

Overcoming barriers to biofuels: Energy from diverse prairie biomass

Presentation to Staff of the United States House Committee on Agriculture on February 26, 2007

Dr. Jason Hill, Research Associate
 Dept. of Applied Economics and Dept. of Ecology, Evolution, and Behavior

hill0408@umn.edu
 University of Minnesota - Twin Cities

Summary

Highly diverse mixtures of native prairie plant species offer an abundant bioenergy source with tremendous environmental benefits such as soil carbon sequestration, low agrichemical input requirements, and wildlife habitat. The public role should be to encourage production of this environment-enriching biomass feedstock by establishing policies that foster availability of stable and cost-competitive supplies to end users.

Introduction

Corn ethanol dominates domestic biofuel production, but it cannot replace much gasoline without impacting food supplies as dedicating all domestic corn production to ethanol would offset only 12% of gasoline use. Although using corn ethanol avoids many negative aspects of burning gasoline, it also has its own unique environmental costs, largely from carbon dioxide release from fossil fuels burned at production facilities and from crop cultivation itself, including ecological damage caused by nitrogen and phosphorus fertilizers, pesticides, and erosion. Biofuels from lignocellulosic sources have reduced environmental impact while potentially avoiding conflicts between food and energy production. In particular, diverse mixtures of native prairie plant species provide biomass feedstocks that may yield greater net energy gains than monoculture energy crops such as corn and switchgrass when converted into biofuels, while also providing wildlife habitat and enriching degraded soils with carbon and nitrogen removed naturally from the atmosphere.

The benefits of biodiversity for bioenergy

Biodiversity provides many benefits in biomass production. Land planted to mixes of 16 native prairie plant species yields on average 238% more biomass than land planted to a single species. Greater diversity also increases amounts of carbon being taken from the air and stored in the soil, provides more stable annual yields, and reduces needs for herbicides, pesticides, and fertilizers such as nitrogen, which can be supplied to grasses by legume species.



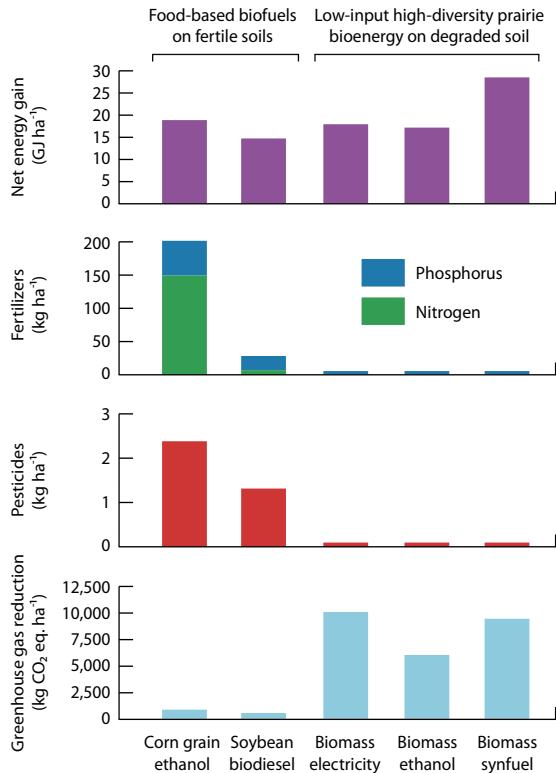
Increasing the number of plant species in a prairie not only yields more biomass but also increases the amount of carbon taken from the air and stored in the soil.

Showing how biodiversity benefits bioenergy



Aerial view of a biodiversity experiment at Cedar Creek Natural History Area in Bethel, Minnesota. Each plot is planted to 1, 2, 4, 8, or 16 species randomly chosen from a selection of native prairie plants. (Photo by David Tilman).

Comparing prairie biofuels to current biofuels



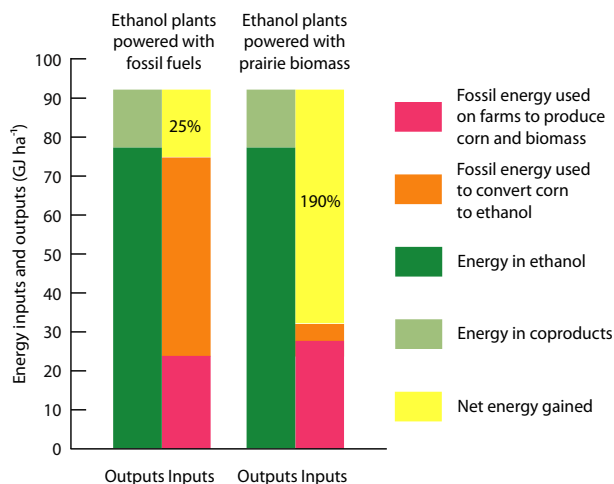
Comparison of the energy return and environmental effects of current biofuels from food crops and biofuels that can be made from diverse prairie biomass.

Transitioning to a biomass bioenergy industry

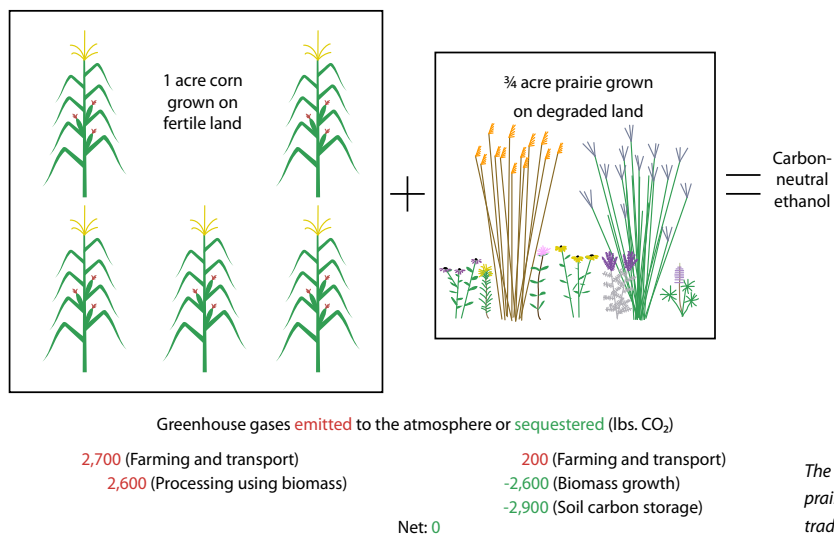
As demand for both food and fuel increases, it will be even more important for us to grow energy crops, such as those that give us cellulosic biomass, that do not compete with our food crops for our most fertile lands. Developing a biomass-based energy industry is complicated, however, by the reality that large-scale biomass production will occur only if there is an existing market for it, and a market will exist only if stable and cost-effective supplies are available.

The following example shows how the biomass production infrastructure could be developed by integrating biomass into existing ethanol production facilities today. Current corn ethanol production uses large amounts of fossil fuels at the ethanol plant for milling, fermentation, and distillation. Diverse prairie biomass could be used in their place, thereby reducing fossil fuel use, fostering a fledgling species diverse biomass production industry, and realizing the many environmental benefits of restoring native grassland ecosystems, which are currently the most endangered ecosystem in this country today.

Substituting biomass for the natural gas and coal currently used in converting corn to ethanol greatly increases the return on the fossil fuel energy invested.



Carbon-neutral ethanol from corn fields and prairies



Even though corn ethanol releases 14% less greenhouse gases than gasoline, producing ethanol from an acre of corn releases 5,300 pounds of carbon dioxide into the atmosphere. Three-quarters of an acre of prairie planted on degraded or idle land can remove the same amount of carbon dioxide from the atmosphere. All of the carbon in prairie plants (about 40% of their dry weight) was removed from the air as they grew. The carbon in the roots of the plants accumulates in the soil, and the carbon in those parts of the plants above ground is released back into the air when it is burned to provide heat and electricity for producing ethanol, thereby offsetting the carbon that would have been released when burning fossil fuels at ethanol plants.

The amount of carbon dioxide removed from the air by a prairie is enough to offset the carbon dioxide released during traditional corn ethanol production.

Removing the barriers to next generation bioenergy production

Making the transition from food-based to biomass-based biofuels is a "chicken and the egg" problem. Large-scale biomass production will occur only if there is a market for biomass with prices that cover the production costs to the farmer including land rental, establishment and harvesting, and transportation. A biomass market will exist only if stable and cost-effective supplies are available to those industries that can use biomass for energy and other high-value products.

The current barrier to next generation bioenergy production from diverse prairies, therefore, is the price and supply stability disconnect between biomass users and suppliers. The public role in overcoming this "coordination problem" may include offsetting costs of land rental, establishing perennial prairie lands, and harvesting and transporting the biomass grown upon them. The public benefit realized by being able to guarantee available supplies for biomass users arises from the significant environmental benefits that low-agricultural input, highly diverse mixtures of prairie plants offer, including plentiful and stable biomass sources, soil carbon sequestration, agricultural mitigation, and wildlife habitat.

Blackeyed Susan, wild bergamot, and big bluestem in a restored Minnesota prairie. (Photo by Clarence Lehman).

