THE FALSE PROMISE OF BIOFUELS

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PREFACE: NO MAGIC ELIXIR

THE BURGEONING REALITY OF GLOBAL CLIMATE CHANGE, rooted in a century of over-consumption of fossil fuels, is merging with another crisis with the same basic root cause—the looming depletion of *inexpensive* oil and gas supplies ("peak oil"). Combined, they bring the world to an unprecedented and profoundly dangerous moment that threatens global environmental and social crises on an epic scale. These crises potentially include a breakdown of the most basic operating structures of our society, even industrialism itself, at least at its present scale. Long distance transportation, industrial food systems, complex urban and suburban systems, and many commodities basic to our present way of life—autos, plastics, chemicals, pesticides, refrigeration, et al.—are all rooted in the basic assumption of ever-increasing inexpensive energy supplies. *(See Manifesto on Global Economic Transitions, published by IFG).*

One would think that such threatening circumstances would bring clear and effective movement from the leaders of national governments, acting on behalf of present and future generations. So far, however, with a few exceptions, the response of most governments has been inadequate to address the scale of the problem. This is *particularly* the case in the U.S., where government, politicians, and most corporations are still hoping to somehow convert the climate and peak oil crises into a new business opportunity.

We *are* seeing a lot of scurrying and signifying, as each sector, government, business, and that odd new third sector—*presidential candidates*—are engaged in a mad rush to identify magic bullets to "solve" the "energy problem" while pushing corporate growth and unabetted consumerism. By avoiding reality, they make the problems worse, and real solutions more difficult to achieve. Solutions so far include, for example, desperate grabs for the last remnants of oil and gas supplies, thus the war in Iraq. And now all eyes are focused on the Canadian tar sands, which can be mined only at stupendous cost and environmental harms. Next may be the Arctic. At least those are the goals of what we might call the fossil fuel "dead-enders," many of whom still doubt climate problems exist at all.

The more rational and increasingly popular opinion is that the ultimate answer will not come by extending the existence of the destructive fossil fuel economy, but purposely *ending* it before it does further harms, and then switching as quickly as possible to renewable alternative energies. But the question is *which* renewables? They are not all equal either in potential performance or potential harms, though none are likely to have the grim downsides of fossil fuels, or nuclear energy. But, there is a strong case that no combination of renewables will be sufficient to sustain the industrial system at its present bloated, wasteful scale. Ultimately, the answer must involve renewables plus significant efforts toward all-out *conservation, efficiency, reduced consumption and "powering down" of energy use*. It is crucial that these latter elements always be included in discussions of sustainable futures.

All of this comes at a quadrennial moment in the U.S. political context, when presidential sweepstakes take center stage. All proposals are processed and evaluated more in terms of their political saleability, and their potential for fund raising, rather than whether or not they will actually contribute to a lasting solution. So we now have the spectacle of governments, businesses, and presidential candidates vying to be the bravest leader in bringing forth renewable energy solutions, breaking with foreign oil dependency, and somehow also keeping our economy growing at an exponential rate. They are desperate to seem as if they have the best answer to the crisis of global warming, and for the environment. Regrettably, that desperation has seriously muddied the waters. Proposals and decisions are heading at us at very high speed, but without much serious evaluation, analysis and thought. In fact, wrong decisions are being made very rapidly because of the pressures and opportunities involved for all parties. *And we are left in grave danger of replacing one set of harms with another set*.

There is some good news. A new process and set of evaluative tools is now gaining favor among scientists, which they are calling "Life Cycle Analysis." This basically means that new technologies, and specifically energy technologies, are evaluated in a far more comprehensive way, including all inputs and materials used at every stage of their extraction through mining, assembly, transport and performance from "dust to dust." Their full ecological footprints from the ground-up, from birth to death.

This process has the potential to dissuade us from making glib assumptions about which energy alternative actually contributes more, and harms less, than the others. So far, Life Cycle Analysis is not sufficiently in use, and so we may not yet be making much progress in our overall quest for the right technologies and energy systems that will lead to ecological sustainability in a world where what is really needed is a new paradigm, a new set of standards to be achieved, and the appropriate technological and lifestyle choices. The basic goal must be to move toward creating an economy that operates first of all in the interests of ecological sustainability, within the ecological limits of the planet, and which includes social and economic equity, without which no long term solution is possible. The lives of our children and the planet literally depend on our doing the right thing, not the most propitious thing.

It is in that spirit that the report which follows was conceived and created among the key players in the International Forum on Globalization's Alternative Energy Working Group. It is the first of a series of reports we will be producing over the next year, that will present fuller details and analysis on some of the hidden problems that may come with certain choices, compare renewables among each other, and compare them to the current fossil-fuel economy.

This document focuses, of course, on biofuels, or agrofuels, which have quickly been blown up into a kind of *mega panacea*, among all the parties mentioned above—government, corporations, and presidential candidates—leaping on the bandwagon, some for the simple reason that they want to seem they are doing *something*, and others out of uninformed assumptions. Anyway, the idea of *growing* fuel, rather than *mining* it, or *drilling* for it, certainly has a far more ecological ring to it. And, how could corn be bad? But the *industrialization of corn growing*; its control by giant global agribusinesses; its conversion away from its former place as a food staple into a fuel source for the tanks of millions of cars; its impact on available *food* growing areas; its effects on food prices in the world; and quite a few negative effects upon soil fertility, water supply and local pollution certainly raise a lot of doubts. The fact that most corn grown in the U.S. is now GM (genetically modified corn) also threatens genetic diversity on a large scale.

In various ways, ethanol production—highly dependent on coal-fired production facilities—also actively contributes to greenhouse gas emissions, rather than allaying them. At the very least, all of this certainly needs to be evaluated and openly discussed before major decisions are made about the future.

Opening just such a crucial discussion is what Jack Santa Barbara does here, with the support of his colleagues. Nor does anyone imply that only corn has some of these problems; many other crops used for biofuels have similar, or different, sets of problems that need discussion. These include sugar cane, soya, switch grasses, oil palm and others.

There is great urgency to this matter. As we write this, the U.S. Congress is working on finalizing a new Farm Bill which would massively subsidize some of the biggest agricultural corporations in the world to proceed on their biofuels quest which they are doing both domestically, and also abroad. They are incessantly seeking more lands to grow more agro-fuel crops, including corn, to convert to more fuel. Archer Daniels Midland, Monsanto, Cargill among others have lately given up their well known advertising slogans from prior decades about their main job being to "feed a hungry world." The new campaign might be based on a new slogan, "feed cars not people." The net result is that, already, quite a few of those hungry people in the world are seeing food commodity prices rising rapidly, the value of food growing lands also rising rapidly due to scarcity, and their own prospects of feeding their families and communities falling.

The U.S. Farm Bill also gives ethanol a 51 cent tax credit for each gallon blended into gasoline, and it finances pipelines for ethanol transport, and other infrastructure projects, to enable passage of larger grain transports. Highway funds also contribute $600 million per year for ethanol production.

With all of this, corn production is skyrocketing, and many farmers are dramatically increasing their production. Rather than leave any land to go fallow—which is otherwise good practice—they are planting every inch, taking a huge toll on scarce water, wildlife, and soil fertility, as Santa Barbara goes further into. And the effects are as much social as they are ecological. Impacts upon poor and subsistence farmers in the Third World are already very great, as the author reports, and this is even the case here in the United States. A *NY Times* report (August 10, 2007) pointed out, "the ethanol boom is accelerating the inequity in the rural landscape. The high price of corn—and the prospect of continued huge demand—doesn't benefit everyone equally. It gives bigger, richer farmers and outside investors the ability to out compete their smaller neighbors. Young farmers hoping to get a start are left out of the equation entirely. It reduces diversity in crops and farm size."

The final truth is that corn-produced ethanol, and many of the other agrofuel varieties are leading us down a path of unsustainability as they continue to impact fragile ecosystems, threaten biodiversity, concentrate corporate power and increase inequities in rural communities. These surely offer no magic bullets to solve our problems, and may, in the end, bring more harm than good, as compared with likely alternatives like wind, solar, small scale hydro, and wave. Future reports in this series will look more closely at those energy options.

But having made ethanol into this magic elixir, politicians, financial investors, and the occasional environmental organization are masking the need for far deeper investigation and solutions. They are pushing us toward practices that actually may be less sustainable and socially just than what preceded them. Are we merely trading one set of problems for another? That is the question this publication tries to explore, while also giving insight into practices and paradigms that do have a chance to help save the planet.

(NOTE: This report makes the important distinction between large-scale and small-scale, locally operated and owned biofuels activities which can be relatively benign in their impacts and useful in local economic situations. The focus in this document is on the large-scale, industrial biofuel operations, run by global mega-agriculture corporations that bulldoze local economies and food systems while producing the series of harms within this report.)

Debi Barker & Jerry Mander, Co-directors
International Forum on Globalization

EIGHT BASIC QUESTIONS ABOUT BIOFUELS

INTRODUCTION

IT IS A RARE OCCURRENCE when President Bush, major environmental organizations, the agriculture community, various federal and state politicians, and even some "peak oil"[1] educators, appear to agree on an issue. The recent expansion of ethanol from corn production is just such an issue.[2] It is a very attractive idea to think that we can satisfy our voracious appetite for inexpensive liquid fuel from a renewable resource such as corn.

But is it justified? Is the large-scale domestic production of corn-based ethanol going to provide "energy independence" from foreign oil as claimed, as well as reduce greenhouse gas emissions, revitalize the farm belt, keep the U.S. economy growing, and *replace* the global decline in petroleum production with the advent of Peak Oil?

In 2005, the U.S. Energy Policy Act set the goal of 12 billion gallons of ethanol by 2012. In 2006 the U.S. consumed almost 5 billion gallons of ethanol for transportation fuel (compared to over 140 billion gallons of gasoline).[3] In 2006, corn for ethanol showed a production spike of 50 percent over the previous year, to a level which surpassed corn exports (USDA, 2007).[4] And there is more to come. President Bush has called for the annual production of 35 billion gallons of "renewable" fuel by 2017.[5]

By the end of 2006 there were 110 ethanol plants in the U.S., many of which are now being expanded, and 73 were under construction. An additional 200 such plants are in the planning stage.[6] This is a very significant commitment, and considerable amounts of taxpayer dollars are now available in various subsidies and energy programs to kick start this wonderfuel. Even General Motors has supported the venture, with its "Live Green Go Yellow" campaign.[7] Some environmental groups hold out the promise that all of the U.S.'s gasoline could be replaced by biofuels by 2050.[8]

But there are a variety of reasons to question whether ethanol, or *any* combination of agrofuels,[9] can provide the benefits extolled by so many supporters. The purpose of this paper is to address the matter, particularily as concerns large-scale industrial production of biofuels, and to answer the following eight questions:

- Does ethanol production actually result in significantly more energy available to do work than the energy required to produce it?
- What impact does the use of corn for ethanol have on the supply and cost of food?
- Is there sufficient water available to produce ethanol on a large scale?
- What is the impact of ethanol production on soil fertility?
- What is the impact of ethanol production on forests?
- Does ethanol reduce greenhouse gas emissions and other pollutants?
- What is the impact of ethanol production on the poor and on indigenous peoples?
- Does ethanol production make economic sense?

First, some definitions. Biofuels are fuels made from biological materials, or biomass. These include anything from straw, wood waste and municipal sewerage, to crops such as corn or sugar cane. Ethanol is a type of biofuel derived from agricultural products with high sugar or starch content. While this document will focus on ethanol, many of the points we are making could also be made with minor modification about any of the biofuels, or as we prefer to call them, agrofuels, especially if used on a large scale.

1. Is Ethanol a Viable Substitute for Petroleum Based Gasoline?

There is no question that ethanol can be used to power an internal combustion engine. It can be mixed in different proportions with gasoline, or used as the sole fuel. In small proportions such as E10 (10 percent ethanol), no engine modifications are required. In larger proportions such as E85 (85 percent ethanol) and above, different engine designs are needed.

The two big questions about ethanol as a substitute for gasoline are: (1) Is the "net energy" from ethanol large enough to justify its production? and (2) Can it be produced in sufficient volume to make a difference?

Net Energy

It takes energy to produce energy, and it is obvious that a desirable fuel should provide considerably *more* energy than it takes to produce it. The amount of energy that is left after the *input energy is subtracted* from the output energy is referred to as net energy.[10] *Input energy* for oil production, for example, includes items like the energy costs of the drilling process, the construction and transport of the drilling rigs, the manufacture of all materials used in these processes, and so on. The *net energy* is the amount of surplus energy available beyond the energy used to produce it.

There is considerable debate over the net energy available from the corn-to-ethanol process. Some researchers claim the net energy (sometimes referred to as energy return on energy invested or EROI) from corn to ethanol has a positive energy return. (See Farrell, et al. in *Science*.)[11]

Of the four articles that showed a positive net energy for ethanol in Farrell's 2006 article, three were not peer-reviewed. The only positive peer-reviewed article cited by Farrell (Dias De Oliveira, 2005) states, "The use of ethanol as a substitute for gasoline proved to be neither a sustainable nor an environmentally friendly option" and the "environmental impacts outweigh its benefits". Dias De Oliveria concluded there'd be a tremendous loss of biodiversity, and if all vehicles ran on E85 and their numbers grew by 4 percent per year, by 2048, the entire country, except for cities, would need to be covered with corn.

Other researchers claim the net energy return from corn to ethanol is negative or very small.[12] The debate centers on what energy inputs should be included in the calculation *(See Box 1)*. The studies that are more inclusive of legitimate energy inputs, such as the energy cost of mitigating the externalized environmental damage from the production process, actually show a *negative energy return* for ethanol production, indicating it takes more energy to produce the ethanol than is contained in the ethanol produced.

Limits of Corn Production

Another way of estimating the amount of gasoline that could be displaced by ethanol is to consider how much corn is produced and how much ethanol could be derived from it. Could this be substantially increased to provide for the U.S.'s liquid fuel needs?

Today, approximately 18 percent of the U.S. corn crop is converted to 4.5 billion gallons of ethanol. This replaces approximately 3 percent of U.S. oil-gasoline consumption. Consequently, even if *all* of the current corn production were to be used for ethanol, it would replace only about 16 percent of U.S. gasoline use. There would then be no corn left for food for either people or livestock, and none to export to other countries who rely on this U.S. crop as a food staple.

So, in terms of both net energy, and total volume of potential production, ethanol has some serious limitations as a substitute for gasoline. In addition, because a gallon of ethanol contains only about two thirds the energy in a gallon of gasoline, even greater volumes of ethanol would have to be produced to replace gasoline. The same conclusion is warranted with other agrofuels as well.[15] The issue of how much corn can be used for fuel brings us directly to the issue of fuel vs. food.

BOX 1: CALCULATING NET ENERGY

Net energy calculations are simple in concept but difficult in execution. There is no universally agreed detailed methodology for all net energy calculations. Decisions must be made in each case about what is legitimate to include and what can be excluded as an energy input. The purpose of the calculation therefore has a large impact on what is included and the final estimate calculated. There are enormous policy implications associated with the debate over the net energy of corn ethanol.

In the case of corn ethanol, the studies which conclude there is a positive net energy return generally overlook some energy inputs associated with U.S. corn production, including farm machinery, machinery for processing the corn into ethanol, and the use of hybrid corn. Or they only include *low* estimates for energy costs associated with use of fertilizers, insecticides and herbicides. These studies also ignore the environmental costs associated with corn production and the energy costs of environmental restoration. And there is debate over the status of by-products generated in the corn to ethanol transformation.

In practical terms, even the most comprehensive net energy analyses exclude many indirect energy inputs simply because they are too numerous to identify and measure. It is generally assumed that these indirect effects are small. But in reality, the cumulative magnitude of these excluded inputs is unknown. What is certain is that *any* net energy calculation is an overestimate of the actual energy return for energy invested because many indirect energy inputs are, for practical purposes, excluded from the calculation. Therefore, the most complete picture is one which includes as many legitimate energy inputs as possible. This is one reason why only fuels with a high net energy ratio (e.g. greater than 10:1) should be seriously considered as worthy of support by policy analysts.

However, the debate over whether the net energy from corn ethanol is negative or slightly positive misses the bigger picture. The studies that report a positive net energy ratio report that it is less than 2:1, or at the very most, 4 to 1. While the higher figure of 4 to 1 for ethanol may appear somewhat attractive, its reliability is questionable as it is based on assumptions that are not supported by most researchers. But what is more critical is that even a 4 to 1 net energy return is far lower than the 100 to 1 ratio that existed for oil at the beginning of the last century, or the current net energy for global oil which is about 20 to 113 (*See Box 4*). Replacing oil that has a 20 to 1 net energy with ethanol that has a 4 to 1 ratio is a bad bargain. It could bring a major crisis for the entire industrial system.

Even if ethanol has a net energy return of 4 to 1 (ignoring for the moment the methodological weaknesses of the calculation), relying on a fuel with such a low energy return would have a dramatic impact on our economy. If the entire U.S. vehicle fleet were to be run on ethanol we would have to invest 5 times as much energy (and finances) to obtain the same amount of energy we are currently getting with a 20 to 1 net energy return from oil. If the energy cost of corn ethanol is only 2:1 or less, then we would have to invest 20 times as much energy and finances to keep the current fleet moving. The most comprehensive energy accounting indicates that the net energy from corn to ethanol is actually less than 2:1, and may even be negative; that is, it may actually take more energy to produce the ethanol than is contained in the ethanol. *This single point makes corn to ethanol an absurd proposition as a replacement for oil.*

BOX 2: THE HISTORICAL DECLINE IN NET ENERGY FROM OIL

The global decline in inexpensive oil and gas supplies in many producing nations ("peak oil") has also produced a decline in the "net energy" of conventional oil, from its former 100 to 1, down to 20 to 1 today. Not only is less oil being produced, but the remaining oil is more difficult and costly to extract. Once peak production is passed for a particular well or field, gas or water must be pumped into the well to force the oil out and maintain production. This pumping requires still greater energy inputs, thereby decreasing the net energy of the oil that is eventually recovered. In addition, mixing in non-conventional sources of oil, such as tar sands, arctic or deep ocean wells, which are even more energy intensive to produce, brings the net energy of global oil even lower. For Example, the net energy of Alberta tar sands oil is likely to be much less than 5 to 1.

The decline in net energy of oil is the underlying reason for even considering agrofuels (and other "renewable energy" sources) as alternatives to oil. But the low or negative net energy return of corn based ethanol speaks to the inadequacy of this strategy. The harsh reality is that once the impact of peak oil occurs in earnest, no renewables are likely to be able to replace oil, and we will have to adapt to a much lower level of energy consumption. This may well be within the next ten years—not much time to make such a monumental transition. [14]

2. What Impact Does Corn for Ethanol Have on Food Supply and Cost?

The recent interest in corn to ethanol production stems in part from the fact that the U.S. can produce more corn than it needs domestically or than it can export. The U.S. currently produces about 300 million tons of corn and exports about 50 million tons, or 17 percent of its total crop. But these corn exports have remained relatively flat over the past two decades or so and growers have been eager to find new markets. Part of the problem for U.S. producers is that EU and other markets do not want to buy U.S. genetically modified corn (GM), a large percent of current production. *(See Box 3).*

Politicians have been eager to help. The result has been a flurry of bills in the U.S. Congress providing incentives for the transition from corn-growing for food, to corn-growing for ethanol. This increased corn and ethanol production has led to a doubling of corn prices over a very short time, and is beginning to affect the entire food chain, from the cost of raising cattle to the price of Mexican tortillas.[16] Even the price of beer is affected as land previously dedicated to barley for hops is converted to corn for ethanol.[17]

Many analysts project that the large increases in food prices over the last few years are directly attributable to the increased use of crops for fuel *(See #7 below. What is the Impact of Agrofuels on the Poor and Indigenous Peoples?)*. These price increases are regarded as permanent due to the new structural relationship between crops and energy.

Raising the demand for corn as an agrofuel, thus increasing its price in world markets, creates an advantage for the U.S. which is by far the world's largest *exporter* of corn. It is also a way for the U.S. to retrieve some of the dollars sitting in China's central bank, as Chinese corn production is now in decline, and China is becoming increasingly dependent on U.S. crop exports.

But there is a moral issue here as well. Corn is a basic food staple for hundreds of millions of people. *Some 2 billion people in the world currently suffer from hunger and even more suffer from nutritional* *deficits.* Hunger is as much a political issue as one of food availability. For the billions of poor even a slight increase in the price of food can have dire consequences. And with an expected increase in the global population over the next few decades, in poorer nations competition between food and agrofuels can only intensify.

Can currently uncultivated land be used to grow these agrofuels, so as to minimize competition between food and fuel? Answering this question requires a consideration of several crucial issues: water availability, the impacts from converting forests to agricultural lands, soil degradation, the availability of petroleum based fertilizers, and the impacts on the poor and on indigenous people who depend on these now marginal lands for their livelihoods.

3. Is There Enough Fresh Water to Produce Ethanol?

"Humanity is moving into uncharted terri-

BOX 3: FRANKEN-FOODS TO FRANKEN-FUELS: THE ROLE OF GM CORN

The crescendo of marketing campaigns promoting the idea that ethanol will be good for farmers, good for U.S. consumers, and good for the environment is inextricably linked to the dwindling corn exports of U.S. genetically modified (GM) corn. Monsanto and a handful of other corporations invested billions of dollars developing GM corn and began promoting it to farmers in the early and mid-1990s. Farmers often had no choice but to plant GM corn, as they were told that the traditional hybrid versions wouldn't be available in time for the next planting. It was a plant-GM-or-plant-nothing choice. By 2003 approximately 45 percent of all U.S. corn was genetically modified. (In 2003, this represented over 36.5 million acres of GM corn.)

The sudden demand for more corn to produce ethanol has increased overall corn production acreage to record highs. In 2007 the U.S. Department of Agriculture (USDA) estimated that growers will harvest over 24 percent more corn than in 2006. This record breaking level also increases the amount of GM corn production. For purveyors of GM corn seed, this increase is good news after experiencing several years of declining exports in corn due to concerns among countries around the world about food safety and genetic contamination from GM products. Additionally, U.S. consumers have concerns about GM corn in domestic products (usually in the form of high fructose corn syrup), and GM corn being fed to livestock.

European markets had reacted very quickly against the initial introduction of GM corn and U.S. corn growers felt it. In 1994-95, the European Union (EU) imported 3.15 million to 3.83 million metric tons of corn from U.S. farmers and agribusinesses. This represented 82 percent of EU corn imports. But after GM corn was adopted in the U.S., the EU import levels dropped radically—to 10 percent (out of approximately 4.5 metric tons of corn imported into the EU). Similarly, many African countries refused GM corn imports from the U.S.

Growers and agribusiness felt the pinch, and have been scrambling to find markets for GM corn. Ethanol provides that safe haven and market niche. Formerly advertised as being an environmentally friendly way of growing food and fiber, GM is once again being marketed as a "green" renewable energy source. However, a decade of experience with GM crops and products has illuminated the serious problems associated with this biotechnology: water and soil contamination from intensive herbicide and fertilizer usage; massive contamination of non-GM crops; and loss of biodiversity.

> tory in the water economy. With the demand for food climbing, and with the overpumping of aquifers now common in industrial and developing countries alike, the world is facing a convergence of aquifer depletions in scores of countries within the next several years."[18]

Some two thirds of global water use is for agriculture[19] and as a result, water tables are dropping significantly in some of the most productive areas of U.S. farmland.[20]

Corn ethanol is a particularly thirsty crop. The production of 1 gallon of ethanol requires 1,700 gallons of freshwater both for corn production and for the fermentation/distillation processing of ethanol.[21] If future yields are to increase, even more water will be required as corn production expands to increasingly marginal lands. Already there is pressure from big agricultural growers to use lands currently set aside for water conservation and wildlife habitat. U.S. farm groups are lobbying the federal government to allow them to plant agrofuel crops on lands now protected by the Conservation Reserve Program and the Wetlands Reserve Program.

The water *output* from corn ethanol is also problematic. A total of about 10 gallons of wastewater must be removed per gallon of ethanol produced, and this relatively large amount of sewage effluent has to be disposed of at great cost in energy, and environmental damage. Furthermore, corn production uses more herbicides, insecticides and nitrogen fertilizer than any other crop produced in the U.S., and these chemicals invade ground and surface water, thereby causing more water pollution than any other crop.[22] U.S. corn production also causes more soil erosion than any other U.S. crop.[23]

Much of U.S. farm land drains into the Mississippi River and eventually into the Gulf of Mexico. The water runoff from these farm lands already causes eutrophication in the Gulf, and the size of this dead zone is expanding.[24] The dead zone has averaged about 4,800 square miles since 1990; the record of 8,500 square miles occurred in 2002. In 2006 it covered about 6,662 square miles—about the size of Connecticut and Rhode Island together. The dead area may now extend to 30 feet or more above the sea bottom. Within it, nothing lives, as there is not enough oxygen to sustain life.[25]

So, water is clearly a limiting factor in any large scaling-up of corn-based ethanol. It is a problem both from the perspective of the volume of water required to produce ever increasing amounts of corn, and because of the erosion and runoff from fertilizers and pesticides which significantly pollute large areas of water, making them toxic to living creatures.

4. What is the Impact of Ethanol Production on Soil Fertility?

> "The nation that destroys its soil destroys itself." —President Franklin D. Roosevelt

> "We stand, in most places on earth, only six inches from desolation, for that is the thickness of the topsoil layer upon which the entire life of the planet depends."[26]

Loss of topsoil has been a major factor in the fall of civilizations over the ages, and it could happen again.[27]

Fertile soil is far more than dirt. It is a complex substance composed of mineral matter from its parent rock, and organic matter from its living organisms.[28] The organic matter is broken down by millions of micro-organisms per cubic foot in the soil which recycle the nutrients, and create tunnels through which air and water can circulate, making even more nutrients available to the root systems of plants. Soil quality varies greatly from place to place. It takes hundreds of years to form even 1 inch of topsoil.[29] Consequently, good soil is a precious resource and essential for a secure food supply.

Unfortunately, both the quantity and quality of soil is now in rapid decline globally. Only 35 percent of global arable land is free from degradation. Studies estimate that approximately 40 percent of the world's agricultural land is *seriously* degraded, with significant impacts on the productivity of about 16 percent of agroecosystems.[30] During the last decade, per capita available cropland decreased 20 percent.[31]

The U.S. is not exempt from this destruction of fertile soil. For example, Iowa has some of the best topsoil in the world, but in the past century, half of it has been lost.[32] Productivity drops off sharply when topsoil depth thins to 6 inches or less, the average crop root zone. On over half of America's best crop land, erosion is 27 times the natural rate[33] of about 400 pounds of soil per acre per year. This is an enormous loss of a precious resource that cannot be easily or quickly replaced. This loss of soil is directly the result of industrial agricultural practices including corn production. It will take centuries for nature to replace it.

Corn production in particular is associated with high rates of soil erosion, with rates as much as 100-2500 times greater than for pasture grasses.[34] Continued erosion at the current pace will result in the loss of over 30 percent of the global soil inventory by the year 2050.[35]

In addition to degradation of the soil, between 1982 and 2002 an average of 2.6 million acres of U.S. agricultural land was lost annually due to land development.[36] If this rate of land development were to continue, then all of the U.S. cropland would be gone in 140 years; clearly an impossible scenario. But the threat to agricultural lands from continuing development is clear.

This is the context in which the expansion of agrofuel crops must be considered.

Loss of Nutrients / Removing Crop Residues

Corn requires fertile soil as well as large amounts of water, fertilizers and pesticides. Producing ethanol from corn also requires the use of the "stover", or non-edible portion of the corn. Ethanol advocates refer to this stover as "waste biomass," suggesting it has no useful (i.e. commercial) purpose. But the term "biowaste" is an engineering term from industrial agriculture which ignores the natural recycling of nutrients from plant matter that is not used for food. This notion of "biowaste" is completely alien to natural ecosystems, which *must* recycle their matter completely in order to survive.[37] Excessive "biowaste" removal robs ecosystems of vital nutrients and species, and degrades them irreversibly.[41] Agricultural practices which ignore the value of stover to soil fertility, including soil carbon, and to water retention are unsustainable.

Rather than being "waste," crop residues like stovers are an extremely efficient means of returning nutrients to the soil. By removing crop residues from the land, fertility and quality of the soil are reduced, thus requiring even more fertilizer in the future. By the year 2020 it is projected that global net primary nutrient removal on agricultural land will reach 366 million metric tons per year. However, inorganic fertilizer production was only 141 million metric tons in 2002.[39] Removing more nutrients than we have the capacity to replace is not only unsustainable but harmful and irresponsible. Unfortunately it is also standard practice.

Modern agriculture is essentially *mining* the soil, using up nutrient resources faster than they can be regenerated naturally, and even faster than they can be artificially replaced with petroleum-based fertilizers. As petroleum supply diminishes and becomes less available as a source of fertilizers, we will be left with highly degraded soil and few options for replenishing it.

Corn requires particularly high levels of fertilization, more than any other major crop; 40 percent of all nitrogen fertilizer currently goes to corn.[40] Much of this fertilizer is imported. More corn production would require even greater U.S. dependence on sometimes unstable or unfriendly foreign states to provide this increasingly expensive fertilizer. Removing crop residues to produce ethanol will only exacerbate matters. This is an example of natural requirements for soil fertility being ignored at considerable risk to food security, environmental protection and economic stability.

When rain water falls on normal dense vegetation, it slowly soaks into the soil, increasing plant growth and recharging underground aquifers. The more stover that is left on the land, the better. Removal of such crop residues makes the land more susceptible to erosion when it rains, because there's no vegetation to protect the soil from washing away. Rain also compacts the surface of the soil so that less water soaks in, causing more run off, further increasing erosion.

Other Impacts

Because the drive to produce corn based ethanol has become so heavily subsidized, big corporate farmers are abandoning crop rotations and growing continuous corn crops on the same land year after year. Failure to rotate nitrogen fixing crops, which draw the natural fertilizer from the air, will further deplete the land and make farming increasingly dependent on dwindling supplies of petroleum based fertilizers.

Compared with traditional crop rotation, growing continuous corn causes increased eutrophication by 189 percent (due to fertilizer and pesticide runoff into the water systems), increased greenhouse gas emissions by 71 percent (due to more combustion of fossil fuels in farm equipment and release of carbon from the soil), and increased acidification by 6 percent (due to irrigation practices).[41]

Many warnings have been made about expanding the corn crop, but short term economic interests have prevailed. Growing more plants for fuel will accelerate the already unacceptable levels of topsoil erosion, as well as soil carbon and nutrient depletion, soil compaction, water retention, water depletion, water pollution, air pollution, eutrophication, destruction of fisheries, siltation of dams and waterways, salination, loss of biodiversity, and damage to human health.[42]

Energy crops also have heavy impacts on water supply and they increase the need for fertilizer.[43] As with all other monoculture crops, ultimately yields of energy crops will ultimately be reduced due to "pest problems, diseases, and soil degradation."[44]

As mentioned earlier, farmers now want to plant corn on highly-erodable, water protecting, or wildlife sustaining Conservation Reserve Program land. Farmers are currently paid *not* to grow crops on this land. But with high corn prices, farmers are now asking the Agricultural Department to release them from these contracts so they can plant corn on low-production, environmentally sensitive lands.[45]

Because the amount of farmland is declining globally, it is becoming increasingly expensive, from Iowa to Argentina, displacing small farmers, as large agricultural and real estate corporations buy up remaining farmlands.[46] As these farmlands are converted to industrial monocrops they will undergo increasing degradation, further reducing the amount of arable land available for a growing world population.

The drive to use increasing amounts of marginal land for energy crops will also require more fertilizer use, create more erosion, and further degrade soil fertility, which is essential for food security. Though not ideally suitable for crops, such marginal lands *must* be used if there is to be a significant increase in corn production for ethanol. But, as they are now either protected for environmental reasons, or are used by the poor for subsistence farming, expanding agrofuels onto them will have negative environmental and social implications.

5. What is the Impact of Agrofuel Production on Forests?

Forests have provided a wide range of essential resources for human use from earliest recorded history. So dependent are we on forests that the expansion of human civilizations has generally meant the decline of forests; in turn, the decline of forests often sets limits on the development of civilizations. As civilizations declined, the forests tend to return.[47]

Today, forests cover roughly 30 percent of the planet's land surface, but this is diminishing at the rate of 0.2 percent each year. In the past 15 years some 3 percent of primary forests have been lost.[48] According to the United Nations Food and Agriculture Organization (FAO) some 20,000 hectares of forest are lost daily, an area twice the size of Paris. However, this "net loss" figure is misleading as it counts *new plantation forests* as adding to the global forest inventory. Such plantation forests do not provide the same ecosystem services as natural forests, and in fact are an overall burden on ecosystems. According to Matti Palo, a forest economics expert affiliated with the Tropical Agricultural Research and Higher Education Center (CATIE) in Costa Rica, if plantation forests are not counted the actual extent of tropical deforestation is actually about 40,000 hectares per day.

Most forest loss is due to deforestation. And increasingly, deforestation is driven by attempts to replace gasoline with agrofuels. For example, between 1985 and 2000, the development of oil-palm plantations was responsible for an estimated 87 per cent of deforestation in Malaysia.[49] Oil palm has now become the world's number one fruit crop, well ahead of bananas.[50]

The majority of forest fires which create huge smog patches over this region are started by palm growers who use the fires to clear the natural forests for palm plantations. When the growers use up dry land they then often move onto swamp forests, which grow on peat. They drain these swamps, and as the peat dries it releases *methane*, a greenhouse gas more potent than carbon dioxide. In addition to destroying these natural forests, and much of the biodiversity they contain, such practices release enormous quantities of greenhouse gases.

Almost all the remaining forests of Malaysia are at risk. Even the famous Tanjung Puting National Park in Kalimantan is being ripped apart by oil planters, pushing the orangutan to extinction in the wild. Sumatran rhinos, tigers, gibbons, tapirs, proboscis monkeys and thousands of other species could go the same way.[51]

Agrofuels are also rapidly becoming the main cause of deforestation in countries like Indonesia, Malaysia and Brazil. The UN has just published a report suggesting that 98 percent of the natural rainforest in Indonesia will be degraded or gone by 2022.[52] Sugarcane producers are moving into rare scrubland habitats (the *cerrado*) in Brazil and soya farmers are ripping up the Amazon rainforests. Both of these crops are increasingly being used as agrofuels. Despite the Brazilian government's attempts to preserve the Amazon, more of it is being destroyed by illegal activities than is being set up as reserves.[53] As President George W. Bush has recently signed an agrofuel agreement with President Ignacio Lula da Silva of Brazil, these practices are likely to become even more widespread.

Indigenous people in South America, Asia and Africa are starting to complain about incursions onto their land by fuel planters. A petition launched by a group called Biofuelwatch, begging western governments to stop, has been signed by campaigners from 250 groups, many from the global South.[54]

Plantation Forests

Once the natural forests and their biodiversity are cleared, they are replaced with industrial plantation forests. These are *monocrops*, and have been shown to have a negative impact on the water cycle, as non-native, fast-growing trees use high volumes of water. Such monocrops are destroying biodiversity in some of the most biologically diverse areas of the world.

High levels of herbicides and pesticides are also commonly used on these plantations to suppress competing growth from other plants and to prevent disease outbreaks, also impacting water quality. In addition to all these environmental impacts, plantation forests offer very few employment opportunities, resulting in a net loss of jobs in areas overtaken with forest plantations.[55]

Despite all the above, the idea that large tree plantations can be used as renewable sources of agrofuel is gaining support from governments around the world. Agrofuels are now seen as a panacea. *But even attempting to replace 10 percent of the fossil fuels used globally would require an area half the size of the United States.* Ideally, such plantations would be developed in the tropics with good climate, soil and water, and easy transportation access. This inevitably means along the edges of natural tropical forests and along major rivers. Less productive lands would have to be even larger in size, leading to the destruction of still more forests.[56]

The largest producer of palm oil for agrofuels, Wilmar International Limited, is currently engaged in illegal logging and the setting of forest fires in Indonesia. Despite these illegal activities, such multinational companies as Unilever, Nestle and Cargill are ready buyers of the palm oil to support the growing European agrofuel market.[57]

Agrofuel Sustainability

While there are calls for developing and producing agrofuels "in ways that protect our planet—not in ways that create new risks" (European Commission President Jose Manuel Barroso in his keynote speech to the International Biofuels Conference in Brussels, July 5, 2007) *there are serious doubts that*

BOX 4: UNIQUE CHARACTERISTICS OF FOSSIL FUELS

In developed nations the current generation has come to expect a high level of per capita energy consumption. Over the last century and a half, energy production and consumption has risen continuously and dramatically. In the last two decades alone, more energy was consumed than in all of previous human history combined. This phenomenal use of energy is entirely due to the use of fossil fuels—oil, natural gas and coal—and their unique physical properties. Fossil fuels have a very high "energy density." This means that just a small quantity of the resource can provide a large amount of energy. All fossil fuels have a much higher energy density than the primary energy source they replaced, namely wood. They also have a higher energy density than all other energy resources available in sufficient quantities to be useful over long periods of time.

It is this unique characteristic of fossil fuels that is responsible for our globalized and highly technical societies. Most people have some inkling of this relationship. But what is much less appreciated is that *fossil fuels are so unusual that once they run out we may never have anything like them again.* This is why the issue of peak oil or natural gas is so important. Once those fuels are no longer available in the quantities we are used to, everything we now take for granted will change. We will experience what is referred to as an *energy descent*—a significant decline in per capita energy availability. The change will be dramatic.

How did fossil fuels become so unique? All fossil fuels are derived from the same source, plant and animal matter that died hundreds of millions of years ago and accumulated over millennia in certain special locations across the planet. These locations were special because they allowed the decaying matter to accumulate and eventually get compressed and buried by the movement of the earth. This burying created heat and basically cooked and compressed the decaying material, changing its chemical composition. Depending on how long the materials were compressed and cooked, and the specific nature of the location, one or another type of what we now know as fossil fuels was formed.

The process took enormous amounts of time and expenditures of (naturally occurring) energy over these eons. In a sense, it was a very inefficient process because it took so long and used so much energy, initially from the sun, and later from the pressure and movement of the earth. Fossil fuels are sometimes referred to as "stored sunshine" because solar energy initially went into growing the plant and animal matter. *Fossil fuels gained such a high energy density because this solar energy has been concentrated over geologic time.* All these energy inputs to produce fossil fuels were "free" in that they came from nature. Humans needed to use relatively little energy to extract this precious energy bonanza from the ground and use the stored energy to build our modern civilization.

Corn and other plant matter, on the other hand, may be considered "baby coal." We would have to apply the same pressure and also heat to the corn to produce coal, a resource with a much higher energy density than corn precisely because of all the applied heat and pressure. The practical problem with such a process is that it would take hundreds of millions of years for the corn to turn into coal. What the corn-to-ethanol process is attempting to do is to bypass this fundamental requirement to put large amounts of energy into the production process. It is a futile attempt, because it is trying to get something for nothing (or a lot for a little), which contravenes one of the most fundamental laws of physics, the conservation of energy.

continued on next page

BOX 4—continued

The original plant and animal matter that went into making fossil fuels was itself produced by energy from the sun. Ultimately this is the source of all our energy—wind, for instance, arises from the differential heating of the earth and atmosphere which makes the atmosphere move.[60] While there is a vast amount of solar energy available, it has very different characteristics from fossil fuels, which have a very high energy density. In comparison, solar energy has a very low energy density. While plentiful, solar energy is diffuse and weak. For solar energy to produce electricity, for example, it has to be collected and concentrated. The collecting process takes materials and energy and that is why solar energy, useful as it is, cannot completely replace fossil fuels.

There is another most important and obvious difference between solar energy and fossil fuels. Fossil fuels are *non-renewable*; at some point we will run out and not have them available in the quantities we need. Many scientists believe the *peak* of conventional oil and natural gas production on a global scale has already passed, and that we are now in an energy descent.[61]

Solar energy, on the other hand, will last for billions of years. We will use it because it is there, but we should not expect it to provide the enormous amounts of energy we have employed over the last century and a half from fossil fuels.

industrial agrofuel plantations can ever be sustainable. This "we can do it all" attitude of business and government officials ignores the biophysical and social realities on the ground.

The net energy return from any type of plant matter dependent on solar energy for its production cannot possibly compete with the energy available from fossil fuels. The simple physical principles of thermodynamics preclude the possibility of significant biofuel production from forests or other plant crops.[58] *(See Box 4. Unique Characteristics of Fossil Fuels).*

Humanity needs *natural* forests for basic resources such as wood, food, fuel for local needs, biodiversity protection, and even spiritual inspiration. These needs are increasingly threatened by the drive to maintain high per capita use of liquid fuels in the richer nations, as it causes natural forests to be destroyed and replaced with monocrop tree plantations. Killing this precious resource for a few more years of driving to the mall is a Faustian bargain.

> ". . . Massive alcohol [ethanol] production from our farms [and forests] is an immoral use of our soils since it rapidly promotes their wasting away. We must save these soils for an oil-less future."[59]

6. Does Ethanol Reduce Greenhouse Gas Emissioins and Other Pollutants?

One main reason why governments say they are promoting ethanol and other agrofuels is because they are seen as "green energy," capable of reducing a nation's greenhouse gas emissions. If the source of energy is itself a supposedly renewable resource such as corn, one would tend to believe that greenhouse gas emissions from such sources would be less than from oil. In fact, The Renewable Fuels Association, a national industry association, claims that the "use of 10 percent ethanol blends reduces greenhouse gas emissions by 18-29 percent compared with conventional gasoline."[62]

Is this true?

How Ethanol Use Increases *Greenhouse Gas Emissions*

It is true that growing corn sequesters carbon from the atmosphere. However, it is also true that using corn products as combustible fuel releases this carbon back into the air. *So there is no net benefit in terms of greenhouse gas emissions.* But more significant is that fossil energy used in planting and harvesting the corn, and the industrial processing of the corn into ethanol, are all *additional* greenhouse gas emissions. Farming activities account for a significant amount of the greenhouse gases created by corn ethanol.[63] In addition, most ethanol plants are powered by coal, which has the highest amount of greenhouse gas emissions of all the fossil fuels. Industrial operations not powered by coal are powered by natural gas, which also emits significant amounts of greenhouse gases. So the outcome is a significant *increase* in greenhouse gas emissions from corn ethanol regardless of how it is produced.

To satisfy just 10 percent of U.S. fuel consumption using corn ethanol, the equivalent CO2 emissions would be an *additional* 127 million metric tons per year.[64] This is roughly equivalent to gasoline emissions from 20 million vehicles.

Contrasting conclusions about the emissions of greenhouse gasses from corn ethanol are understandable if the *total life cycle* of corn ethanol production is considered. The studies which report *increases* in greenhouse gas emissions from ethanol generally include more complete analyses of all stages of the production cycle. One such study, from the U.S. Energy Information Agency, reports that use of corn ethanol results in almost as much CO2 as gasoline, *more methane and nitrous oxide, and considerably more water vapour*.[65] All of these emissions contribute to climate change, with water vapour being the most potent greenhouse gas.[66]

In addition, as we have seen, many natural forests are already being destroyed to provide agrofuels, and considerable amounts of greenhouse gases are released in the fires used to clear the land for the monocrop tree plantations that replace the natural forests.

The widespread tropical forest and peat fires in Indonesia during 1997, combined with the fires in Central and South America and in the boreal regions of Eurasia and North America, emitted 7.7 billion tons of carbon dioxide. The *cumulative emissions from these forest fires rival the world's total anthropogenic emissions.* Degraded peatlands in Southeast Asia alone produce some two billion tons of carbon "which is equivalent to almost 8 percent of the total carbon dioxide emissions from fossil fuels."[67] All of these emissions must be included in the calculations as to total polluting impacts from agrofuels.

Putting an end to this deforestation is therefore a major issue in restoring greenhouse gas emissions to an acceptable level.[68]

Despite these dangerous emissions, the UN plans to support development of some 380 million hectares of these industrial tree plantations. This represents twice all the arable land area in the U.S. Carbon dioxide releases from the burned forest and oxidized peat will dwarf emissions from agriculture in the developed countries.

It must be concluded that corn ethanol's greenhouse gas emissions, as well as emissions from other agrofuels, are not climate friendly, and may be worse than those from petroleum based gasoline. In addition to these high levels of greenhouse gas emissions, corn ethanol produces a range of other pollutants and public health concerns.

Other Pollutants

Ethanol mixed in gasoline seriously pollutes the air.[69] The reactivity of the combined exhaust and evaporative emissions using the ethanol-blended reformulated gasoline is estimated to be about 17 percent larger than those using the MTBE-blended reformulated gasoline.[70] Ethanol does *reduce* the carbon monoxide emissions, but *increases* those of nitrogen oxides (NOx), acetaldehyde, and peroxyacetyl-nitrate (PAN).[71] Finally, all the energy contained in corn ethanol comes from fossil fuels, with their own emissions, and since it takes roughly one unit of gasoline to produce one unit of corn ethanol, these emissions are considerable, with little if any actual gain in fuel energy.

Another recent study[72] concludes that more ethanol use would result in considerable increases in atmospheric levels of ozone and peroxy-acetyl-nitrate (PAN), leading indicators of photochemical smog in the Los Angeles basin, the most polluted airshed in the U.S. Vehicles operating on 85 percent ethanol (E85) will increase two major carcinogens, *acetaldehyde* and *formaldehyde* while slightly reducing another, *butadiene*, and reducing a fourth, *benzene*. Such ethanol powered vehicles are at best an equal and at worst a greater risk to public health than equivalent gasoline vehicles. They will contribute to thousands of cases of premature mortality and millions of cases of asthma.

Pollution from ethanol plants is so well known that the U.S. Environmental Protection Agency recently changed the rules to allow corn milling facilities that make ethanol for fuel to emit more than double the amount of air pollutants previously allowed. The six criteria pollutants are particulate matter, ground level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead. These pollutants can harm human health and the environment, and cause property damage,[73] yet the EPA is allowing more of them into our air to facilitate corn based ethanol production.

Ethanol plants are notorious polluters, emitting ethanol vapors, carbon monoxide, volatile organic compounds (VOCs), and carcinogens. In the last few years, the EPA has had to crack down on ethanol plants discharging 5 to 430 times more VOCs and carcinogens than their permits allow. The EPA has stated that the problem is common to most, if not all, ethanol plants, and in a few cases the EPA has taken the drastic step of actually closing some plants.

When all the air pollutants associated with the entire ethanol system are measured, ethanol production contributes to the serious U.S. air pollution problem.[74]

So while corn and other agrofuel crops appear to be environmentally benign compared to the know dangers associated with fossil fuels, the reality is that these agrofuels have their own set of environmental and health hazards. The crops themselves must undergo considerable preparation and processing to be used as a liquid fuel.. The fanciful idea of a renewable energy crop that will be capable of replacing petroleum based fuels is unrealistic *(See Box 4: Unique Characteristics of Fossil Fuels)*. The sooner this conclusion is accepted, the sooner we can make a transition to a genuinely sustainable energy future.

7. What is the Impact of Agrofuels on Poor and Indigenous Peoples?

Today's world is characterized by unprecedented inequalities in wealth. The top 2 percent of wealth holders control some 50 percent of the world's financial assets; the poorest 50 percent of the global population control only 1 percent of wealth.[75] This is the context in which the discussion of agrofuels must be considered. It should also be noted that most people reading this report likely fall within the top 2 percent globally; our reality is privileged compared to that for the vast majority of people affected by agrofuel production.

The World Bank reports that almost half of humanity lives on less than $2 a day; almost a third of humanity does not have access to electricity. Almost 1 billion people do not eat enough calories regularly to be healthy and active. Several studies by economists at the World Bank and elsewhere suggest that caloric consumption among the world's poor declines by about half of one percent whenever the average prices of all major food staples increase by one percent. When the price of one food staple increases the poor tend to switch to a cheaper staple. But if all staples become more expensive this option is closed to them. Malnutrition and starvation become more widespread. Currently, there are least 18,000 children dying every day from hunger and malnutrition;[76] it is a slow and painful death.

The world's poorest people already spend 50 to 80 percent of their total household income on food. For the many among them who are landless laborers or rural subsistence farmers, large increases in the prices of staple foods mean malnutrition and hunger. Some of them will tumble over the edge of subsistence into outright starvation, and many more will die from a multitude of hunger-related diseases. This is a result of food staples being converted to use as agrofuels.

The International Food Policy Research Institute in Washington, D.C., estimates the potential global impact of the rising demand for agrofuels.[77] Given continued high oil prices, the rapid increase in global agrofuel production is anticipated to push global corn prices up 20 percent by 2010 and 41 percent by 2020. The prices of oilseeds, including soybeans, rapeseeds, and sunflower seeds, are projected to rise 26 percent by 2010 and 76 percent by 2020. Wheat prices are expected to rise 11 percent by 2010 and 30 percent by 2020. In the poorest parts of sub-Saharan Africa, Asia, and Latin America, where cassava is a staple, its price is expected to increase 33 percent by 2010 and 135 percent by 2020. All of these crops, and more, are increasingly used as agrofuels.

Applying the above-mentioned World Bank formula to these estimates, it appears that caloric intake among the world's poor could decline by anywhere from 15 percent to 65 percent by 2020 if current higher food prices are maintained. For families who rely on cassava as a staple the situation is especially perilous. Cassava is a tropical potato-like tuber also known as manioc; it provides one-third of the caloric needs of the population in sub-Saharan Africa and is the primary staple for over 200 million of Africa's poorest people. In many tropical countries, it is the food people turn to when they cannot afford anything else. It also serves as an important reserve when other crops fail because it can grow in poor soils and dry conditions and can be left in the ground to be harvested as needed.

Unfortunately for these families, cassava is also an attractive source of ethanol, thanks to its high-starch content. If the technology for converting it to fuel improves, many countries—including China, Nigeria, and Thailand—are considering using more of the crop to that end. If peasant farmers in developing countries could become suppliers for the emerging industry, they would benefit from the increased income. But the history of industrial demand for agricultural crops in these countries suggests that large producers will be the main beneficiaries *(see below)*. The likely result of a boom in cassava-based ethanol production is that an increasing number of poor people will struggle even more to feed themselves.

The increase in the prices of basic foods is not likely to be temporary. A recent joint Organization for Economic Cooperation and Development (OECD) and UN Food and Agriculture Organization (FAO) report concludes that increased demand for agrofuels is causing fundamental changes to agricultural markets that could drive up world prices for many farm products. While acknowledging temporary factors such as drought, the report emphasizes that structural changes are underway which could maintain relatively high nominal prices for many agricultural products over the coming decade. Increased demand for agrofuels is identified as the major factor.[78]

The International Monetary Fund agrees: "Rising demand for biofuels will likely cause the prices of corn and soybean oil to rise further, and to move more closely with the price of crude oil, as has been the case with sugar." [79]

Business analysts also agree. Food prices are set for a period of "significant and long-lasting" inflation because of demand from China and India and the use of crops for agrofuels. Peter Brabeck, chairman of the world's largest food company, Nestlé, said rises in food prices reflected not only temporary factors but also long-term and structural changes in supply and demand. "They will have a long-lasting impact on food prices."[80] Eric Katzman, an analyst at Deutsche Bank Securities in New York recently said "U.S. government energy policy [support for agrofuels], higher demand from developing markets and need for quality inputs stresses the entire food chain from commodity processor to packaged food company, to retailer, to consumer."[81]

Already, there have been food riots as a result of these price increases. In late 2006, the price of tortilla flour in Mexico doubled thanks partly to a rise in U.S. corn prices from $2.80 to $4.20 a bushel over the previous several months. The price surge was exacerbated by speculation and hoarding. With about half of Mexico's 107 million people living in poverty and relying on tortillas as a main source of calories, the public outcry was fierce. In January 2007, Mexico's new president, Felipe Calderon, was forced to provide subsidies to cap the prices of corn products.[82]

Ultimately, the choice is between using 450 pounds of corn for food and filling a 25-gallon tank of an SUV with pure ethanol.[83] The 450 pounds of corn (or its equivalent in any number of crops) contains enough calories to feed one person for a year. The crops that would go into two tanks of ethanol per week over a year would therefore feed over 100 people for the year. This bizarre situation is the result of market forces. People with cars (the minority) have more purchasing power than the majority who are living at a subsistence level; therefore, crops for *fuel* are more valuable for producers than crops for *food*, as car drivers can pay more for the same crops than the poor.

This situation will only worsen as more crops are diverted to fuels and as the global population grows over the next few decades. One of the UN's Millennium Development Goals is to halve world hunger by 2015; agrofuels will not only make achievement of this goal impossible, but will actually increase world hunger.

The poor are always the first to suffer, and hunger is not the only challenge they face from agrofuels. As the demand for agrofuels increases, more marginal land must be used to provide increased crop production. Much of this new crop land comes from poor and indigenous peoples, and much of it comes from forests. Some experts from a recent meeting of the UN Forum on Indigenous Issues highlights the concerns:

> "For forest-dependent indigenous peoples, the forest is the basis of their sustenance and subsistence. It is their profound symbiotic relationship with the forest, for millennia, which shaped their societies, their worldviews, knowledge, cultures, spirituality and values. They evolved strict spiritual and customary laws and sophisticated land tenure, mostly under communal ownership and resource management systems in relation to the forests to ensure that their needs are met and to protect the forests from destruction. The maintenance of the integrity of the forests is crucial for them as this represents the past, present, and future ways of how they live in mutual reciprocity among themselves and with nature.
>
> "Social conflicts associated with large-scale industrial logging (both legal or illegal) and monocrop plantations are basically conflicts about who has the right to own, use and manage the forests. The main protagonists are indigenous peoples versus the state and its machineries (military and police forces, departments of forestry, environment, mining, agriculture, local governments, etc.), the logging, plantation or carbon trading companies and sometimes even NGOs. Land rights remains as one of the most contested and violated rights of indigenous peoples."[84]

It is the marginalized people who are expected to make way for rich nations' development projects, of which agrofuel production is the latest in a long series. The shameful history of colonial exploitation is currently being repeated in the name of climate friendly development projects and energy security. In reality, these projects contribute little if anything to reducing greenhouse gas emissions. Evidence suggests the net impact is actually increased emissions. *(See above)*. These projects create an illusion of contributing to energy security, but continue to heap an ever greater burden on the poor. The loss of land is as much a killer of the spirit as the lack of food kills the body.

Agrofuel development projects by the World Bank and its regional affiliates too often become smokescreens for massive exploitation of poor and indigenous populations. These projects may appear on paper to have many social and environmental benefits, but on the ground they literally displace poor communities onto ever more marginalized land, and often involve intimidation, forced evacuations and violence. The remote location of these projects makes it easier for those bent on profit to literally get away with murder. Many cases of forced evictions, torture and murder with respect to subsistence farmers and indigenous peoples in the way of agrofuel expansion have been documented.[85]

Even when it is existing farmlands or savannas that are used for agrofuels, subsistence farmers and indigenous peoples are forced into nearby forests and national parks, which they then clear to grow crops, pasture animals and gather firewood.[86] This same process is occurring not only due to expansion of agrofuels but also because of the increased interest of developed nations in forestation to create "carbon sinks" to mitigate climate change. During the 6th meeting of the Conference of Parties of the United Nations Framework Convention on Climate Change (UNFCCC) indigenous representatives from 22 countries released a statement rejecting the inclusion of forests in the Clean Development Mechanisms (CDMs), and calling for the establishment of a fund for indigenous peoples to address the impacts of climate change.[87]

While the displacement of poor and indigenous peoples from their traditional lands for both agrofuels and carbon sinks drives some of them into the forest, it drives others to slums on the outskirts of cities. Some jobs are created by these projects, but they are few and dangerous. For each 100 hectares, there is one job in eucalyptus plantations, two for soya, and ten for sugar cane. This disruption of traditional living arrangements also leads to increased health risks, alienation and greater likelihood of malnutrition and starvation. The displacement of these small farmers brings a corresponding loss of local crop varieties and associated knowledge, further undermining local agricultural sustainability and food sovereignty.

The few workers who do get jobs on the agrofuel plantations hardly fare any better. They receive subsistence wages, are forced to live in appalling conditions, are exposed to harmful pesticides, and are essentially treated as slaves.

According to FBOMS in Brasil (Fórum Brasileiro de ONGs e Movimentos Sociais para o Meio Ambiente e o Desenvolvimento)

> ". . . sugar cane cutters are paid for their daily work only if they meet a pre-established production quota. Many are hired by intermediaries and come from other regions. They live on the farms, in cabins with no mattresses, water or stove, cook in cans over small campfires and buy their food at the farm's store, paying sums that are well-over market prices. If wages were increased even by a small margin, this would give plantation owners an incentive to mechanize and reduce their workforce, resulting in many workers losing jobs. Working conditions include poor housing, lack of water and sanitary provisions, lack of sufficient food, no work training, use of agrochemicals without sufficient protection, health impacts of sugar cane burning before harvesting, minimum rest and exhaustion, wage level under living standards, child and even forced labour."88

Brazil's agrofuel industry has some 200,000 cane cutters whose low wages and poor working conditions keep the cane-based ethanol flowing. Their working conditions are abysmal, described as prison like, where the heat and malnutrition has resulted in workers dying on the job.[89] In July, 2007, more than 1,000 "enslaved" workers were released from a sugar cane plantation in the Amazon following a police raid that has highlighted the dark side of the current ethanol boom in that country. Workers in the northern state of Para were being forced to work 14-hour days in horrendous conditions cutting cane for ethanol production. The raid was Brazil's biggest to date against debt slavery, a practice reminiscent of indentured labour where poor workers are lured to remote rural areas, then pushed into debt to plantation owners who charge exorbitant prices for everything from food to transportation. The plantation's owner, Para Pastoril e Agricola SA, is one of the biggest ethanol producers in Brazil.[90]

With the recent agreement for Brazil to provide increasing amounts of agrofuels for the U.S., these human rights abuses may continue or get worse.[91]

Will "certification" of agrofuels help?

The growing recognition by NGOs and governments of the many environmental, health and human rights problems associated with agrofuels globally, has resulted in a movement to certify agrofuels as a way of insuring that these unintended and undesirable effects are eliminated. There are a number of different initiatives, some of which have already joined forces. The EU itself, the Netherlands, Germany and the UK are all developing initiatives. Industry is also developing standards. Some advocate mandatory certification, others voluntary.

There are many issues to be addressed in devising credible agrofuel certification systems. One of the major problems is that certification does not prevent expansion of production beyond sustainable limits.

Another issue relates to monitoring and compliance, especially in the remote areas where many of the abuses occur. None of the certification procedures currently being developed have included Southern stakeholder groups affected by monoculture expansion for agrofuels from the outset.[92] Finally, World Trade Organization (WTO) rules are often cited as legal barriers to certification systems, as they prevent nations from making rules that interfere in any way with trade.

It appears that we are years away from adequate certification processes for agrofuels. In the meantime, poor and indigenous peoples continue to suffer. Unimpressed with these certification procedures, NGOs aware of the issues, many from the global South, are forming coalitions to call for more radical reform of the growing agrofuel industry.[93]

The rhetoric of agrofuel supporters is ironic given the realities of agrofuel production from both an environmental and social perspective. What is touted as clean energy is in fact increasing greenhouse gas emissions, as well as air and water pollution, destroying forests and biodiversity, and displacing and brutalizing subsistence farmers and indigenous peoples—and all for, at best, a small increase in fuel supply. With a net energy return as low as it is for agrofuels, these additional environmental and social costs make agrofuels a violent extravagance imposed on the many for the benefit of the few. Who are those few? Large corporations and industrial societies.

8. Does Ethanol Production Make Economic Sense?

Massive increases in ethanol production would be impossible without significant government subsidies. U.S. federal and state subsidies push the real price of ethanol beyond $7 for the ethanol equivalent of a gallon of gasoline.[94] This is the actual cost to taxpayers, many of whom may never use ethanol or even drive a vehicle. Even in Brazil which relies on sugar cane based ethanol that has a much higher net energy return than the corn based ethanol popular in the U.S., the government subsidies equal 150 percent of the price to consumers.[95]

Government subsidies in the U.S. are made in a variety of ways. Because farmers have been losing money, corn prices are subsidized up to 50 percent: the Volumetric Ethanol Excise Tax Credit (VEETC) amounts to 0.51 cents a gallon; the mean tax credit for small producers amounts to 0.06 cents a gallon; until 2004, the average corn subsidies were about 0.44 cents a bushel; in addition, the average State subsidies were about 0.15 cents a gallon, to name just a few. In absolute terms, U.S. Federal corn subsidies alone amounted to about $4 billion dollars a year up to 2004; with another $3 billion a year going to ethanol subsidies. U.S. corn subsidies are now over $10 billion a year, and with the expansion of ethanol production anticipated over the next decade subsidies for both corn and ethanol will continue to grow.

These direct subsidies, however, are only part of the picture. As mentioned earlier there are a considerable number of *externalized* environmental and health related costs associated with ethanol production. These costs can be estimated by considering the negative impacts of the full corn ethanol cycle and the costs of restoring the damages done to soil, water, air, plants and wildlife. In 2004 these external costs were estimated to be at least $2 billion dollars a year in the U.S., at the then current level of ethanol production. If corn based ethanol were to be increased to provide 10 percent of all U.S. transport fuel, the cost of restoring the environment would be $12 billion—each and every year.[96]

These estimates of externalized costs are conservative as true restoration is often impossible (i.e., the damage done is irreversible), and the destruction that can be restored is less than that which is forever lost. In addition, some environmental costs such as the minimum reversible work of restoring surface and ground water, and restoring soils contaminated by the corn field runoff water, were not included in the above study.[97] These externalized costs, or subsidies from the environment and future generations, are as real as the subsidies provided by various levels of government.

In addition to these direct and indirect environmental costs, citizens are also paying increased prices for a wide variety of basic foods such as meat, milk and eggs, all consequences of high corn subsidies finding their ways through the rest of the food economy.

There are also indirect health costs associated with subsidized corn production. For example, each year dozens of pounds of high fructose corn syrup are consumed by the average American, contributing to Type 2 diabetes in some 20 million people. The economic impact of this one food related disease alone is about $135 billion a year.[98] Large food corporations rely on these sweeteners to make their products appealing and are unlikely to change their practices unless the price of corn-based fructose becomes prohibitive.

So who benefits from all these government subsidies? Many U.S. politicians mistakenly believe the U.S. farmer is the beneficiary. Many farmers have been losing money on corn and related crops for many years, and the opportunity for them now to have a crop that provides a decent income is very attractive. Unfortunately, the real beneficiaries are the large food corporations that dominate the global market; small farmers receive very little of these government funds. Billion dollar corporations, such as Archer Daniels Midland, U.S. BioEnergy Corp and VeraSun Energy, are the major recipients of these subsidies. From 1995 to 2003, the top 10 percent of corn subsidy recipients were paid 68 percent of all corn subsidies. The mean payments were $465,172 each for the top one percent, and $176,415 each for the top ten percent of recipients. The bottom 80 percent of farmers received mean payments of $4,763 each.[99]

Such large subsidies to billion dollar corporations have attracted the interests of some consumer groups concerned about the impact of corporate lobbying efforts on political decisions.[100] "Ethanol producers receive $2 billion in subsidies from taxpayers, with ADM [Archer Daniels Midland] getting the lion's share," said Tyson Slocum, director of Public Citizen's energy program. "It's important that the American people have an accurate representation of how this industry influences government officials to help determine how the public's money is spent." Records show a significant discrepancy between what RFA [Renewable Fuels Association, a national association for the ethanol industry] told the government it spent on lobbying and what lobbying firms reported earning from RFA. As a result, RFA appears to have underreported its true lobbying expenditures to the public by at least $1,220,000 from 1999 to 2005, according to Public Citizen.

The U.S. federal government's push for "energy independence" under the guise of a clean energy program to combat climate change, appears to have resulted in a half-baked plan to ramp up corn based ethanol as a major transportation fuel for the U.S. The rich subsidies supported by industry lobbyists are putting a tax burden on consumers and extracting a high price from the environment. The broader impact of agrofuels—on environmental pollution, on climate change, on food prices, on subsistence farmers and indigenous peoples, and on genuine energy security—have been ignored by decision makers, even though these problems have been clearly identified.

The real costs of agrofuels are unacceptable when all environmental and social costs are accounted for. The large subsidies for agrofuels in particular, which are many times larger than government incentives for other renewable energy sources, reveals the economic unsustainability of this policy.

THE WAY FORWARD:

HOW TO ACHIEVE ENERGY SECURITY, DEAL WITH CLIMATE CHANGE, AVOID POLLUTION AND HELP THE POOR

If the U.S. Congress and other national legislatures are serious about the climate, energy and social justice goals they espouse, then they should be realistic as to how they are achieved. What we have now are major distortions of policy initiatives fueled by corporate lobbyists and short sighted greed. But special interest pressure and lobbying is obviously no way to make policy which can begin to meet current challenges. As the interdependent crises of climate change, energy scarcity and gross inequality are reaching critical stages, what is needed is a comprehensive decision-making framework that can meet environmental and social goals as well as create a rational and sustainable energy policy.

The situation we now face is critical and unprecedented. The imminence of global energy scarcity that will occur with peak oil,[101] predictably followed by peak natural gas[102] and peak coal,[103] is coming at the same time that climate change is reaching a potential point of no return.[104] In addition, many other global challenges such as soil degradation, water loss, pollution and escalating social and economic inequalities, make it clear that this is a moment in history for the best of human values to guide a cooperative global effort for humanity to survive and thrive. How we produce and consume energy is central to this effort.

Discussions and debate on a sustainable energy future tend to focus on the *production* side, the technical issues which compare environmental impacts and net energy ratios, as well as economic costs. But the discussions are also highly politicized as evidenced by the ethanol debacle. This is putting a policy priority on an energy source with little if any net energy return, which *contributes* to climate change rather than alleviating the problem, and which contributes to several other serious environmental problems as listed above. It is also having a devastating impact on traditional farm communities and indigenous peoples around the world. None of this unfortunate transition would be possible without massive government subsidies.

The energy *consumption* side of the discussion has hardly begun, yet it is essential for a just and sustainable future. If oil and natural gas availability are soon likely to decline significantly, and with a decline in coal perhaps only decades behind, it is urgent that all societies acknowledge that the high per capita energy consumption that occurred in developed countries over the last century and a half is about to come to an end. There are no alternative energy sources that have the high net energy return of oil, gas and coal,[105] and when these non-renewable resources reach their peak production and start to decline, everything will change. The realization that these peaks are imminent is too slowly finding its way into public consciousness,[106] and the full impact has not yet set in. We will all be forced to consume less energy; of this there is little doubt. The big question is whether this will be forced on us by the inexorable economic chaos from depletion of our primary non-renewable resources, oil, natural gas and coal, or by our adapting to this inevitability in a thoughtful and organized manner.

The prospect of declining energy availability can arouse considerable fear of economic and social collapse, making it difficult to face the realities. Ironically, it is avoiding these energy realities that will give rise to much greater dangers than if we look at the facts and deal with them in a fair and realistic way.

Fortunately there are considerable data available which point to the conclusion that human happiness and well being, objectively measured, do not require the high per capita consumption levels that characterize northern industrial nations. A state of well being and general contentment is quite possible with about one third of the annual per capita current energy consumption in North America.[107] With a variety of renewable energy sources that are relatively benign environmentally, it might just be possible to provide this level of energy consumption for a stable global population.[108] The sooner we embrace this reality and plan for adapting to it, the more likely will we retain a reasonable quality of life for developed nations, as well as be able to assist the majority of poor people to attain similar standards of well being. The important point is to acknowledge that a lower level of energy consumption is inevitable in any case over the next few decades.

Our current path of frantically seeking more oil and gas exploration, expansion of nuclear power, and subsidies to the *wrong* renewable sources of energy —precisely the path the G8 nations decided to take last year in St. Petersburg[109]—will only make the situation worse. A sustainable and just energy future is not possible with such an approach. We desperately require a new framework in which to think about humanity's energy future.

This is not the place for the full development of a comprehensive global framework for choosing energy systems to deal with the global crises identified above; but we can identify three essential requirements for such a comprehensive framework:

- First and foremost, *our energy systems must be ecologically sustainable*. The present climate crisis should make evident the need for maintaining critical global ecosystem services upon which we are dependent. Sustainability across generations is also a justice issue, making this criterion the most basic and vital condition for planning our energy future.
- Secondly, *social justice* demands that we choose *energy systems, that if scaled up globally to their sustainable limits, are accessible to everyone.* Fair distribution of scarce energy resources should be regarded as a basic human right.
- Finally, we must choose *energy systems that meet the first two criteria while providing the highest level of net energy available.*

The example of ethanol and other agrofuels highlights the absurdity of investing in an energy system which at first appears renewable and environmentally benign without comprehensive *life cycle analyses* of all the environmental and social impacts that go along with that system. Lurching to a solution because it appears to be environmentally friendly, without such life-cycle analyses is simplistic and irresponsible. We have the skill and knowledge to provide life cycle data to test agrofuels against the above criteria. Current data indicate that agrofuels fail each of the above three critical tests. The *massive subsidies and investments in agrofuels should therefore cease*, as they are causing more harm than good, and the benefits are concentrated in the hands of those who need them the least, large corporations.

The data on agrofuels indicates they have much lower net energy returns than other renewables, as well as more negative environmental impacts. And the social impacts are nothing less than a continuation of a brutal colonialism under the guise of economic globalization. A just and sustainable energy future is possible, but as Einstein pointed out many years ago.

> "We can't solve problems by using the same kind of thinking we used when we created them." —Albert Einstein

A new paradigm is required. Not just more engineering but a new way of looking at quality of life. Not just more "economic development," but a new sense of genuine global cooperation. Not just pursuing the chimera of nationalistic "energy security," but a new paradigm based on social justice, and ecological sustainability—non-violence against people and nature. The alternatives are too horrible to contemplate.

ENDNOTES

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