

# Biobased Greases and Lubricants: From Research to Commercialization

Biomass R&D Technical Advisory Committee



Dr. Lou A.T. Honary  
Professor and Director  
National Ag-Based Lubricants (NABL) Center  
University of Northern Iowa

# *The University of Northern Iowa*



[www.uni.edu](http://www.uni.edu)

# ***UNI-NABL Center***

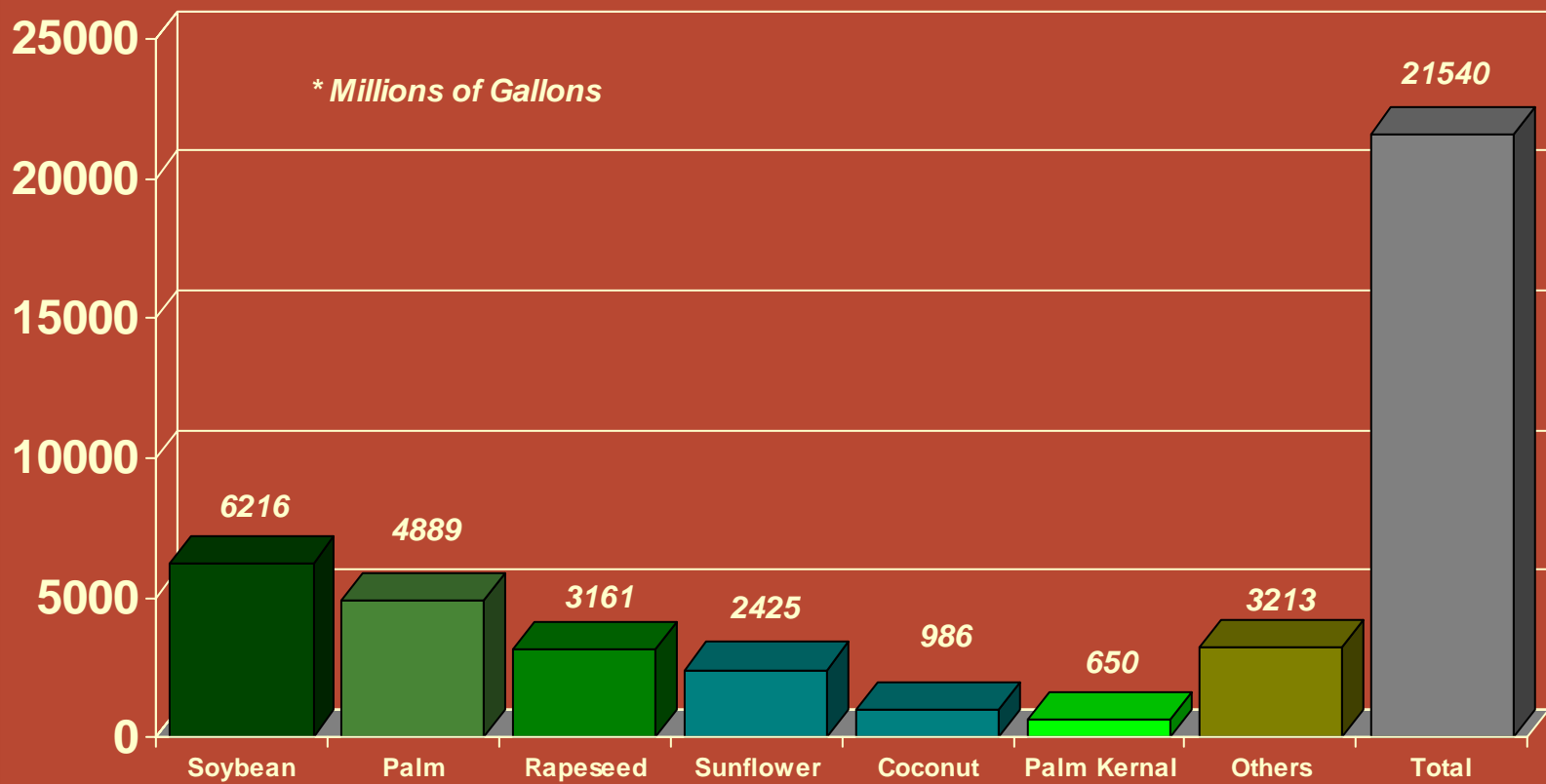


[www.uni-nabl.org](http://www.uni-nabl.org)

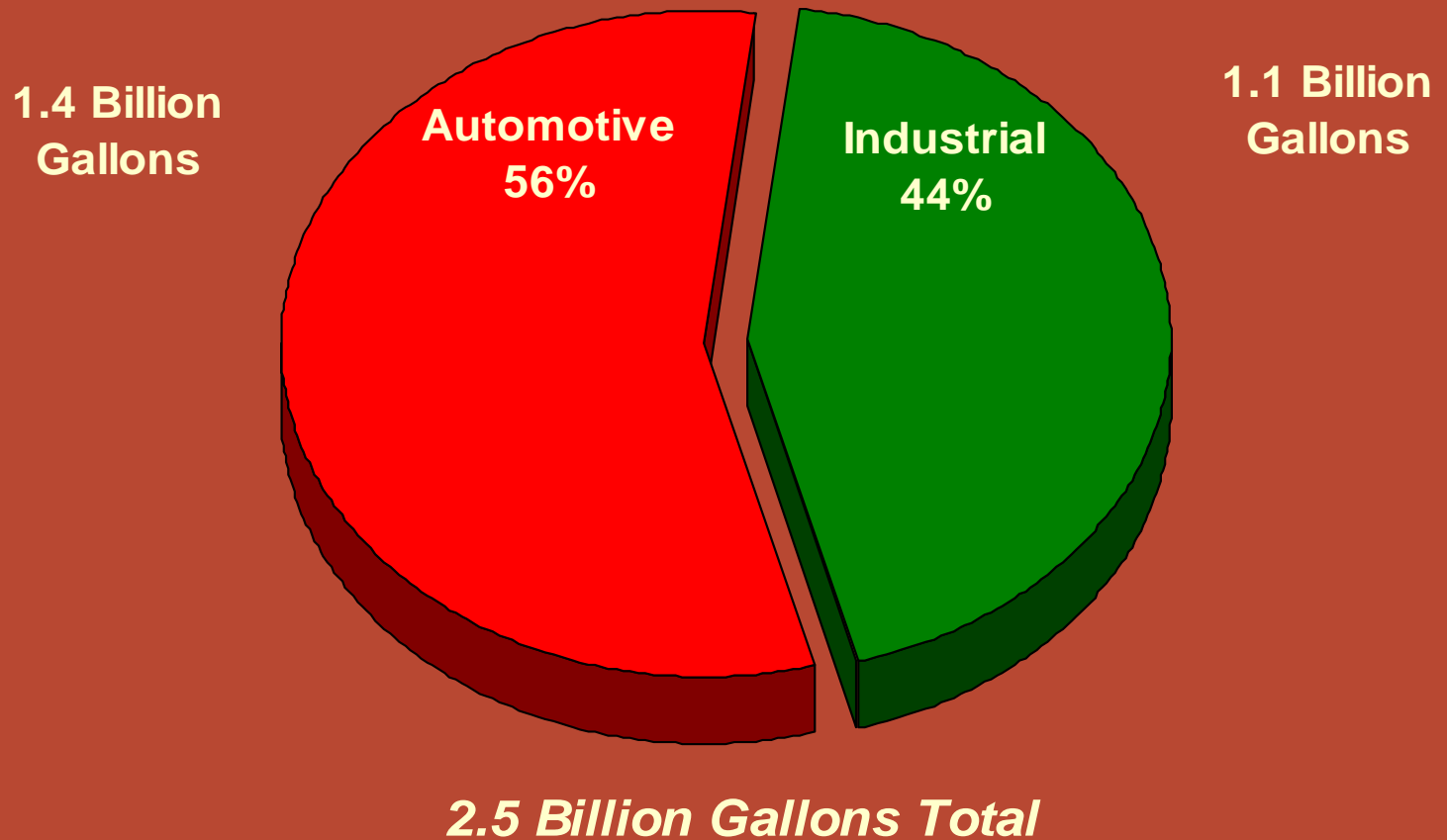
# Outline

- ***UNI-NABL:***
  - Background and History
  - Recent Activities and Future Endeavors
- ***Market Opportunities***
  - Lubricant Sales and Usage
  - The Effect of Biofuels
- ***Government Influence on the Biobased Products Industry***
  - State Initiatives (Iowa)
- ***Commercialization of Biobased Lubricants***
  - UNI-NABL Experience
  - Price Comparison with Petroleum Products
- **Conclusions**

# Problem: Excess Capacity



# Opportunity: \$20 Billion



# UNI-NABL History

- 1991: Formed as a Research Project



- 1995: Expanded into the Ag-Based Industrial Lubricants (ABIL) Research Program



- 2000: Commercial Spin off to market products

# Research and Development Work

- 7 patents or joint patents
- Proprietary formulations
- Numerous publications including a book chapter:  
Mercel-Dekker (2000): Handbook of Hydraulic Fluid Technology
- First multi-season grease
- First biobased stick lubricant
- Patented soybean oil based transformer fluid
- Patented soy based wood preservative



# UNI-NABL History

UNI-NABL

Growers et al.



**SoyDiesel**

(SoyLube is a sister product to Soydiesel)

## UNI-NABL History: 2006 - 2011

### 4th Five years: Transition to a National Center and Continuation of Market Advocacy

- Expanded scope to include all lubricants
- *Applied* biolubricants research and field testing
- Testing and technical support resource for the biobased and biofuels industry
- Participation in standard-setting committees
- Continued publications and presentations



# UNI-NABL Today: 2006-Present

Provide Overall Support for the Growing U.S. Biobased Industry

## ***Mission:***

To provide a national focus for research and technology transfer activities that creates and nurtures the commercialization of biobased *lubricants* which will expand market opportunities for the agricultural community, minimize environmental impact, and help the United States become more energy independent.

# Advocacy and Promotion





# Advocacy and Promotion



# ***Analytical Lubricants Testing***

*(\$5M equipment acquisition for biolubes and biofuels)*



# ***Analytical materials testing***

*(\$5M equipment acquisition for biolubes and biofuels)*





# ***Analytical lubricants testing***

*(\$5M equipment acquisition for biolubes and biofuels)*





# ***Friction and Wear Testing***

*(\$5M equipment acquisition for biolubes and biofuels)*

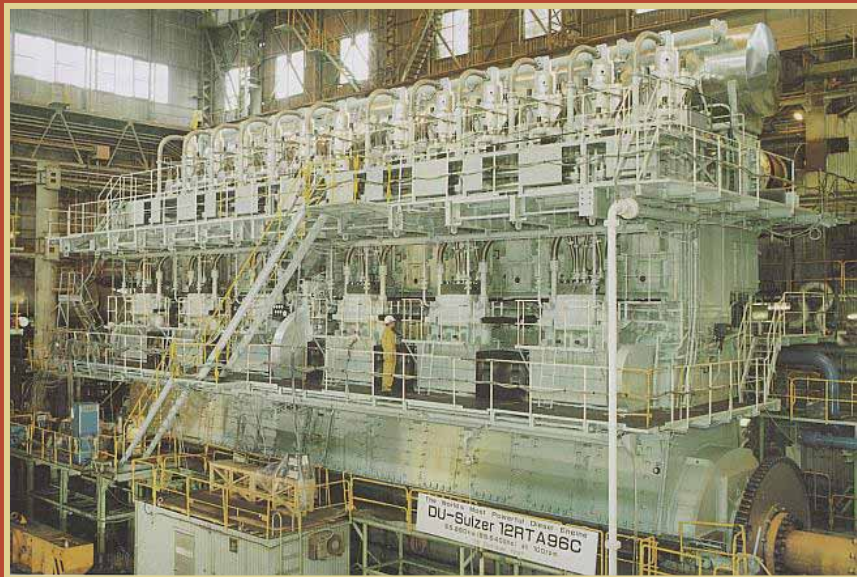


# *Performance Testing*

*(\$5M equipment acquisition for biolubes and biofuels)*



# UNI-NABL Future



***Diesel Engine Oils***

# UNI-NABL Future

*SoyDiesel*  
*Ethanol*



*Fuel and Injector Research*



# UNI-NABL Future



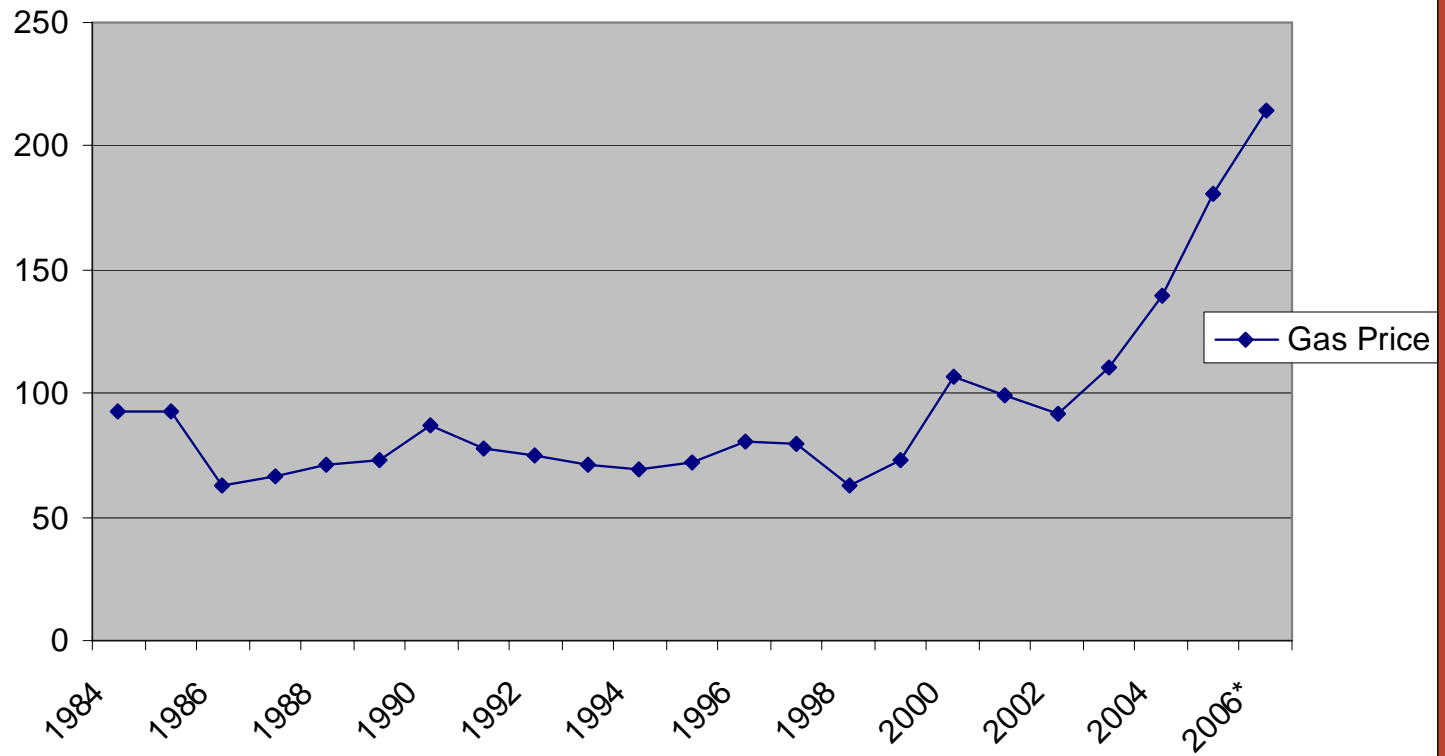
*Research the Use of Specialty Crops for  
Industrial Lubricants*

# Market Statistics



# Petroleum Demand: Gasoline Prices

Average Annual U.S. Gasoline Price to End-Users 1984-2006  
(Source: DOE, EIA)



# **Governmental Focus on Biobased Products in the U.S.**





# Factors Affecting the Success of Biobased Products

- ◇ Demand for petroleum
- ◇ Farmers Investments
- ◇ Federal Initiatives
- ◇ State Initiatives
- ◇ Technology Advancement

# ***USDA Recently Designated Biobased Products – BioPreferred***

<http://www.biobased.oce.usda.gov/fb4p/>

1. Hydraulic Fluids for Mobile Equipment
2. Urethane Roof Coatings
3. Water Tank Coatings
4. Diesel Fuel Additives
5. Penetrating Lubricants
6. Bedding, Bed Linens & Towels
7. Adhesive & Mastic Removers
8. Insulating Foam for Wall Construction
9. Hand Cleaners & Sanitizers
10. Composite Panels
11. Fluid-Filled Transformers
12. Biodegradable Containers
13. Fertilizers
14. Metalworking Fluids
15. Sorbents
16. Graffiti & Grease Removers
17. Two-Cycle Engine Oils
18. Lip Care Products
19. Biodegradable Films
20. Hydraulic Fluids for Stationary Equipment
21. Equipment
22. Biodegradable Cutlery
23. Glass Cleaners
24. Greases
25. Dust Suppressants
26. Carpets
27. Carpet & Upholstery Cleaners

# DOE – USDA: Biomass Research and Development Technical Advisory Committee

([www.brdisolutions.com](http://www.brdisolutions.com))

## *Vision Goals:*

	Units	2000	2004	2010	2015	2020	2030
<b>Biofuels</b>	Market share (%)	0.7	1.2	4.0	6.0	10.0	20.0
	Consumption (billion gasoline-equivalent gallons)	1.1	2.1	8.0	12.9	22.7	51.0
<b>Biopower</b>	Market share (%)	3.0	3.0	4.0	5.5	7.0	7.0
	Consumption (Quadrillion Btu)	2.0	2.1	3.1	3.2	3.4	3.8
<b>Bioproducts</b>	Production (billion lbs)	12.8	17.6	23.7	26.4	35.6	55.3

# State Initiatives

## Iowa Efforts

- ★ **Senate File 2185 (1998)**

Purchasing preference for soy hydraulic oils.

- ★ **Senate File 2249 (2000)**

Amended SF 2185 to include soy lubricants and greases.

- ★ **House File 645 (2003)**

Provides a sales / use tax exemption for purchasers of soy rail lubricants.

# State Initiatives

## Iowa Efforts

### ◇ Senate File (2005)

State Corporate Income Tax Credit \$2.00/gallon up to 2000 gallon per company for switching to soy based METALWORKING FLUIDS.

### ◇ Senate File (2006)

State Corporate Income Tax Credit of \$2.00/gallon up to 20,000 gallons per company for switching to soy based TRANSFORMER Oil.

# Characteristics and Compositions of Vegetable Oils

*Vegetable Oils as Base Oils*



# Advantages of Vegetable Oils

- **Naturally Better Lubricant**
- **Better Viscosity / Pressure Performance**
- **Superior Thin Film Strength**
- **Excellent Viscosity Index**
- **Lower Volatility**
- **High Flash / Fire Points**

# Disadvantages of Vegetable Oils

- **If Untreated, Lack Oxidative Stability**
- **If Untreated, Have High Pour Points**
- **Generally More Expensive than Petroleum?????**





# ***Commercialization Pitfalls***

- **Oxidation breakdown**
- **Polymerization of the oil**
- **Long term performance issues**



# Oxidation of Vegetable Oils (Naturally)





# Oxidation of Vegetable Oils (Naturally)





# Oxidation of Vegetable Oils

(in machinery)



ASTM D2271 Pump Test

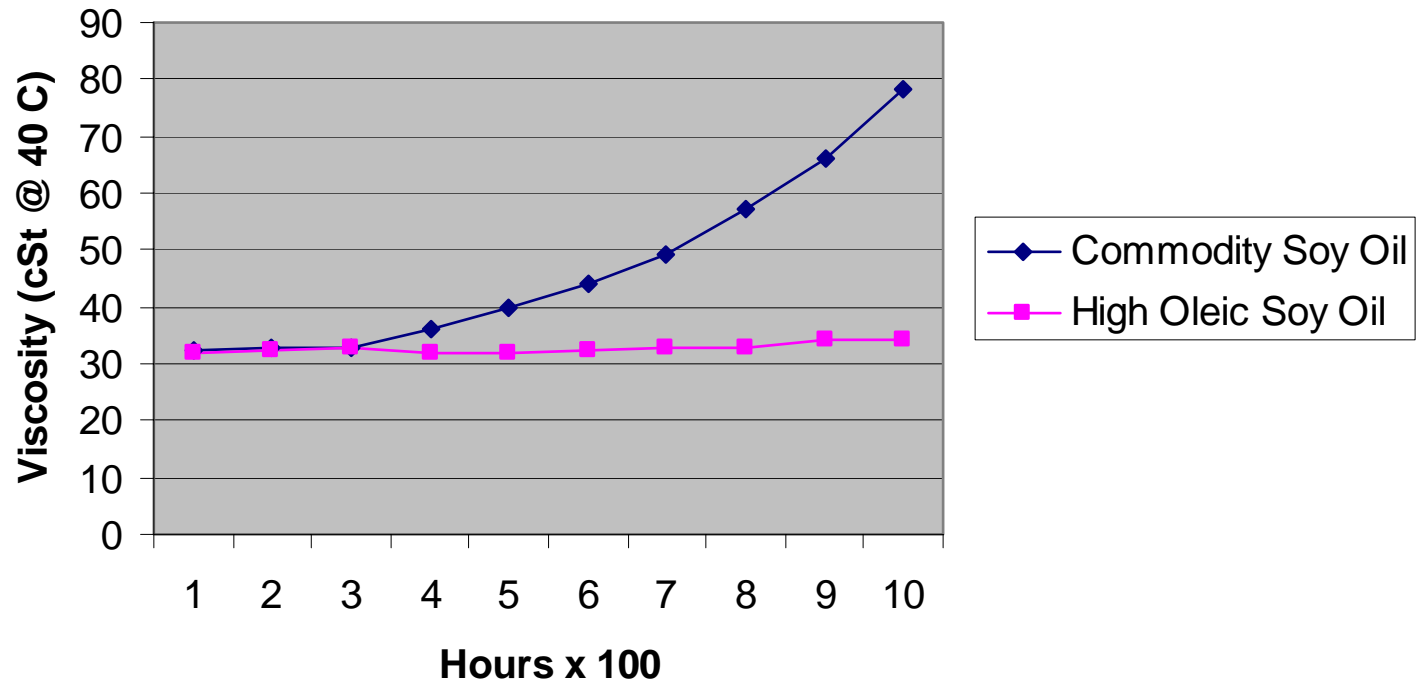




# Oxidation of Vegetable Oils

(in machinery)

Viscosity Change in ASTM D-2271



Viscosity chart in 1000 hour pump test



# Oxidation of Vegetable Oils

(by mistake!?!)





# Controlled Oxidation



# Solution Approaches

- *Genetic enhancement of seed oils*
- *Breeding techniques to find new more stable varieties*
- *Advances in chemical modification techniques*
- *Better or improved additive technologies*



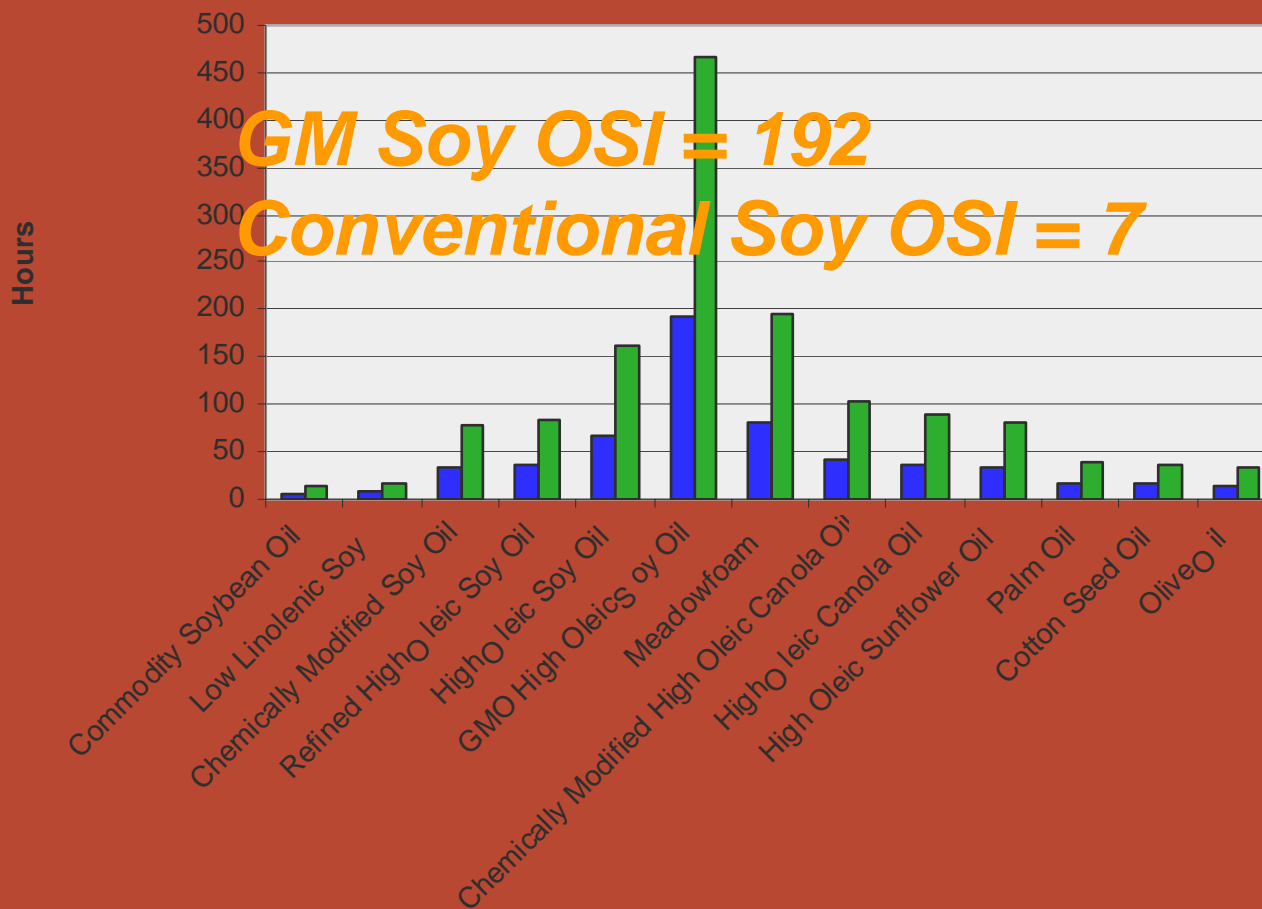
# Oxidative Stability Instrument



# OSI Comparisons

Oxidative Stability Index and Active Oxygen Method

■ OSI Values (hours @ 110 C)  
■ AOM Values (hours @ 97.8 C)



# Continued Comparisons

Test	Mid-Oleic/1% Linolenic Results	Ultra Low Linolenic Results
Pour Point (°C)	-7.0	-7.0
Cloud Point of Transparent Fluids (°C)	-5.0	-5.0
Pensky Marten Closed Cup Flash Point (°C)	282	273
Viscosity Index Calculation	211	223
<b>Oxidative Stability Index (hours)</b>	<b>14.91</b>	<b>9.51</b>
Four Ball Wear Test @ 40 kgf	0.66	0.67
Four Ball Weld (kg)	126	126
Acid Number	0.09	0.08

# Commercialization Efforts

- *Licensing*
- *Sale of Technology*
- *Formation of a Commercial Entity*

[www.elmusa.com](http://www.elmusa.com)





# Challenge: Segregation

Storage and Dedicated Transportation





# The Leading Manufacturer of **Biobased & Biodegradable** Lubricants & Greases



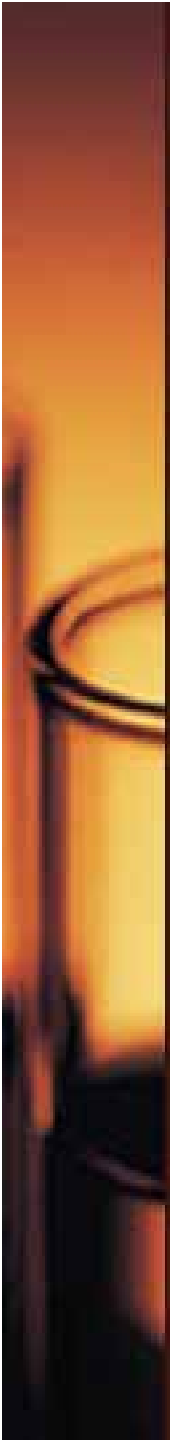
# Commercialization Efforts



# Commercialization Efforts



# Commercialization Efforts



# Commercialization Efforts





# Commercialization Efforts





# Political Recognition



# Other Products

- **Metalworking Fluids**
  - **Straight Oils**
  - **Water Emulsified**
- **Coolants**



# SoyStik™ Stick Lube



# ELM Truck Grease

Crete Carrier Corp. and affiliated companies use soy grease



# ***Price Comparison: Commercialized Biobased Products vs. Conventional***

- **Hydraulic Tractor Fluid: 1.5 – 2x**
- **Food Grade Hydraulic Fluid: 1-1.5x**
- **Industrial Hydraulic Fluid: 1-2x**
- **Chain Saw Bar Lubricants: 1-1.5x**
- **Multi-Purpose Truck Grease: SAME**
- **Soy & Cotton Oil-Based Greases: 1-1.5x**
- **Rail Curve Grease: (0.9) - 1.2x**
- **SoyStik™ Stick Lube: SAME**
- **Metalworking Fluids: 1-1.5x**
- **Gear Lube: 1.5-2x**
- **SoyLubes in Retail: 1-1.2x**

# Inc. 5000

The Fastest Growing Companies in America



Researchers at the University of Northern Iowa created this industrial lubricant from local soybeans. Soybean oil oxidizes in machines, so the professors had to stabilize it through genetic and chemical modification. Amtrak and the Beijing subway grease their rails with the product. And it's an ecofriendly lubricant: When it drips into the earth, bacteria consume it, which rejuvenates petroleumsoaked soil. *Pounds sold in 2006: three million. Price: A 14-ounce tube wholesales for \$1.80; a 2,100-pound container, \$4,100.*



# Soy-canola- bio- Lubes

## Technology is Transferable

ELM Environmental Lubricants Manufacturing, Inc. • Piquette, IA 50586 USA • www.elmusa.com

**Great News!**

**Pollution Prevention SoyLube<sup>®</sup>**  
 BRAND  
**Household Lubricants, Safer, Slicker**  
 SoyLube Biobased Lubrikit for home & workshop








Lubrikit: 7 free ways to use SoyLube  
 Multi-purpose in-home lubricant  
 Grease oil  
 Household appliances, services  
 Motor grease  
 Protect driveline  
 Safe for the whole family

ELM

**Great News!**

**University Research Confirms CanolaLube's Superior Performance**

Leading scientists at the University of Northern Iowa created a line of bio-based grease that outperforms most petroleum products and is offered by Environmental Lubricants Manufacturing Inc. (ELM)

- Renewable, biodegradable
- Canada grown, supports farmers, agribusiness
- Environmentally friendly
- Exceeds industry standards

Created At University of Northern Iowa Ag Based Industrial Lubricants (ABIL) Research Program  
  
 Grown in Canada

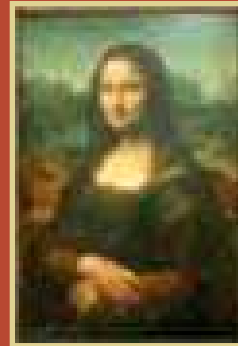
**Pollution Prevention CanolaLube<sup>®</sup>**  
 BRAND  
**Biobased Lubricants & Greases**

- Withstands Extreme Pressures
- Protects Against Wear & Rust
- Extends Equipment Life
- Lasts Longer, Reduces Consumption
- Preserves Healthy Environment

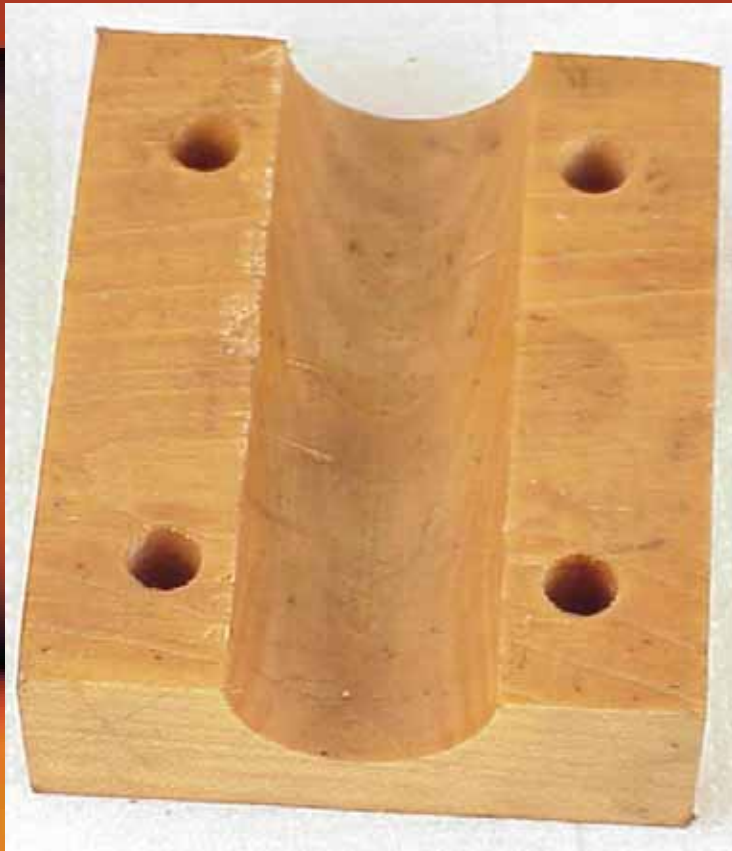
**Great Protection At HIGH TEMPS**

# Problem to Opportunity

1<sup>st</sup> Five years: Addressing Shortcomings of Soybean Oil for Industrial Use

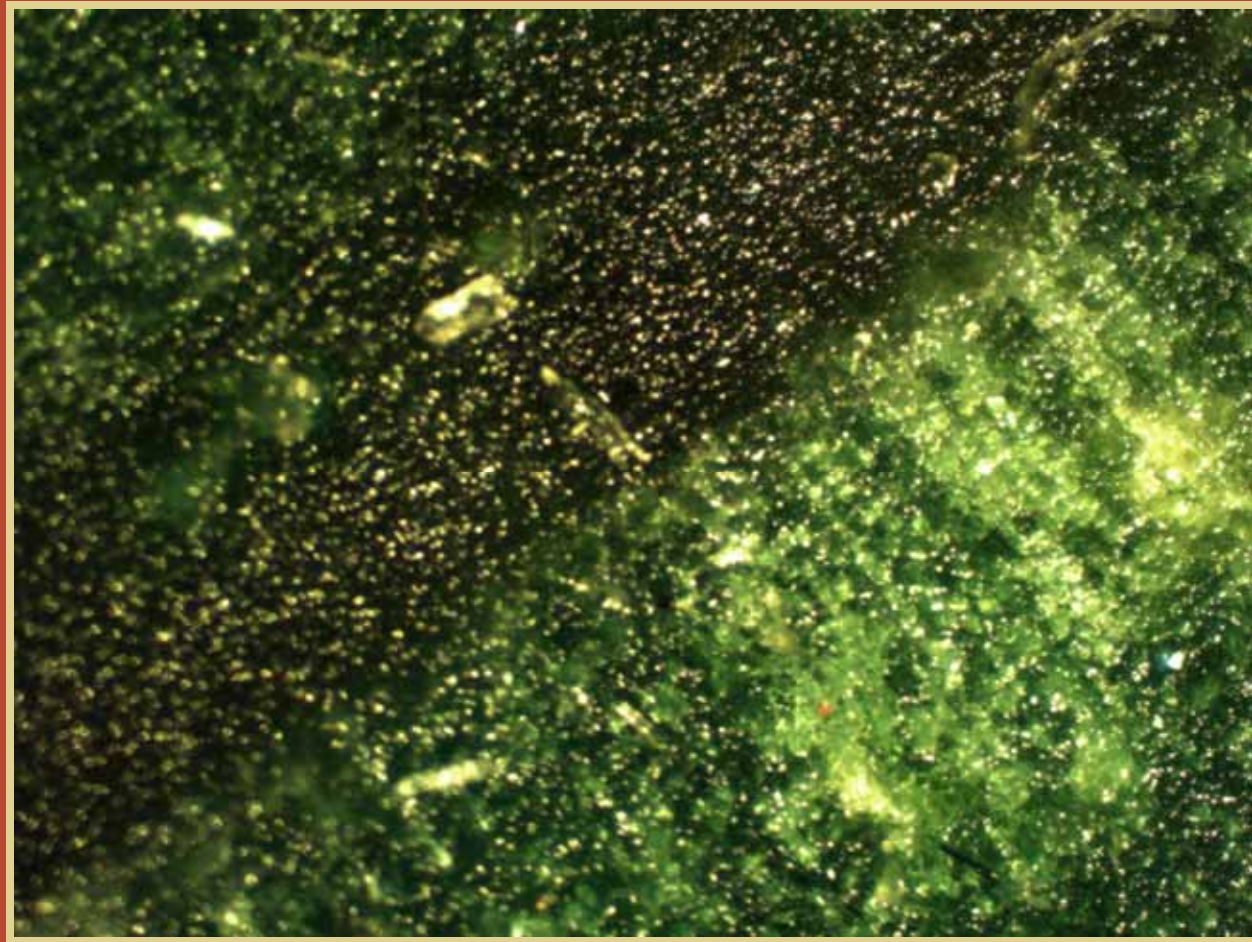


# *Concept Started from Experiments with Wood Bearings*





# Lab Inspection



# Field Test of Bio Oil Impregnated Boards





# Field Test of Bio Oil Impregnated Boards



# Impregnation Process



# Sign Posts – Field Test





# Railroad Ties Field Test



# Wood Preservatives

*Soy based  
creosote substitute  
for posts, ties, and poles*



*SoyTimber™*

*SoyLumber™*





# Summary:

- Biobased products are being recognized as critical to the U.S. economy, national security, and environment.
- Biobased products are being promoted at state and federal levels, and by U.S. growers, the industry and the government.
- Biobased products offer the greatest potential for revitalizing U.S. rural communities; adding-value to commodities.
- Biobased products are building a strong performance history: meeting and exceeding performance specifications and becoming cost competitive.

# Summary:

- Biofuels have created awareness and momentum for biobased products.
- Increase in the price of petroleum due to increased worldwide demand offers opportunity for investment in biobased products.
- In the U.S. the products are being marketed on the basis of economy and performance
- Federal Government uses leadership by example to promote the products.
- Demand for bio products increase economic incentive and advances in seed oil technology.

# Conclusions

- NABL Technology is transferable to other crop oils such as rapeseed oil (and canola oil), sunflower oil, palm oil, and many other vegetable oils
- To increase global use of biobased lubricants, the goal of NABL is to ensure Indigenous crop oils could be used for industrial lubes and grease
- Future research will identify crop oil properties that would be suitable for biobased lubricants and native to given geographic locations



# Thank You!

[www.uni-nabl.org](http://www.uni-nabl.org)