Soil Association

Lady Eve Balfour lecture

What will we eat when the oil runs out?

given by Richard Heinberg

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*** UNCORRECTED, UNFOOTNOTED DRAFT ***

Our global food system faces a crisis of unprecedented scope. This crisis, which threatens to imperil the lives of hundreds of millions and possibly billions of human beings, consists of four simultaneously colliding dilemmas, all arising from our relatively recent pattern of dependence on depleting fossil fuels.

The first dilemma consists of the direct impacts on agriculture of *higher oil prices*: increased costs for tractor fuel, agricultural chemicals, and the transport of farm inputs and outputs.

The second is an indirect consequence of high oil prices—the *increased demand for biofuels*, which is resulting in farmland being turned from food production to fuel production, thus making food more costly.

The third dilemma consists of the impacts of *climate change and extreme weather events* caused by fuel-based greenhouse gas emissions. Climate change and fossil fuel depletion are the central crises of our time; both arise from society's current patterns of energy use and, as we will see, both have similar solutions.

Finally comes the *degradation or loss of basic natural resources* (principally, topsoil and fresh water supplies) as a result of high rates, and unsustainable methods, of production stimulated by decades of cheap energy.

Each of these problems is developing at a somewhat different pace regionally, and each is exacerbated by the continually expanding size of the human population. As these dilemmas collide, the resulting overall food crisis is likely to be profound and unprecedented in scope.

I propose to discuss each of these dilemmas briefly and to show how all are intertwined with our societal reliance on oil and other fossil fuels. I will then argue that the primary solution to the overall crisis of the world food system must be a planned rapid reduction in the use of fossil fuels in the growing and delivery of food. As we will see, this strategy, though ultimately unavoidable, will bring enormous problems of its own unless it is applied with forethought and intelligence. But the organics movement is uniquely positioned to guide this inevitable transition of the world's food systems away from reliance on fossil fuels, if leaders and practitioners of the various strands of organic agriculture are willing to work together and with policy makers.

Structural Dependency

Until now, fossil fuels have been widely perceived as an enormous boon to humanity, and certainly to the human food system. After all, there was a time not so long ago when famine was an expected, if not accepted, part of life even in wealthy countries. Until the 19th century—whether in China, France, India or Britain—food came almost entirely from local sources and harvests were variable. In good years, there was plenty—enough for seasonal feasts and for storage in anticipation of winter and hard times to come; in bad years, starvation cut down the poor, the very young, the old, and the sickly. Sometimes bad years followed one upon another, reducing the size of the population by several percent. This was the *normal* condition of life in pre-industrial societies, and it persisted for thousands of years.[1]

By the nineteenth century a profound shift in this ancient regime was under way. For Europeans, the export of surplus population to other continents, crop rotation, and the application of manures and composts were all gradually making famines less frequent and severe. European farmers, realizing the need for a new nitrogen source in order to continue feeding burgeoning and increasingly urbanized populations, began employing guano imported from islands off the coasts of Chile and Peru. The results were gratifying. However, after only a few decades, these guano deposits were being depleted. By this time, in the late 1890s, the world's population was nearly twice what it had been at the beginning of the century. A crisis was in view.

But crisis was narrowly averted through the use of fossil fuels. In 1909, two German chemists named Fritz Haber and Carl Bosch invented a process to synthesize ammonia from atmospheric nitrogen and the hydrogen in fossil fuels. The process initially used coal as a feedstock, though later it was adapted to use natural gas. After the end of the Great War, nation after nation began building Haber-Bosch plants; today the process yields 150 million tons of ammonia-based fertilizer per year, producing a total quantity of available nitrogen equal to the amount introduced annually by all natural sources combined.[2]

Fossil fuels went on to offer other ways of extending natural limits to the human carrying capacity of the planet.

In the 1890s, roughly one quarter of British and American cropland had been set aside to grow grain to feed horses, of which most worked on farms. The internal combustion engine provided a new kind of horsepower not dependent on horses at all, and thereby increased the amount of arable land available to feed humans. Early steam-driven tractors had come into limited use in 19th century; but, after World War I, the size and effectiveness of powered farm machinery expanded dramatically, and the scale of use exploded throughout the twentieth century, especially in North America, Europe, and Australia.

Chemists developed synthetic pesticides and herbicides in increasing varieties after World War II, using knowledge pioneered in laboratories that had worked to perfect explosives and other chemical warfare agents. Petrochemical-based pesticides not only increased crop yields in North America, Europe, and Australia, but also reduced the prevalence of insect-borne diseases like malaria. The world began to enjoy the benefits of "better living through chemistry," though the environmental costs, in terms of water and soil pollution and damage to vulnerable species, would only later become widely apparent.

In the 1960s, industrial-chemical agricultural practices began to be exported to what by that time was being called the Third World: this was glowingly dubbed the Green Revolution, and it enabled a tripling of food production during the ensuing half-century.

At the same time, the scale and speed of distribution of food increased. This also constituted a means of increasing human carrying capacity, though in a more subtle way. The trading of food goes back to Paleolithic times; but, with advances in transport, the quantities and distances involved gradually increased. Here again, fossil fuels were responsible for a dramatic discontinuity in the previously slow pace of growth. First by rail and steamship, then by truck and airplane, immense amounts of grain and ever-larger quantities of meat, vegetables, and specialty foods began to flow from countryside to city, from region to region, and from continent to continent.

The end result of chemical fertilizers, plus powered farm machinery, plus increased scope of transportation and trade, was not just an enormous leap in crop yields, but a similar explosion of human population, which has grown over six-fold since dawn of industrial revolution. However, in the process, conventional industrial agriculture has become overwhelmingly dependent on fossil fuels. According to one study, approximately ten calories of fossil fuel energy are needed to produce each calorie of food energy in modern industrial agriculture.[3] With globalized trade in food, many regions host human populations larger than local resources alone could possibly support. Those systems of global distribution and trade also rely on oil.

Today, in the industrialized world, the frequency of famine that our ancestors knew and expected is hard to imagine. Food is so cheap and plentiful that obesity is a far more widespread concern than hunger. The average mega-supermarket stocks an impressive array of exotic foods from across the globe, and even staples are typically trucked or shipped from hundreds of miles away. All of this would be well and good if it were sustainable, but the fact that nearly all of this recent abundance depends on depleting, non-renewable fossil fuels whose burning emits climate-altering carbon dioxide gas means that the current situation is not sustainable.

The Worsening Oil Supply Picture

During the past decade a growing chorus of energy analysts has warned of the approach of "Peak Oil," the time when the global rate of extraction of petroleum will reach a maximum and begin its inevitable decline.

During this same decade, the price of oil has advanced from about US$12 per barrel to nearly $100 per barrel.

While there is some dispute among experts as to *when* the peak will occur, there is none as to *whether*. The global peak is merely the cumulative result of production peaks in individual oilfields and whole oil-producing nations, and these mini-peaks are occurring at an increasing rate.

The most famous and instructive national peak occurred in the US in 1970: at that time America produced 9.5 million barrels of oil per day; the current figure is less than 5.2 Mb/d. While at one time the US was the world's foremost oil exporting nation, it is today the world's foremost importer.

The history of US oil production also helps us evaluate the prospects for delaying the global peak. After 1970, exploration efforts succeeded in identifying two enormous new American oil provinces—the North Slope of Alaska and the Gulf of Mexico. During this period, other kinds of liquid fuels (such as ethanol and gas condensates) began to supplement crude. Also, improvements in oil recovery technology helped to increase the proportion of the oil in existing fields able to be extracted. These are precisely the strategies (exploration, substitution, and technological improvements) that the oil producers are relying on to delay the global production peak. In the US, each of these strategies made a difference—but not enough to reverse, for more than a year or two at a time, the overall 37-year trend of declining production. To assume that the results for the world as a whole will be much different is probably unwise.

The recent peak and decline in production of oil from the North Sea is of perhaps of more direct relevance to this audience. In just seven years, production from the British-controlled region has declined by almost half.

How near is the global peak? Today the majority of oil-producing nations are seeing reduced output: in 2006, BP's *Statistical Review of World Energy* reported declines in 27 of the 51 producing nations listed. In some instances, these declines will be temporary and are occurring because of lack of investment in production technology or domestic political problems. But in most instances the decline results from factors of geology: while older oil fields continue to yield crude, beyond a certain point it becomes impossible to maintain existing flow rates by any available means. As a result, over time there are fewer nations in the category of oil exporters and more nations in the category of oil importers.[4]

Meanwhile global rates of discovery of new oilfields have been declining since 1964.[5]

These two trends (a growing preponderance of past-peak producing nations, and a declining success rate for exploration) by themselves suggest that the world peak may be near.

Clearly the timing of the global peak is crucial. If it happens soon, or if in fact it already has occurred, the consequences will be devastating. Oil has become the world's foremost energy resource. There is no ready substitute, and decades will be required to wean societies from it. Peak Oil could therefore constitute the greatest economic challenge since the dawn of the industrial revolution.

An authoritative new study by the Energy Watch Group of Germany concludes that global crude production hit its maximum level in 2006 and has already begun its gradual decline.[6] Indeed, the past two years have seen sustained high prices for oil, a situation that should provide a powerful incentive to increase production wherever possible. Yet actual aggregate global production of conventional petroleum has stagnated during this time; the record monthly total for crude was achieved in May 2005, nearly 30 months ago.

The latest medium-term report of the IEA, issued July 9, projects that world oil demand will rise by about 2.2 percent per year until 2012 while production will lag, leading to what the report's authors call a "supply crunch."[7]

The Price of Sustenance

During these past two years, as oil prices have soared, food prices have done so as well. Farmers now face steeply increasing costs for tractor fuel, agricultural chemicals, and the transport of farm inputs and outputs. However, the linkage between fuel and food prices is more complicated than this, and there are other factors entirely separate from petroleum costs that have impacted food prices. I will attempt to sort these various linkages and influences out in a moment.

First, however, it is worth taking a moment to survey the food price situation.

An article by John Vidal published in the *Guardian* on November 3, titled "Global Food Crisis Looms As Climate Change and Fuel Shortages Bite," began this way:

> Empty shelves in Caracas. Food riots in West Bengal and Mexico. Warnings of hunger in Jamaica, Nepal, the Philippines and sub-Saharan Africa. Soaring prices for basic foods are beginning to lead to political instability, with governments being forced to step in to artificially control the cost of bread, maize, rice and dairy products.
>
> Record world prices for most staple foods have led to 18 percent food price inflation in China, 13 percent in Indonesia and Pakistan, and 10 percent or more in Latin America, Russia and India, according to the UN Food and Agricultural Organisation (FAO).
>
> Wheat has doubled in price, maize is nearly 50 percent higher than a year ago and rice is 20 percent more expensive, says the UN. . . .
>
> Last week the Kremlin forced Russian companies to freeze the price of milk, bread and other foods until January 31, for fear of a public backlash with a parliamentary election looming. . . .

> India, Yemen, Mexico, Burkina Faso and several other countries have had, or been close to, food riots in the last year, something not seen in decades of low global food commodity prices. Meanwhile, there are shortages of beef, chicken and milk in Venezuela and other countries as governments try to keep a lid on food price inflation.[8]

Jacques Diouf, head of the FAO, said in London early this month, "If you combine the increase of the oil prices and the increase of food prices then you have the elements of a very serious [social] crisis. . . ." FAO statistics show that grain stocks have been declining for more than a decade and now stand at a mere 57 days, the lowest level in a quarter century, threatening what it calls "a very serious crisis."[9]

According to Josette Sheeran, director of the UN's World Food Program (WFP), "There are 854 million hungry people in the world and 4 million more join their ranks every year. We are facing the tightest food supplies in recent history. For the world's most vulnerable, food is simply being priced out of their reach."[10]

In its biannual Food Outlook report released November 7, the FAO predicted that higher food prices will force poor nations, especially those in sub-Saharan Africa, to cut food consumption and risk an increase in malnutrition. The report noted, "Given the firmness of food prices in the international markets, the situation could deteriorate further in the coming months."[11]

Meanwhile, a story by Peter Apps in Reuters from October 16 noted that the cost of food aid is rising dramatically, just as the global need for aid is expanding. The amount of money that nations and international agencies set aside for food aid remains relatively constant, while the amount of food that money will buy is shrinking.[12]

To be sure, higher food prices are good for farmers—assuming that at least some of the increase in price actually translates to higher income for growers. This is indeed the case for the poorest farmers, who have never adopted industrial methods. But for many others, the higher prices paid for food simply reflect higher production costs. Meanwhile, it is the urban poor who are impacted the worst.

Impact of Biofuels

One factor influencing food prices arises from the increasing incentives for farmers worldwide to grow biofuel crops rather than food crops. Ethanol and biodiesel can be produced from a variety of crops including maize, soy, rapeseed, sunflower, cassava, sugar cane, palm, and jatropha. As the price of oil rises, many farmers are finding that they can produce more income from their efforts by growing these crops and selling them to a biofuels plant, rather than growing food crops either for their local community or for export.

Already nearly 20 percent of the US maize crop is devoted to making ethanol, and that proportion is expected to rise to one quarter, based solely on existing projects-in-development and government mandates. Last year US farmers grew 14 million tons of maize for vehicles.

This took millions of hectares of land out of food production and nearly doubled the price of corn. Both Congress and the White House favor expanding ethanol production even further—to replace 20 percent of gasoline demand by 2017—in an effort to promote energy security by reducing reliance on oil imports. Other nations including Britain are mandating increased biofuel production or imports as a way of reducing carbon emissions, though most analyses show that the actual net reduction in CO2 will be minor or nonexistent.[13]

The US is responsible for 70 percent of world maize exports, and countries such as Mexico, Japan, and Egypt that depend on American corn farmers use maize both as food for people and feed for animals. The ballooning of the US ethanol industry is therefore impacting food availability in other nations both directly and indirectly, raising the price for tortillas in Mexico and disrupting the livestock and poultry industries in Europe and Africa.

Grain, a Barcelona-based food-resources NGO, reports that the Indian government is committed to planting 14 million hectares with Jatropha for biodiesel production. Meanwhile, Brazil plans to grow 120 million hectares of fuel crops, and Africa up to 400 million hectares. While currently unproductive land will be used for much of this new production, many millions of people will be forced off that land in the process.[14]

Lester Brown, founder of the Washington-based Earth Policy Institute, has said: "The competition for grain between the world's 800 million motorists, who want to maintain their mobility, and its two billion poorest people, who are simply trying to survive, is emerging as an epic issue."[15] This is an opinion no longer being voiced just by environmentalists. In its twice-yearly report on the world economy, released October 17, the International Monetary Fund noted that, "The use of food as a source of fuel may have serious implications for the demand for food if the expansion of biofuels continues."[16] And earlier this month, Oxfam warned the EU that its policy of substituting ten percent of all auto fuel with biofuels threatened to displace poor farmers. Jean Ziegler, a UN special rapporteur went so far as to call the biofuel trade "a crime against humanity," and echoed journalist George Monbiot's call for a five-year moratorium on government mandates and incentives for biofuel expansion.[17]

The British government has pledged that "only the most sustainable biofuels" will be used in the UK, but, as Monbiot has recently noted, there are no explicit standards to define "sustainable" biofuels, and there are no means to enforce those standards in any case.[18]

Impact of Climate Change and Environmental Degradation

Beyond the push for biofuels, the food crisis is being also being driven by extreme weather events and environmental degradation.

The phrase "global warming" implies only the fact that the world's average temperature increase by a degree or more over the next few decades. The much greater problem for farmers is destabilization of weather patterns. We face not just a warmer climate, but *climate chaos*: droughts, floods, and stronger storms in general (hurricanes, cyclones, tornadoes, hail storms)—in short, unpredictable weather of all kinds. Farmers depend on relatively consistent seasonal patterns of rain and sun, cold and heat; a climate shift can spell the end of farmers' ability to grow a crop in a given region, and even a single freak storm can destroy an entire year's national production for some crops. Given the fact that modern agriculture has become highly centralized due to cheap transport and economies of scale, the damage from that freak storm is today potentially continental or even global in scale. We have embarked on a century in which, increasingly, freakish weather is normal.

According to the UN's World Food Program (WFP), 57 countries, including 29 in Africa, 19 in Asia and nine in Latin America, have been hit by catastrophic floods. Harvests have been affected by drought and heatwaves in south Asia, Europe, China, Sudan, Mozambique and Uruguay.[19]

Last week the Australian government said drought had slashed predictions of winter harvests by nearly 40 percent, or four million tons. "It is likely to be even smaller than the disastrous drought-ravaged 2006-07 harvest and the worst in more than a decade," said the Bureau of Agriculture and Resource.[20]

In addition to climate chaos, we must contend with the depletion or degradation of several resources essential to agriculture.

Phosphorus is set to become much more scarce and expensive, according to a study by Patrick Déry, a Canadian agriculture and environment analyst and consultant. Using data from the US Geological Survey, Déry performed a peaking analysis on phosphate rock, similar to the techniques used by petroleum geologists to forecast declines in production from oilfields. He found that "we have already passed the phosphate peak [of production] for United States (1988) and for the World (1989)." We will not completely run out of rock phosphate any time soon, but we will be relying on lower-grade ores as time goes on, with prices inexorably rising.[21]

At the same time, soil erosion undermines food production and water availability, as well as producing 30 percent of climate-changing greenhouse gases. Each year, roughly 100,000 square kilometres of land loses its vegetation and becomes degraded or turns into desert, altering the temperature and energy balance of the planet.[22]

Finally, yet another worrisome environmental trend is the increasing scarcity of fresh water. According to United Nations estimates, one third of the world's population lives in areas with water shortages and 1.1 billion people lack access to safe drinking water. That situation is expected to worsen dramatically over the next few decades. Climate change has provoked more frequent and intense droughts in sub-tropical areas of Asia and Africa, exacerbating shortages in some of the world's poorest countries.

While human population tripled in the 20th century, the use of renewable water resources has grown six-fold. According to Bridget Scanlon and colleagues, writing in *Water Resources Research* this past March 27, in the last 100 years irrigated agriculture expanded globally by 480 percent, and it is projected to increase another 20 percent by 2030 in developing countries. Irrigation is expanding fastest in countries such as China and India. Global irrigated agriculture now accounts for almost 90 percent of global freshwater consumption, despite representing only 18 percent of global cropland. In addition to drawing down aquifers and surface water sources, it also degrades water quality, as salts in soils are mobilized, and as fertilizers and pesticides leach into aquifers and streams.[23]

These problems all interact and compound one another. For example, soil degradation produces growing shortages of water, since soil and vegetation act as a sponge that holds and gradually releases water. Soil degradation also worsens climate change as increased evaporation triggers more extreme weather.

This month the UN Environment Program concluded that the planet's water, land, air, plants, animals and fish stocks are all in "inexorable decline." Much of this decline is due to agriculture, which constitutes the greatest single source of human impact on the biosphere.[24]

In the face of all these daunting challenges, the world must produce more food every year to keep up with population growth. Zafar Adeel, director of the United Nations University's Canadian-based International Network on Water, Environment and Health (INWEH), has calculated that more food will have to be produced during the next 50 years than during the last 10,000 years combined, even though global food production per hectare is already declining.[25] Food production has kept pace with population growth during the past few decades, increasing 50 percent just between 1980 and 2000. But there may be another three billion mouths to feed by 2050—if there is the food to support these additional members of the human family.

What Is the Solution?

International food agency officials spin out various scenarios to describe how our currently precarious global food system might successfully adapt and expand. Perhaps markets will automatically readjust to shortages, higher prices making it more profitable once again to grow crops for people rather than cars. New designer-gene crop varieties could help crops adapt to capricious climactic conditions, to require less water, or to grow in more marginal soils. And if people were to simply eat less meat, more land could be freed up to grow food for humans rather than farm animals. A slowdown or reversal in population growth would naturally ease pressures on the food system, while the cultivation of currently unproductive land could help increase supplies.

However, given the scale of the crisis facing us, merely to assume that these things will happen, or that they will be sufficient to overcome the dilemmas we have been discussing, seems overly optimistic, perhaps even to the point of irresponsibility.

One hopeful sign is that governments and international agencies are beginning to take the situation seriously. This month the World Bank issued a major report, "Agriculture for Development," whose main author, economist Alain de Janvry, appears to reverse his institution's traditional stance. For a half-century, development agencies such as the World

Bank have minimized the importance of agriculture, urging nations to industrialize and urbanize as rapidly as possible. Indeed, the Bank has not featured agriculture in an annual report since 1982. De Janvry says that, since half the world's population and three-quarters of the world's poor live in rural areas where food production is the mainstay of the economy, farming must be central to efforts to reduce hunger and poverty.[26]

Many agencies, including the International Network on Water, Environment and Health, are now calling for an end to the estimated 30 billion dollars in food subsidies in the North that contribute directly to land degradation in Africa and elsewhere, and that force poor farmers to intensify their production in order to compete.[27]

In addition, there are calls for sweeping changes in how land use decisions are made at all levels of government. Because soil, water, energy, climate, biodiversity, and food production are interconnected, integrated policy-making is essential. Yet policies currently are set by various different governmental departments and agencies that often have little understanding of one another's sectors.

Delegates at a soils forum in Iceland this month took up a proposal for a formal agreement on protecting the world's soils. And the World Water Council is promoting a range of programs to ensure the availability of clean water especially to people in poorer countries.[28]

All these efforts are in most cases laudable, even essential; however, they largely fail to address the common sources of the dilemmas we face—human population growth, and society's and agriculture's reliance on fossil fuels.

The solution most often promoted by the biggest companies within the agriculture industry—the bioengineering of crops and farm animals—does little or nothing to address these deeper causes. One can fantasize about modifying maize or rice to fix nitrogen in the way that legumes do, but so far efforts in that direction have failed. Meanwhile, and the bio-engineering industry itself consumes fossil fuels, and assumes the continued availability of oil for tractors, transportation, chemicals production, and so on.[29]

To get to the heart of the crisis, we need a more fundamental reform of agriculture than anything we have seen in many decades. In essence, we need an agriculture that does not require fossil fuels.

The idea is not new. The aim of substantially or entirely removing fossil fuels from agriculture is implicit in organics in all its various forms and permutations—including ecological agriculture, Biodynamics, Permaculture, Biointensive farming, and Natural Farming. All also have in common a prescription for the reduction or elimination of tillage, and the reduction or elimination of reliance on mechanized farm equipment. Nearly all of these systems rely on increased amounts of human labor, and on greater application of place-specific knowledge of soils, microorganisms, weather, water, and interactions between plants, animals, and humans.

Critics of organic or biological agriculture have always contended that chemical-free and less-mechanized forms of food production are incapable of feeding the burgeoning human population. This view is increasingly being challenged.

A recent survey of studies, by Christos Vasilikiotis, Ph.D., U.C. Berkeley, titled “Can Organic Farming Feed the World?”, concluded: “From the studies mentioned above and from an increasing body of case studies, it is becoming evident that organic farming does not result in either catastrophic crop losses due to pests nor in dramatically reduced yields. . . .”[30]

The most recent publication on the subject, by Perfecto et al., in *Renewable Agriculture and Food Systems,* found that “Organic farming can yield up to three times as much food on individual farms in developing countries, as [conventional] methods on the same land. . . .”[31]

Moreover, is clear that ecological agriculture could help directly to address the dilemmas we have been discussing.

Regarding water, organic production can help by building soil structure, thus reducing the need for irrigation. And with no petrochemical runoff, water quality is not degraded.[32]

Soil erosion and land degradation can be halted and even reversed: by careful composting, organic farmers have demonstrated the ability to build humus at many times the natural rate.[33]

Climate change can be addressed, by keeping carbon molecules in the soil and in forests and grasslands. Indeed, as much as 20 percent of anticipated net fossil fuel emissions between now and 2050 could be stored in this way, according to Maryam Niamir-Fuller of the U.N. Development Program.[34]

Natural gas depletion will mean higher prices and shortages for ammonia-based nitrogen fertilizers. But ecologically sound organic-biological agricultural practices use plant and manure-based fertilizers rather than fossil fuels. And when farmers concentrate on building healthy topsoil rich in beneficial microbes, plants have reduced needs for nitrogen.[35]

The impending global shortage of phosphate will be more difficult to address, as there is no substitute for this substance. The only solution here will be to recycle nutrients by returning all animal and humans manures to cultivated soil, as Asian farmers did for many centuries, and as many ecological farmers have long advocated.[36]

What Will Be Needed

How might we actually accomplish this comprehensive transformation or world agriculture? Some clues are offered by the example of a society that has already experienced and dealt with a fossil-fuel famine.

In the late 1980s, farmers in Cuba were highly reliant on cheap fuels and petrochemicals imported from the Soviet Union, using more agrochemicals per acre than their US counterparts. In 1990, as the Soviet empire collapsed, Cuba lost those imports and faced an agricultural crisis. The average Cuban lost 20 pounds of body weight and malnutrition was nearly universal. The Cuban GDP fell dramatically and inhabitants of the island nation experienced a substantial decline in their material standard of living.[37]

Several agronomists at Cuban universities had for many years been advocating a transition to organic methods. Cuban authorities responded to the crisis by giving these ecological agronomists *carte blanche* to redesign the nation's food system. Officials broke up large state-owned farms, offered land to farming families, and encouraged the formation of small agricultural co-ops. Cuban farmers began employing oxen as a replacement for the tractors they could no longer afford to fuel. Cuban scientists began investigating biological methods of pest control and soil fertility enhancement. The government sponsored widespread education in organic food production, and the Cuban people adopted a mostly vegetarian diet out of necessity. Salaries for agricultural workers were raised, in many cases to above the levels of urban office workers. Urban gardens were encouraged in parking lots and on public lands, and thousands of rooftop gardens appeared. Small food animals such as chickens and rabbits began to be raised on rooftops as well.

As a result of these efforts, Cuba was able to avoid what might otherwise have been a severe famine. Today food production there has returned to 90 percent of its pre-crisis levels.[10]

If the rest of the world does not plan for a reduction in fossil fuel use in agriculture, its post-peak-oil agricultural transition may be far less successful than was Cuba's. Already in poor countries, farmers who are attempting to apply industrial methods but cannot afford tractor fuel and petrochemical inputs are watching their crops fail. Soon farmers in wealthier nations will be having a similar experience.

Where food is still being produced, there will be the challenge of getting it to the stores. Britain had a taste of this problem in 2000; David Strahan relates in his brilliant book *The Last Oil Shock* how close Britain came to political chaos then as truckers went on strike because of high fuel costs. He writes: "Supermarket shelves were being stripped of staple foods in scenes of panic buying. Sainsbury, Asda, and Safeway reported that some branches were having to ration bread and milk."[38] This was, of course, merely a brief interruption in the normal functioning of the British energy-food system. In the future we may be facing instead what my colleague James Howard Kunstler calls "the long emergency."[39]

How will Britain and the rest of the world cope? What will be needed to ensure a successful transition away from an oil-based food system, as opposed to a haphazard and perhaps catastrophic one?

Because ecological organic farming methods are often dramatically more labor- and knowledge-intensive than industrial agriculture, their adoption will require an economic transformation of societies. The transition to a non-fossil-fuel food system will take time. Nearly every aspect of the process by which we feed ourselves must be redesigned. And, given the likelihood that global oil peak will occur soon, this transition must occur at a forced pace, backed by the full resources of national governments.

Without cheap transportation fuels we will have to reduce the amount of food transportation that occurs, and make necessary transportation more efficient. This implies increased local food self-sufficiency. It also implies problems for large cities that have been built in arid regions capable of supporting only small populations from their regional resource base. In some cases, relocation of people on a large scale may be necessary.

We will need to grow more food in and around cities. Recently, Oakland California adopted a food policy that mandates by 2015 the growing within a fifty-mile radius of city center of 40 percent of the vegetables consumed in the city.[40] If the example of Cuba is followed, rooftop gardens may result, as well as urban raising of small food animals like chickens, rabbits, and guinea pigs.

Localization of food systems means moving producers and consumers of food closer together, but it also means relying on the local manufacture and regeneration of all of the elements of the production process—from seeds to tools and machinery. This again would appear to rule out agricultural bioengineering, which favors the centralized production of patented seed varieties, and discourages the free saving of seeds from year to year by farmers.

Clearly, we must also minimize indirect chemical inputs to agriculture—such as those introduced in packaging and processing.

We will need to re-introduce draft animals in agricultural production. Oxen may be preferable to horses in many instances, because the former can eat straw and stubble, while the latter would compete with humans for grains. We can only bring back working animals to the extent that we can free up land with which to produce food for them. One way to do that would be to reduce the number of farm animals grown for meat.

Governments must also provide incentives for people to return to an agricultural life. It would be a mistake to think of this simply in terms of the need for a larger agricultural work force. Successful traditional agriculture requires social networks and intergenerational sharing of skills and knowledge. We need not just more agricultural workers, but a rural culture that makes farming a rewarding way of life capable of attracting young people.

Farming requires knowledge and experience, and so we will need education for a new generation of farmers; but only some of this education can be generic—much of it must of necessity be locally appropriate.

It will be necessary as well to break up the corporate mega-farms that produce so much of today's cheap food. Industrial agriculture implies an economy of scale that will be utterly inappropriate and unworkable for post-industrial food systems. Thus land reform will be required in order to enable smallholders and farming co-ops to work their own plots.

In order for all of this to happen, governments must end subsidies to industrial agriculture and begin subsidizing post-industrial agricultural efforts. There are many ways this could be done. The present regime of subsidies is so harmful that merely stopping it in its tracks might be advantageous; but, given the fact that rapid adaptation is essential, offering subsidies for education, no-interest loans for land purchase, and technical support during the transition from chemical to organic production would be essential.

Finally, given carrying-capacity limits, food policy must include population policy. We must encourage smaller families by means of economic incentives and improve the economic and educational status of women in poorer countries.

All of this constitutes a gargantuan task, but the alternatives—doing nothing or attempting to solve our food-production problems simply by applying mere techno-fixes—will almost certainly lead to dire consequences. All of the worrisome trends mentioned earlier would intensify to the point that the human carrying capacity of Earth would be degraded significantly, and perhaps to a large degree permanently.[41]

So far we have addressed the responsibility of government in facilitating the needed transformation in agriculture. Consumers can help enormously by becoming more conscious of their food choices, seeking out locally produced organic foods and reducing meat consumption.

The organics movement, while it may view the crisis in industrial agriculture as an opportunity, also bears an enormous responsibility. In the example of Cuba just cited, the active lobbying of organic agronomists proved crucial. Without that guiding effort on the part of previously marginalized experts, the authorities would have had no way to respond. Now crisis is at hand for the world as a whole. The organics movement has most of the answers that will be needed; however, its message still isn't getting through. Three things will be necessary to change that.

1. The various strands of the organics movement must come together so that they can speak to national and international policy makers with a unified voice.

2. The leaders of this newly unified organics movement must produce a coherent plan for a global transition to a post-fossil-fuel food system. Organic farmers and their organizations have been promoting some of the needed policies for decades in a piecemeal fashion. Now, however, there is an acute need for a clearly formulated, comprehensive, alternative national and global food policy, and there is little time to communicate and implement it. It is up to the organics movement to proactively seek out policy makers and promote this coherent alternative, just as it is up to representatives of government at all levels to listen.

3. I have just called for unity in the organics movement, and to achieve this it will be necessary to address a recent split within the movement. What might be called traditional organics remains focused on small-scale, labor-intensive, local production for local consumption. In contrast to this, the more recently emerging corporate organic model merely removes petrochemicals from production, while maintaining nearly all the other characteristics of the modern industrial food system. This trend may be entirely understandable in terms of the economic pressures and incentives within the food industry as a whole. However, corporate organics has much less to offer in terms of solutions to the emerging crisis. Thus as the various strands of the organic movement come together, they should do so in light of the larger societal necessity. The discussion must move beyond merely gaining market share; it must focus on averting famine under crisis conditions.

To conclude, let me simply restate what is I hope clear by now: Given the fact that fossil fuels are limited in quantity and that we are already in view of the global oil production peak, we *must* turn to a food system that is less fuel-reliant, even if the process is problematic in many ways. The transition to a fossil-fuel-free food system does not constitute a distant utopian proposal. It is an unavoidable, immediate, and immense challenge that will call for unprecedented levels of creativity at all levels of society. A hundred years from now, everyone will be eating what we today would define as organic food, whether or not we act. But what we do now will determine how many will be eating, what state of health will be enjoyed by those future generations, and whether they will live in a ruined cinder of a world, or one that is in the process of being renewed and replenished.

Notes

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3. David Pimentel
4. BP, countries in decline
5. ExxonMobil, decline in discoveries
6. Energy Watch Group, "Crude Oil—The Supply Outlook," http://www.energywatchgroup.de/fileadmin/global/pdf/EWG_Oilreport_10-2007.pdf
7. IEA
8. John Vidal, "Global Food Crisis Looms as Climate Change and Fuel Shortages Bite", *The Guardian*, Nov. 3, 2007 www.guardian.co.uk/environment/2007/nov/03/food.climatechange
9. Jacques Diouf quoted by John vidal, *op. cit.*
10. http://www.guardian.co.uk/environment/2007/nov/03/food.climatechange
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12. Peter Apps, "Cost of Food Aid Soars As Global Need Rises, Reuters, October 16 http://africa.reuters.com/top/news/usnBAN648660.html
13. Source of biofuels stats
14. John Vidal, "And If the Food Runs Out?", *The Age*, Nov. 4, 2007 www.theage.com.au/news/in-depth/and-if-the-food-runs-out/2007/11/03/1193619201825.html
15. Lester Brown quoted in John Vidal, *op. cit.*
16. IMF
17. Ziegler, quoted by George Monbiot www.monbiot.com/archives/2007/11/06/an-agricultural-crime-against-humanity/
18. Monbiot, op. cit.
19. WFP stats
20. Australian government quote
21. Patrick Déry

22. http://www.ipsnews.net/news.asp?idnews=39083

23. www.geotimes.org/june07/article.html?id=nn_agriculture.html

24. UNEP quote

25. Adeel quote

26. World Bank

27. INWEH

28. Iceland soil conference

29. biotech reference

30. www.cnr.berkeley.edu/~christos/articles/cv_organic_farming.html

31. (vol 22, p 86) University of Michigan, July 10, 2007

32. Organics and water

33. Organics and soil

34. Niamir-Fuller quote

35. organics and nitrogen

36. Recycling phosphates

37. The story of Cuba

38. David Strahan, *The Last Oil Shock*

39. Jamees Howard Kunstler, *The Long Emergency*

40. Oakland food policy

41. Peter Goodchild, "Agriculture In A Post-Oil Economy," 22 September, 2007
www.countercurrents.org/goodchild220907.htm