

# A Review of Oleochemicals Processing Efforts at the University of Nebraska

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IAPC website: <http://agproducts.unl.edu>

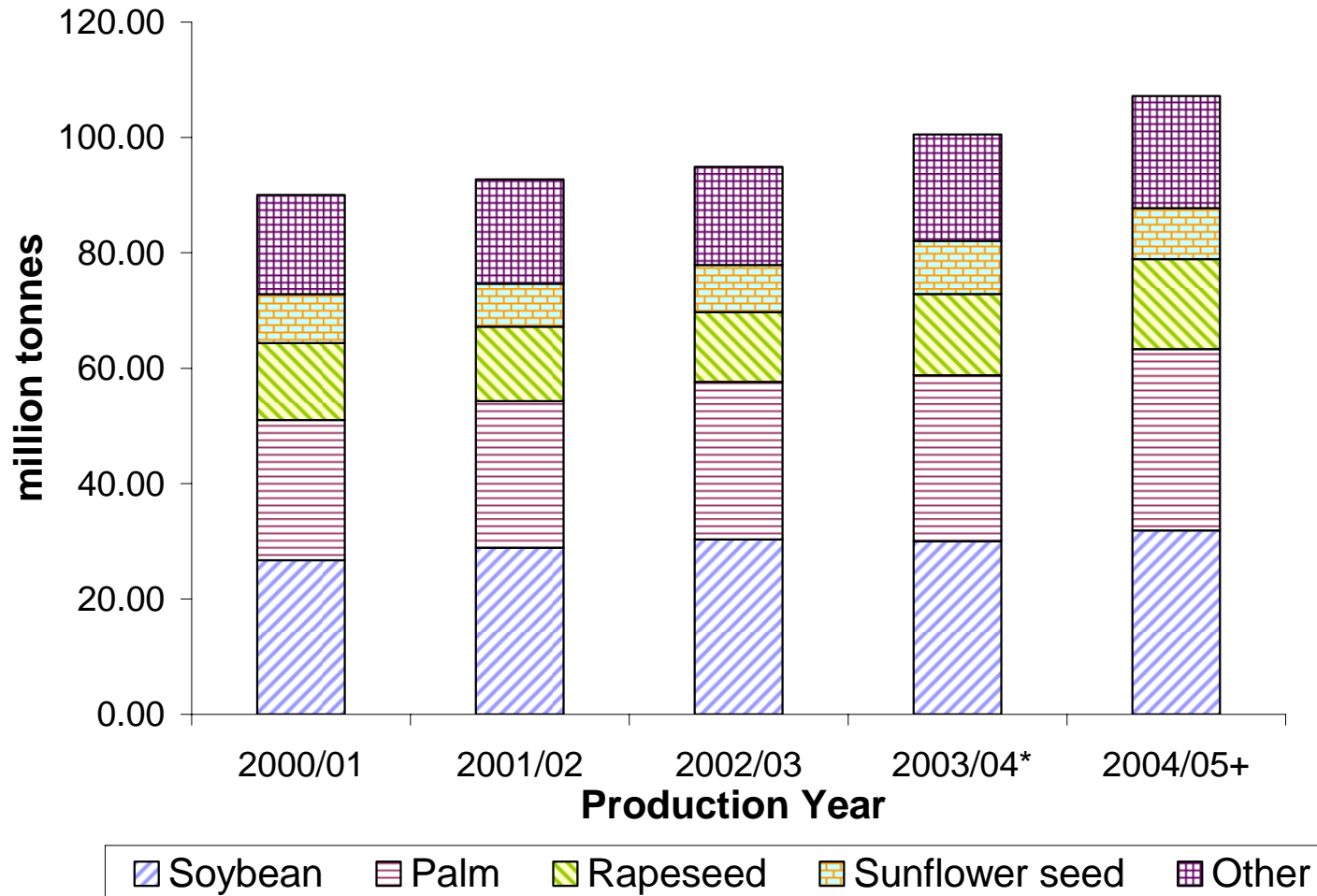
UNIVERSITY OF  
**Nebraska**  
Lincoln



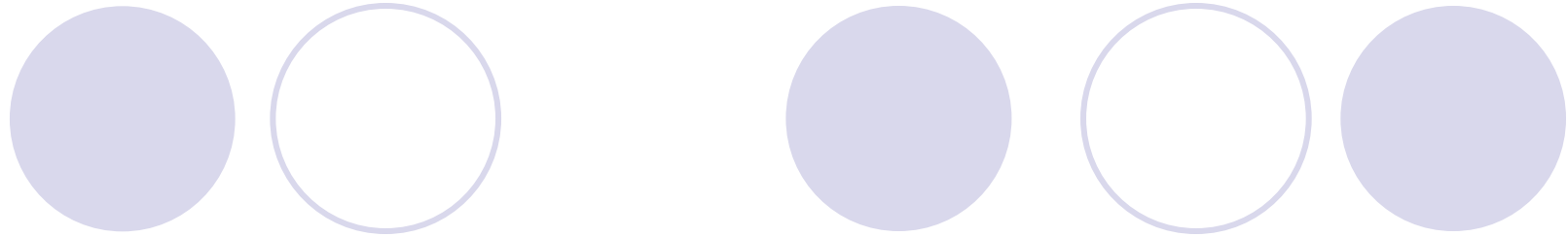
# Reason for Developing Renewable Oleochemical Products

- The increase in crude oil price due to petroleum resource limitations (and other issues);
- Global warming caused by carbon dioxide released from burning fossil fuels; and
- The need of rural economic development.

# Worldwide Vegetable Oil Feedstocks

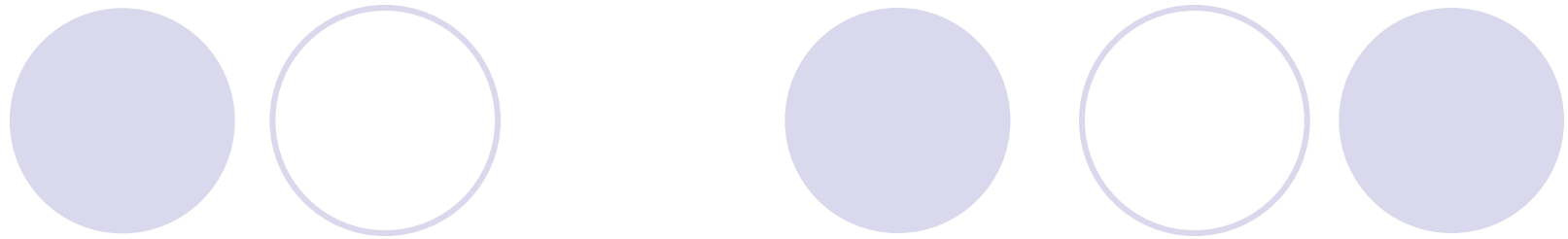


\* Preliminary estimate. + Preliminary estimate as of May 2005.



# Nebraska Feedstock Resources

<b>Potential biodiesel feedstocks available in Nebraska</b>	<b>MGPY</b>	<b>Million pounds</b>
<i>Note: major quantities will still go to traditional applications</i>		<b>per year</b>
crude soybean oil from extrusion expellers	5	40
crude degummed or refined soybean oil from solvent extractors	75	570
refined corn oil from wet mill ethanol plants	45	340
crude corn oil potential from current dry mill ethanol plants	22	169
crude corn oil potential from expanding or developing dry mill ethanol plants	95	720
animal fat from cattle slaughtering	119	908
animal fat from pork slaughtering	27	207
yellow grease from restaurants	1	10
<b>Total</b>	<b>390</b>	<b>2,964</b>

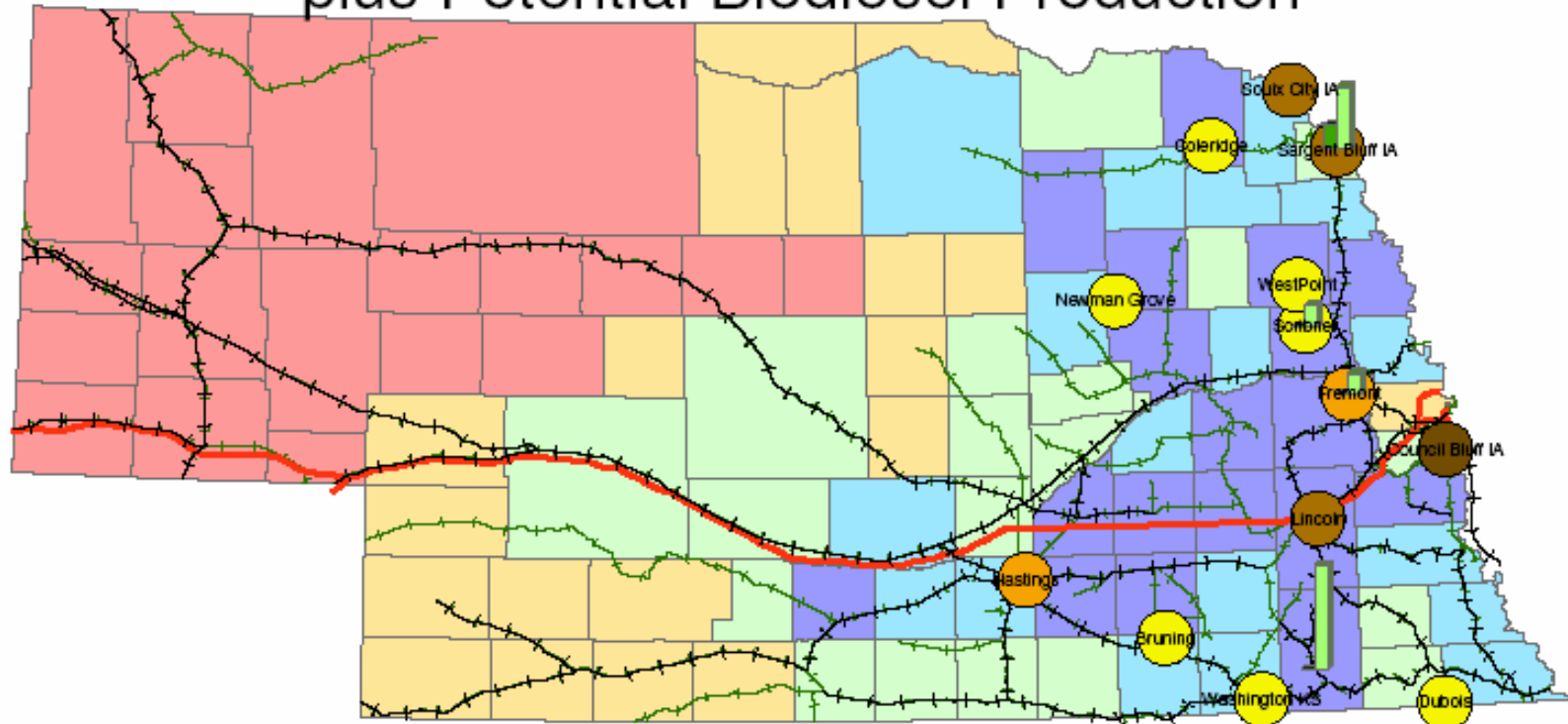


# **Biodiesel Industry Study**

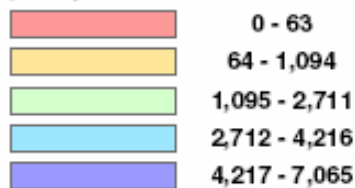
USDA-Rural Development  
Value Added Producer Grant:

“Strategically Locating Soybean and Biodiesel  
Processing Facilities in Nebraska”

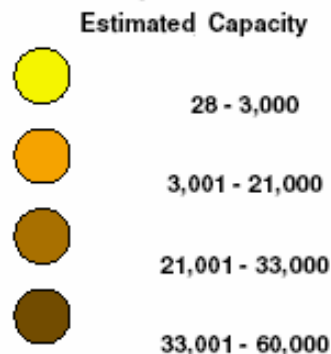
# Average Soybean Production (1999-2005) and Processing plus Potential Biodiesel Production



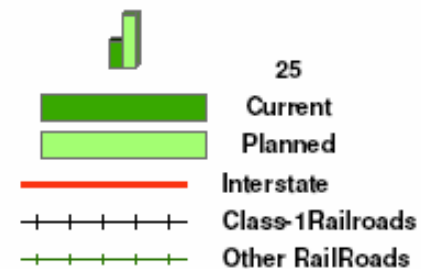
Average Soybean Production (1,000 bu/yr)



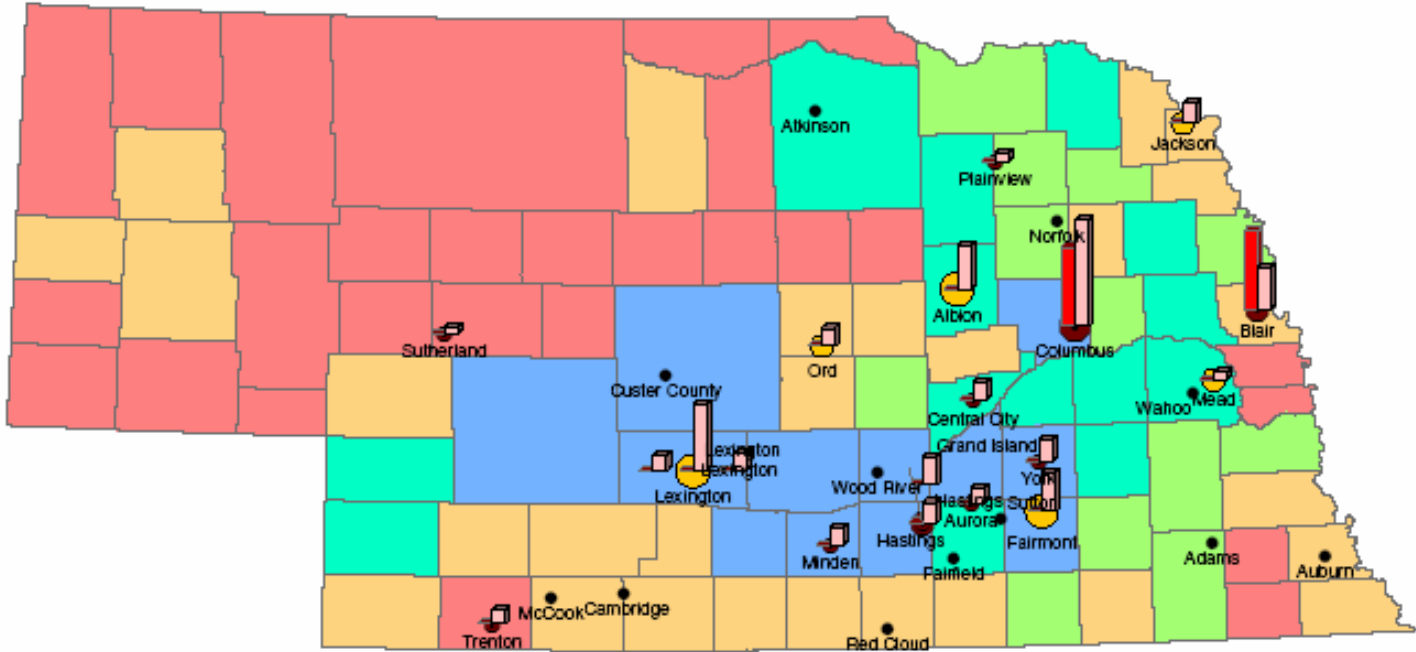
Soybean Processing Plants (1,000 bu/yr)



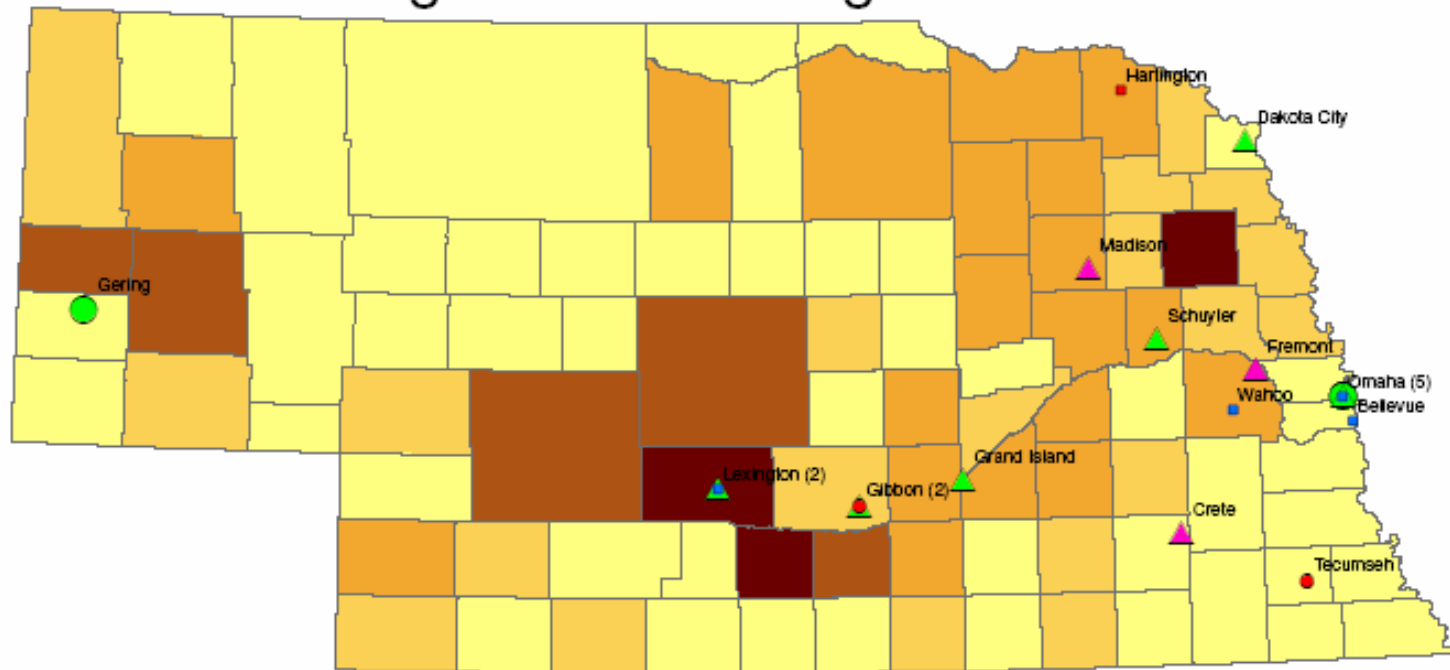
Biodiesel Production (MGPY)



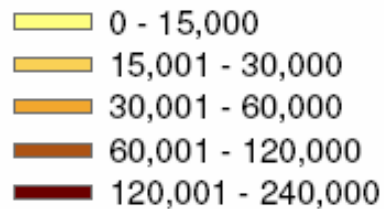
# Average Corn Production (1999-2005) and Processing plus Corn Oil Potential



# Nebraska- Cattle on Feed (2002) with Slaughter/Rendering Locations



## Cattle on Feed (USDA Census of Agriculture, 2002)



## Slaughter

### Species, Type

- Any, Rendering
- BEEF, Slaughter
- ▲ BEEF, Slaughter and Rendering
- ▲ PORK, Slaughter and Rendering
- POULTRY, Slaughter
- Poultry, Rendering

# Potential Feedstock Resources

- Hazelnut Oil



Hybrid hazelnut tree



Hazelnut

Pictures provided by Dr. Scott Josiah, Nebraska Forest Service

# Preliminary Studies on Hazelnut Oil



# Hazelnut Oil Production and Characterization

Characteristics of the oils	Soybean oil	Hazelnut oil
Crude oil fat (%)	~20	58.1-65.1
Oil yield (kg/ha)	500	1,000
Fatty acid composition (%)		
C16:0	11.4	4.5-5.9
C18:0	4.2	0.5-2.8
<b>C18:1</b>	<b>24.7</b>	<b>68.8-78.6</b>
C18:2	52.1	14.2-23.3
C18:3	7.6	0.1-0.2
Iodine value (g iodine absorbed /100g)	130.4	90.6-97.4
<b>Oxidative onset temperature (° C)</b>	<b>148.4</b>	<b>184.7-190.4</b>
Cloud point (° C)	-9.9	-12.4-- -14.9

# Potential Feedstock Resources (continued)

- Camelina oil



Provided by Duane Johnson in Montana

- Corn oil (from ethanol production)
- Okra, etc.

# Opportunities for Biodiesel Production in Nebraska

Nebraska typically ranks 1st, 2nd, or 3rd for animal slaughter, and is a leader in the availability of animal fats.





# Tallow Biodiesel

Research efforts have concentrated on:

- Converting beef tallow into biodiesel (methyl esters) by transesterification;
- Optimizing this conversion process; and
- Testing engine performance.

# Challenges of Tallow Biodiesel

- Biodiesel from animal fat is not as widely accepted as biodiesel made from vegetable oils because of concerns regarding cold temperature flow. It is generally accepted that this is not an issue with B2 and B5.

# Opportunities for Biodiesel Production in Nebraska

- Nebraska typically ranks in the top five for soybean production, the primary biodiesel feedstock in the U.S.
- Local soybean processing could significantly contribute to local economies and could provide locally processed meal for livestock and oil for biodiesel processing and consumption

# Challenges of Soybean Biodiesel

- Nebraska has limited soybean processing capacity and little excess oil.
  - Solvent extraction plants:
    - ADM: Lincoln & Fremont
    - AGP: Hastings
  - Extrusion-Expeller plants
    - fewer than 10 plants of various capacity



# The Concept of EB diesel

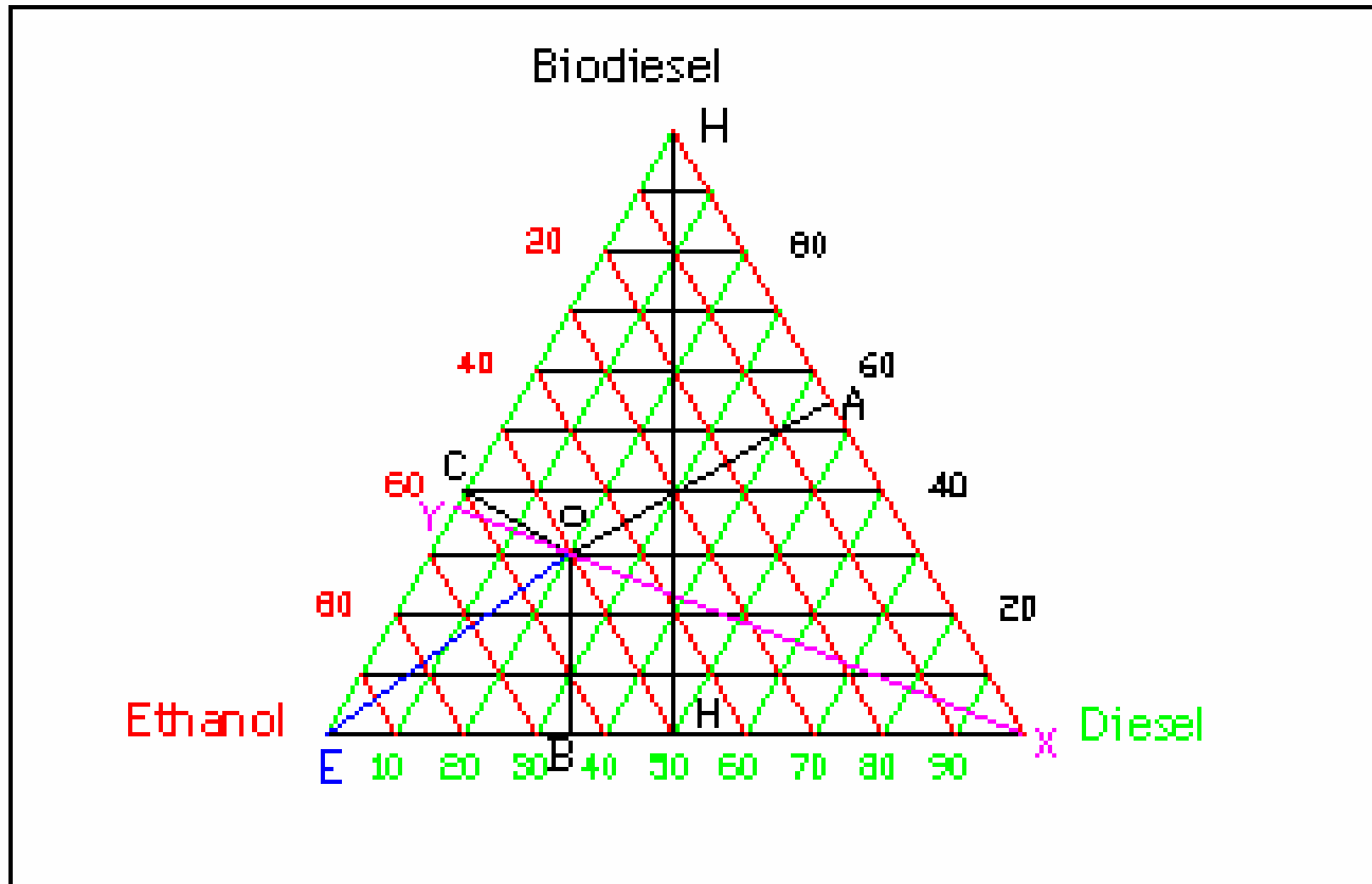
- This project looked at the concept of using biodiesel as an amphiphile for e-diesel blends
- Marrying ethanol and biodiesel to harness the advantages of both fuels
  - Ethanol
    - Oxygenation, improve cold flow properties
  - Biodiesel
    - Resolve reduction of lubricity and cetane number caused by ethanol

The concept of EB diesel...

## **Research objectives were to:**

1. Study the phase behavior of the ethanol-biodiesel-diesel three component system;
2. Investigate the effects of temperature, ethanol type, diesel fuel type and water content on the phase behavior of the three component system; and
3. Identify the fuel blend with the best low temperature phase stability.

# Use of Ternary Phase Diagrams in Biofuels to Represent Phase Behaviors



# Ethanol-Biodiesel Field and Engine Tests



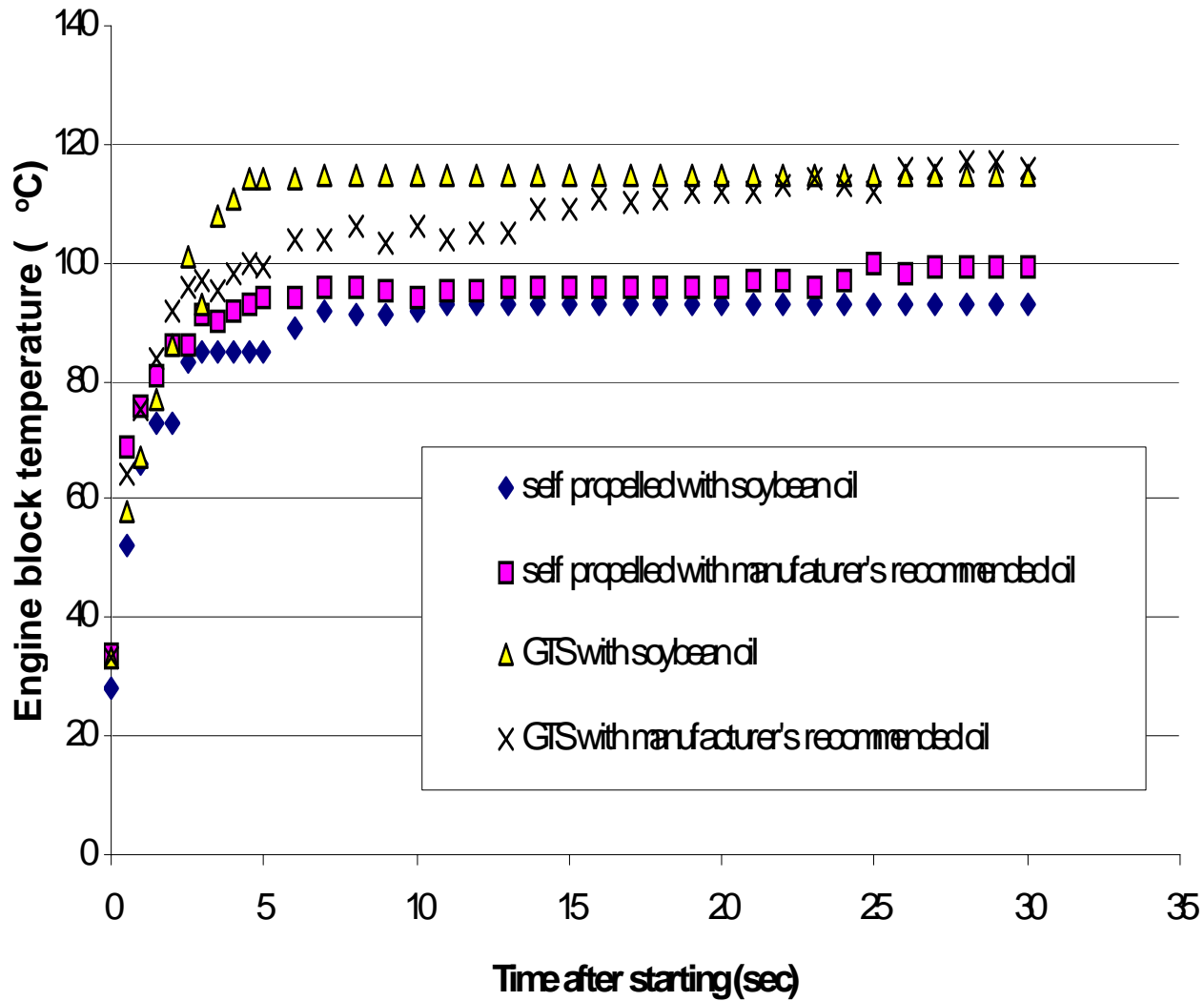
# Use of Glycerol (By-Product)

- Production of ethers of glycerol from crude glycerol- Dr. Hossein Nouredini in Chemical and Biomolecular Engineering Department
- Process for producing fuel with reduced viscosity and a cloud point below 32 F - Patent #6015440, January 18, 2000.

# Biolubricants – irrigation drip oil



# Biolubricants – two-stroke engine oil



# Barriers to Soy Based Biolubricants

- Lack of thermal and oxidative stability due to high amount of linoleic acid (18:2, 52%) and linolenic acid (18:3, 7%)
- High pour point due to high content of saturated (palmitic (11.4%) and stearic (4.2%)) acids.

# Improving Functional Properties of Soy-Based Lubricants

- Hydroxylation

Hydroxylation was performed by reacting oil with hydrogen peroxide with sulfuric acid as catalyst.

- Nitroxylation

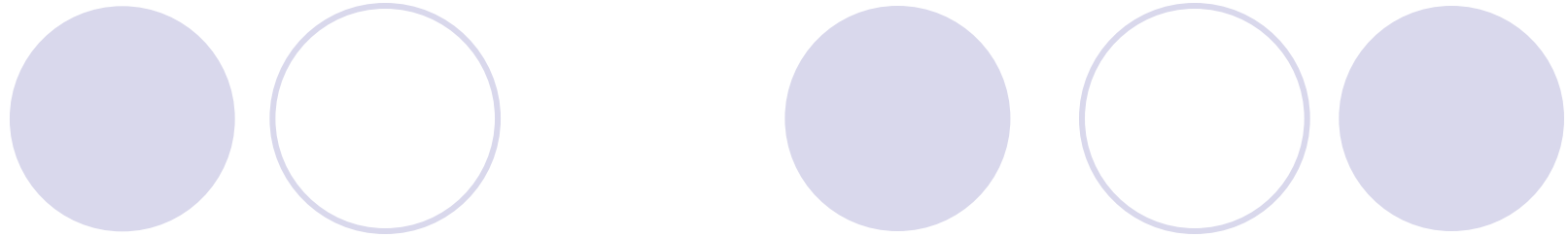
Nitroxylation was accomplished by adding nitroxyl free radicals to hydroxylated oil.



Photo by Brett Hampton

# Questions and Comments





**University of Nebraska – Lincoln  
Industrial Agricultural Products Center**

a ***RESOURCE*** to conduct technical  
analyses through scientific research

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