The Machine in the Garden: Linking Biofuels Research and Development to Ecological Principles

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Twenty-first century industrial society is faced with two enormous problems: global climate change and energy security. Science tells us that global greenhouse emissions must be reduced by 80 percent by mid-century to avoid "dangerous levels" of climate change. Oil security problems are expected to increase as reserves are increasingly concentrated in the hands of a few volatile countries, as oil prices shoot past $100 a barrel, and as demand increases from rapidly developing economies in Asia. There are even predictions that we may soon reach "peak oil," when demand outstrips supply, causing widespread economic shock.

There are considerable government incentives for using biomass to produce both motor fuels and electricity fuels,. In December, the Energy Independence and Security Act of 2007 set a national mandate of 36 billion gallons of biofuel production by 2022, up from about 6 billion gallons in 2007. The law requires th much of this production will have to come from cellulosic sources, and limits eth from corn starch to 15 billion gallons per year. While government and private investors are pouring billions of dollars into developing cellulosic conversion technologies, no companies have yet developed a market-ready product.

As the industry grows, a major opportunity to affect the rural landscape, for bette worse, will emerge. It is clear that, so far, conventional biofuels production is ha substantial impacts on the landscape. [cite #1 below]

Our current industrial agriculture is driven largely by economic considerations, which are in turn largely predetermined by government policy. The large scale production of uniform commodities facilitates economies of scale for farmers, distributors, and processors, but requires millions of acres to be given over to a si plant species. To protect this monoculture from pests and diseases, and to compensate for unnatural nutrient, carbon, and water cycles, large amounts of fertilizers and pesticides are needed. Wildlife habitat is damaged by being displac with monocultures and by chemical pollution. Current corn ethanol and soy diese production continues this monoculture approach.

Some cellulosic biofuel producers are applying the same principles to their indus developing crops engineered for maximum yield per acre that will be processed using enzymes engineered to be optimal for converting that particular crop to fue This model, with patented crops and enzymes, is an economic model that offers major rewards for the companies that control the patents. It also creates a fragile and vulnerable industry, subject to diseases and extremes in temperature and precipitation: the key perturbations in a future changing climate.

The alternative vision to supply cellulose for the biofuels industry has been described by David Tillman of the University of Minnesota [cite #2 below] and others [cite #3 below]. Their research has investigated the yields per acre of native polycultures and found that mixed grasses and forbs have higher yields than grass monocultures. Such polycultures would provide better wildlife habitat, better resilience to pests and disease, and demand fewer inputs. They would also yield ecological benefits, such as improved water quality, soil conservation, and carbon storage benefits. These same prairie grasses are what built the fertility of farmland soils in the Midwest over the centuries.

This polyculture approach to feedstock supply—the grass, garbage, woodchips and other biomass used to create biofuels--creates an opportunity to replicate native prairies for the sake of energy production. This is an exciting vision for our energy future, creating a large-scale energy system that actually improves the environment rather than damages it. But it hinges on one inescapable fact: the product of this polyculture will have to pass muster as a commercially viable feedstock The technologies that will convert biomass to liquid fuels must be capable of handling a stream of diverse plants with diverse chemical and physical properties.

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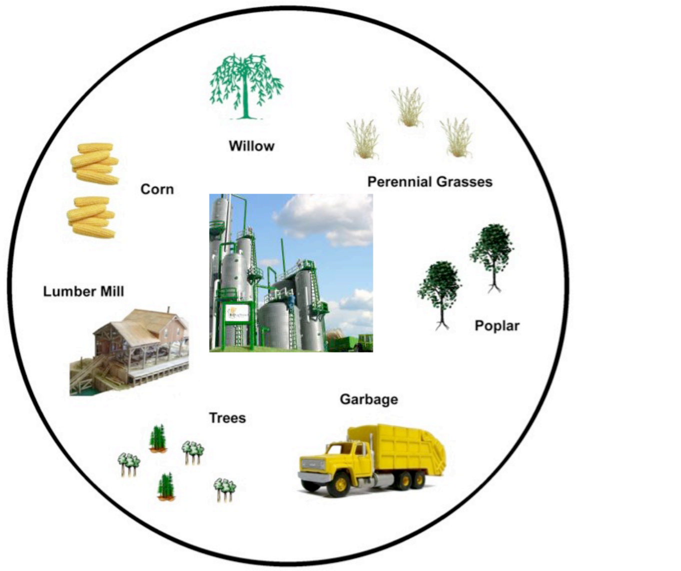
Solving the conversion technology problem is the key to fostering a sustainable biofuel industry, and will drive feedstock decisions, and by extension, define landscape impacts.

Once the conversion technology is developed that can deal with diverse feedstocks, a host of new opportunities and benefits arise.



The ideal conversion technology would handle not only a mixed feedstock like a natural prairie, but also different streams of plants and materials. Imagine a biorefinery, drawing materials from a given radius, using a range of annuals and perennials, crop and forest residues, industrial biomass byproducts, and even municipal garbage. By tapping a wide variety of feedstocks, the refiner could improve profitability by gaining some important logistical and risk mitigation benefits. A diverse feedstock base would be less vulnerable to drought, pests, and disease; harvest times could occur throughout the year, maximizing the use of labor and equipment; and storage needs would be reduced considerably due to "just in time" harvesting of rotating feedstocks, saving costs and reducing risks.

Yet, instead of working towards this vision, most efforts at research and commercialization by both public agencies and private investors focus on maximizing yields per acre and economic yields. These are necessary goals, but biofuels investment decisions should also be guided by achieving "maximum ecological yields."

A narrow focus on the single ideal plant married to the single ideal enzyme misses the real world implications of producing and handling monocultures. Instead, the development of this flexible "machine in the garden" should be considered a top priority for public and private investors. Successful development of this "machine" would influence a huge new industry at its birth and to steer it toward sustainable landscape impacts.

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