

The Sustainability of Cellulosic Biofuels



All biofuels, by definition, are made from plant material.

The main biofuel on the U.S. market is corn ethanol, a type of biofuel made using the starch in corn grain. But only using grain to produce biofuels can lead to a tug of war between food and fuel sources, as well as other environmental and economic challenges.

Biofuels made from cellulosic sources – the leaves, stems, and other fibrous parts of a plant – have been touted as a promising renewable energy source. Not only is cellulose the

most abundant biological material on Earth, but using cellulose to produce biofuels instead of grain can have environmental benefits.

Cellulosic biofuel sources offer a substantially greater energy return on investment compared to grain-based sources. However, environmental benefits are not guaranteed. The environmental success of cellulosic biofuels will depend on 1) which cellulosic crops are grown, 2) the practices used to manage them, and 3) the geographic location of crops.

Both grain-based and cellulosic biofuels can help lessen our use of fossil fuels and can help offset carbon dioxide emissions. But cellulosic biofuels are able to offset more gasoline than can grain-based biofuels – and they do so with environmental co-benefits.



Cellulosic Biofuels Help Reduce Competition for Land



Cellulosic fuel crops can grow on lands that are not necessarily suitable for food crops and thereby reduce or avoid food vs. fuel competition. If grown on land that has already been cleared, cellulosic crops do not further contribute to the release of carbon to the atmosphere.

Because many cellulosic crops are perennial and roots are always present, they guard against soil erosion and better retain nitrogen fertilizer. Additionally, carbon is sequestered belowground in roots and soil organic matter because there is no further tillage after crop establishment. Most cellulosic sources require

much less intensive management than do grain crops, saving the fuel and carbon dioxide costs associated with field crop operations such as planting, tillage, and weed control.

Cellulosic Biofuels Provide Environmental Benefits and Increase Ecosystem Services

Ecosystems are communities of living things and the environment in which they interact. Ecosystems are essential to life, providing innumerable and invaluable services such as clean water, food, and fiber, nutrient cycling, crop pollination, and pest suppression. Biodiversity refers to the portfolio of organisms in a natural community. Generally, the more diverse the portfolio, the greater the degree of ecosystem services provided.



Cellulosic biofuel sources can diversify agricultural landscapes by allowing farmers to grow a greater variety of crops with more complex mixtures of plant species. This increases the diversity of plants and the birds, insects, and other organisms that live in different plant communities. A mixture of native grass and tree crops can keep wildlife habitat intact and support vital ecosystem services, including those that help other crops in the landscape.

Economic Viability of Cellulosic Biofuels Depends on Location, Technology, and Policy



Whether cellulosic biofuels are economically competitive and environmentally sustainable will depend on 1) location, 2) the development of new technology, and 3) policies that reward environmental performance.

The economic viability of cellulosic biofuels from crop residues and perennial grasses such as switchgrass and miscanthus will differ across geographic locations. Crop yields differ across the U.S., and therefore a mix of crop types is more economically viable than a single type of crop. Likewise, costs of production – harvesting, storage, and transportation – will vary by location.

Current estimates suggest that cellulosic biofuels are likely to be more expensive to produce than grain-based biofuels. However, the advent of new technologies for harvesting, storing, and converting cellulosic sources into biofuels could make them more competitive.



Policy Implications

The U.S. Energy Policy Act of 2007 mandates that biofuels make up 22% of transportation fuel mix by the year 2022. This translates to 36 billion gallons of ethanol – 15 billion gallons of grain-based ethanol and 21 billion gallons of cellulosic ethanol. The 2008 Farm Bill offers a \$1.01 subsidy per gallon for cellulosic ethanol and \$45 per ton to growers of biomass feedstock for biofuels.

Policies that monetarily reward the environmental performance of alternative biofuels are needed to improve competitiveness of cellulosic biofuels relative to grain-based fuels and gasoline. Aligning energy policy and climate policy through biofuel tax credits that are inversely related to their carbon footprint can provide incentives to use high yield, low carbon cellulosic sources. Policies and incentives should also decrease reliance on exotic and invasive species, favor increased biodiversity at farm and field levels, and maintain or enhance ecosystem services.

A large background image of a grass field with the logo of the Ecological Society of America (ESA) overlaid in the center. The logo consists of the letters 'esa' in a stylized, lowercase font, with 'ECOLOGICAL SOCIETY OF AMERICA' written in a smaller, uppercase font below it.

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