops that will purportedly increase yields, tolerate drought, and cure all manner of ills.



Not everyone is convinced, not even small brained squirrels as the picture to the right shows.

National Geographic, Oct 2014

"Modern supercrops can be (might) a big help. But agriculture can't be fixed by biotech alone."

…Half a century ago disaster loomed ominously… Speaking about global hunger at a meeting of the Ford Foundation in 1959, an economist said 'At best the world outlook for decades ahead is grave; at worst it is frightening'…Before those grim visions could come to pass, the green revolution transformed global agriculture, especially wheat and rice. Through selective breeding (and applying natural gas derived nitrogen and mined prosperous), Norman Borlaug created a dwarf variety of wheat that put most of its energy into edible kernels rather than long, inedible stems. The result: more grain per acre…

From the 1960s through the 1990s, yields of rice and wheat doubled. Even as the population dramatically increased grain prices fell…the poverty rate was cut in half. When Borlaug won the Nobel Peace Prize in 1970, the citation read 'More than any other person in this age, he helped provide bread for a hungry world'…

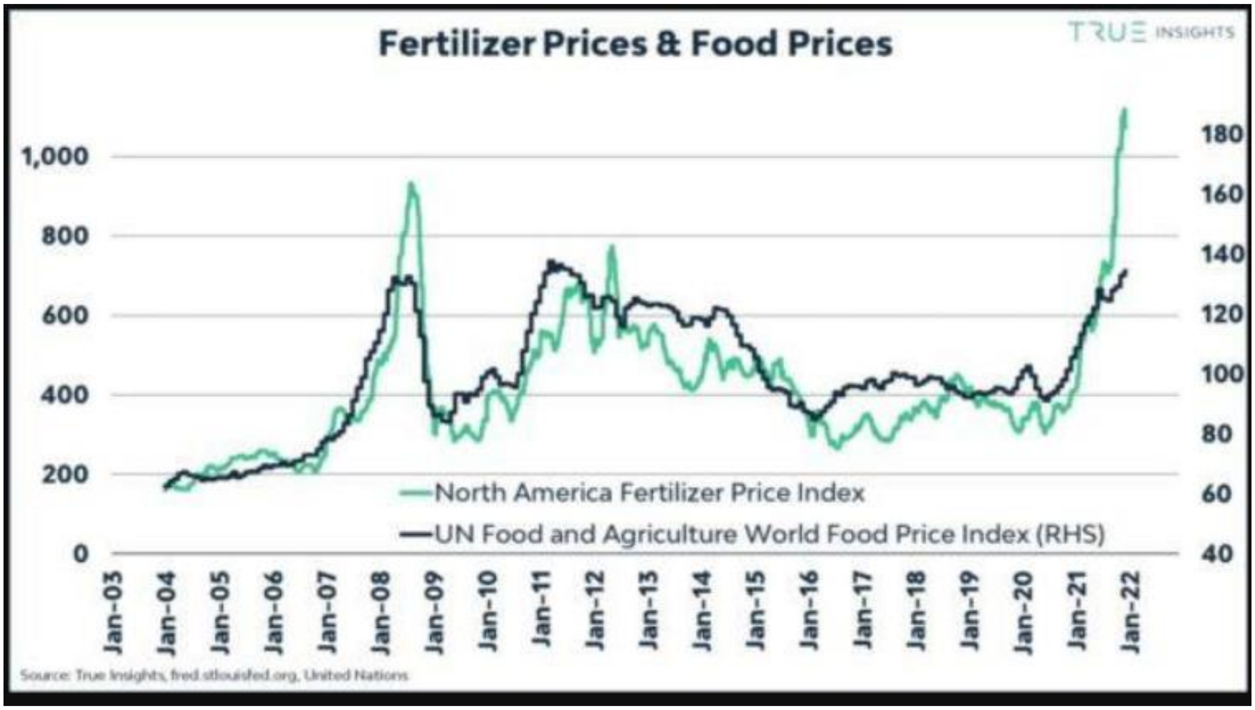
Energy used in the food system accounted for 80% of the increase in American energy use between 1997 and 2002 according to the USDA's Economic Research Service. Putting food on the plate of the average American required 2.4 million BTU more in 2002 than in 1997. To put that in context, total per capita energy consumption of 20 nations was less than 2.4 million BTU in 2002. How does the way we eat have such a big effect on the amount of energy we use? According to this report, about half the change is due to increased use of labour-saving devices (technology which leads to less employment), with the remainder being split between population growth and changing food choices.

The USDA estimates that about half of the fertilizer used each year simply replaces soil nutrients lost by topsoil erosion. This puts us in the odd position of consuming fossil fuels – geologically one of the rarest and most useful resources ever discovered – to provide a substitute for soil – the cheapest and most widely available agricultural input imaginable. We have forgotten the wisdom of best practices developed over a century ago: http://www.resilience.org/stories/2015-05-21/soil-science-spelled-it-out-a-whole-century-ago

In his 1970 Nobel Peace Prize acceptance speech, Norman Borlaug, credited synthetic fertilizer production for dramatic increases in crop production. "If the high-yielding dwarf wheat and rice varieties are the catalysts that have ignited the Green Revolution, then chemical fertilizer is the fuel that has powered its forward thrust." Without cheap fertilizers – and the cheap fossil fuels used to make them – this productivity cannot be sustained.

Agribusiness now represent perhaps the largest, highest potential opportunity landscape on the planet. Two historically unprecedented convergences (nexus) are now colliding at the world's busiest intersection: the intersection of Clean Tech/Life Sciences, and the intersection of the **Global Food, Energy & Water Crises.**

According to FAO's new report "World fertilizer trends and outlook to 2018": Global use of nitrogen fertilizers tripled between the Second World War and 1960, tripled again by 1970, and then doubled once more by 1980. The ready availability of cheap nitrogen led farmers to abandon traditional crop rotations and periodic fallowing in favor of continuous cultivation of row crops. For the period from 1961 to 2000, there is an almost perfect correlation between global fertilizer use and global grain production. Soil productivity became divorced from the condition of the land as industrialized agrochemistry ramped up crop yields. The shift to large-scale monoculture and increasing reliance on fertilizer segregated animal husbandry from growing crops. Armed with fertilizers, manure was no longer needed to maintain soil fertility. **Without cheap fertilizers through cheap natural gas – and the cheap oil and used to make them – this productivity can't be sustained. At present, agriculture consumes 30 percent of our fossil fuel use. As supplies dwindle, oil and natural gas will become too valuable to use for fertilizer production. "Fossil fuel based industrial agriculture will end sometime later this century"** states David Montgomery in his book Dirt: The Erosion of Civilizations.



Some basic energy costs:

- One metric ton of cement = 5.1 GJ
- One metric ton of glass = 5.3 GJ
- One metric ton of steel = 21.3 GJ
- One metric ton of aluminum = 64.9 GJ
- One MT of nitrogen fertilizer = 78.2 GJ
- One MT of phosphorus fertilizer = 17.5 GJ
- One MT of potassium fertilizer = 13.8 GJ

Source: R. L. Jaffe and W. Taylor Energy info card, Physics of energy 8.21, Massachusetts Institute of Technology.

In case the reader is unaware, very little food is grown without prescribed levels of nitrogen, phosphorus and potassium. For each plant Mother Nature strictly dictates what can be grown and has proven rather non-negotiable on the matter.

In the USA in 2004, 317 billion cubic feet of natural gas were consumed in the industrial production of ammonia for the making of nitrogen fertilizer; less than 1.5% of total U.S. annual consumption of natural gas. The production of ammonia consumes about 5% of global natural gas consumption.

"Approximately 80-90% of the cost of producing nitrogen fertilizer is the cost of natural gas" says Richard Downey, Vice President of Agrium (now Nutrium) in the Globe and Mail on Sept 11, 2013. Given this cost relationship, it only stands to reason that Nutrium and other fertilizer manufacturers would make it their business to be among the best in anticipating where the price of natural gas might be going, in any geography. Given that fossil fuel fertilizers made the green revolution possible, and thus population expansion from 1 to 6 billion possible, it is unfathonable to us, that anyone would argue against its juggular importance.

Until recently, the trend toward inexpensive natural gas through the great shale gas reprieve in North America was thought to re-incentivize and relocalize fertilizer production especially considering limiting the demand for fertilizer imports from places such as the Middle East, Eastern Europe and parts of South Africa. The majority of the nitrogen fertilizer used in North America is imported. But…

"The world needs two to three nitrogen plants built per year at a minimum just to meet growing global demand and historically that has tended to be built in the Middle East or some other areas where there's (been) trapped gas" explains Downey.

Cheap natural gas in North America was going to enable the rebuilding of North American fertilizer manufacturing capacity, but of late plans have been "postponed". In June 2013, Agrium/Nutrium announced it would delay its multimillion-dollar expansion builds. In the same month, Norway's Yara – the world's largest fertilizer producer – postponed its $2 billion expansion plan in Belle Plaine, Sask. What are these expert natural gas buyers on to? We suspect they are mining the data that points out, all the issues with fracking and the fact that LNG terminals will export material quantities of natural gas over the next few years, so despite the fact that Western Canada is one of the most expensive places in the world to buy nitrogen fertilizer, they have halted plans because they do not like what they see in the natural gas supply data. I read, there's a high risk of resumed, fast rising natural gas prices and therefore electricity prices - on a par to catch up with Europe and yes even Asia.

Sun- Trudeau pushes ahead on fertilizer reduction as provinces and farmers cry foul

Canadian law being ignored:

- Mandatory cuts to fertilizer use by Alberta Farmers - violation of s.95
- Mandatory emissions and production cuts to Alberta energy projects - violation of s.92A
- Bill C-69 'No New Pipelines' Law - found unconstitutional by Alberta Court of Appeal

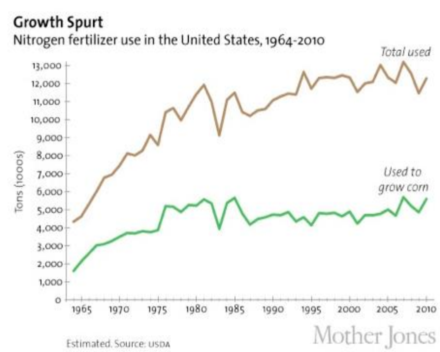
There isn't **really** a war on agriculture?

It's just a hostile takeover.

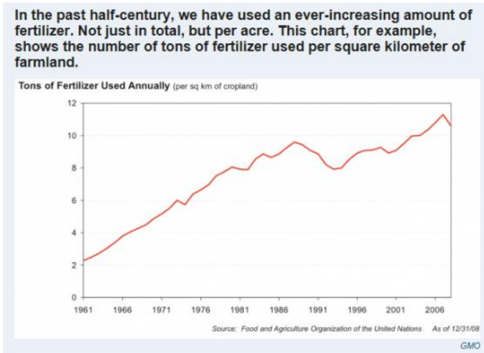
"**N. Nitrogen. Atomic number seven.** Unnoticed, untasted, it nevertheless fills our stomachs. It is the engine of agriculture, the key to plenty in our crowded, hungry world.

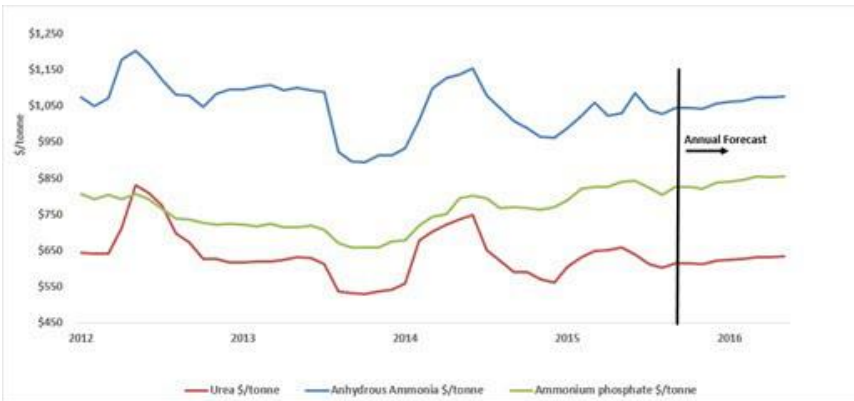
Without this independent-minded element, disinclined to associate with other gases, the machinery of photosynthesis cannot function — no protein can form, and no plant can grow. Corn, wheat and rice, the fast-growing crops on which humanity depends for survival (for over 50% of our calorific intake), are among the most nitrogen hungry of all plants. They demand more, in fact, than nature alone can provide given current world population levels and current agriculture practices.

What are current agriculture practices? Giant factories capture inert nitrogen gas from the vast stores in our atmosphere and force it into a chemical union with the hydrogen in natural gas, creating the reactive compounds that plants crave. That nitrogen fertilizer — more than two hundred million tons applied worldwide every year — fuels harvests. Without it, human civilization in its current form could not exist. Our planet's soil simply could not grow enough food to provide all seven billion of us our accustomed diet. In fact, almost half of the nitrogen found in our bodies' muscle and organ tissue started out in a fertilizer factory". National Geographic May 2013



Tom Philpott at **Mother Jones** has an in-depth look at the history of nitrogen fertilizer's development and use

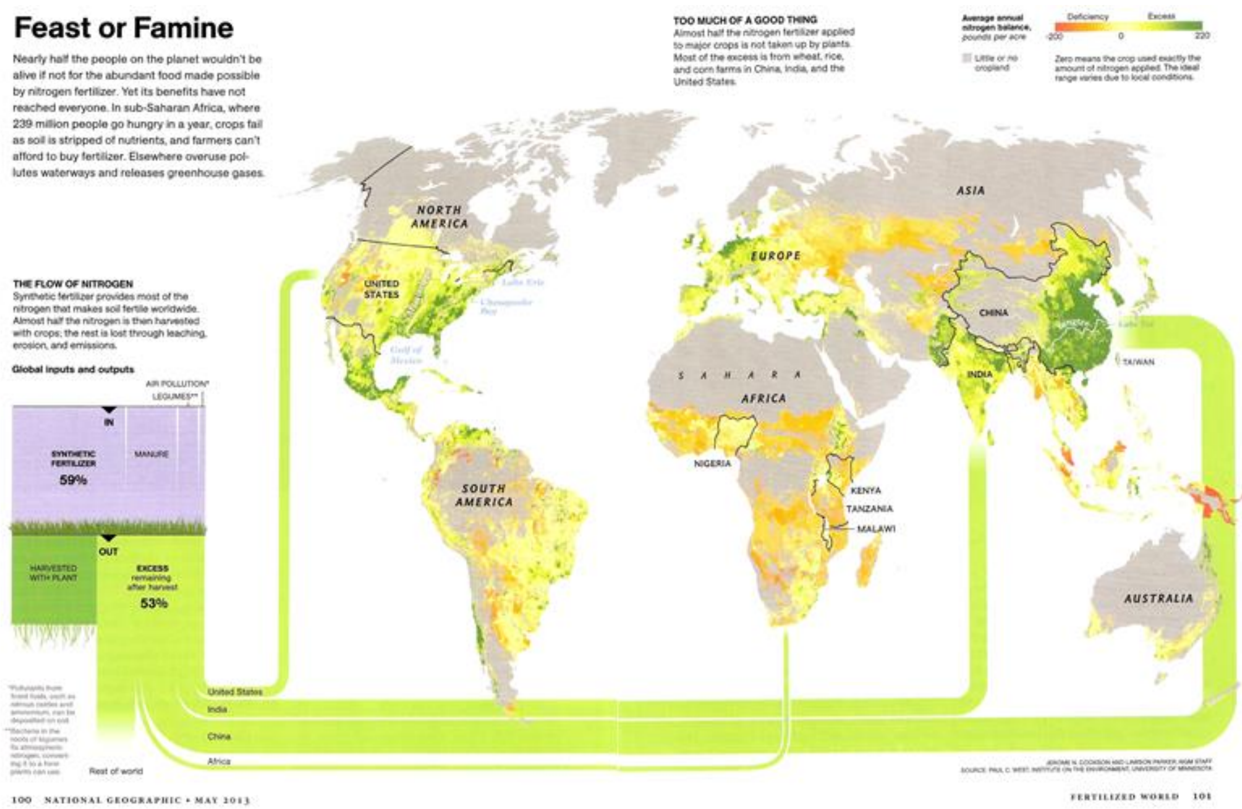




Places like the Port Lisas Industrial Estate on the Caribbean island nation of Trinidad and Tobago is where 10 natural gas-sucking ammonia plants produce about a quarter of the nitrogen fertilizer used by American farmers. Nitrogen fertilizer production is tied directly to natural gas, the energy source used to synthesize nitrogen-rich ammonia from thin air. So you could also imagine our food coming from some vast natural gas deposit in the Gulf of Mexico or off of Trinidad. Nearly as much as grain elevators or supermarkets, off-shore gas rigs count as vital food-system infrastructure. The situation is literally unsustainable. Natural gas, like oil, is a finite resource. According to a 2005 International Monetary Fund report, Trinidad's natural gas reserves "are expected to taper off by 2021."

Plants use artificial fertilizers inefficiently, and when it rains, the fertilizer ends up running off into our drinking water. More than a quarter of wells in the United States now contain levels of nitrates that are considered higher than the acceptable standard. Lakes all over Canada struggle yearly with blue green algae problems which are a direct result of excess fertilizer run off. Excess human consumption of nitrates has been linked to gastric and bladder cancers.

The water we can use is being polluted through the very agriculture that it nurtures. In the 2000 National Water Quality Inventory, states reported that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts on surveyed rivers and lakes, the second largest source of impairments to wetlands and a major contributor to contamination of surveyed estuaries and ground water. What is "nonpoint source" pollution? It is pollution that comes from a diffuse array of sources instead of a single "point," like a factory or a sewage treatment plant. Agricultural activities that cause NPS pollution include poorly located or managed animal feeding operations; overgrazing; plowing too often or at the wrong time; and improper, excessive or poorly timed application of pesticides, irrigation water and fertilizer. Pollutants that result from farming and ranching include sediment, nutrients, pathogens, pesticides, metals and salts. The consequence is widespread water pollution and degradation of our lakes, streams and groundwater. (US Environmental Protection Agency, 2005)


Feast or Famine
Nearly half the people on the planet wouldn't be alive if not for the abundant food made possible by nitrogen fertilizer. Yet its benefits have not reached everyone. In sub-Saharan Africa, where 239 million people go hungry in a year, crops fail as soil is stripped of nutrients, and farmers can't afford to buy fertilizer. Elsewhere overuse pollutes waterways and releases greenhouse gases.
TOO MUCH OF A GOOD THING
Almost half the nitrogen fertilizer applied to major crops is not taken up by plants. Most of the excess is from wheat, rice, and corn farms in China, India, and the United States.
Average annual nitrogen balance, pounds per acre
Deficiency
Excess
-200
0
220
Little or no cropland
Zero means the crop used exactly the amount of nitrogen applied. The ideal range varies due to local conditions.
THE FLOW OF NITROGEN
Synthetic fertilizer provides most of the nitrogen that makes soil fertile worldwide. Almost half the nitrogen is then harvested with crops; the rest is lost through leaching, erosion, and emissions.
Global inputs and outputs
AIR POLLUTION*
LEGUMES**
IN
SYNTHETIC FERTILIZER
59%
MANURE
OUT
HARVESTED WITH PLANT
EXCESS remaining after harvest
53%
United States
India
China
Africa
Rest of world
NORTH AMERICA
UNITED STATES
EUROPE
ASIA
CHINA
INDIA
TAIWAN
AFRICA
NIGERIA
KENYA
TANZANIA
MALAWI
SOUTH AMERICA
AUSTRALIA
100 NATIONAL GEOGRAPHIC • MAY 2013
FERTILIZED WORLD 101

Great Lakes experiencing 'new stresses' - Pharmaceutical waste, fertilizers and climate change all new threats to fresh water http://www.cbc.ca/news/technology/story/2013/03/15/wdr-great-lake-stresses.html

This satellite image shows blue-green algae on Lake Erie in 2011, the worst year for algal blooms on record. (Courtesy Essex Region Conservation Authority)

Too much nitrogen and pollution and we introduce dead spots in bodies of water which kills fish stocks and causes the proliferation of jelly fish in salt water (see http://www.bbc.co.uk/news/business-24823266 for details)

Soil is eroding off North American farmland at an alarming rate. The vast prairies — the famed North American breadbasket — have lost half their original topsoil. And erosion from agriculture continues to sweep away soils 30 times faster than new soil is being produced. Around 2 million acres of cropland go out of production every year because of erosion, soil depletion or waterlogging. Another million acres or more a year are lost to development. Because food crops drain more nutrients than natural grasses, the soil that remains is increasingly dependent on fossil fuel-based fertilizers for the big three fertilizers minus many micro-nutrients. Growing water shortages cannot help but hit agriculture hard. In Asia, 70% of all fresh water is used for growing rice. In a world where 2–5 million people already die every year from lack of potable water, the demand for fresh water will exceed supply. Half of the world's people live in countries where water tables in aquifers are failing because of over pumping. Saudi Arabia used to be self-sufficient in wheat, which was irrigated by a now-depleted fossil aquifer. From 2007–2011, Saudi wheat production dropped by two thirds.

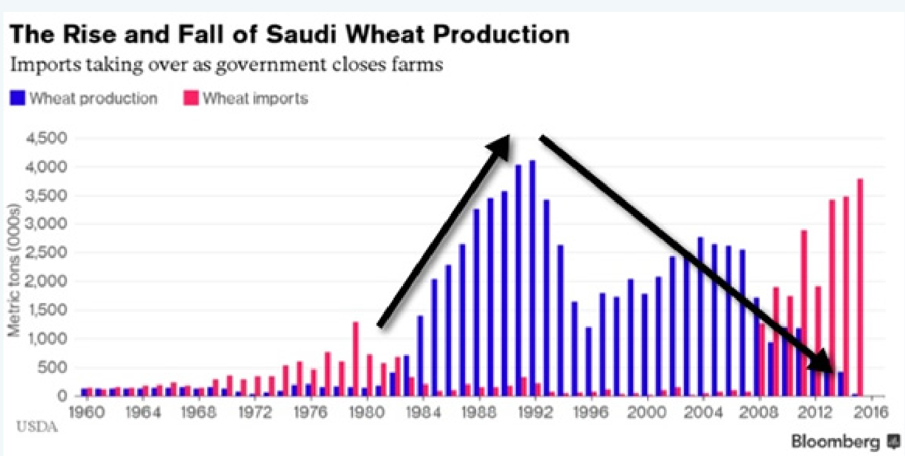
Saudi Wells Running Dry — of Water — Spell End of Desert Wheat

Nov 3, 2015

Saudi Arabia became a net exporter of wheat in 1984 from producing almost none in the 1970s. The self-sufficiency program became a victim of its own success, however, as it **quickly depleted aquifers that haven't been filled since the last Ice Age.**

In an unexpected U-turn, the government said in 2008 it was phasing out the policy, reducing purchases of domestic wheat each year by 12.5 percent and bridging the gap progressively with imports.

The last official local harvest occurred in May, although the United Nations Food and Agriculture Organization projects that a small crop of about metric 30,000 tons for traditional specialty bakery products will "prevail" in 2016. **At its peak in 1992, Saudi Arabia produced 4.1 million tons of wheat and was one of the world's top 10 wheat exporters.**



The Ogallala Aquifer, which sits in the middle of the United States, is the source of irrigation for 20% of America's farmland. It is being overdrawn by 3.1 trillion gallons a year. As available water supplies shrink, the cost of foods requiring large amounts of water is bound to go up, as does the chance that those foods will become less available.
https://www.revealnews.org/article/what-california-can-learn-from-saudi-arabias-water-mystery/

"Food be thy medicine, and medicine be thy food." - Hippocrates

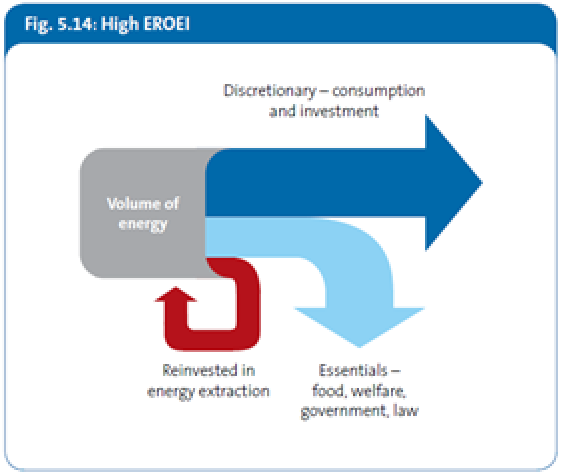
Depleted soils produce poor nutritional value foods. For example, the average potato has lost 100% of its vitamin A (important for eyesight), 50% of its vitamin C and iron (for healthy blood) and 28% of its calcium. Also gone is 50% of its riboflavin and 18% of its thiamine. Only niacin, of the seven key ingredients measured, increased. Similar results were found in 25 fruits and vegetables analyzed.

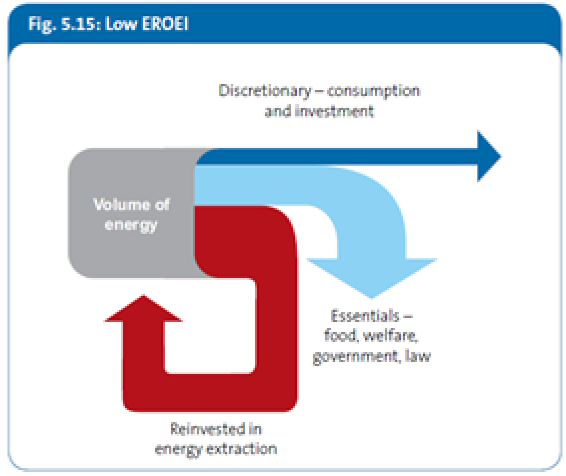
Many experts argue as it turns out, adding pesticides, fertilizers and genetically modified varieties on open-field crops is producing smaller increases in yields, sometimes even lower yields, as soil breaks down and erosion increases. Recently an article appeared titled "**Synchronized peak-rate years of global resources use**," which to the average person means nothing, and it was published in something called the Journal of Ecology and Society. What these five researchers did is look at 27 resources and tried to determine if global production had reached a peak year. And according to their work, 16 of the 17 agricultural commodities — the most important ones — their peak year of production growth occurred in 1985-2009, which is making a lot of people realize that the short-term concern for agriculture as documented in this chapter is stronger than we ever thought it was. Peak corn production in the world was in 1985. Soybeans peaked in 2009. The system is likely going to tighten dramatically.

Water irrigation makes the uninhabitable land habitable in California's Central Valley (what some used to be called Death Valley). The valley represents just under 2 percent of the country's crop, but in dollar terms it produces nearly half the nation's fruit and nuts". What does the future hold for the Valley? Only time will tell.

Year after year, through the 1960s, '70s, and '80s, California growers boasted the highest per capita income compared to any other farm group in the world, attracting even more agriculture to the Central Valley. Then one day, a funny thing happened. Actually, no one laughed. Ponds started to form by groundwater welling up from saturated aquifers, creating an artificial wet land like ecology in many localities throughout the 300-mile-long valley. Migrating waterfowl began using these newfound bodies of water to nest along their shores. But things were not what they seemed to be. Birds of all species soon began to die in large numbers. Testing revealed that many ponds were contaminated with high levels of selenium and other heavy metals, trace components of fertilizers that were being used indiscriminately by nearly every farm operation. Pesticide levels were high too. Most disturbing was the water's high salt content. The toxic groundwater had reached the bedrock below and was now headed up toward the surface; each year's flood irrigation activity brought it that much closer to the taproots of almond and citrus trees. One study published in the Proceedings of the National Academy of Sciences in 2005, gave a detailed outlook for the next twenty-five to fifty years based on current practices. The outlook was positively depressing. According to this study, failure of much of the southern half of the Great Central Valley is certain due to high salt levels in groundwater, unless another method of supplying water to crops can be implemented that does not allow runoff to accumulate in the aquifer. But finding such a method may not be possible if California runs out of water, which it might over the next number of years. The Department of Energy secretary, Nobel Prize winner Steven Chu, flatly stated three weeks after he took office in 2009 that the entire agricultural sector of California would become obsolete in short order due to lack of a source of non-contaminated fresh water: "I don't think the American public has gripped in its gut what could happen. We're looking at a scenario where there's no more agriculture in California." PBS's Bill Moyers produced a Frontline story in 1993 titled "In Our Children's Food," documenting the environmental disasters that were incubating just under the surface of the most productive agricultural site on the planet. If the Central Valley fails, then consumers the world over will feel the economic effects, as food prices will certainly go even higher than predicted based on rising fuel prices…

"For the past 5 years I have espoused a general thesis that in a post credit bubble world there is less money–less money to waste on non-essentials, less money to spend on essentials, less money to export to other countries. Seems obvious: getting more for less is key. (Always is really, but while credit and cash flow are easy many people forget about efficiency). As one of our largest necessary expenditures, energy is an obvious area of focus. Countries, like households, must find every intelligent way to stitch up the pocket holes that are draining precious cash flow and escalating debt. All western countries must focus on reducing their imports and developing domestic energy sources of all kinds for different applications. The solution is not one type of energy, **but many (with maximized Energy Return On Energy Invested (EROEI).** This is no time for pig-headed dogma and rigid attachment to old ideas." Danielle Park, June 1, 2013 www.jugglingdynamite.com





* Source: Tullett Prebon estimates, see text

http://www.tullettprebon.com/Documents/strategyinsights/TPSI_009_Perfect_Storm_009.pdf

Specialization & Trade + Fossil Fuel + Innovation = Unparalleled Prosperity

Fossil Fuel = Green Agricultural Revolution = Food for Unparalleled Population Enjoying Unparalleled Prosperity

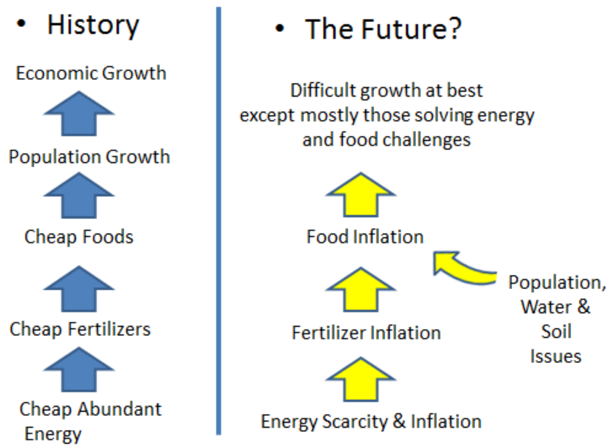
"Stored food is essential for feeding non-food-producing specialists, and certainly for supporting whole towns of them. Hence nomadic hunter-gatherer societies have few or no such full-time specialists, who instead first appear in sedentary societies. Two types of such specialists are kings and bureaucrats. Hunter-gatherer societies tend to be relatively egalitarian, to lack full-time bureaucrats and chiefs, and to have small-scale political organization at the level of the band or tribe. That's because all able-bodied hunter-gatherers are obliged to devote much of their time to acquiring food/energy. In contrast, once food can be stockpiled, a political elite can gain control of food produced by others, assert the right of taxation, escape the need to feed itself, and engage full-time in political activities. Hence moderate-sized agricultural societies are often organized in chiefdoms, and kingdoms are confined to large agricultural societies.

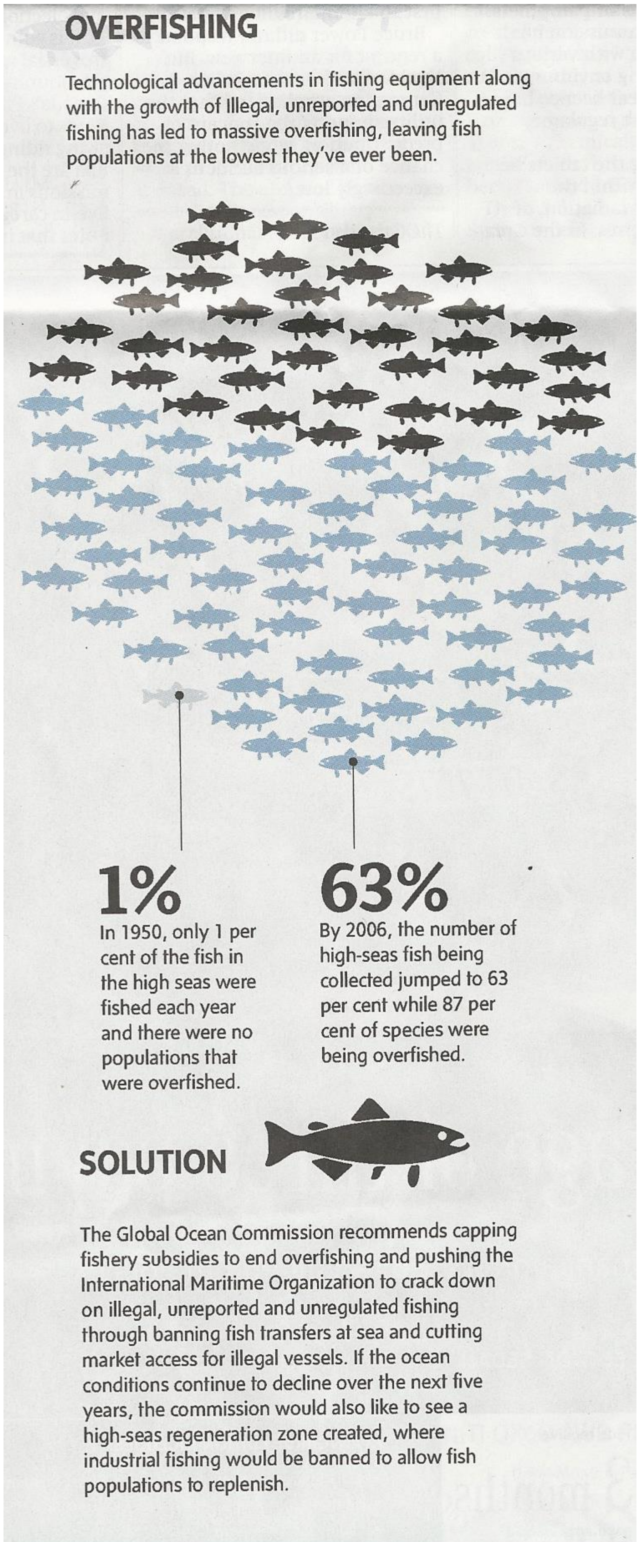
The principle of alphabetic writing, developed in the western part of the Fertile Crescent by 1500 B.C., spread west to Carthage and east to the Indian subcontinent within about a thousand years, but the Mesoamerican writing systems that flourished in prehistoric times for at least 2,000 years never reached the Andes. Naturally, wheels and writing aren't directly linked to latitude and day length in the way crops are. Instead, the links are indirect, especially via food production systems and their consequences. The earliest wheels were parts of ox-drawn carts used to transport agricultural produce. Early writing was restricted to elites supported by food-producing peasants, and it served purposes of economically and socially complex food-producing societies (such as royal propaganda, goods inventories, and bureaucratic record keeping). In general, societies that engaged in intense exchanges of crops, livestock, and technologies related to food production were more likely to become involved in other exchanges as well.

By selecting and growing those few species of plants and animals that we can eat, so that they constitute 90 percent rather than 0.1 percent of the biomass on an acre of land, we obtain far more edible calories per acre. As a result, one acre can feed many more herders and farmers—typically, 10 to 100 times more—than hunter-gatherers.

Crops and livestock yield natural fibers for making clothing, blankets, nets, and rope. Most of the major centers of plant domestication evolved not only food crops but also fiber crops—notably cotton, flax (the source of linen), and hemp. Several domestic animals yielded animal fibers—especially wool from sheep, goats, llamas, and alpacas, and silk from silkworms.

In short, plant and animal domestication meant much more food and hence much denser human populations. The resulting food surpluses, and (in some areas) the animal-based means of transporting those surpluses, were a prerequisite for the development of settled, politically centralized, socially stratified, economically complex, technologically innovative societies. Hence the availability of domestic plants and animals ultimately explains why empires, literacy, and steel weapons developed earliest in Eurasia and later, or not at all, on other continents. The military uses of horses and camels, and the killing power of animal-derived germs, complete the list of major links between food production and conquest" states Jared Diamond.





OVERFISHING

Technological advancements in fishing equipment along with the growth of Illegal, unreported and unregulated fishing has led to massive overfishing, leaving fish populations at the lowest they've ever been.

1%
In 1950, only 1 per cent of the fish in the high seas were fished each year and there were no populations that were overfished.

63%
By 2006, the number of high-seas fish being collected jumped to 63 per cent while 87 per cent of species were being overfished.

SOLUTION

The Global Ocean Commission recommends capping fishery subsidies to end overfishing and pushing the International Maritime Organization to crack down on illegal, unreported and unregulated fishing through banning fish transfers at sea and cutting market access for illegal vessels. If the ocean conditions continue to decline over the next five years, the commission would also like to see a high-seas regeneration zone created, where industrial fishing would be banned to allow fish populations to replenish.

A "Rescue Package" for the Fragile Ocean System, Globe & Mail June 24, 2014

A new report by a group of former world leaders, including ex-prime minister Paul Martin, says oceans have been pushed to the point of collapse – and fixing them will require unpopular, expensive changes. The Global Ocean Commission is a body of 18 prominent former politicians, and heads of major international organizations.

Taking Stock: World Fish Catch Falls to 90 Million Tons in 2012

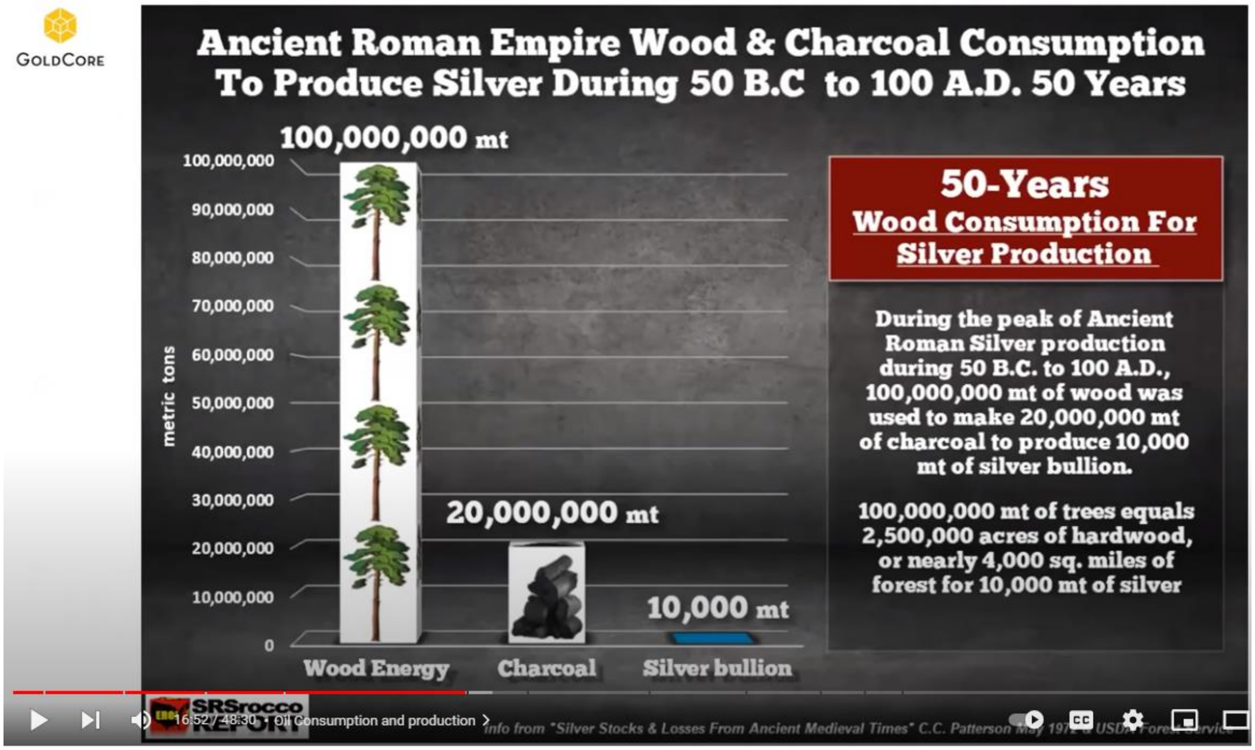
J. Matthew Roney, Earth Policy Institute

The U.N. Food and Agriculture Organization (FAO) projects that the world's wild fish harvest will fall to 90 million tons in 2012, down 2 percent from 2011. This is close to 4 percent below the all-time peak haul of nearly 94 million tons in 1996. The wild fish catch per person has dropped even more dramatically, from 17 kilograms (37.5 pounds) per person at its height in 1988 to 13 kilograms in 2011--a 37-year low.

Our oceans are arguably the last wild source of food on our planet, and we are quickly emptying them of fish (The End of the Line, 2009):

- We have lost 2,048 fish species that we know of due to overfishing.
- In March 2009, the Food and Agriculture Organization of the United Nations reported that more than 70 percent of fish species were currently endangered.
- In a study at the National Center of Ecological Analysis and Synthesis at the University of California, scientists projected that, barring significant changes, the oceans would become barren of fish by 2048.
- According to some estimates, 85 to 95 percent of the fish caught by commercial fishers is bycatch (aquatic life accidentally harvested by trawlers).

Food Production and Forests



About 31% of the world's land surface – about 4 billion hectares – is forested, according to a 2012 report by the Food and Agriculture Organization of the United Nations. An estimated 1.8 billion hectares of woodland has vanished through deforestation over the past 5,000 years, tracking population growth.

Deforestation: More than 40 percent of the earth's land has already been cleared for agriculture. Agriculture currently uses 60 times more land than urban and suburban areas combined and covers an area of the earth the size of Africa. Yet it probably isn't enough to feed the growing demand for farmland. In our quest for more and more fertile soil, we are turning to the soils that have been created on the floors of the tropical rain forests. According to Rainforest Action Network, more than an acre and a half of tropical rain forest is being cleared every second of every day. This means that every week, we lose an area the size of Rhode Island, and every year an area twice as big as Florida is destroyed. At this rate the rain forests will be entirely gone by 2060. (Save the Rainforest, 2005)

Canada, by comparison, has 397.3 million hectares of forest, which is about half of the country's land surface and almost 10% of the world's remaining woodland cover, according to Natural Resources Canada. Ottawa pegged deforestation in 2010 at 45,000 hectares, with annual rates decreasing over the past two decades.

What if the Chinese were able to increase their standard of living to match that of North America? In a New York Times essay (January 2, 2007), geographer and historian Jared Diamond pointed out that "What really matters is the total world consumption, the sum of all local consumptions, which is the product of the local population times the local per capita consumption rate. Currently, each of us 300 million Americans consumes as much as 32 Kenyans. Per capita consumption rates in China are about 11 times below ours. If the Chinese consumed the way we do, we would roughly double world consumption rates.

"The resulting deforestation, water shortages, declining biodiversity and climate change are putting the well-being and development of all nations at increasing risk."

Appreciating why in a sustainable biomass context:

Despite the facts presented above regarding deforestation, some governments promote the use of wood bio-mass as a "sustainable" approach. Consider the following as to the wisdom of such programs:

Estimated quantity of wood pellets/cubic feet of biomass required to convert one percent of coal consumption to wood pellets (2011/2012 sources)

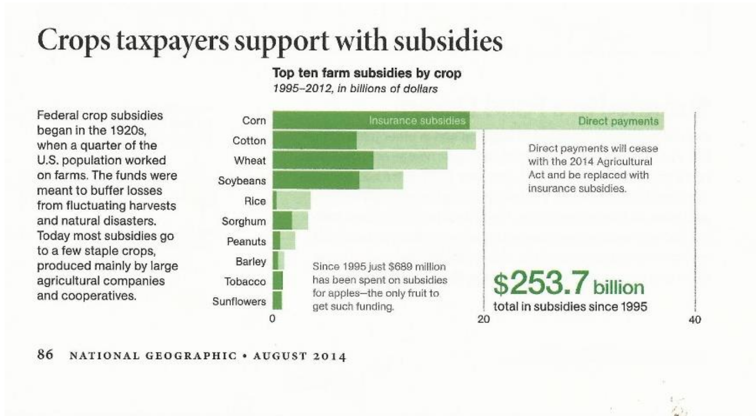
Coal source	Japan (MM short tons)	South Korea (MM short tons)	China (MM short tons)
Domestic	0.000	2.297	3,844.942
Imported	207.000	138.165	174.334
Total	**207.000**	**140.462**	**4,019.276**
Coal replaced	1%	1%	1%
One percent of current consumption (MM tons)	2.070	1.405	40.193
Pellet-coal substitution rate (ton/pellet per ton/ coal)	1.000	1.000	1.250
Volume wood pellets to replace one percent MM tons	2.070	1.405	50.241
Cubic feet of biomass required to produce above quantity of wood pellets			
	10^6	**10^6**	**10^6**
[illegible]	[illegible]	[illegible]	[illegible]

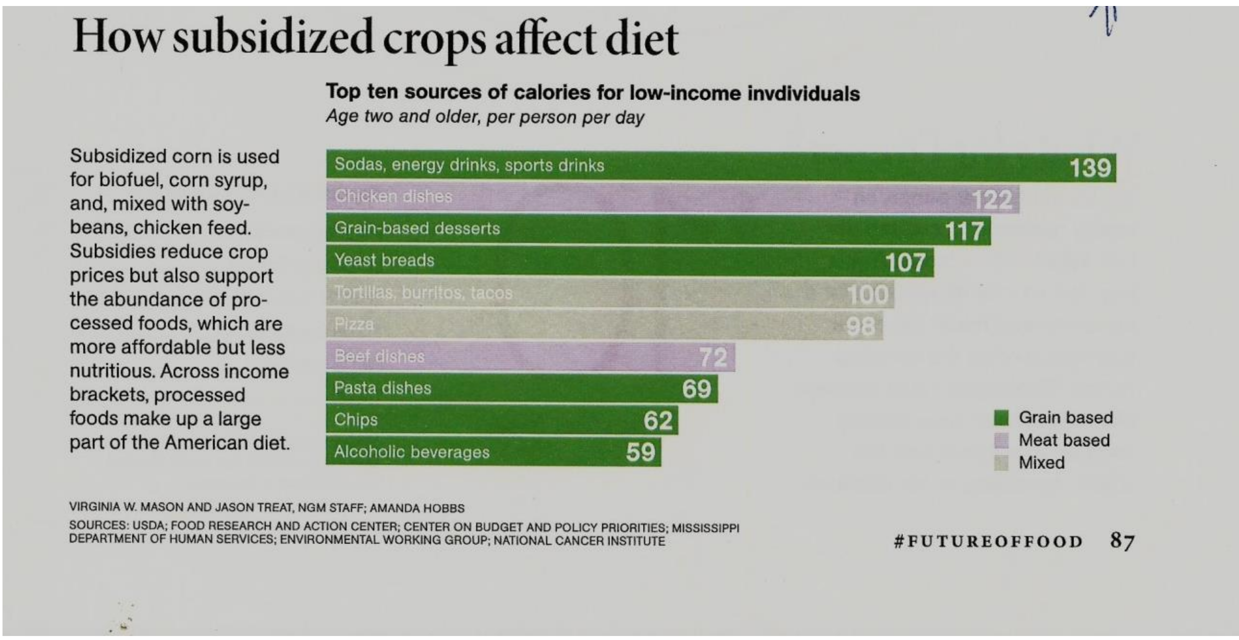
As the Q1 2013 Pellet Mill Magazine enthusiastically noted: “Asia and Europe’s ambitious renewable energy and greenhouse gas emission targets have triggered significant growth in North America’s pellet export markets. Exporting producers in North America have current capacity to export 6.6 million metric tons of pellets, which if fully utilized, would generate $900 million in trade revenue. The pellet export market in 2012 topped 1.4 million metric tons”. Fully realized, export capacity in North America could reach 15.5 million metric tons of pellets and $2.1 billion in potential trade revenue. $2.1 billion is important of course but rather sobering to think that 15.5 million metric tonnes equals only 7% of Japans coal consumption or .3875% of China’s coal consumption. One really has to wonder, how sustainable is this trade gain?! (More on this in Chapter 10).

Subsidies Causing Ill Advised Bigger Problems

“America’s current agricultural system was hardly created by free market forces. Between 1995 and 2010, American farmers received about $262 billion in federal subsidies. And the wealthiest 10 percent of farmers received 74 percent of those subsidies. Almost two-thirds of American farmers didn’t receive any subsidies at all. In addition to getting massive support from taxpayers, the current system is imposing enormous costs on society — costs that aren’t included on the balance sheets of the major fast food and agribusiness companies. Last year the revenues of the fast-food industry were about $168 billion, an impressive sum. But estimates of the cost of foodborne illnesses in the United States and of the nation’s obesity epidemic, as calculated by researchers at Georgetown and Emory universities, are even higher. Those two costs alone add up to about $320 billion. By any rational measure, this industrial food system isn’t profitable or self-sufficient” The Good Food Revolution: Growing Healthy Food, People, and Communities by Will Allen

One recent study has shown that a two-thousand-calorie diet can cost as little as $3.50 a day if it consists entirely of junk food, while healthy foods can cost more than ten times as much. “If you have $3 to feed yourself,” a researcher at the University of Washington recently told The New York Times, “your choices gravitate toward the foods that give you the most calories per dollar. Not only are empty calories cheaper, but the healthier foods are becoming more and more expensive. Vegetables and fruits are rapidly become luxury goods.”





"When I started trying to follow the industrial food chain—the one that now feeds most of us, most of the time and typically culminates either in a supermarket or fast-food meal—I expected that my investigations would lead me to a wide variety of places. And though my journeys did take me to a number of states, and covered a great many miles, at the very end of these food chains (which is to say, at the very beginning), I invariably found myself in almost exactly the same place: a farm field in the American Corn Belt. The great edifice of variety and choice that is a North American supermarket turns out to rest on a remarkably narrow biological foundation comprised of a tiny group of plants that is dominated by a single species: Zea mays, the giant grass most Americans know as corn. Corn feeds the chicken and the pig, the turkey and the lamb, the catfish and the tilapia and, increasingly, even the salmon, a carnivore by nature that the fish farmers are reengineering to tolerate corn. The eggs are made of corn. The milk and cheese and yogurt, which once came from dairy cows that grazed on grass, now typically come from Holsteins that spend their working lives indoors tethered to machines, eating corn. Head over to the processed foods and you find ever more intricate manifestations of corn. A chicken nugget, for example, piles corn upon corn: what chicken it contains consists of corn, of course, but so do most of a nugget's other constituents, including the modified corn starch that glues the thing together, the corn flour in the batter that coats it, and the corn oil in which it gets fried. Much less obviously, the leavenings and lecithin, the mono-, di-, and triglycerides, the attractive golden coloring, and even the citric acid that keeps the nugget "fresh" - all be derived from corn. To wash down your chicken nuggets with virtually any soft drink in the supermarket is to have some corn with your corn. Since the 1980s virtually all the sodas and most of the fruit drinks sold in the supermarket have been sweetened with high-fructose corn syrup (HFCS)—after water, corn sweetener is their principal ingredient. Read the ingredients on the label of any processed food and, provided you know the chemical names it travels under, corn is what you will find" to quote Michael Pollen from his excellent book Omnivores Dilemma with further excerpts below .

For modified or unmodified starch, for glucose syrup and maltodextrin, for crystalline fructose and ascorbic acid, for lecithin and dextrose, lactic acid and lysine, for maltose and HFCS, for MSG and polyols, for the caramel color and xanthan gum, read: corn. Corn is in the coffee whitener and Cheez Whiz, the frozen yogurt and TV dinner, the canned fruit and ketchup and candies, the soups and snacks and cake mixes, the frosting and gravy and frozen waffles, the syrups and hot sauces, the mayonnaise and mustard, the hot dogs and the bologna, the margarine and shortening, the salad dressings and the relishes and even the vitamins. (Yes, it's in the Twinkie, too.) There are some forty-five thousand items in the average American supermarket and more than a quarter of them now contain corn. This goes for the nonfood items as well—everything from the toothpaste and cosmetics to the disposable diapers, trash bags, cleansers, charcoal briquettes, matches, and batteries, right down to the shine on the cover of the magazine that catches your eye by the checkout: corn.

Forty percent of the calories a Mexican eats in a day comes directly from corn, most of it in the form of tortillas. So when a Mexican says "I am maize" or "corn walking," it is simply a statement of fact.

At the same time, the food industry has done a good job of persuading us that the forty-five thousand different items or SKUs (stock keeping units) in the supermarket — seventeen thousand new ones every year — represent genuine variety rather than so many clever rearrangements of molecules extracted from the same plant.

After water, carbon is the most common element in our bodies — indeed, in all living things on earth. We earthlings are, as they say, a carbon life form. (As one scientist put it, carbon supplies life's quantity, since it is the main structural element in living matter, while much scarcer nitrogen supplies its quality — but more on that later.) Originally, the atoms of carbon from which we're made were floating in the air, part of a carbon dioxide molecule. The only way to recruit these carbon atoms for the molecules necessary to support life — the carbohydrates, amino acids, proteins, and lipids — is by means of photosynthesis. Using sunlight as a catalyst, the green cells of plants combine carbon atoms taken from the air with water and elements drawn from the soil to form the simple organic compounds that stand at the base of every food chain. It is more than a figure of speech to say that plants create life out of thin air.

But corn goes about this procedure a little differently than most other plants; a difference that not only renders the plant more efficient than most, but happens also to preserve the identity of the carbon atoms it recruits, even after they've been transformed into things like Gatorade and Ring Dings and hamburgers, not to mention the human bodies nourished on those things. Where most plants during photosynthesis create compounds that have three carbon atoms, corn (along with a small handful of other species) make compounds that have four: hence "C-4," the botanical nickname for this gifted group of plants, which wasn't identified until the 1970s. The C-4 trick represents an important economy for a plant, giving it an advantage, especially in areas where water is scarce and temperatures high. In order to gather carbon atoms from the air, a plant has to open its stomata, the microscopic orifices in the leaves through which plants both take in and exhaust gases. Every time a stoma opens to admit carbon dioxide precious molecules of water escape. It's as though every time you opened your mouth to eat you lost a quantity of blood. Ideally, you would open your mouth as seldom as possible, ingesting as much food as you could with every bite. This is essentially what a C-4 plant does. By recruiting extra atoms of carbon during each instance of photosynthesis, the corn plant is able to limit its loss of water and "fix" — that is, take from the atmosphere and link in a useful molecule — significantly more carbon than other plants.

<u>At its most basic, the story of life on earth is the competition among species to capture and store as much energy as possible</u> (thus energy is the universal master currency) — either directly from the sun, in the case of plants, or, in the case of animals, by eating plants and plant eaters. The energy is stored in the form of carbon molecules and measured in calories. The calories we eat, whether in an ear of corn or a steak, represent packets of energy once captured by a plant. The C-4 trick helps explain the corn plant's success in this competition. Few plants can manufacture quite as much organic matter (and calories) from the same quantities of sunlight and water and basic elements as corn. (Ninety-seven percent of what a corn plant is comes from the air, three percent from the ground.)

The higher the ratio of carbon 13 to carbon 12 in a person's flesh, the more corn has been in his diet — or in the diet of the animals he or she ate.

One would expect to find a comparatively high proportion of carbon 13 in the flesh of people whose staple food of choice is corn — Mexicans, most famously. Americans eat much more wheat than corn — 114 pounds of wheat flour per person per year, compared to 11 pounds of corn flour. The Europeans who colonized America regarded themselves as wheat people, in contrast to the native corn people they encountered; wheat in the West has always been considered the most refined, or civilized, grain.

"When you look at the isotope ratios," Todd Dawson, a Berkeley biologist who's done this sort of research said, "we North Americans look like corn chips with legs." Compared to us, Mexicans today consume a far more varied carbon diet: the animals they eat still eat grass (until recently, Mexicans regarded feeding corn to livestock as a sacrilege); much of their protein comes from legumes; and they still sweeten their beverages with cane sugar. So that's us: processed corn, walking.

Planted, a single corn seed yielded more than 150 fat kernels, often as many as 300, while the return on a seed of wheat, when all went well, was something less than 50:1. (At a time when land was abundant and labor scarce, agricultural yields were calculated on a per-seed-sown basis.)

This one plant supplied settlers with a ready-to-eat vegetable and a storable grain, a source of fiber and animal feed, a heating fuel and an intoxicant. Corn could be eaten fresh off the cob ("green") within months after planting, or dried on the stalk in fall, stored indefinitely, and ground into flour as needed. Mashed and fermented, corn could be brewed into beer or distilled into whiskey; for a time it was the only source of alcohol on the frontier. (Whiskey and pork were both regarded as "concentrated corn," the latter a concentrate of its protein, the former of its calories; both had the virtue of reducing corn's bulk and raising its price.) No part of the big grass went to waste: The husks could be woven into rugs and twine; the leaves and stalks made good silage for livestock; the shelled cobs were burned for heat.

The Business of Corn

If I crossed two corn plants to create a variety with an especially desirable trait, I could sell you my special seeds, but only once, since the corn you grew from my special seeds would produce lots more special seeds, for free and forever, putting me out business in short order. It's difficult to control the means of production when the product you're selling can reproduce itself endlessly. This is one of the ways in which the imperatives of biology are difficult to mesh with the imperatives of business.

Hybrid corn offered its breeders what no other plant at that time could: the biological equivalent of a patent. Farmers now had to buy new seeds every spring; instead of depending upon their plants to reproduce themselves, they now depended on a corporation. The corporation, assured for the first time of a return on its investment in breeding, showered corn with attention — R&D, promotion, advertising — and the plant responded, multiplying its fruitfulness year after year. With the advent of the F-1 hybrid, a technology with the power to remake nature in the image of capitalism, Zea mays entered the industrial age and, in time, it brought the whole American food chain with it.

The average back in 1920 was about twenty bushels per acre — roughly the same yields historically realized by Native Americans.

Hybrid seed came on the market in the late the 1930s, and soon the farmer was getting seventy to eighty bushels an acre in the fifties.

Corn isn't solely responsible for remaking this landscape: It was the tractor, after all, that put the horses out of work, and with the horses went the fields of oats and some of the pasture. But corn was the crop that put cash in the farmer's pocket, so as corn yields began to soar at mid-century, the temptation was to give the miracle crop more and more land. Of course, every other farmer in America was thinking the same way (having been encouraged to do so by government policies), with the inevitable result that the price of corn declined. One might think falling corn prices would lead farmers to plant less of it, but the economics and psychology of agriculture are such that exactly the opposite happened. Beginning in the fifties and sixties, the flood tide of cheap corn made it profitable to fatten cattle on feedlots instead of on grass, and to raise chickens in giant factories rather than in farmyards.

Soon livestock farmers couldn't compete with the factory-farmed animals their own cheap corn had helped spawn, so the chickens and cattle disappeared from the farm, and with them the pastures and hay fields and fences. In their place the farmers planted more of the one crop they could grow more of than anything else: corn. And whenever the price of corn slipped they planted a little more of it, to cover expenses and stay even. By the 1980s the diversified family farm was history and corn was king. (Planting corn on the same ground year after year brought down the predictable plagues of insects and disease, so beginning in the 1970s farmers started alternating corn with soybeans, a legume. Recently, though, bean prices having fallen and bean diseases having risen, some farmers are going back to a risky rotation of "corn on corn.")

Hybrid corn is the greediest of plants, consuming more fertilizer than any other crop. For though the new hybrids had the genes to survive in teeming cities of corn, the richest acre of Iowa soil could never have fed thirty thousand hungry corn plants without promptly bankrupting its fertility. To keep their land from getting "corn sick" farmers would carefully rotate their crops with legumes (which add nitrogen to the soil), never growing corn more than twice in the same field every five years; they would also recycle nutrients by spreading their cornfields with manure from their livestock. Before synthetic fertilizers the amount of nitrogen in the soil strictly limited the amount of corn an acre of land could support. Though hybrids were introduced in the thirties, it wasn't until they made the acquaintance of chemical fertilizers in the 1950s that corn yields exploded. The discovery of synthetic nitrogen changed everything — not just for the corn plant and the farm, not just for the food system, but also for the way life on earth is conducted. All life depends on nitrogen; it is the building block from which nature assembles amino acids, proteins and nucleic acids; the genetic information that orders and perpetuates life is written in nitrogen ink. (This is why scientists speak of nitrogen as supplying life's quality, while carbon provides the quantity.) But the supply of usable nitrogen on earth is limited. Although earth's atmosphere is about 80 percent nitrogen, all those atoms are tightly paired and nonreactive; the nineteenth-century chemist Justus von Liebig spoke of atmospheric nitrogen's "indifference to all other substances.” To be of any value to plants and animals, these self-involved nitrogen atoms must be split and then joined to atoms of hydrogen. Chemists call this process of taking atoms from the atmosphere and combining them into molecules useful to living things “fixing” that element. Until a German Jewish chemist named Fritz Haber figured out how to turn this trick in 1909, all the usable nitrogen on earth had at one time been fixed by soil bacteria living on the roots of leguminous plants (such as peas or alfalfa or locust trees) or, less commonly, by the shock of electrical lightning, which can break nitrogen bonds in the air, releasing a light rain of fertility. Vaclav Smil, a geographer who has written a fascinating book about Fritz Haber called Enriching the Earth, pointed out that “there is no way to grow crops and human bodies without nitrogen.” Before Fritz Haber’s invention the sheer amount of life earth could support — the size of crops and therefore the number of human bodies — was limited by the amount of nitrogen that bacteria and lightning could fix.

Think of the impact on history Haber’s invention has had. For example, after Nixon’s 1972 trip to China, the first major order the Chinese government placed with the US was for thirteen massive fertilizer factories. Without them, much of China would probably have starved at that time.

Fritz Haber? No, I’d never heard of him either, even though he was awarded the Nobel Prize in 1920 for “improving the standards of agriculture and the well-being of mankind.” But the reason for his obscurity has less to do with the importance of his work than the ugly twist of his biography, which recalls the dubious links between modern warfare and industrial agriculture. During World War I, Haber threw himself into the German war effort, and his chemistry kept alive Germany’s hopes for victory. After Britain choked off Germany’s supply of nitrates from Chilean mines, an essential ingredient in the manufacture of explosives, Haber’s technology allowed Germany to continue making bombs from synthetic nitrate. Later, as the war became mired in the trenches of France, Haber put his genius for chemistry to work developing poison gases — ammonia, then chlorine. (He subsequently developed Zyklon B, the gas used in Hitler’s concentration camps.) On April 22, 1915, Smil writes, Haber was “on the front lines directing the first gas attack in military history.” His “triumphant” return to Berlin was ruined a few days later when his wife, a fellow chemist sickened by her husband’s contribution to the war effort, used Haber’s army pistol to kill herself. Though Haber later converted to Christianity, his Jewish background forced him to flee Nazi Germany in the thirties; he died, broken, in a Basel hotel room in 1934. Perhaps because the history of science gets written by the victors, Fritz Haber’s story has been all but written out of the twentieth century. Not even a plaque marks the site of his great discovery at the University of Karlsruhe.

On the days in the 1950s that farmers spread his first load of ammonium nitrate fertilizer, the ecology of his farm underwent a quiet revolution. What had been a local, sun-driven cycle of fertility, in which the legumes fed the pasture which fed the livestock which in turn (with their manure) fed the corn, was now broken.

Liberated from the old biological constraints, the farm could now be managed on industrial principles, as a factory transforming inputs of raw material—chemical fertilizer—into outputs of corn. Since the farm no longer needs to generate and conserve its own fertility by maintaining a diversity of species, synthetic fertilizer opens the way to monoculture (something nature does not do), allowing the farmer to bring the factory’s economies of scale and mechanical efficiency to nature. If, as has sometimes been said, the discovery of agriculture represented the first fall of man from the state of nature, then the discovery of synthetic fertility is surely a second precipitous fall. Fixing nitrogen allowed the food chain to turn from the logic of biology and embrace the logic of industry. Instead of eating exclusively from the sun, humanity now began to sip fossil fuels.

More than half of all the synthetic nitrogen made today is applied to corn, whose hybrid strains can make better use of it than any other plant.

When you add together the natural gas in the fertilizer to the fossil fuels it takes to make the pesticides, drive the tractors, and harvest, dry, and transport the corn, you find that every bushel of industrial corn requires the equivalent of between a quarter and a third of a gallon of oil to grow it — or around fifty gallons of oil per acre of corn. (Some estimates are much higher.) Put another way, it takes more than a calorie of fossil fuel energy to produce a calorie of food; before the advent of chemical fertilizer the farm produced more than two calories of food energy for every calorie of energy invested. From the standpoint of industrial efficiency, it’s too bad we can’t simply drink the petroleum directly. Ecologically this is a fabulously expensive way to produce food — but “ecologically” is no longer the operative standard. As long as fossil fuel energy is so cheap and available, it makes good economic sense to produce corn this way. The old way of growing corn — using fertility drawn from the sun — may have been the biological equivalent of a free lunch, but the service was much slower and the portions were much skimpier. In the factory, time is money, and yield is everything. One problem with factories, as compared to biological systems, is that they tend to pollute. Hungry for fossil fuel as hybrid corn is, farmers still feed it far more than it can possibly eat, wasting most of the fertilizer they buy. Maybe it’s applied at the wrong time of year; maybe it runs off the fields in the rain; maybe the farmer puts down extra just to play it safe.

But what happens to the one hundred pounds of synthetic nitrogen that corn plants don’t take up? Some of it evaporates into the air, where it acidifies the rain and contributes to global warming. (Ammonium nitrate is transformed into nitrous oxide, an important greenhouse gas.) Some seeps down to the water table. When I went to pour myself a glass of water in some farm kitchens, some farmers made sure I drew it from a special faucet connected to a reverse-osmosis filtration system in the basement. As for the rest of the excess nitrogen, the spring rains wash it off fields, carrying it into drainage ditches that eventually spill into rivers.

For example, the city of Des Moines—which drinks from the Des Moines River in spring, when nitrogen runoff is at its heaviest, the city issues “blue baby alerts,” warning parents it’s unsafe to give children water from the tap. The nitrates in the water convert to nitrite, which binds to hemoglobin, compromising the blood’s ability to carry oxygen to the brain.

The last period in North American history that food prices climbed high enough to generate real political heat was only in the 1970’s. In the fall of 1972 Russia, having suffered a series of disastrous harvests, purchased 30 million tons of American grain. Senior federal government member Butz had helped arrange the sale, in the hopes of giving a boost to crop prices in order to bring restive farmers tempted to vote for George McGovern into the Republican fold. The plan worked all too well: The unexpected surge in demand, coinciding with a spell of bad weather in the Farm Belt, drove grain prices to historic heights. The 1972 Russian grain sale and the resulting spike in farm income that fall helped Nixon nail down the farm vote for his re-election, but by the following year those prices had reverberated through the food chain, all the way to the supermarket. By 1973 the inflation rate for groceries reached an all-time high, and housewives were organizing protests at supermarkets. Farmers were killing chicks because they couldn’t afford to buy feed, and the price of beef was slipping beyond the reach of middle-class consumers. Some foods became scarce; horse meat began showing up in certain markets. “Why a Food Scare in a Land of Plenty?” was a headline in U.S. News and World Report that summer. Nixon had a consumer revolt on his hands, and he dispatched Earl Butz to quell it. The Sage of Purdue set to work reengineering the American food system, driving down prices and vastly increasing the output of American farmers.

“Farmers facing lower prices have only one option if they want to be able to maintain their standard of living, pay their bills, and service their debt, and that is to produce more.” A farm family needs a certain amount of cash flow every year to support itself, and if the price of corn falls, the only way to stay even is to sell more corn. Farmers desperate to boost yield end up degrading their land, plowing and planting marginal land, applying more nitrogen — anything to squeeze a few more bushels from the soil. Yet the more bushels each farmer produces, the lower prices go, giving another turn to the perverse spiral of overproduction. Even so, corn farmers persist in measuring their success in bushels per acre, a measurement that improves even as they go broke.

But why corn and not something else? “We’re on the bottom rung of the industrial food chain here, using this land to produce energy and protein, mostly to feed animals. Corn is the most efficient way to produce energy, soybeans the most efficient way to produce protein.” The notion of switching to some other crop many farmers gruffly dismiss. “What am I going to grow here, broccoli? Lettuce? We’ve got a long-term investment in growing corn and soybeans; the elevator is the only buyer in town, and the elevator only pays me for corn and soybeans. The market is telling me to grow corn and soybeans, period.” As is the government, which calculates his various subsidy payments based on his yield of corn.

So the plague of cheap corn goes on, impoverishing farmers (both here and in the countries to which we export it), degrading the land, polluting the water, and bleeding the federal treasury, which now spends up to $5 billion a year subsidizing cheap corn. But though those subsidy checks go to the farmer (and represent nearly half of net farm income today), <u>what the Treasury is really subsidizing are the buyers of all that cheap corn</u>.

For example, the Iowa Farmers Cooperative does not write the only check a farmer will receive for his corn crop in the fall. He gets a second check from the U.S. Department of Agriculture (USDA) — about twenty-eight cents a bushel no matter what the market price of corn is, and considerably more should the price of corn drop below a certain threshold. Let’s say the price of a bushel falls to $1.45, as it did in October 2005. Since the official target price (called the “loan rate”) in Greene County stands at $1.87, the government would then send farmers another $0.42 in “deficiency payments,” for a total of $0.70 for every bushel of corn they can grow. Taken together, these federal payments account for nearly half the income of the average Iowa corn farmer and represent roughly a quarter of the $19 billion U.S. taxpayers spend each year on payments to farmers. This is a system designed to keep production high and prices low. In fact, it’s designed to drive prices ever lower, since handing farmers deficiency payments (as compared to the previous system of providing loans to support prices) encourages them to produce as much corn as they possibly can, and then to dump it all on the market no matter what the price — a practice that inevitably pushes prices even lower. And as prices decline, the only way a farmer can keep his income from declining is by producing still more corn. So the mountain grows, from 4 billion bushels in 1970 to 10 billion bushels today. Moving that mountain of cheap corn — finding the people and animals to consume it, the cars to burn it, the new products to absorb it, and the nations to import it — has become the principal task of the industrial food system, since the supply of corn for years and until recently has vastly exceeded demand.

What’s involved in absorbing all this excess biomass goes a long way toward explaining several seemingly unconnected phenomena; from the rise of factory farms and the industrialization of our food, to the epidemic of obesity and prevalence of food poisoning in America, to the fact that in the country where Zea mays was originally domesticated, campesinos descended from those domesticators are losing their farms because imported corn, flooding in from the North, had become too cheap.

Such is the protean, paradoxical nature of the corn in that pile that getting rid of it could contribute to obesity and to hunger both.

The golden river of American commodity corn, wide though it is, passes through a tiny number of corporate hands. Though the companies won't say, it has been estimated that Cargill and ADM together probably buy somewhere near a third of all the corn grown in America. These two companies now guide corn's path at every step of the way: They provide the pesticide and fertilizer to the farmers; operate most of America's grain elevators (Member-owned cooperative is an exception); broker and ship most of the exports; perform the wet and dry milling; feed the livestock and then slaughter the corn-fattened animals; distill the ethanol; and manufacture the high-fructose corn syrup and the numberless other fractions derived from number 2 field corn. Oh, yes — and help write many of the rules that govern this whole game, for Cargill and ADM exert considerable influence over U.S. agricultural policies. More even than the farmers who receive the checks (and the political blame for cashing them), these companies are the true beneficiaries of the "farm" subsidies that keep the river of cheap corn flowing. Cargill is the largest privately held corporation in the world.

THE PLACE where most of those kernels wind up — about three of every five — is on the American factory farm, a place that could not exist without them. Here, hundreds of millions of food animals that once lived on family farms and ranches are gathered together in great commissaries, where they consume as much of the mounting pile of surplus corn as they can digest, turning it into meat. Enlisting the cow in this undertaking has required particularly heroic efforts, since the cow is by nature not a corn eater. But Nature abhors a surplus, and the corn must be consumed. Enter the corn-fed American steer in CAFO's—Concentrated Animal Feeding Operations.

Corn itself profited from the urbanization of livestock twice. As the animals left the farm, more of the farm was left for corn, which rapidly colonized the paddocks and pastures and even the barnyards that had once been the animals' territory. The animals left because the farmers simply couldn't compete with the CAFOs. It cost a farmer more to grow feed corn than it cost a CAFO to buy it, for the simple reason that commodity corn now was routinely sold for less than it cost to grow. Corn profited again as the factory farms expanded, absorbing increasing amounts of its surplus. Corn found its way into the diet of animals that never used to eat very much of it (like cattle) or any corn at all, like the farmed salmon now being bred to tolerate grain.

The economic logic of gathering so many animals together to feed them cheap corn in CAFOs is hard to argue with; it has made meat, which used to be a special occasion in most American homes, so cheap and abundant that many of us now eat it three times a day.

One of the most striking things that animal feedlots do (to paraphrase Wendell Berry) is to take this elegant solution and neatly divide it into two new problems: a fertility problem on the farm (which must be remedied with chemical fertilizers) and a pollution problem on the feedlot

A "cow-calf" operation is the first stage in the production of a hamburger and the stage least changed by the modern industrialization of meat. While the pork and chicken industries have consolidated the life cycle of those animals under a single roof, beef cattle still get born on hundreds of thousands of independently owned ranches scattered mainly across the West. Although a mere four giant meatpacking companies (Tyson subsidiary IBP, Cargill subsidiary Excel, Swift & Company, and National) now slaughter and market four of every five beef cattle born in this country, that concentration represents the narrow end of a funnel that starts out as wide as the Great Plains. These corporations have concluded that it takes so much land (and therefore capital) to produce a calf ready for the feedlot — ten acres per head at a minimum — that they're better off leaving the ranching (and the risk) to the ranchers.

THE COEVOLUTIONARY RELATIONSHIP between cows and grass is one of nature's underappreciated wonders; it also happens to be the key to understanding just about everything about modern meat. For the grasses, which have evolved to withstand the grazing of ruminants, the cow maintains and expands their habitat by preventing trees and shrubs from gaining a foothold and hogging the sunlight; the animal also spreads grass seed, plants it with his hooves, and then fertilizes it with his manure. In exchange for these services the grasses offer ruminants a plentiful and exclusive supply of lunch. For cows (like sheep, bison, and other ruminants) have evolved the special ability to convert grass — which single-stomached creatures like us can't digest — into high-quality protein. They can do this because they possess what is surely the most highly evolved digestive organ in nature: the rumen. About the size of a medicine ball, the organ is essentially a twenty-gallon fermentation tank in which a resident population of bacteria dines on grass.

Truly this is an excellent system for all concerned: for the grasses, for the bacteria, for the animals, and for us, the animals' eaters. While it is true that overgrazing can do ecological harm to a grassland, in recent years ranchers have adopted rotational grazing patterns that more closely mimic the patterns of the bison, a ruminant that sustainably grazed these same grasses for thousands of years before the cow displaced it. In fact, a growing number of ecologists now believe the rangelands are healthier with cattle on them, provided they're moved frequently. Today the most serious environmental harm associated with the cattle industry takes place on the feedlot.

So then why a feedlot and why is it that a steer won't taste a blade of prairie grass after October? Speed, in a word, or, in the industry's preferred term, "efficiency." Cows raised on grass simply take longer to reach slaughter weight than cows raised on a richer diet, and for half a century now the industry has devoted itself to shortening a beef animal's allotted span on earth. "In my grandfather's time, cows were four or five years old at slaughter," Rich explained. "In the fifties, when my father was ranching, it was two or three years old. Now we get there at fourteen to sixteen months." Fast food, indeed. What gets a steer from 80 to 1,100 pounds in fourteen months is tremendous quantities of corn, protein and fat supplements and an arsenal of new drugs.

This corn-fed meat is demonstrably less healthy for us, since it contains more saturated fat and less omega-3 fatty acids than the meat of animals fed grass. A growing body of research suggests that many of the health problems associated with eating beef are really problems with corn-fed beef.

The economic logic behind corn is unassailable, and on a factory farm there is no other kind. Calories are calories, and corn is the cheapest, most convenient source of calories on the market. Of course, it was the same industrial logic — protein is protein — that made feeding rendered cow parts back to cows seem like a sensible thing to do, until scientists figured out that this practice was spreading bovine spongiform encephalopathy (BSE), more commonly known as mad cow disease until the Food and Drug Administration (FDA) banned the practice in 1997.

Cattle rarely live on feedlot diets for more than 150 days, which might be about as much as their systems can tolerate. "I don't know how long you could feed them this ration before you'd see problems," Dr. Metzin said; another vet told me the diet would eventually "blow out their livers" and kill them.

What keeps a feedlot animal healthy — or healthy enough — are antibiotics. Rumensin buffers acidity in the rumen, helping to prevent bloat and acidosis, and Tylosin, a form of erythromycin, lowers the incidence of liver infection. Most of the antibiotics sold in America today end up in animal feed, a practice that, it is now generally acknowledged (except in agriculture), is leading directly to the evolution of new antibiotic-resistant superbugs. In the debate over the use of antibiotics in agriculture, a distinction is usually made between their clinical and nonclinical uses. Public health advocates don't object to treating sick animals with antibiotics; they just don't want to see the drugs lose their effectiveness because factory farms are feeding them to healthy animals to promote growth. But the use of antibiotics in feedlot cattle confounds this distinction. Here the drugs are plainly being used to treat sick animals, yet the animals probably wouldn't be sick if not for the diet of corn we feed them. I asked Dr. Mel what would happen if drugs like Rumensin and Tylosin were banned from cattle feed, as some public health experts advocate. "We'd have a high death rate [it's currently about 3 percent, matching the industry average] and poorer performing cattle. We just couldn't feed them as hard." The whole system would have to change — and slow down.

Compared to other food animals, cattle are terribly inefficient: The ratio of feed to flesh in chicken, the most efficient land animal by this measure, is two pounds of corn to one of meat, which is why chicken costs less than beef.

Follow the corn from this bunk back to the fields where it grows and I'd find myself back in the middle of that 125,000-mile-square monoculture, under a steady rain of pesticide and fertilizer. Keep going, and I could follow the nitrogen runoff from that fertilizer all the way down the Mississippi into the Gulf of Mexico, adding its poison to an eight-thousand-square-mile zone so starved of oxygen nothing but algae can live in it. And then go farther still, follow the fertilizer (and the diesel fuel and the petrochemical pesticides) needed to grow the corn all the way to the fossil fuel fields of the Persian Gulf. I don't have a sufficiently vivid imagination to look at a steer and see a barrel of oil, but petroleum is one of the most important ingredients in the production of modern meat, and the Persian Gulf is surely a link in the food chain that passes through this (or any) feedlot. One-fifth of America's petroleum consumption goes to producing and transporting our food.

One of the truly odd things about the 10 billion bushels of corn harvested each year is how little of it we eat before processing. Sure, we grind some of it to make cornmeal, but most of the corn we eat as corn — whether on the cob, flaked, or baked into muffins or tortillas or chips — comes from varieties other than number 2: usually sweet corn or white corn. These uses represent a tiny fraction of the harvest — less than a bushel per person per year — which is probably why we don't think of ourselves as big corn eaters. And yet each of us is personally responsible for consuming a ton of the stuff every year. Much of the rest of that per capita ton does enter our bodies, but not before it has been heavily processed, broken down into simple compounds either by animals or a processing plant, and then reassembled either as beef, chicken, or pork, or as soft drinks, breakfast cereals or snacks. What doesn't pass through the gut of a food animal to become meat, will pass through one of America's twenty-five "wet mills" on its way to becoming one of the innumerable products food science has figured out how to tease from a kernel of corn. (These mills are called wet to distinguish them from the traditional mills where corn is simply ground into dry meal for things like tortillas.) The two companies who wet mill most of America's corn are Cargill and ADM.

Wet milling is an energy-intensive way to make food; for every calorie of processed food it produces, another ten calories of fossil fuel energy are burned.

In many ways breakfast cereal is the prototypical processed food: four cents' worth of commodity corn (or some other equally cheap grain) transformed into four dollars' worth of processed food. What an alchemy! On the strength of this alchemy the cereals group generates higher profits for General Mills than any other division.

Each of us can eat about fifteen hundred pounds of food a year. What this means for the food industry is that its natural rate of growth is somewhere around 1 percent per year — 1 percent being the annual growth rate of the American population. The problem is that Wall Street won't tolerate such an anemic rate of growth. This leaves companies like General Mills and McDonald's with two options if they hope to grow faster than the population: figure out how to get people to spend more money for the same three-quarters of a ton of food, or entice them to actually eat more than that. The two strategies are not mutually exclusive, of course, and the food industry energetically pursues them both at the same time.

Like most other warm-blooded creatures, humans have inherited a preference for energy-dense foods, a preference reflected in the sweet tooth shared by most mammals. Natural selection predisposed us to the taste of sugar and fat (its texture as well as taste) because sugars and fats offer the most energy (which is what a calorie is) per bite. Yet in nature — in whole foods — we seldom encounter these nutrients in the concentrations we now find them in in processed foods: You won't find a fruit with anywhere near the amount of fructose in a soda, or a piece of animal flesh with quite as much fat as a chicken nugget.

You begin to see why processing foods is such a good strategy for getting people to eat more. The power of food science lies in its ability to break foods down into their nutrient parts and then reassemble them in specific ways that, in effect, push our evolutionary buttons, fooling the omnivore's inherited food selection system. Add fat or sugar to anything and it's going to taste better on the tongue of an animal that natural selection has wired to seek out energy-dense foods. Animal studies prove the point: Rats presented with solutions of pure sucrose or tubs of pure lard — goodies they seldom encounter in nature — will gorge themselves sick. Whatever nutritional wisdom the rats are born with breaks down when faced with sugars and fats in unnatural concentrations — nutrients ripped from their natural context, which is to say, from those things we call food. Food systems can cheat by exaggerating their energy density, tricking a sensory apparatus that evolved to deal with markedly less dense whole foods. It is the amped-up energy density of processed foods that gets omnivores like us into trouble. Type II diabetes typically occurs when the body's mechanism for managing glucose simply wears out from overuse. Just about everything we eat sooner or later winds up in the blood as molecules of glucose, but sugars and simple starches turn to glucose faster than anything else.

I asked Todd Dawson, a biologist at Berkeley, to run a McDonald's meal through his mass spectrometer and calculate how much of the carbon in it came originally from a corn plant. It is hard to believe that the identity of the atoms in a cheeseburger or a Coke is preserved from farm field to fast-food counter, but the atomic signature of those carbon isotopes is indestructible, and still legible to the mass spectrometer. Dawson and his colleague Stefania Mambelli prepared an analysis showing roughly how much of the carbon in the various McDonald's menu items came from corn, and plotted them on a graph. The sodas came out at the top, not surprising since they consist of little else than corn sweetener, but virtually everything else we ate revealed a high proportion of corn too. In order of diminishing 'corniness', this is how the laboratory measured our meal: soda (100 percent corn), milk shake (78 percent), salad dressing (65 percent), chicken nuggets (56 percent), cheeseburger (52 percent), and French fries (23 percent). What in the eyes of the omnivore looks like a meal of impressive variety turns out, when viewed through the eyes of the mass spectrometer, to be the meal of a far more specialized kind of eater. But then, this is what the industrial eater has become: corn's koala.

SO WHAT? Why should it matter that we have become a race of corn eaters such as the world has never seen? Is this necessarily a bad thing? The answer all depends on where you stand. If where you stand is in agribusiness, processing cheap corn into forty-five different McDonald's items is an impressive accomplishment. It represents a solution to the agricultural contradictions of capitalism, the challenge of increasing food industry profits faster than America can increase its population. Supersized portions of cheap corn-fixed carbon solves the problem of the fixed stomach; we may not be expanding the number of eaters in America, but we've figured out how to expand each of their appetites, which is almost as good. An average McDonald's meal totals 4,510 calories — more than half as many as we each should probably consume in a day. We had certainly done our parts in chomping through the corn surplus. (We had also consumed a lot of petroleum, and not just because we were in a car. To grow and process those 4,510 food calories took at least ten times as many calories of fossil energy, the equivalent of 1.3 gallons of oil.) If where you stand is on one of the lower rungs of America's economic ladder, our cornified food chain offers real advantages: not cheap food exactly (for the consumer ultimately pays the added cost of processing), but cheap calories in a variety of attractive forms. In the long run, however, the eater pays a high price for these cheap calories: obesity, Type II diabetes, heart disease. If where you stand is at the lower end of the world's economic ladder, however, America's corn-fed food chain looks like an unalloyed disaster. I mentioned earlier that all life on earth can be viewed as a competition for the energy captured by plants and stored in carbohydrates, energy we measure in calories. There is a limit to how many of those calories the world's arable land can produce each year, and an industrial meal of meat and processed food consumes — and wastes — an unconscionable amount of that energy. To eat corn directly (as Mexicans and many Africans do) is to consume all the energy in that corn, but when you feed that corn to a steer or a chicken, 90 percent of its energy is lost — to bones or feathers or fur, to living and metabolizing as a steer or chicken.

FOOD

EXPLORE

By the Numbers natgeofood.com

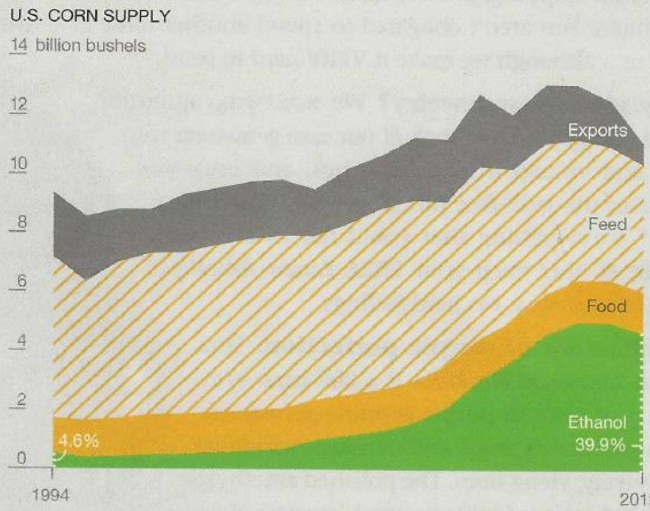
When Food Is Fuel

Biofuel production is booming, up fivefold in a decade. Investment in biofuel technologies creates more renewable fuels and jobs, but critics argue that industry-friendly policies have artificially inflated demand. Producing green fuels like corn-based ethanol diverts land and water resources from food crops.

Biofuels can also drive up the cost of corn that is used for food, especially in developing countries that rely on imports of the grain. According to Timothy A. Wise of Tufts University, "The higher your import dependence, the higher your vulnerability to global price spikes." *—Kelsey Nowakowski*

MEXICO'S CORN DILEMMA

Mexico produces most of its corn but still imports a third of its supply under a 1994 trade agreement with the U.S. Since 2005 growth in U.S. biofuel production has driven up corn prices in Mexico. Today 40 percent of U.S. corn goes to make ethanol.



MEXICO'S IMPORTS OF U.S. CORN AS A PORTION OF TOTAL CONSUMPTION

1994 8%

Eased trade restrictions allowed the U.S. to flood the Mexican market with corn, leading to a rise in Mexico's import dependency. Corn imports were cheap before the U.S. ethanol boom.

2012 34%

4%

OF THE WORLD'S TRANSPORTATION FUEL IS BIOFUEL.

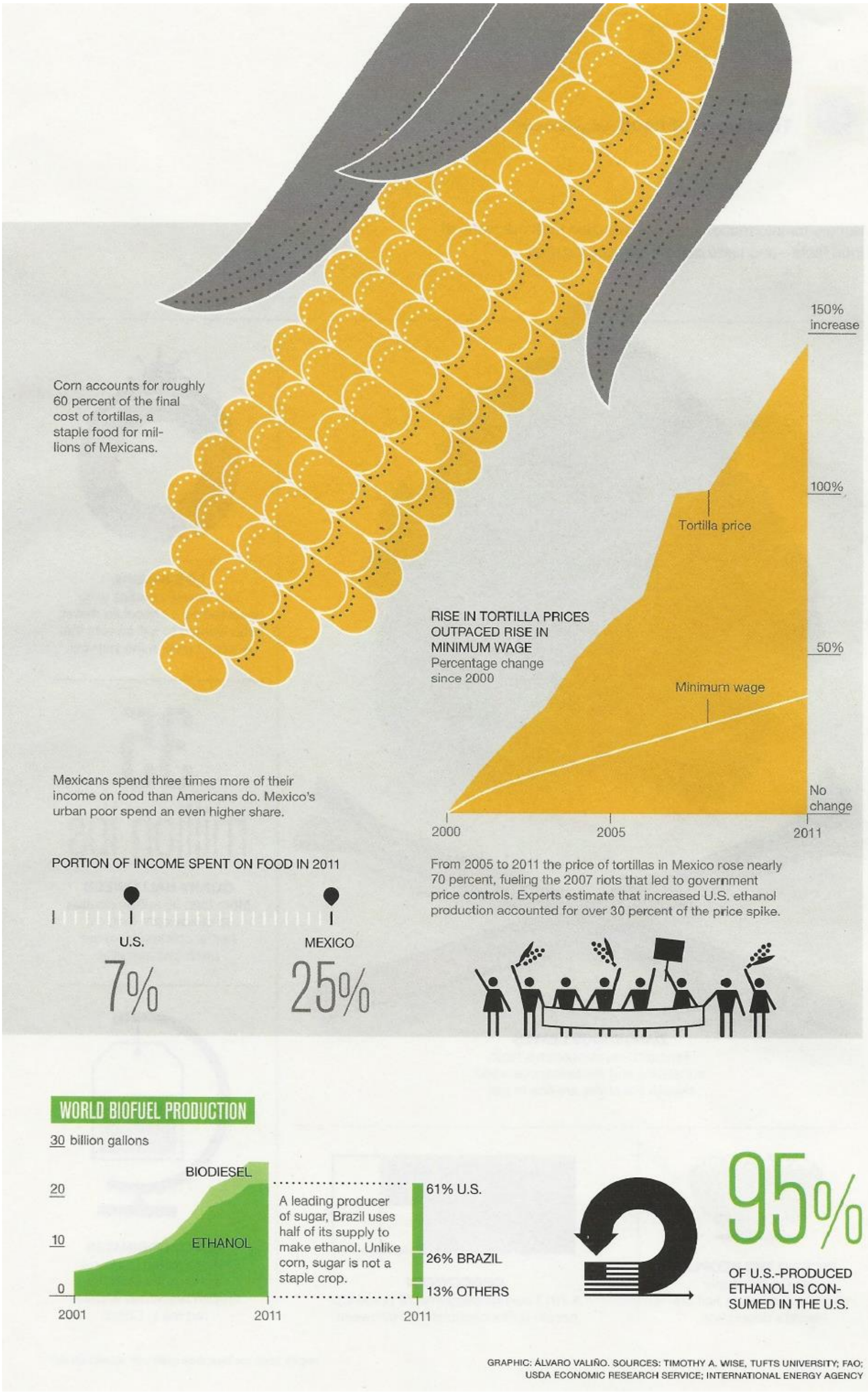
Biofuels account for 23% of all road transport fuel in Brazil but only 5% in the U.S. and 4% in the European Union.

SOURCES

99%

OF BIOFUELS PRODUCED AND CONSUMED WORLDWIDE IN 2011 WERE MADE FROM FOOD CROPS.

	FERMENTATION OF FOOD CROPS			CHEMICAL MODIFICATION OF NONFOOD CROPS	
RAW MATERIAL	Oil Soy Palm Rapeseed	Starch Corn Wheat Cassava	Sugar Sugar beet Sugarcane	Lignocellulose Softwood Hardwood	*Miscanthus* Switchgrass
PRODUCT	Biodiesel	Ethanol		Ethanol	Biomass-to-liquid (BTL) fuels


Corn accounts for roughly 60 percent of the final cost of tortillas, a staple food for millions of Mexicans.
150% increase
100%
Tortilla price
RISE IN TORTILLA PRICES OUTPACED RISE IN MINIMUM WAGE
Percentage change since 2000
50%
Minimum wage
No change
2000
2005
2011
Mexicans spend three times more of their income on food than Americans do. Mexico's urban poor spend an even higher share.
PORTION OF INCOME SPENT ON FOOD IN 2011
U.S.
7%
MEXICO
25%
From 2005 to 2011 the price of tortillas in Mexico rose nearly 70 percent, fueling the 2007 riots that led to government price controls. Experts estimate that increased U.S. ethanol production accounted for over 30 percent of the price spike.
WORLD BIOFUEL PRODUCTION
30 billion gallons
20
10
0
BIODIESEL
ETHANOL
2001
2011
A leading producer of sugar, Brazil uses half of its supply to make ethanol. Unlike corn, sugar is not a staple crop.
61% U.S.
26% BRAZIL
13% OTHERS
2011
95%
OF U.S.-PRODUCED ETHANOL IS CONSUMED IN THE U.S.
GRAPHIC: ÁLVARO VALIÑO. SOURCES: TIMOTHY A. WISE, TUFTS UNIVERSITY; FAO; USDA ECONOMIC RESEARCH SERVICE; INTERNATIONAL ENERGY AGENCY

"People have a mistaken understanding of corn. They think it's incredibly productive.

The fact is, if you have a farmer who farms an acre of land in Iowa and then ships off all the corn, does all the work, puts in all the fuel, the fertilizer, the water and the pesticide, and harvests all that corn and ships it to a feedlot. That feedlot will produce around 1,500 pounds of meat from the corn on that acre of land.

If, however, that farmer planted a pasture in that land and put a cow on it, and they owned the cow, they would also produce 1,500 pounds of meat from that grass. However, instead of just getting the value of the feed, they would also get the value of the cow. And that is really how agriculture used to be, for as long as agriculture went on. Agriculture was having livestock and vegetable crops in a rotation on the land. Unfortunately, over the past 60 years, we have geared towards this monocropping system of corn and soy. And we have really destroyed a lot of the soil fertility. We've reversed basically 8000 years of agricultural progress over the past 60 years." Craig Wichner, Farmland LP, investing

Future food economics: decreased supply. Now, think back to a simple economic model of supply and demand. We have indicated why with ongoing population pressures and crop land degradation, two reasons why global food demand and supply might be under intense pressure over the next number of years. Our current model of industrial agriculture depends on three factors that are no longer in place: cheap fossil fuels, unlimited water and a stable climate.

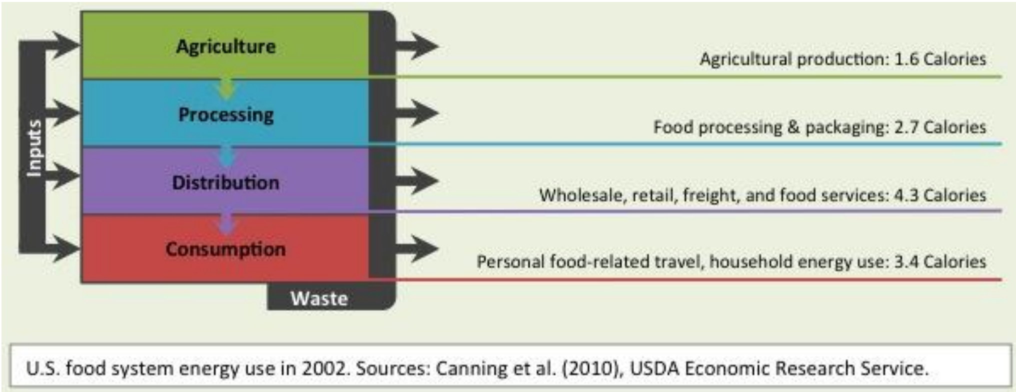
Petroleum use is well illustrated by the owner of a small farm in England who was exploring how she was going to survive in a world of declining energy reserves. The farmer explained how vital fossil fuel is to producing our food by taking apart her sandwich and showing how petroleum was used in each step of its making: (Hoskin, 2009) • First, you use a tractor to plow and plant the field to grow the wheat for the bread • Then you add the petroleum-based fertilizer required to grow the wheat crop in depleted soils • Next you control insects, weeds and disease using petroleum-based pesticides, herbicides and fungicides • Once the grain is ripe, you harvest it using gas-powered harvesters • Then you drive the grain to a factory to be dried, which uses even more power and oil • Then you drive it to a factory bakery to be processed into bread, and then drive it to the store where it can be bought • The pigs that produced the ham in her sandwich were also energy "hogs." One pig can eat nearly half a ton of the grain that was produced using all the oil discussed above • The tiny bit of lettuce and tomato were either shipped or flown in or produced in a heated greenhouse; either way they consumed oil to get to their destination. That ordinary sandwich was figuratively dripping with oil. In her continuing remarks, the farmer brought up the oft-quoted statistic that we use ten calories of energy for every one calorie of food we produce worldwide. This is only sustainable if there is an unlimited supply of cheap, renewable energy. Petroleum, the energy engine of agriculture, is only renewable if you consider time horizons in the millions of years. And while scientists, researchers and activists are debating the exact date of "peak oil," no one disagrees that our supplies are limited.

Each of the substances with a food product (e.g. salt, sugar, spices, vegetables, fruit, oils, etc.) might be sourced from different parts of the world, having been shipped, driven or flown. Furthermore, the glass jar or packaging could have been produced in one place, the paper for the label in another place, the inks for label produced yet somewhere else again. Once the product is finally complete, it too is shipped, driven or flown to a retailer who then stocks the shelves with hundreds of thousands of items all made in similarly complex ways. On study (Salleh 2007) in Australia concluded the items in a single basket of food from a supermarket typically travels 70,000 kilometres to the table (aggregating the distance each item travels).

Such travel and overall energy cost leads to food insecurity which was exemplified by the trucker's strike in the UK in 2000. The nation realized very quickly how dependent it was on the globalised food system, because when the truckers we out, food didn't get to supermarkets. Before long supermarkets were calling members of parliament advising them that without the lines of transport being re-opened to restock shelves, supermarkets would deplete their approximately three days of supply. In the words of one commentator, the nation was "only nine meals from anarchy" (Simms 2008). Current, globalized, industrial food production is extremely energy intensive and hugely complex, but partly for those reasons it is not very resilient.

Tainter, argues that complexity typically precedes an energy surplus. He argues complexity arises when new problems present themselves, and attempting to solve for them forces more complexity which unfortunately most often consumes more energy. "Complexity often compels the production of energy, rather than following its abundance" Examples include the industrial military complex, how we now farm and fish the oceans, industrial food production, etc. Tainter goes on to conclude "all solutions to the problem of complexity are temporary". But complex societies could become far more self-reliant, and benefit from this, if only we made a commitment to source much of our food locally.

A study of Toronto, for example, concluded the city could possibly produce 10% of its own fruit and vegetables, if available growing space within the city's boundaries were converted to agriculture (MacRae et al 2010).



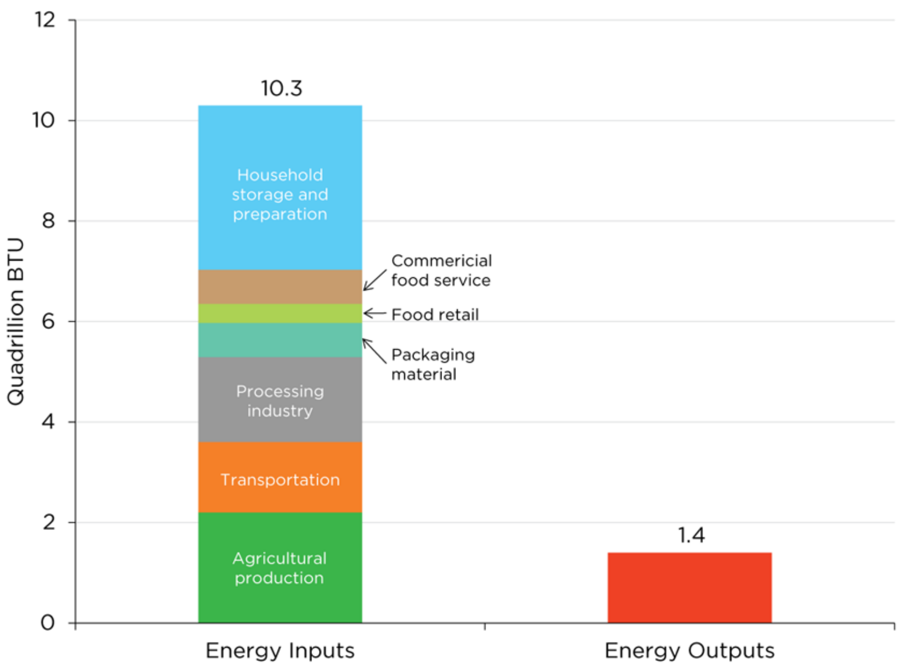


Figure 2.7. Energy inputs and outputs in the US food system.
Source: Center for Sustainable Systems, University of Michigan, "U.S. Food System Factsheet." Pub. No. CSS01-06 (2015).

"Consumer lifestyles have a time limit and this time limit is fast running out. If the global financial system does not collapse under the weight of its own debt, perhaps induced by rising oil prices or the bursting of financial bubbles, then at some point our trembling ecosystems will collapse, taking industrial civilization down with them. Either way, consumerism and the growth paradigm that supports it have no future" Samuel Alexander, Prosperous Decent.

Pick your problem: soil erosion, biological and corporate mono-culture vulnerabilities, water shortages, population pressures, peak oil, carbon pricing, wild fish population collapse, farmer shortages, biofuel competition, sickening diets or antibiotic contamination. Any one of these by itself loads a big problem onto our plates. Put them all together and all that bountiful food in my corner IGA store is certain to become more costly, less safe, less nutritious and less available. No wonder so many people are kicking into action to do something about this. Walmart, for example, has launched a new initiative intended to increase the amount of local food it bought by 2015 to 9 percent.