Winter Barley Ethanol and Other New Advanced Biofuels

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Number of Ethanol Plants, Locations, and Their Capacities as of 9/30/2010

204 Plants with 13.8 Billion Gallons Capacity

Plants under Construction will Provide another 0.8 Billion Gallons

Total Capacity When Completed = 14.6 Bil. Gal.

14.6 Billion Gallons meets about 10% of our total transportation fuel needs!

Corn is Still the #1 Feedstock

Source: RFA
The 2007 Energy Independence and Security Act Requires Aggressive Increase in Advanced Biofuels!

*Advanced biofuels* is renewable fuel other than ethanol derived from corn starch that is derived from renewable biomass, and achieves a 50 percent greenhouse gas (GHG) emissions reduction (compared to gasoline).
How will we meet these goals?

→ **Cellulosic Ethanol**
  - Outstanding Potential
  - Uses Non Food Feedstocks
  - Still Major Research Challenges to Solve
  - Still 5-10 years away from commercial viability?

→ **Pyrolysis and Gasification-Based Bio-Fuels**
  - Outstanding Potential
  - Uses Non Food Feedstocks
  - Still Major Research Challenges to Solve
  - Still 5 years away from commercial viability?
Is There a Simpler Way?

Wouldn’t it be great if there were another feedstock we could use right now to make Advanced Biofuels?

- One that we could convert to “low-carbon” fuel ethanol and valuable food and feed products
- One that wouldn’t compete with food crop production
- One that wouldn’t harm the environment
There is Such a Crop and it is Winter Barley!

These “barley belts” can provide feedstock for ethanol plants outside the corn belt where transportation fuels and economic development are needed!
Why Winter Barley For Fuel Ethanol?

- Provides feedstock for ethanol plants outside the Corn Belt
- Farmers on the East Coast and other areas with mild winters can grow barley as a winter crop, allowing double cropping with soy followed by corn the next year! (3 crops in 2 years – More grain on same acreage)
- Winter barley is grown on “fallow ground” and doesn’t compete with food production thus there are no Indirect Land Use Change effects.
- Winter barley acts as a cover crop, preventing soil and nutrient losses to the environment- this is critical for sustainability of soil and water. Especially important for the Delaware and Chesapeake Bays.
- Higher protein and digestible amino acids than corn, especially lysine means that barley DDGS should sell at a premium relative to other grain DDGS.
Major Challenges with Barley for Ethanol Production in 2001

- Abrasive nature of hull – destructive to grain handling and grinding equipment

- Low starch content (~50-55%) compared to corn’s (~70%) – results in low ethanol yields plus too much fiber

- High viscosity of mash due to beta-glucans – makes ethanol production difficult and expensive and limits the feed use of the ethanol co-products, DDGS to primarily ruminant animals
ERRC/ARS Created A Barley Research Program to Solve These Technical Issues

- Working with breeders at Virginia Tech to develop better hull-less and hulled barley with high starch content for fuel ethanol production. (Griffey, C. et al. Journal of Cereal Science. 51: 41–49. 2010.)

- Developing dry fractionation and other processes to separate barley grain into fermentable and non-fermentable fractions and coproducts. (Flores, R.A., et al., Cereal Chem. 82(6):727-733. 2005.)

- Working with Genencor, A Danisco Division to develop new enzymes to reduce viscosity, increase ethanol yield, and develop energy saving fuel ethanol processes.
We Discovered How to Completely Hydrolyze β-Glucans and Simultaneously Increase Ethanol Yields

Our studies showed that complete conversion of β-glucan to glucose can be achieved when we also add another key enzyme, β-Glucosidase.

What are the benefits of this?
- Additional Viscosity Reduction
- Additional Glucose Produced is Fermented to Ethanol, Increasing Yields

This is What Provides the “Edge” to the Barley EDGE Process
Barley EDGE* Process
*Enhanced Dry Grind Enzymatic


Pre-liquefaction

Milled Barley

Evaporation condensate

Steam

58 - 60°C
60 min

SPEZYME® Xtra

OPTIMASH™ BG

OPTIMASH™ TBG

Fresh water

Liquefaction

85-90°C
pH 5.2

FERMENZYM® L-400

SSF

8-β-gluco-sidase

Urea

SSF

Barley EDGE* Process

Thermochemically Derived CoProducts

Conversion of Barley Hulls, Straw, and DDGS by Pyrolysis can yield valuable Bio-Oil and Bio-Char

Hulls, Straw, DDGS

Green Gasoline and Diesel

Bio-Oil and Bio-Char

Improves soil fertility and sequesters carbon


Osage Bio Energy is Turning a Vision into a Reality by Building the First Winter Barley Ethanol Plant in Hopewell Virginia!
Growing winter barley for ethanol feedstock does not compete with food production and it actually improves soil and water quality!

High starch fractions (high-protein, high-Tocol, high-β-glucan) for health-promoting, obesity-fighting, foods and nutraceuticals

High fiber (hulls) and straw from barley can be used to make cellulosic ethanol and pyrolysis oil for producing “green” transportation fuels.

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First US Winter Barley Ethanol Facility