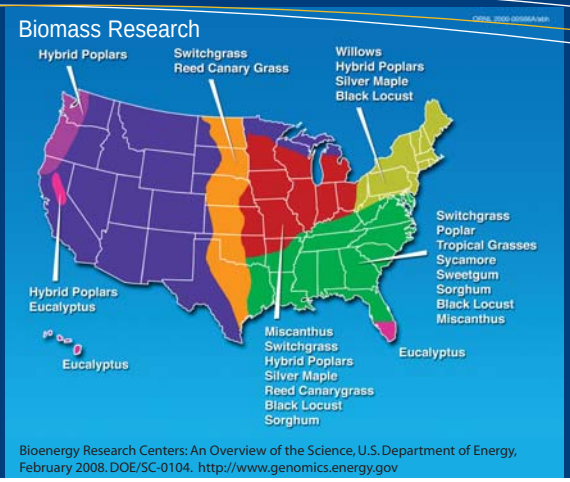
UNIVERSITY OF ILLINOIS
EXTENSION

Ethanol



Bioenergy Research Centers: An Overview of the Science, U.S. Department of Energy, February 2008. DOE/SC-0104. http://www.genomics.energy.gov

1 acre of corn =
150-300 bushels of corn =
420-840 gallons of ethanol
vs.
1 acre of grass =
5-15 tons of plant material =
150-1200 gallons of ethanol

The Future of Ethanol: Cellulosic

The next step for ethanol—cellulosic ethanol—is turning garbage and plant materials into fuel. It is a bit more complicated than Doc Brown in the "Back to the Future" movie demonstrated.

Ethanol is a process that ferments sugars into alcohol. It can be made from many different plant sources or feedstocks. Currently, corn is the most common feedstock in the United States. Sugar cane is used in Brazil. Sorghum and other small grains are used as the feedstock for ethanol in parts of Europe.

Researchers are exploring ways to make ethanol from other feedstocks or plant materials. Feedstocks are also known as biomass and include corn stover (leaves and stalks of the corn plant), corncobs, and wheat straw, perennial grasses, wood chips (including waste from the forestry and paper industries), and waste from food manufacturing. Waste from our communities such as garbage, shredded paper, and wood waste is being considered also. Researchers from around the world are evaluating plant materials that grow in their region for cellulosic ethanol production potential.

Cellulosic Ethanol Process

Traditional ethanol production grinds corn kernels to release the starch, which is then fermented. Cellulosic ethanol production starts with the biomass or plant materials and breaks down the cell wall to release the starch or sugars in the plants leaves and stems. These simpler compounds are then fermented into ethanol.

The combination of lignin, hemicellulose and cellulose in plant material is very resistant to breakdown into the molecular sugar components. Two main pathways to converting lignocellulose to biofuels are:

Biological – specialized enzymes or microbes break pre-treated biomass-based cellulose into sugars, which are then fermented into alcohols.

Thermochemical – biomass is converted by pyrolysis, gasification, or liquefaction into gaseous and liquid chemical "building blocks." It is recombined through catalytic processes into a variety of fuels and chemicals.

Biomass Materials

Left: *Miscanthus x giganteus* (taller and green) and switchgrass

Right: corn stover - baled (stalks, leaves, and husks)

Efficiencies and Economics of Cellulosic Ethanol Production

Researchers have been working on breaking down cell walls for many years. There still is no quick or efficient way to break down the cell walls using biological pathways. The cost for producing ethanol from plant material is more expensive than ethanol produced from corn. In January 2009, the first cellulosic ethanol plant in the United States began production. Time will be the judge of its success.

Today, researchers believe that it will be 10 years before the U.S. has high volume cellulosic ethanol production. Every week you can find a news article about the latest discovery. The researchers must test it at varying scales and production processes to make sure it works. They look at the efficiency at the commercial scale. The process must be cost effective so that it can compete with other fuels in the marketplace.

Impact for Land Owners

As researchers are improving the science of cellulosic ethanol production, land owners may wonder about the biomass crops that will be needed.

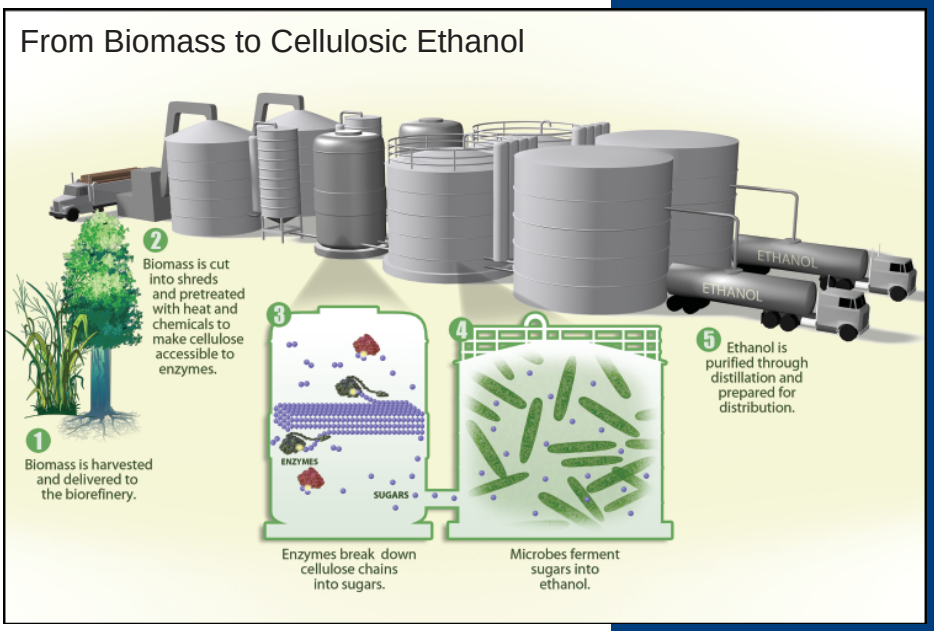
In Illinois, the crop land is fertile and produces high yields of corn and soybeans. Landowners will need to consider: economic impacts, agronomic and environmental factors, and logistics to the marketplace for new biomass crops.

Biomass is bulky when harvested. It is challenging to transport very far. Researchers estimate that perennial grasses in large bales can be transported economically for 30-50 miles. Researchers are identifying ways to compact or densify the plant material. One way to create dense material is to compact it into pellets. This takes specialized equipment that can compact the plant material under high pressure. These pellets allow the plant material to be transported longer distances and to be stored conveniently. The pellets may be burned in coal-powered boilers, which can create energy while reducing net carbon emissions.

It is difficult for solid biomass such as crop residue and wood chips used for heat and power to compete with coal at present prices. If pelletizing processes are used to make the biomass denser and easier to handle these add to the cost. However, there are other markets such as pellet stoves for home or small business heating that may offer good near-term returns on biomass crops.

Commercial production of cellulosic ethanol is forecasted to begin in 2010. About 8 million dry tons of biomass material will be needed that year.

From Biomass to Cellulosic Ethanol



Source: Genome Management Information System, Oak Ridge National Laboratory: U.S. Department of Energy Genome Programs http://genomics.energy.gov.

References:

U.S. Department of Energy Genome Programs http://genomics.energy.gov.

Resources:

Bioenergy Feedstock Information Network: http://bioenergy.ornl.gov/main.aspx

Biomass Research and Development Initiative: http://www.brdisolutions.com/default.aspx

Energy Information Administration (U.S. Department of Energy) : http://www.eia.doe.gov/fuelrenewable.html

Idaho National Laboratory: https://inlportal.inl.gov/portal/server.pt?open=512&objID=421&parentname=CommunityPage&parentid=4&mode=2

National Renewable Energy Laboratory: http://www.nrel.gov/biomass/

- Biomass Maps: http://www.nrel.gov/gis/biomass.html

Oak Ridge National Laboratory | Biomass Energy Data Book: http://cta.ornl.gov/bedb/index.shtml

Phyllis, database for biomass and waste (Energy research Centre of the Netherlands): http://www.ecn.nl/phyllis

Sun Grant Bioweb: http://bioweb.sungrant.org/

Sun Grant Initiative: http://www.sungrant.org/

U.S. Department of Energy | Energy Efficiency and Renewable Energy | Biomass Program: http://www1.eere.energy.gov/biomass/

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