EATING FOSSIL FUEL

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Humanity is facing a dire emergency in the coming years: the end of an era, the end of cheap and available oil. Oil is a finite resource that is about to reach peak production, after which its prices will rise continuously and significantly. The phrase "energy crisis" typically instills images of long lines at the gasoline station, high electric bills, blackouts, or even conflict in the Middle East. What is usually not considered is the looming agricultural crisis. Modern industrial agriculture is energy-intensive and heavily dependent on oil. In his article, "The Post-Petroleum Paradigm—and Population," geologist and energy expert, Walter Youngquist, argues that because oil is such an integral part of modern U.S. agriculture, a world without oil spells agricultural collapse and thus social catastrophe. Agriculture in the United States (and other regions with similar farming practices) is headed towards inevitable collapse, with few but potentially efficacious solutions: alternative energies, Amish-style and organic farming, and a transition to a more vegetarian collective diet. While optimists like economist and editor of *Reason* magazine, Ronald Bailey, may argue for developing new technologies to allow the current agricultural paradigm to persist, the more practical solution to this problem is to revert to "old-fashioned" farming methods and diets. Rather than attempt technological miracles, the U.S. should be planning a change in the fundamental structure of its agricultural system.

Fossil fuel is a vital part of the global economy. The coming of "Peak Oil" will have serious consequences: Youngquist correctly claims that "worldwide decline of oil production…will have many ramifications, changing world economies, social structures, and individual lifestyles" (298). When exactly this worldwide decline of oil production will occur is debatable. However, the overwhelming consensus is that oil will "run out" some time this century. "Peak Oil" is the maximum output of oil production, after which the price of oil and all associated products and processes, including agricultural production, will increase. There will be considerable effects on the global economy long before there is actually no recoverable oil. Based on the global proven oil reserves, about one trillion barrels, and an annual global consumption of 27 billion barrels per year ("World Oil Balance"), the world will completely run out of oil by 2040, assuming that the proven oil reserves do not grow at all. But as an author and social critic, James Kunstler points out in his book, *The*

Long Emergency, that this may be a valid assumption, as oil discovery peaked worldwide forty years ago (65). Society cannot assume that more and more oil will be discovered; neither can it look towards other fossil fuels. Coal and natural gas are the second and third-most utilized sources of energy ("U.S. Electric Power"), mostly for electricity production; their consumption will likely increase to partially offset the decrease in oil production, but this will not last long, as coal and natural gas are finite fossil fuel resources as well.

Civilization, especially in the U.S., currently operates under the assumption that oil, coal, and natural gas are and will continue to be cheap and plentiful. Youngquist appropriately suggests that "we are fortunate to be living in what has been called the Age of the Hydrocarbon Man" (307). He implies that the current society has the luxury of inexpensive and available fossil fuels (hydrocarbons). He also insinuates that civilization is utterly dependent on these hydrocarbons, so as to rebrand "Man" as "Hydrocarbon Man." Of the major sources of energy in the world, oil is the most used. According to the U.S. Department of Energy, over forty percent of all energy consumed comes from oil ("Oil"). And even though the United States owns less than three percent of the global proven oil reserves, it consumed one quarter of the oil produced globally in 2000 ("World Oil Balance"). While two thirds of national oil consumption occurs in the transportation sector, much of the remaining oil is used for agricultural purposes. Any sector of the economy contingent on hydrocarbons is imperiled, be it the monstrous transportation industry or the smaller but more essential agribusiness which feeds the country. The United States economy is particularly vulnerable to the effects of Peak Oil because its overall energy consumption is so much higher than the economies of other nations.

Agriculture is much more energy-intensive than it used to be. Soil physicist and hydrologist Daniel Hillel explains that the advent of irrigation made multiple cropping possible, which gave farmers the security needed to be able to invest so much energy and capital into each growing season (141). The result is "high-input" agriculture, which has become the mainstream method of food production in the United States. Considering that "the principle raw material of modern U.S. agriculture is fossil fuel, whereas the labor input is relatively small" (Pimentel et al 448), logic says that there is a looming agricultural crisis in the United States. The "Green Revolution," the widespread development of high-yield strains of certain crops, secured the grim fate of U.S. agriculture at its inception in the 1960s (EPA).

This new method of agricultural production was exceptionally high-yield, but at remarkably high energy costs. These crops are genetically modified through selective breeding to increase the ratio of edible parts to non-edible parts. Youngquist, quoting Brown and Kane, states, "'new [grain] varieties have high yields precisely because they are more responsive to fertilizer than traditional ones'" (305). For example, plants are bred to stop growing taller at an earlier point in the growing season, so that more of the season promotes grain production. Applied fertilizer, therefore, yields more grain, instead of producing taller plants. Plants are also bred to have a smaller root system, so as to allocate more energy for grain biomass. However, smaller roots inevitably require further fertilization and more frequent irrigation. Terry Gross of NPR interviewed Fred Pearce, an expert of hydrology and crop irrigation, in March 2006: Pearce states that "compared to thirty years ago we grow twice as much food as we did then, feeding a population of the world twice as large, but we use three times as much water to do it" (Pearce "Fresh Air"). Not only does this imply potential regional water shortages, but also high energy expenditure in irrigation practices. Smaller plants also require herbicide application in order to kill weeds that would otherwise choke out the crop. In addition, large agricultural fields are typically monocultures, consisting of only one crop type. These require insecticide application because monocultures cannot support a diverse ecosystem with insect and vertebrate predators, capable of controlling pest populations. Monocultures also exhaust the soil quickly, requiring further fertilizer application to replace lost soil nutrients. These extremely energy-intensive farming "advances," although seemingly beneficial in the short-term, have destabilized the U.S. agricultural system, supporting Youngquist's claim that industrial agriculture will collapse without a supply of cheap oil.

The Green Revolution temporarily reduced world hunger but increased the need for fossil fuels. Youngquist quotes Bartlett in his essay: "'Modern agriculture is the use of land to convert petroleum into food'" (303). This, of course, was not always the case; most of the non-solar energy applied in agriculture in its roughly ten thousand year history has been by human and animal labor. David Pimentel, renowned professor of ecology and agriculture at Cornell University, supports Youngquist's stance: "Fossil fuel inputs have…become so integral and indispensable to modern agriculture that the anticipated energy crisis will have a significant impact upon food production" (Pimentel et al. 1973 443). These energy inputs produce the

chemical pesticides and fertilizers, power farm machinery, run the irrigation system, dry the grain after being harvested, and so on. Considering that "in the United States, we are using an equivalent of 80 gallons of gasoline to produce an acre of corn" (448), the energy expenditures in modern industrial agriculture are obviously staggering. Richard Heinberg, one of the world's foremost Peak Oil educators, pertinently summarizes the energy costs of U.S. agriculture in an interview with Global Public Media:

> **U.S. agriculture is responsible for well over 10% of all national energy consumption. Over 400 gallons of oil equivalent are expended to feed each American each year. About a third of that amount goes toward fertilizer production. About 20% to operate farm machinery, about 16% for transportation of food, 13% for irrigation, 8% for livestock raising not including the livestock feed and about 5% for pesticide production. Now this doesn't even include the energy costs for packaging, refrigeration, or transportation to retailers or cooking. (Heinberg)**

Clearly, modern agricultural production is quite energy-intensive. The late Gerald Leach, a prominent environmental scientist, summarized the energy budget for one acre of potatoes in *The Man / Food Equation*. The total energy input into one acre of potatoes, including transportation about thirty miles into a hypothetical city is 5,440,000 kilocalories. In this model, thirty percent of the energy input comes from fertilizer application and ten percent of the energy input comes from transportation of the final product to the city. Obviously, the energy due to transportation could be much more or much less depending on the crop, time of year, and distance to the destination city. The total caloric output of these potatoes is between 5,490,000 and 6,440,000 kilocalories, depending on the potato type (Leach 146). This means that the energy ratio (output / input) is not much better than break-even. One could even say that potatoes are made entirely of fossil fuel! Purchasing local produce can effectively improve the energy ratio of food, but unfortunately, most grain nowadays comes from the Midwest, and a majority of energy expenditure comes from farm machinery and fertilizer application. Since the country is essentially "eating" petroleum, Youngquist is correct that without cheap and available oil, modern U.S. agriculture will collapse, which could initiate mass starvation.

Animal products like eggs, dairy and meat are even less energy-efficient. As a comparison to the potato example, the energy ratio calculated for one year's worth of

eggs from one hen is a measly 0.16 (Leach 150), and that for a broiler hen is 0.11 (152). As a rule, animal protein demands eight more times the fossil fuel energy than vegetable protein. And unfortunately, much of the grain grown in the United States is fed to livestock; 644 of the 1750 million tons of grain produced in 1995 went toward meat consumption—about thirty-seven percent (McConnell and Abel 81). That grain could feed millions directly and save energy. Pimentel argues that "if the world population were willing to eat nothing but corn grain, potential petroleum reserves could feed a projected 10 billion humans for 448 years" (Pimentel et al. 1973 448). Such a notion seems laughable, but it makes a good point: perhaps the agricultural crisis could be averted, or at least delayed, if American people ate a vegetarian diet. Considering the extreme energy costs of animal products, and the extreme demand for animal products in the United States—the average American consumes well over two hundred pounds of meat per year ("Food Consumption")—some may wish to look towards alternative means of powering conventional agriculture, before voluntarily changing their diets.

Those sharing Ronald Bailey's philosophy hope that an alternative energy source will "save the day" before the deleterious effects of Peak Oil manifest. Bailey states that "economic growth and technological progress are not enemies of the environment but are perhaps its best friend, since they allow us to reduce humanity's footprint on the natural world" ("Environment Canada"). Unfortunately, this optimism is not realistic. Youngquist correctly claims that "the versatility in oil in convenience of handling and transport, and in end uses…is unequaled by any other energy source" (308). For instance, enormous and extremely heavy storage batteries would be required to transport the same amount of energy stored by a tank full of gasoline. Renewable energy like solar and wind power can in fact generate ample electricity; the problem is storing and transporting this energy. For example, power is lost when traveling through power lines, so there is limit to the distance a power grid can be from a renewable energy source like an offshore wind farm. Kunstler argues that even the widespread belief that a "Hydrogen Economy" will take over as fuel cell technology becomes available is delusional. Hydrogen fuel cells are energy sinks because it takes more electricity to isolate and contain pure hydrogen than the electricity the hydrogen puts out (110-113). At this point, completely renewable sources of energy could neither isolate nor contain that hydrogen. Because seventy-one percent of all electricity in the United States is generated by fossil fuel ("U.S.

Electric Power"), the Hydrogen Economy would be supported by a shadow Fossil Fuel Economy. Even if the U.S. obtained all of its electricity from renewables like wind and solar power, technological and logistical barriers would prevent an adequate supply of hydrogen from reaching all areas of the country (Kunstler 114-116). The aim to establish a Hydrogen Economy is unrealistic, evidence that optimism and faith in technological advancement will not solve the pending agricultural crisis.

Almost identical to the hydrogen myth is the ethanol myth: many believe that ethanol, an alcohol derived from biomass like the vegetative parts of maize, will one day replace petroleum as a fuel for machinery and automobiles. However, as Youngquist correctly argues, ethanol is also an energy-sink as it takes more energy to create than the energy it stores. He cites David Pimentel: "'About 71% more energy is used to produce a gallon of ethanol than the energy contained in a gallon of ethanol'" (308). Kunstler also points out that all "biomass schemes are predicated entirely on the assumption of an underlying fossil fuel platform" (138). These biomass schemes include ethanol production and all depend on high-input agricultural methods. Scientists are currently researching the feasibility of using switchgrass as a source of ethanol; although this seems much more promising than using crops like corn ("Scientists Study Feasibility of Switchgrass), it is safe to assume that encouraging the use of ethanol in farm machinery would in fact increase the amount of fossil fuel used.

Modern high-input agriculture is, therefore, utterly dependent on fossil fuel, especially oil. Ronald Bailey argues that "the number of possible discoveries and inventions is incomprehensibly vast" (8) and that we ought to rearrange "resources we already have available so that they provide us with more of what we want" (7). Idealists like Bailey hope or assume that the agricultural collapse will be averted because civilization will come up with the correct ideas and inventions. However, we should not invest our intellect, time and money in new technologies to ensure that one day high-input agriculture would be possible without oil. Rather than attempt technological miracles, the United States should be preparing a change in the basic structure of its agricultural system. Humanity must invest its intellectual capacity and creativity to ensure that food is readily available. Youngquist declares that futile debate over the date of Peak Oil should be secondary, and that "concern should be turned toward…developing both social and economic programs that will allow the human race to survive" in the post-petroleum world (312). Certain changes are

necessary. Because the country cannot rely on alternate forms of energy to solve the pending crisis in agriculture, it must devise alternative methods of farming and choose to sacrifice a certain lifestyle. For example, the extant Amish communities of the Northeast and Midwest provide a vignette of early America; perhaps they also offer a vision of the future. Organic agriculture and Integrated Pest Management (IPM) practices will also need to expand in this new era. Finally, a broad social change towards a vegetarian collective diet is also necessary. Bailey's proposal that the country should develop new technologies, however, is an inappropriate strategy.

Conventional agricultural methods are quite precarious, involving debt that will only increase as Peak Oil manifests. Biologist and founding editor of *Conservation Biology*, David Ehrenfeld, in his essay "Implementing the Transition to a Sustainable Agriculture: An Opportunity for Ecology," explains modern agriculture as a high-risk, high-debt process; farmers are locked into a cycle of borrowing large sums of money for the seeds, machinery, maintenance, and chemicals required for harvest. The banks that issue these loans are often owned by the chemical corporations that manufacture the synthetic fertilizers and pesticides required to grow the "Green Revolution" crops, and may even require the borrower to use their chemicals. To avoid this situation, farms may practice low-input, low-debt "Ecological Agriculture" that relies mostly on labor rather than technology (6). Amish-style agriculture is an example of such low-input practice, which Ehrenfeld would speculate to be sustainable (8). Bailey and other optimists would hope for new methods and technologies to improve the odds of a profitable harvest. While Bailey advocates looking to the future and investing in new technologies, the better, less risky strategy for the U.S. is to look to its past through the Amish.

The Amish are considered "one of the best available sources of information on the farming life of sixteenth-century century Germany" (Johnson, Stoltzfus and Craumer 373). All of the labor in sixteenth-century Germany was performed by humans and animals. The Amish, however, blend a simple technology with sufficient labor intensity in order to provide jobs for the family as well as profits to buy land, pay taxes, and support the shared obligations of their community (373). Amish agriculture, therefore, seems to mirror Ehrenfeld's concept of ecological agriculture: "The frugality of their consumption patterns and their willingness to use a labor-intensive intermediate technology make Amish agriculture sustainable without suffering low yields" (Johnson, Stoltzfus and Craumer 378). Perhaps

Americans need to learn from their Amish neighbors and go "back to their roots" if they are to make the agricultural system work in the post-petroleum world. Johnson suggests, "if labor is substituted for increasingly expensive energy, idle small farms may be returned to the extent that they permit the utilization of local energy sources such as wood and pastures" (377). Eric Brende's article, "Technology Amish Style," reinforces the notion that Amish-style agriculture may be the future of farming in the States. Brende reports, "[the Amish] have been the living cornerstone for a nationwide return to horse farming, which they have proven is 'much more profitable than tractor farming if done correctly,' according to agricultural industry observer Baron Taylor of Lancaster County" (29). Amish agriculture is potentially both sustainable and profitable. The profitability of Amish agriculture directly contradicts Bailey's statement that "high-tech agriculture boosts farm productivity, which means a cheaper food supply and more land spared for nature" ("Environment Canada"). Bailey believes that technological advances will yield higher productivity and profit. In actuality, the Amish, using extremely simple technology, can achieve higher yields and profits than farmers using conventional methods. Although it is impossible to prove that Amish agriculture is one-hundred-percent sustainable (Ehrenfeld 8), this method of farming certainly seems to be an excellent candidate for sustainability.

The Amish are not the only group of people practicing ecological agriculture. There is a growing movement called "Permaculture," in which the central theme is "the design of ecological landscapes that produce food" ("Introduction to Permaculture"). This philosophy aims to establish permanent farming methods—ones based on renewable resources, including human and animal labor—as well as permanent communities built with sustainable energy and simple materials. Permaculture is, consequently, synonymous with "ecological agriculture," and requires no further technological development. Bailey incorrectly assumes that the most promising solutions to environmental problems are technological advances. Instead, society must look to the simple technologies and methods of the past and present. There are many contemporary examples of Permaculture, including the urban agriculture movement in Cuba. In the past two decades, Cuba has transformed its food production using the philosophies of Permaculture and "biodynamic" farming. Havana produces up to fifty percent of its food requirements from within the city limits, all of it organic and produced by people in their homes, gardens and in municipal spaces (Quinn). As Cubans replace petroleum-fed machinery with labor

and abandon synthetic chemicals, their country is becoming a model for a global sustainable agriculture movement. Youngquist declares that a world without oil spells agricultural collapse and social catastrophe. If the rest of humanity begins to make the same changes as in Cuba, he may be dead wrong.

Another alternative form of agriculture is organic farming. According to renowned researcher in Plant Biology, Raymond Poincelot, in his book, *Toward a More Sustainable_Agriculture*, organic farmers are practitioners of sustainable agriculture, stressing the need for conservation of resources and maintenance of environmental quality (15). And like Amish agriculture, organic farming usually requires more manual labor. For example, cultivating one hectare of wheat in organic and conventional systems requires 21.0 and 8.9 man-hours, respectively (24). The majority of energy saved in organic farming methods, as is the case in Amish agricultural methods, is achieved by the elimination of chemical fertilizers and pesticides from the energy budget (17). This is possible because organic grains and produce are not genetically-modified, "Green Revolution" crops. This energy saved in organic agriculture comes at the expense of slightly lower yields; the average corn yields per acre in the mid 1970s for organic and conventional corn were 77.9 (+/-) 5.4 bushels and 80.6 (+/-) 7.6 bushels, respectively (19). A more recent study shows corn yields under normal rainfall are about 68 bushels per acre and 94 bushels per acre in organic and conventional systems (Pimentel et al. 2005 575). Another problem with organic methods is that pesticides are replaced by mechanical cultivation and mulching in addition to the biological controls and Integrated Pest Management (IPM) methods that are most commonly associated with organic farms. According to David Pimentel, fossil energy inputs for modern organic production of a crop like corn are about thirty percent lower than for conventional farming (580). Although organic farms are more energy-efficient than conventional farms, they still require fossil fuel energy. Based on Ehrenfeld's definition of ecological agriculture, traditional organic farming is in most cases *not* sustainable.

Since Amish or ecological agriculture may only be applicable in certain places, and organic agriculture continues to rely on petroleum, society can quell the collapse of modern agriculture by changing its diet, because animal protein is far less energy-efficient to produce than vegetable protein. In 1990, of the 740 kilograms of grain (including exports) that were produced per person, 663 kilograms were fed to livestock (McConnell and Abel 81). That is almost ninety percent. Such a large

amount of grain is fed to livestock because the annual per capita meat consumption in the U.S. is so extreme: the average American in 1999 consumed a staggering two hundred fifty-three pounds of meat, compared to less than three pounds by the average person in India (McConnell and Abel 80). In order to decrease per capita grain production, society should discourage meat consumption with education and taxation, and farms should convert to grass-fed and free-range livestock operations. A smaller human demand for meat, and other animal products, will result in a smaller supply of farm animals (factory farms will breed fewer animals). With fewer farm animals, the animal demand for grain would be reduced as well. Therefore, U.S. farms could produce less grain overall, and at the same time redirect some of that grain towards direct human consumption. About one hundred and thirty tons of grain could be diverted to human consumption, which could feed four hundred million people annually (McConnell and Abel 81). Obviously, though, the USDA and lobbyists for the meat industry, on the basis of free-market capitalism, would try to prevent these changes from taking place because grass-fed livestock operations are more expensive, and taxes would hurt the industry further. Therefore, the easiest way to decrease petroleum use in this country must be a rigorous education program, instructing people to curtail per capita meat consumption. This tactic is the least political, requiring only personal choice and sacrifice rather than lobbying for legislation or protesting, say, the petroleum consumption by the U.S. military. Although the obvious and most effective way to reduce per capita petroleum use is to have fewer cars on the road and to invest in public transportation, this will take more time and political energy to occur. The country must step away from the lifestyle of hyper-consumption and recognize meat as a luxury, not a necessity. And whichever tactics are used, the nation needs to recognize not that a change in U.S. agriculture *might* occur, but that a drastic change in U.S. agriculture *will* and *must* occur. While Bailey supports the more external tactic of developing new technologies to solve the problem, the more practical solution is internal. To avoid the collapse of U.S. agriculture, as Youngquist foresees (310), Americans must change their individual lifestyles. The agricultural system must begin functioning without oil, or the world will face mass starvation.

Dramatic change in U.S. agricultural system is not a possibility, but rather, an inevitability. Youngquist thoroughly discusses the pending collapse of current United States agriculture, given the limited supply of petroleum. Conventional and

organic farms depend on fossil fuel energy and cannot exist when oil becomes too scarce and expensive. There are two solutions to this problem: 1) small, sustainable agrarian populations designed like Amish communities must be established; and 2) society as a whole must wean itself off of its addiction to animal products and consume more grain directly. Contained, sustainable communities that practice ecological agriculture, like the Amish, will be immune from the effects of Peak Oil and the resulting energy crisis and agricultural collapse. Before these communities are established, society can easily lessen its reliance on oil by choosing to be vegetarian. Even if society never achieves fully sustainable agriculture, adopting these two strategies has the potential to significantly postpone the crippling effects of Peak Oil on agriculture. The necessary revolution will not come as a miraculous technology that will save the day, as Bailey's fantasy suggests, but rather as a new consciousness and realization of necessity—U.S. agriculture must change its nonsensical practices of energy consumption. The revolution will occur when agribusiness decentralizes and kicks its hydrocarbon addiction by implementing old-fashioned, labor-intensive farming methods, and when society kicks its animal product addiction by consuming more vegetable matter directly. This country has had the luxury of cheap fossil fuel energy for so long that we take it for granted. As long as we wake up and take action now, we will always have food to eat.

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