
United Soybean Board Life Cycle Profile
U.S. SOY DELIVERS ENVIRONMENTAL & ENERGY BENEFITS
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www.soybiobased.org

TODAY'S SPEAKERS

John Cooper, United Soybean Board Director and Member of the Domestic Marketing Committee. John is a soybean farmer from Wynne, Arkansas

James W. Pollack, Omni Tech International, Ltd Environmental Business Manager

Don Scott, National Biodiesel Board Director of Sustainability

Bob Moffit, Ashland Performance Materials Product Manager

Shelly West, BioBased Technologies® Sales Manager, Polyols

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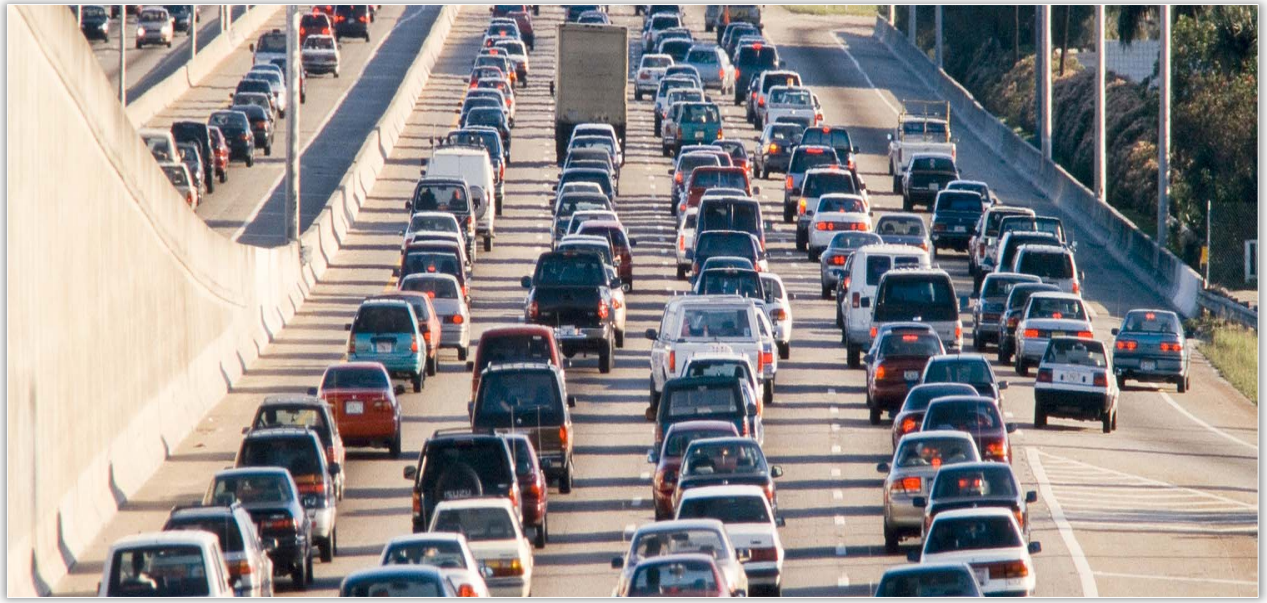
Key Findings on Soybean Production and Processing

As soybeans grow, they remove greenhouse gases from the atmosphere. The **3.36 billion bushels of soybeans grown in the United States in 2009 removed the carbon equivalent of taking 21 million cars off the road** when the figures are computed using the Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator.



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Key Finding
Soybean Yields Rising

The average soybean yield for 2004-2007 was 42.3 bushels per acre – a 12 percent increase over the data (1998-2000 average) used in the current U.S. Life Cycle Inventory database.

This is consistent with other analysis that found plant breeders have succeeded in increasing the yield potential of soybeans by an average of 0.41 bushels/acre per year for the past 35 years. Meanwhile, plant breeding companies anticipate new soybean varieties will allow farmers to increase soybean yields by 40 percent in the next decade.

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Key Findings Continued

The calculated release of nitrous oxide (N2O), a greenhouse gas, is 85% less than the data contained in the current U.S. Life Cycle Inventory Database due to a corrected emission factor issued by the International Panel on Climate Change (IPCC) in 2006.

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Key Findings Continued

The updated data show approximately 20% less direct energy used in soybean farming due to reduced diesel and gasoline usage

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Key Findings Continued

Soybean processing facilities reduced their energy consumption by 45% compared to 1998 data.

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CRADLE TO GATE

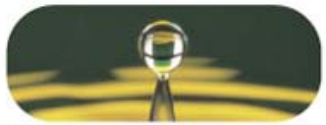
< Farmer to Product >

Soybean Farming

Soybeans

Soybean Processing

Crude Soybean Oil (20%)



Soy Oil Refining

Soybean Oil

Human Food

Industrial Soy Lubricant Base Stock

Soy Lubes

Lubricants for Heavy Equipment, Two-Cycle Engines and More

Transesterification

Methyl Soyate

Biodiesel, Cleaning Products, Hand Lotions, Paint Strippers and other Solvents

Soy Polyol Production

Soy Polyol

Insulation, Foam for Cars, Furniture Cushions and Carpet Backing

Soy Resin Production

Soy Resin

Vehicle and Equipment Exterior Panels

Soybean Meal (80%)

Animal Feed

Human Food

Industrial Soy Lubricant Base Stock

Soy Lubes

Lubricants for Heavy Equipment, Two-Cycle Engines and More

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Soy Resin Production

Soy Resin

Vehicle and Equipment Exterior Panels

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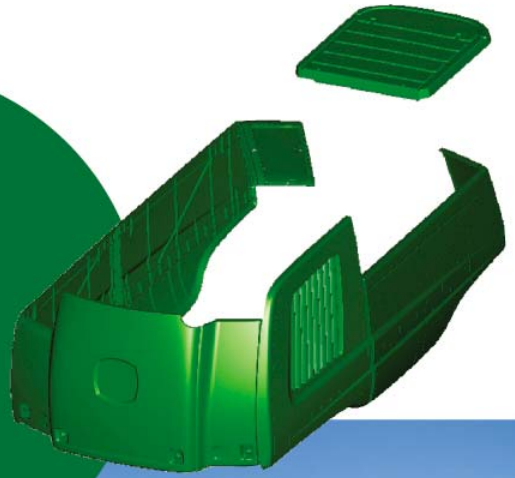
Soy Resin



Vehicle and Equipment Exterior Panels

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Soy Polyol

**Insulation,
Foam for Cars,
Furniture Cushions,
Carpet Backing**

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Soy Lubes

Lubricants for Heavy Equipment, Two-cycle Engines and more

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Peer Review

The entire project was peer reviewed in accordance with International Organization for Standardization (ISO) 14040/44 Life Cycle Requirements.

Peer Reviewers included:

- **Dr. Martin Patel of Utrecht University**
- **Michael Levy of the American Chemistry Council**
- **Dow Chemical**
- **BASF**
- **Bayer**
- **Center for Polyurethane Industry (ACC)**

Omni Tech International, Ltd conducted the study for the United Soybean Board. Four Elements Consulting, LLC performed the life cycle assessment modeling.

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Sources of Information

- U.S. Department of Agriculture and Ag Research Service Lab—agriculture and process data
- National Oilseed Processors Association (NOPA) mass balance for soybean crushing (50/60 plants-83%)
- National Biodiesel Board (NBB) mass balance for biodiesel production (37% plants reporting)

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Boundary Conditions and Methodology

- Cradle-to-Gate
- Transportation Included
- Packaging Excluded
- Functional Unit of 1,000 kg of product
- Mass allocation for baseline analysis
- Economic allocation to assess sensitivity

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Boundary Conditions and Methodology (cont.)

- LCA model built in Sima Pro 7
- Material data from U.S. Life Cycle Inventory Database, EcoInvent and SimaPro
- Building for Environmental and Economic Sustainability (BEES) impacts used for Life Cycle Impact Assessment
- Carbon sequestration included

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Product Impact Results

- Shows environmental and energy benefits of soybean-derived feedstocks
- Reduced greenhouse gas emissions
- Lower fossil fuel depletion

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Current Activities

Continue to monitor soy agriculture practices

- **Conservation Technology Information Center**
- **U.S. Department of Agriculture – Agricultural Research Service**
- **Discussions with farmers**

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Sound Benefits

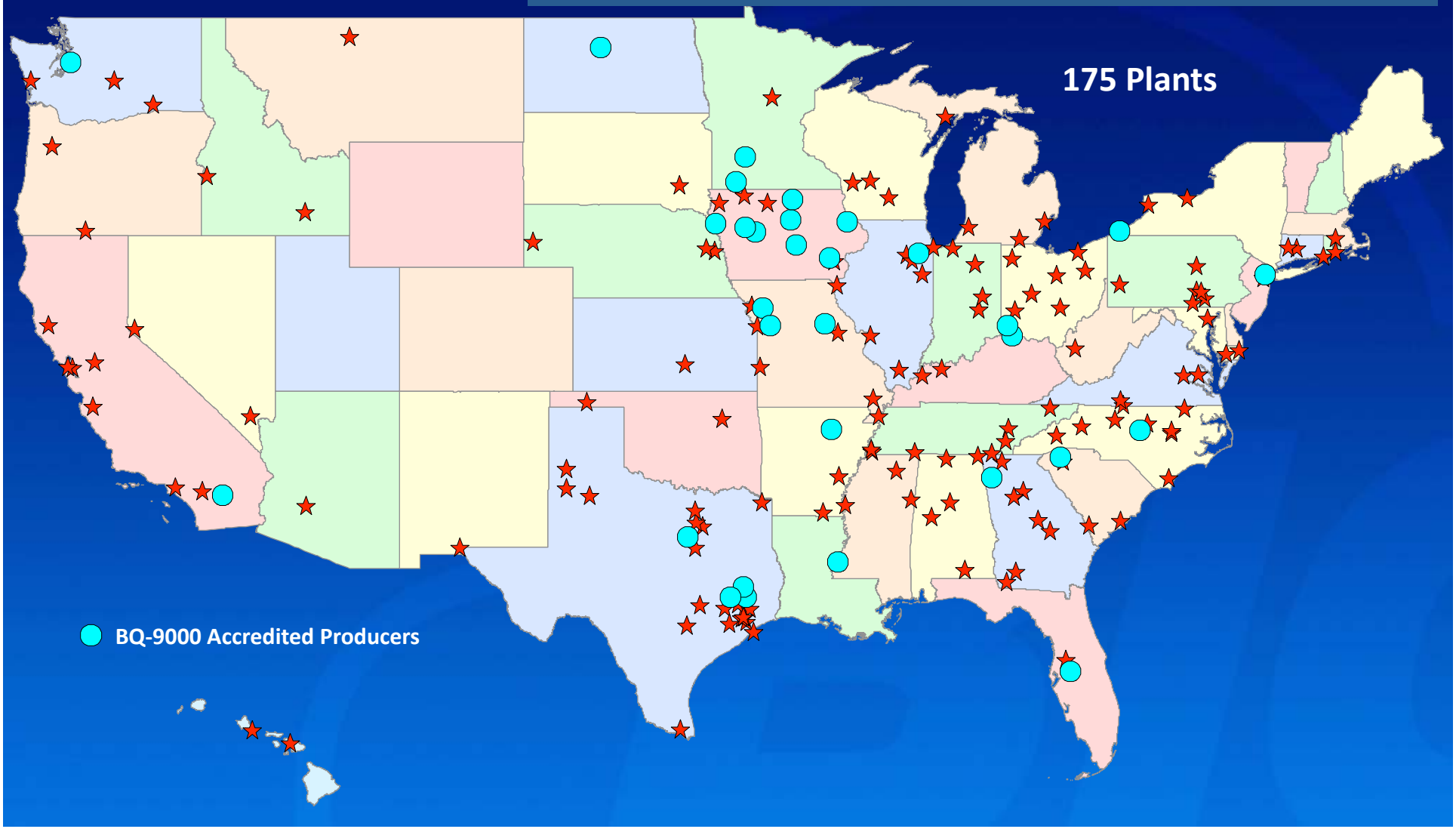
- Renewable
- Domestic
- Energy Efficient
- Clean
- Safe

- Better than ever
- Continues to improve

photo courtesy of 1998 USDA/DOE Lifecycle Inventory

Production Locations (9/17/08)

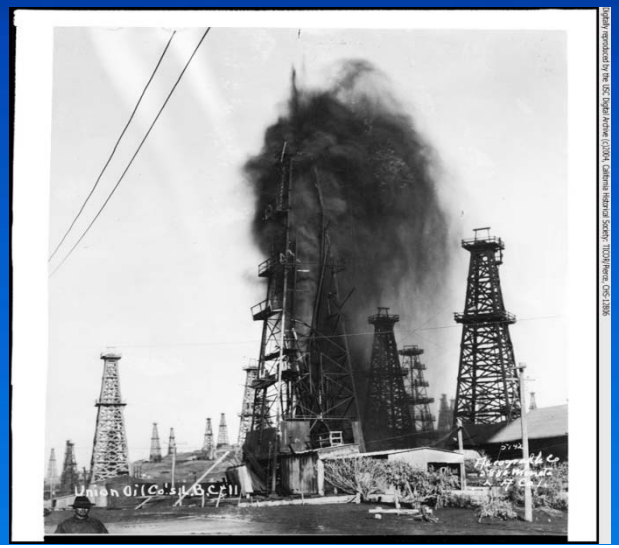
Production Capacity 2.55 billion gallons per year



BIODIESEL Lowers Tailpipe Emissions

Emission Type	B100	B20	B2
Total Unburned Hydrocarbons	-67%	-20%	-2.2%
Carbon Monoxide	-48%	-12%	-1.3%
Particulate Matter	-47%	-12%	-1.3%

vs.



Survey Results

	Energy Use
Electricity (Kwh/gal)	0.12
Natural Gas (SCF/gal)	2.69

Sound Benefits

- Renewable
- Domestic
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photo courtesy of 1998 USDA/DOE Lifecycle Inventory

ENVIREZ® Resins

- Ashland developed the first commercially available biobased unsaturated polyester resin in 2003
  - ENVIREZ 1807 was developed at the request of the United Soybean Board and John Deere
  - The initial applications were tractor and combine side panels

- Ashland continues to invest in the research and development of green resins
  - Commercial products using biobased materials are now available for most composite fabrication processes
  - Ashland designates resins formulated with recyclable and/or renewable raw materials with the ENVIREZ brand

Value Proposition for Green Products

- Stewardship
  - Individuals and some organizations transition to “greener” products and processes because of the environmental, social and sustainable benefits of these products.

- Initiatives
  - Government and Industry Initiatives are developed to capture the stewardship benefits from a larger population segment. These initiatives often have economic benefit to one or more members within the supply chain.

Stewardship

ENVIREZ Resins

PRODUCT NAME	Fabrication Process	Product Example	Bio Content	CO_2	Energy	Reference
ENVIREZ 1807	SMC/BMC	Combine Panel	18	-0.91	-2600	(1)
ENVIREZ 70301	Pultrusion	Window Frame	22	-0.35	-3800	(2)
ENVIREZ L 86300	Laminating	Boat Hull	12	-0.19	-2100	(2)
ENVIREZ LF 80630	Laminating	Shower Unit	20	-0.62	-5300	(1,3)
ENVIREZ 86400 INF	Infusion	Furniture	12	-0.19	-2100	(2)
ENVIREZ Q 11500 INF	Infusion	Surface Parts	9	-0.45	-800	(1)
ENVIREZ SS 70419	Casting	Counter Top	18	-0.28	-3100	(2)
ENVIREZ MR 80220	Casting	Sinks	20	-0.31	-3400	(2)

- Bio Content: The percent, by weight, of the total raw material charge
- CO_2: The CO_2 contribution, in pounds per pound of resin, vs a standard petrochemical based equivalent
- Energy: The energy consumption, in BTU/Lb resin, vs a standard petrochemical based equivalent.

References apply to CO_2 and ENERGY

(1) Based on product life cycle assessments by Omnitech International

(2) Based on cradle to gate life cycle assessment of raw material component(s) on a design basis provided by DuPont Tate & Lyle.

(3) Based on energy and CO2 data provided by raw material supplier

ASHLAND

Stewardship

Examples from above table

Compared to similar use petroleum based polyester resin:

ENVIREZ® 1807 Resin

CO_2: A 40,000 lb tank wagon

Reduces 36,400 Pounds of CO2

ENVIREZ® 1807 Resin

Energy: A 40,000 lb tank wagon

Saves 104 Million BTU

Equal to 17 Barrels of Crude Petroleum

ASHLAND

Initiatives

- Fabricated composites can be preferentially selected when they meet requirements of government and industry initiatives, such as:
  - USDA Biopreferred
  - Green Globes
  - LEED

- Ashland is helping our Customers understand how their products meet the requirements of these programs.

Green Globes

USDA United States Department of Agriculture BioPreferred℠

U.S. GREEN BUILDING COUNCIL USGBC

ASHLAND

BioBased Technologies®

We enable sustainability.®

BioBased Technologies ▪ Agrol® Polyols

- Using a unique chemical process, BioBased Technologies® manufactures a polyol for use in polyurethane applications:
- Range of functionalities allows for a unique application flexibility
- Qualities such as low acid number, mild odor, and light color make it ideal for replacement of petroleum-based polyols

Extraction & Refining →

Soybean Oil

BBT Process →

Agrol♦

PU Formulation →

Environmental Benefits of Agrol® Polyols

High Biobased Content

Biobased content = 96% (ASTM D6866)

Low VOC Emissions

Total VOC emission factor = <40 (µg/kg)/hr

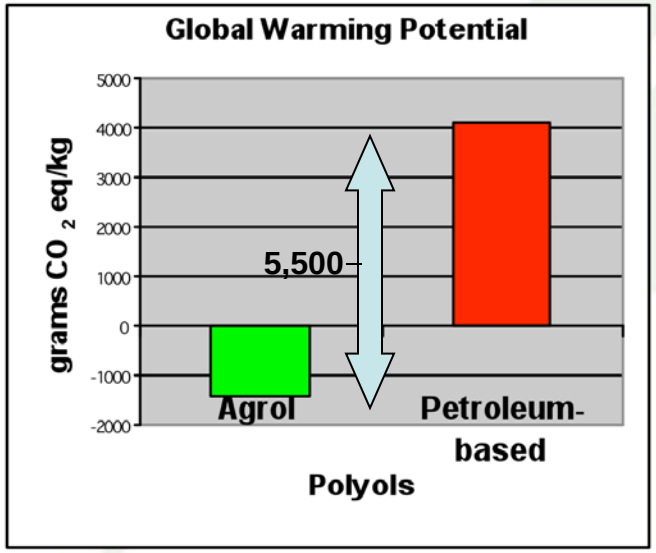
Formaldehyde emission factor = BQL (below quantifiable level)

ASTM D5116

Environmental Benefits of Agrol® Polyols

Agrol® polyols help lower your Carbon Footprint

5.5 pounds of carbon dioxide equivalents are removed or prevented from entering the atmosphere for every pound of **Agrol®** that replaces a pound of petroleum-based polyether polyol*



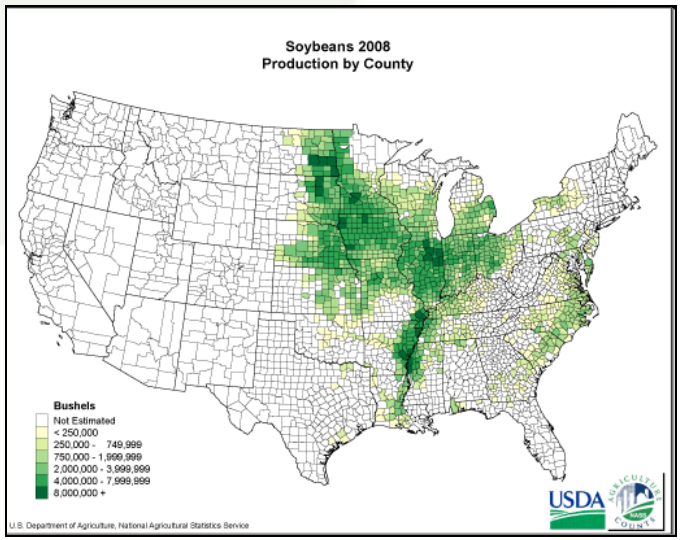
Agrol® polyols have lower GWP

Agrol® has a Global Warming Potential of -1,400 gm CO2 eq/kg compared to petroleum-based polyols resulting in 4,100 gm CO2 eq/kg*

***This data is from a 3rd party, cradle to gate Life Cycle Analysis (LCA) of Agrol® Polyols by Omni Tech International.

Market Drivers for Agrol® Polyols

- Agrol® is a value-added portion to final products
- Quantifiable environmental, social & economic impact:
  - Qualification for USDA Biopreferred purchasing program
  - Lower carbon footprint for the customer and manufacturer
  - Reduced dependence on petroleum-based products
  - Sustainable feedstock, made in U.S.A.
  - Improved air quality emissions



Questions?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FOR MORE INFORMATION

Go to www.soybiobased.org to download documents related to the New Life Cycle Profile for Soy Products
or contact Karen Coble Edwards
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