WNC's Biofuels Market & Supply Chain

Regional Biofuels Educational Workshop
Western Piedmont Council of Governments-Hickory, NC
August 22, 2014

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Why Biofuels?

- Few alternatives to petroleum
- Transportation accounts for over 1/4 of total emissions in US
- Vehicle miles traveled per capita remains constant and CAFÉ standards slowly rise
- National Security
- Develop bio-products economy
- Utilize wastes and side streams
- Carbon sink with forestry and non-food crops

Biofuels at their best…

Economic Impacts:	Fuel Diversity, investment in manufacturing, job creation, Agricultural development, reduce dependency on petroleum
Environmental Impacts:	Green house gas reductions, reduce air pollution, biodegradability, higher combustion efficiency, carbon sequestration
Energy Security:	Domestic production, supply and ready reliability, domestic distribution , Reduce use of fossil fuels, renewability

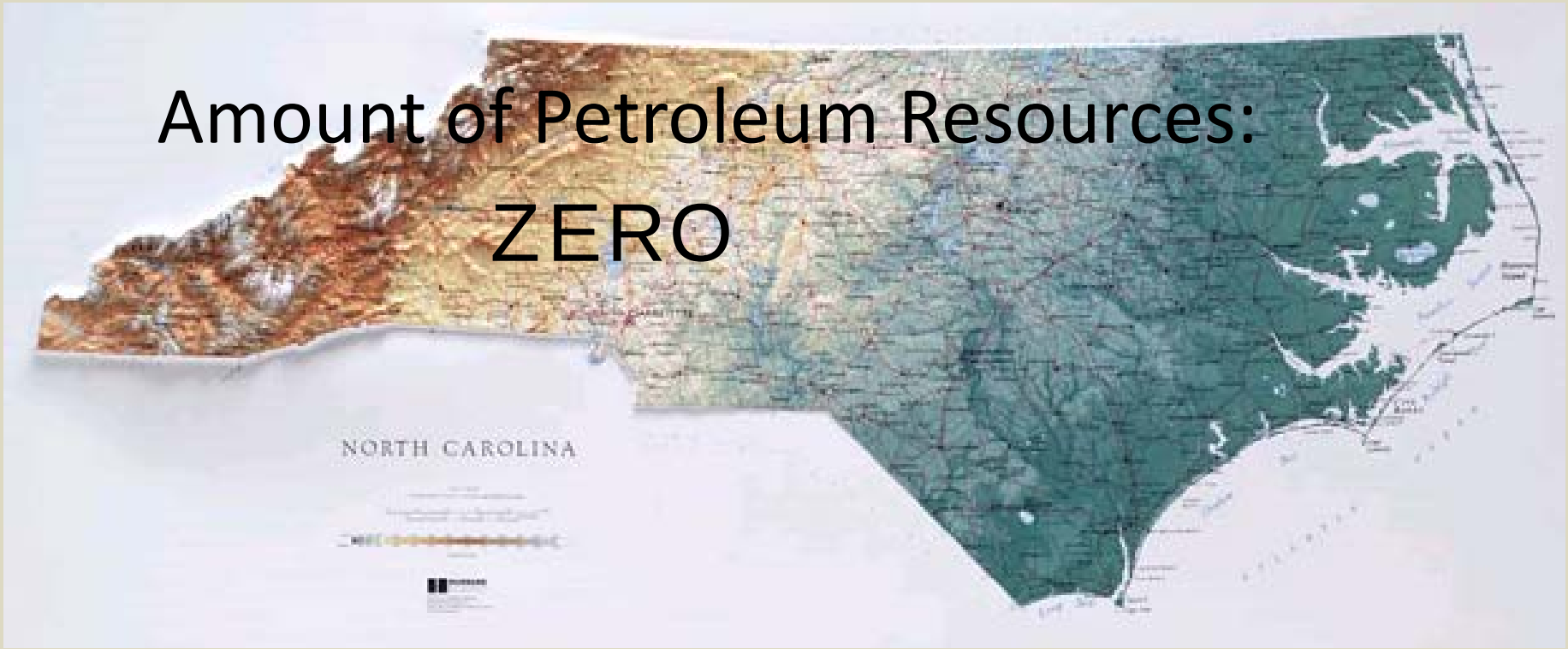
Economics of Dependence - US

- GASOLINE CONSUMPTION: **350 MILLION GAL/DAY**
- DIESEL CONSUMPTION: **125 MILLION GAL/DAY**

- TOTAL: 575 M GAL/DAY – 230 M GAL/DAY (US PRODUCTION) = **345 M GAL/DAY**

- **EQUALS ~ $1.2 BILLION ECONOMIC LOSS/DAY**

North Carolina



- **NC currently consumes approximately 4.2 billion gallons of gasoline and 1.2 billion gallons of petroleum diesel each year. WNC consumes 868MGPY combined.**

- **Our transportation fuel use represents over $10 billion leaving the state economy annually, >$3B in WNC.**

Biodiesel

- Biodiesel made from used cooking oil reduces overall GHG Emissions on a life cycle basis by 80% compared to petroleum diesel.
- Biodiesel made from used cooking oil is a renewable fuel that has a Net Energy Ratio of 6 units returned for each unit invested.
- Biodiesel adds lubricity to increase engine equipment life at even low blend levels such as B2
- Particulates, total hydrocarbons, and carbon monoxide from biodiesel combustion have resulted in a reduction of 48%, 77%, and 48% respectively compared to conventional diesel
- Use of biofuels can help keep air quality high in sensitive areas such as historical nonattainment areas including high mountains, Unifor and Charlotte metro areas.

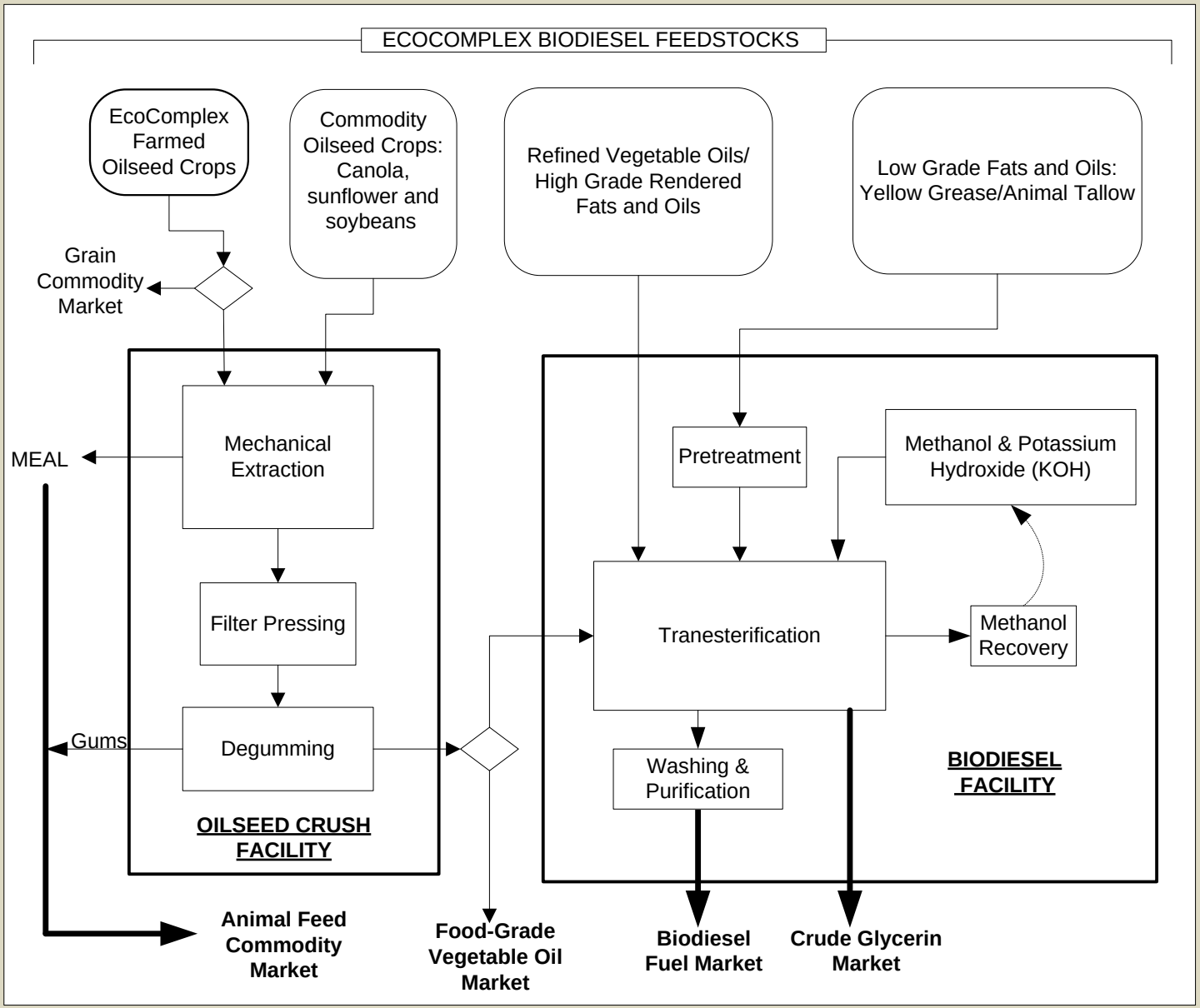
Biodiesel Feedstocks

Feedstock accounts for nearly 80% of the overall production cost!

- Traditional
  - **Yellow Grease ($.29/lb)**
  - **White Grease ($.33/lb)**
  - **Tallow ($.40/lb)**
  - **Soybean Oil ($.33/lb)**
  - Palm
  - Other Vegetable Oils (Canola, sunflower)
- Next Generation
  - Brown Grease
  - Trap Grease
  - Algae, yeast, bacteria
  - Woody, Cellulosic, Energy grasses
  - MSW

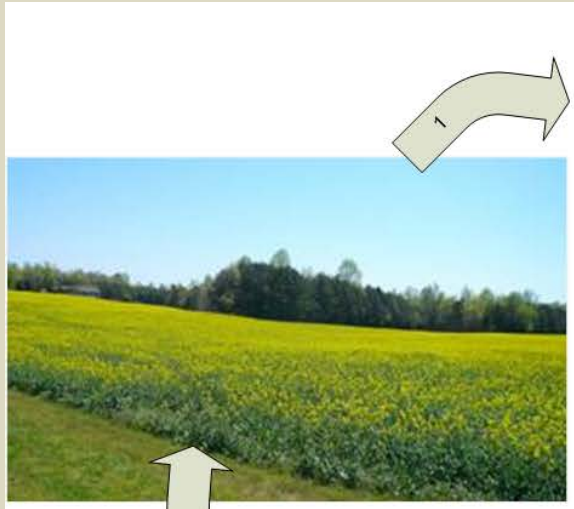
http://www.progressivefuelslimited.com/web_data/pfldaily.pdf

Material flow for biodiesel production process.



WNC Oilseed Feedstock Crops & Rotation:

1 Acre in a 3 year period = 210 gallons oil, 2 tons protein meal, and stover



3 Year Crop Rotation:

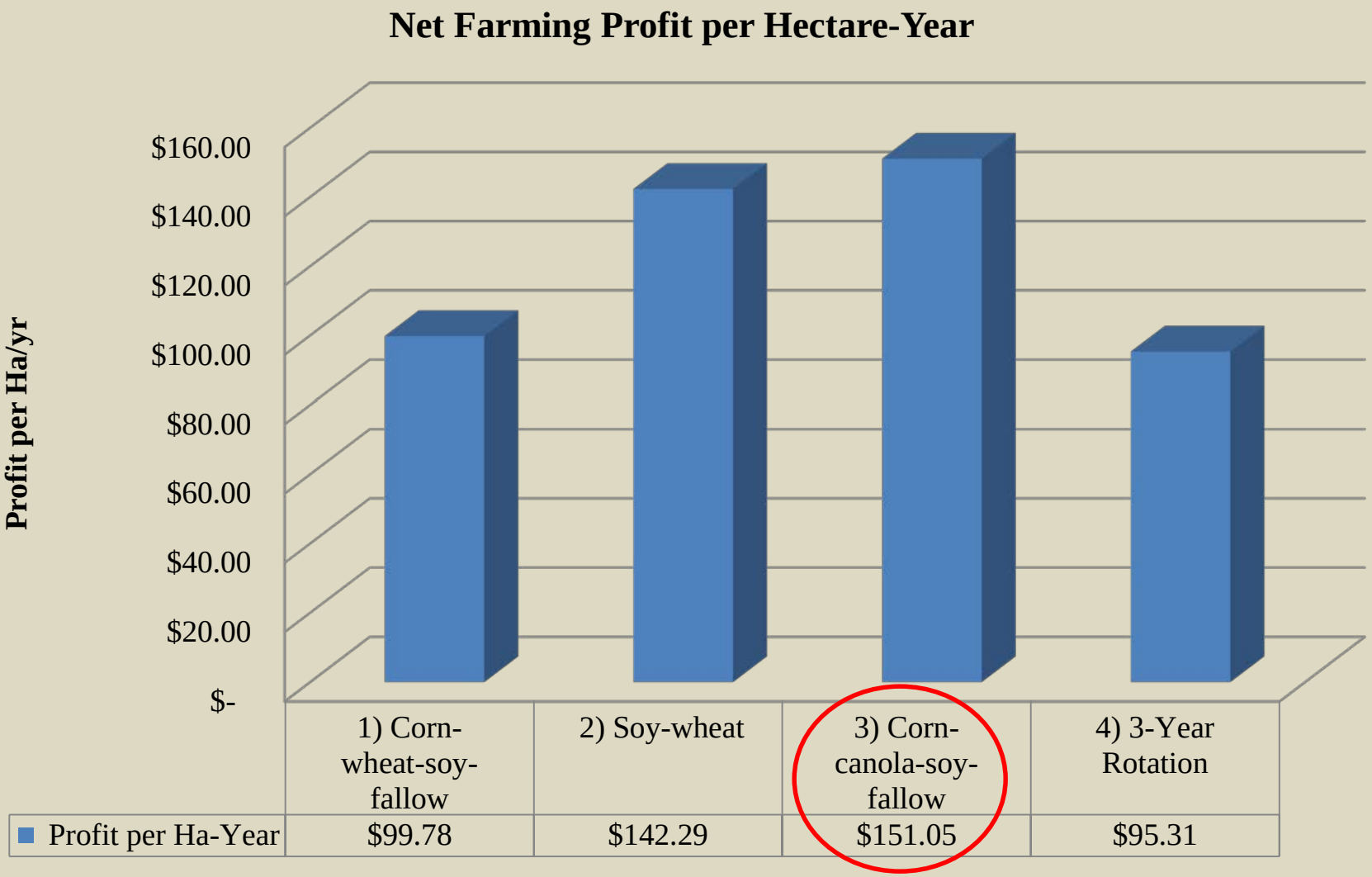
1) Soybeans, Rye/Vetch cover
2) Sunflower, Winter Wheat*
3) Corn, Canola*

**harvested in the following year*

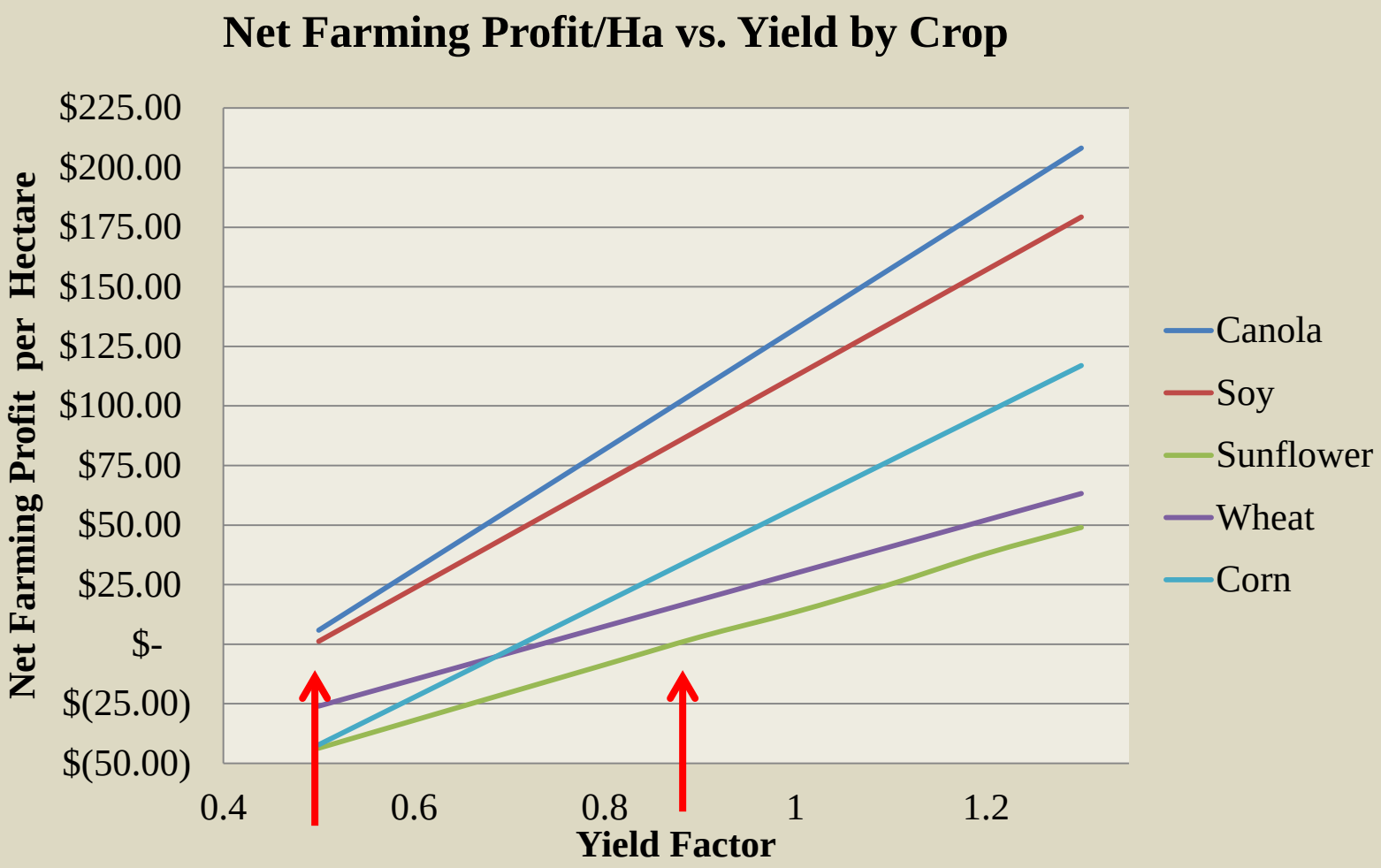
Vegetable Oil and Meal Yields by Rotation

Rotation	**Average Vegetable Oil liters/hectare/year *(gallons/acre/year)***	**Average Oilseed Meal kg/hectare/year *(Lbs/acre/year)***
1) Corn-Wheat-Soybeans-Fallow	178 *(19)*	1067 *(950)*
2) Soy-Wheat	355 *(38)*	2133 *(1900)*
3) Corn-Canola-Soy-Fallow	617 *(66)*	1976 *(1760)*
4) Soybeans-Winter Cover Crop-Sunflower-Wheat-Corn-Canola *(3-Year Rotation)*	580 *(62)*	1671 *(1488)*

Net Farming Profit vs. Crop Rotation.



Net Farming Profit vs. Crop Yield.



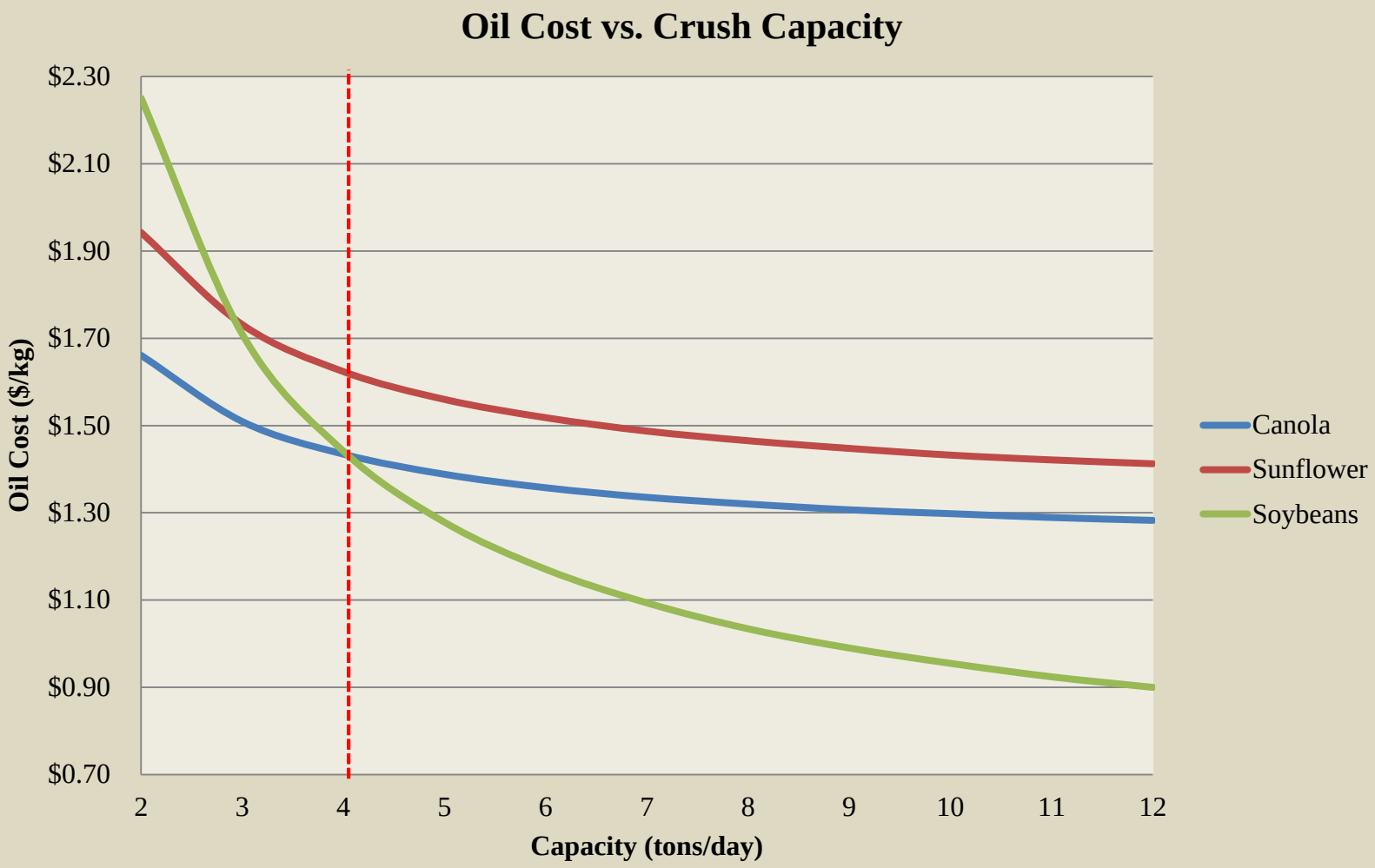
Small-scale Oilseed Crush and Biodiesel Facilities, Catawba EcoComplex

Economic Analysis

Crush Facility *Oil Costs by Oilseed*

Oilseed	**Canola**	**Sunflower**	**Soybean**
Land Area Ha *(Ac)*	455 *(1124)*	559 *(1382)*	298 *(736)*
Oil Production liters/year *(gal/yr)*	395,660 *(104,533)*	282,615 *(74,667)*	111,279 *(29,400)*
Costs	Cost per liter oil *($/gallon)*	Cost per liter oil *($/gallon)*	Cost per liter oil *($/gallon)*
Feedstock (oilseeds)	$ 1.79 *(6.79)*	$ 1.95 *(7.41)*	$ 4.38 *(16.59)*
Variable	$ 0.05 *(0.20)*	$ 0.09 *(0.37)*	$ 0.22 *(0.85)*
Fixed	$ 0.21 *(0.80)*	$ 0.29 *(1.11)*	$ 0.75 *(2.83)*
Total	$ 2.05 *(7.78)*	$ 2.35 *(8.89)*	$ 5.36 *(20.27)*
Revenue (meal)	$ 0.75 *(2.84)*	$ 0.86 *(3.28)*	$ 4.04 *(15.29)*
Total Cost	$ 1.31 *(4.94)*	$ 1.48 *(5.61)*	$ 1.31 *(4.97)*
Oil Cost per kg *($/lb)*	$ 1.43 *(0.65)*	$ 1.63 *(0.74)*	$ 1.45 *(0.66)*

Sensitivity of Oil Cost to Crush Capacity.



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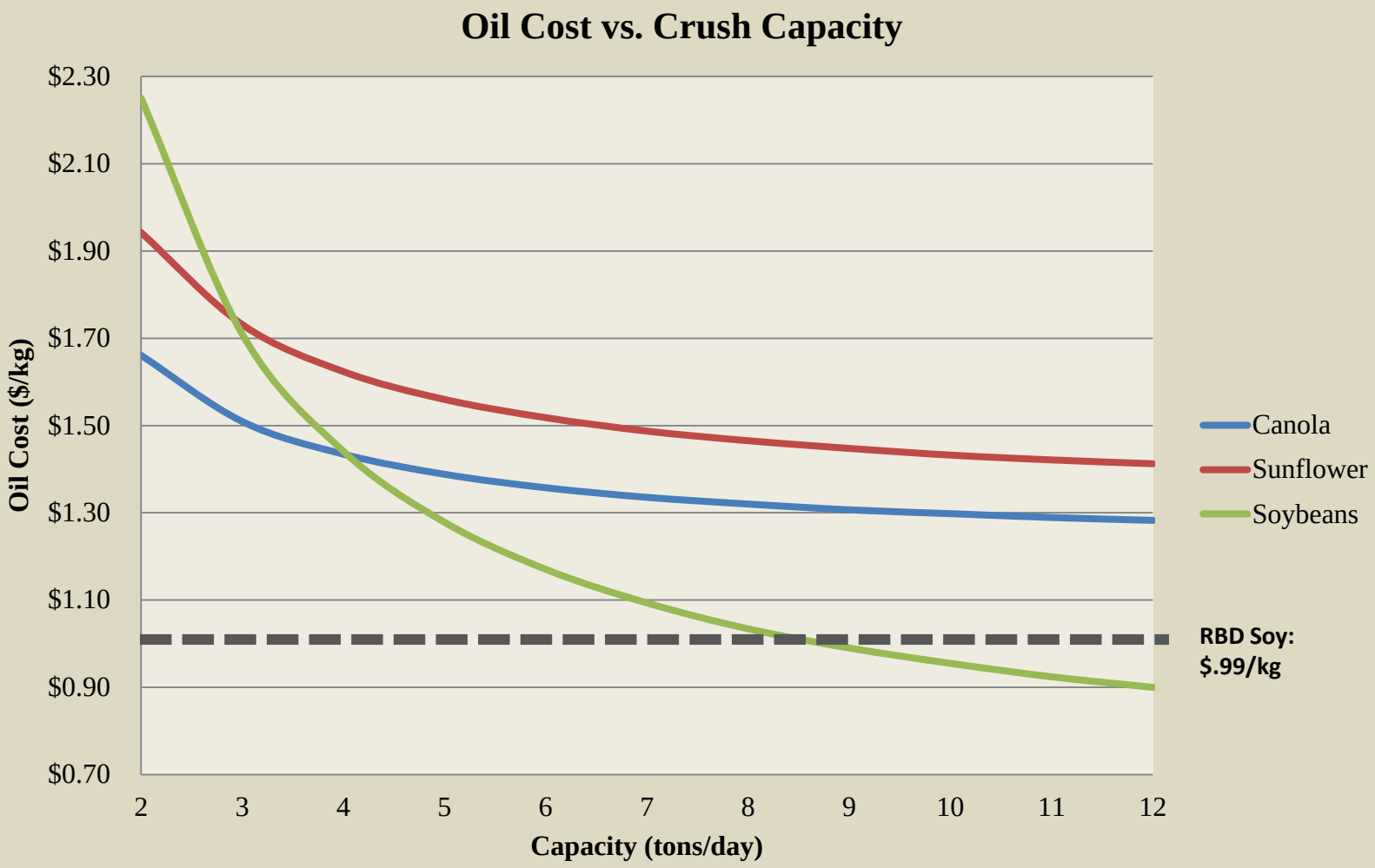

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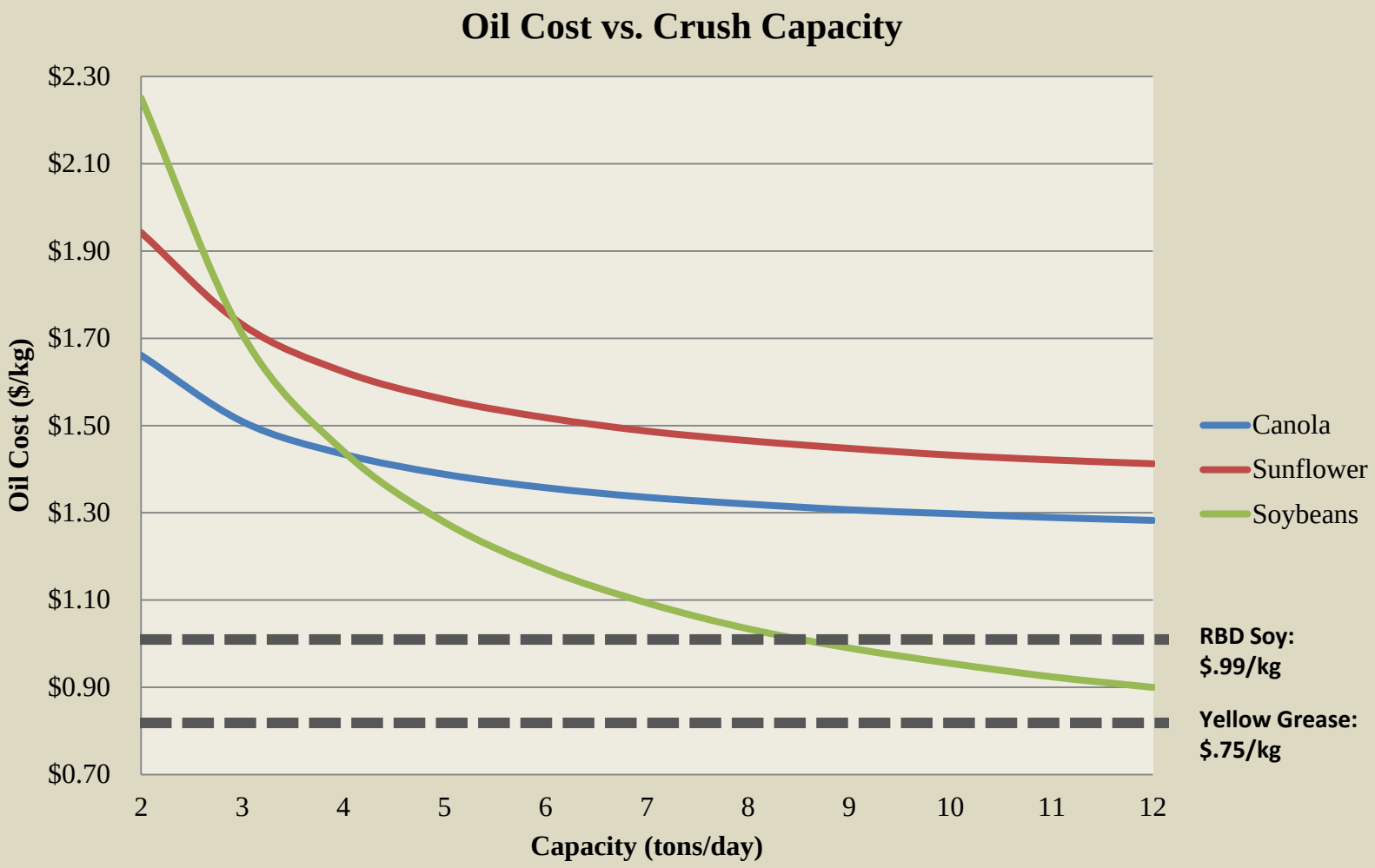
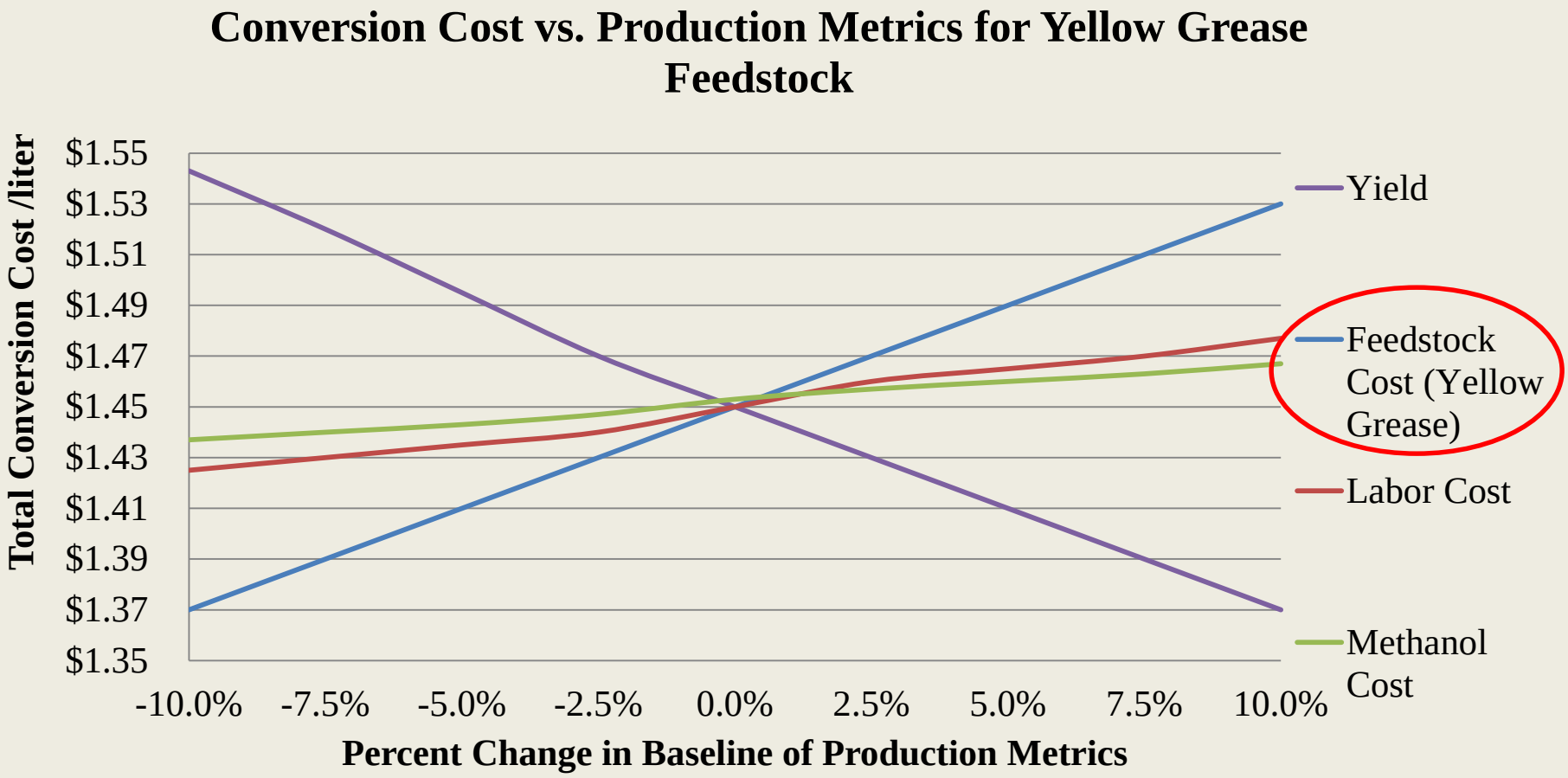
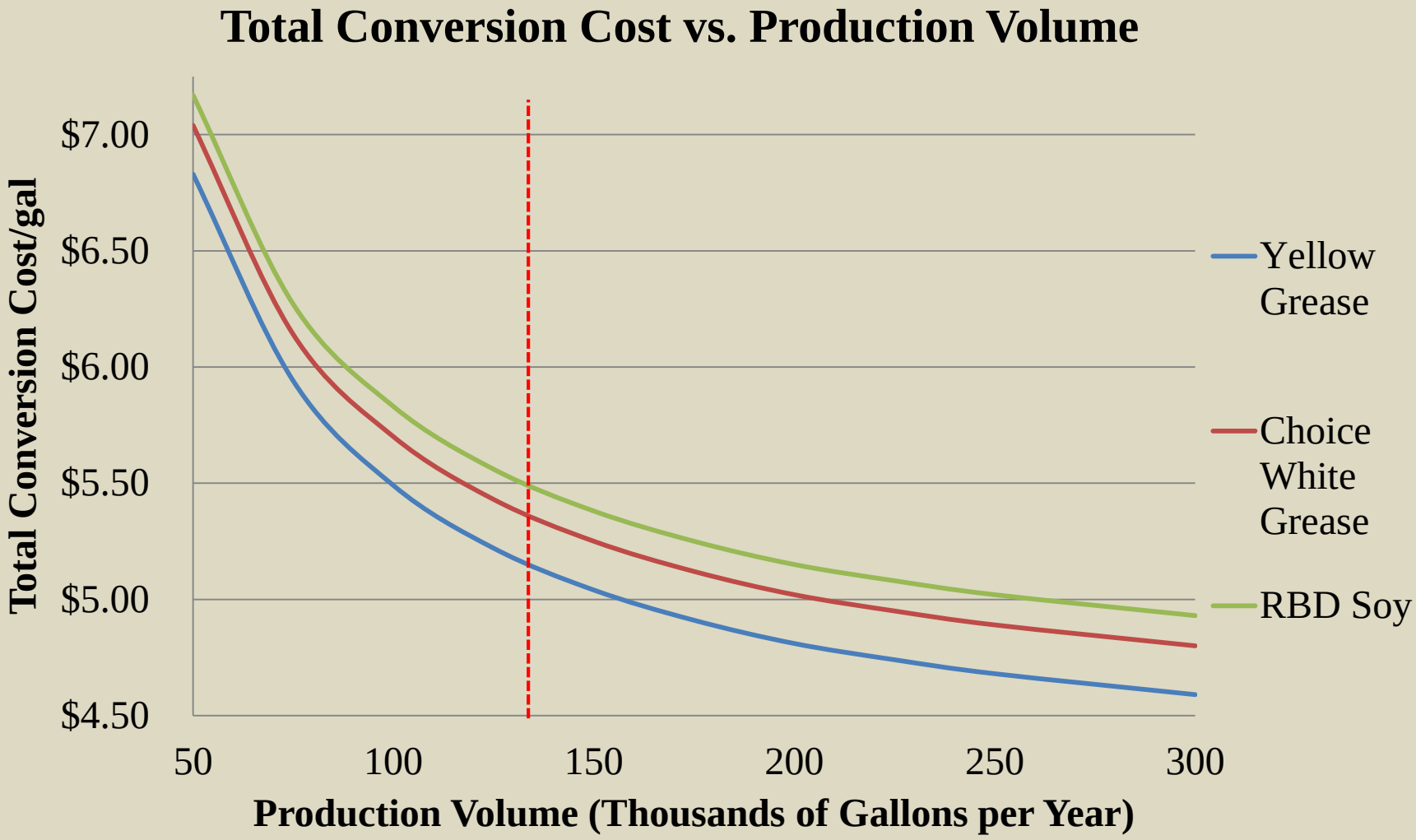


Conversion costs by commodity feedstock, with Subsidies

Commodity Feedstock	Yellow Grease/UCO	White Grease	Soybean
Oil Cost per kg[(PFL, 2013)] *($/lb)*	$ 0.75 *(0.34)*	$ 0.86 *(0.39)*	$ 0.99 *(0.45)*
Conversion Yield	80%	85%	90%
Costs	Cost per liter of biodiesel *($/gal)*		
Feedstock	$ 0.83 *(3.16)*	$ 0.91 *(3.44)*	$ 0.96 *(3.63)*
Variable	$ 0.28 *(1.06)*	$ 0.27 *(1.01)*	$ 0.26 *(0.97)*
Fixed	$ 0.34 *(1.29)*	$ 0.34 *(1.29)*	$ 0.34 *(1.29)*
Total	$ 1.46 *(5.51)*	$ 1.52 *(5.74)*	$ 1.56 *(5.89)*
Revenue (Glycerin)	$ 0.02 *(0.08)*	$ 0.02 *(0.10)*	$ 0.03 *(0.12)*
Total Conversion Cost	$ 1.43 *(5.43)*	$ 1.49 *(5.64)*	$ 1.52 *(5.77)*
RIN ★	$ 0.31 *(1.20)*	$ 0.31 *(1.20)*	$ 0.31 *(1.20)*
Fuel Tax Credit ★	$ 0.26 *(1.00)*	$ 0.26 *(1.00)*	$ 0.26 *(1.00)*
Net Conversion Cost	$ 0.85 *(3.23)*	$ 0.91 *(3.44)*	$ 0.94 *(3.57)*
Diesel Bulk Cost	$ 0.86 *(3.25)*	$ 0.86 *(3.25)*	$ 0.86 *(3.25)*
Net Profit	$ 0.005 *(0.02)*	$ -0.05 *(-0.19)*	$ -0.08 *(-0.32)*

Sensitivity of Biodiesel Conversion Costs to Production Metrics.




Total Conversion Cost vs. Production Volume
Total Conversion Cost/gal
$7.00
$6.50
$6.00
$5.50
$5.00
$4.50
50
100
150
200
250
300
Production Volume (Thousands of Gallons per Year)
Yellow Grease
Choice White Grease
RBD Soy

3 Opportunities related to Inputs & Outputs of Biodiesel Production

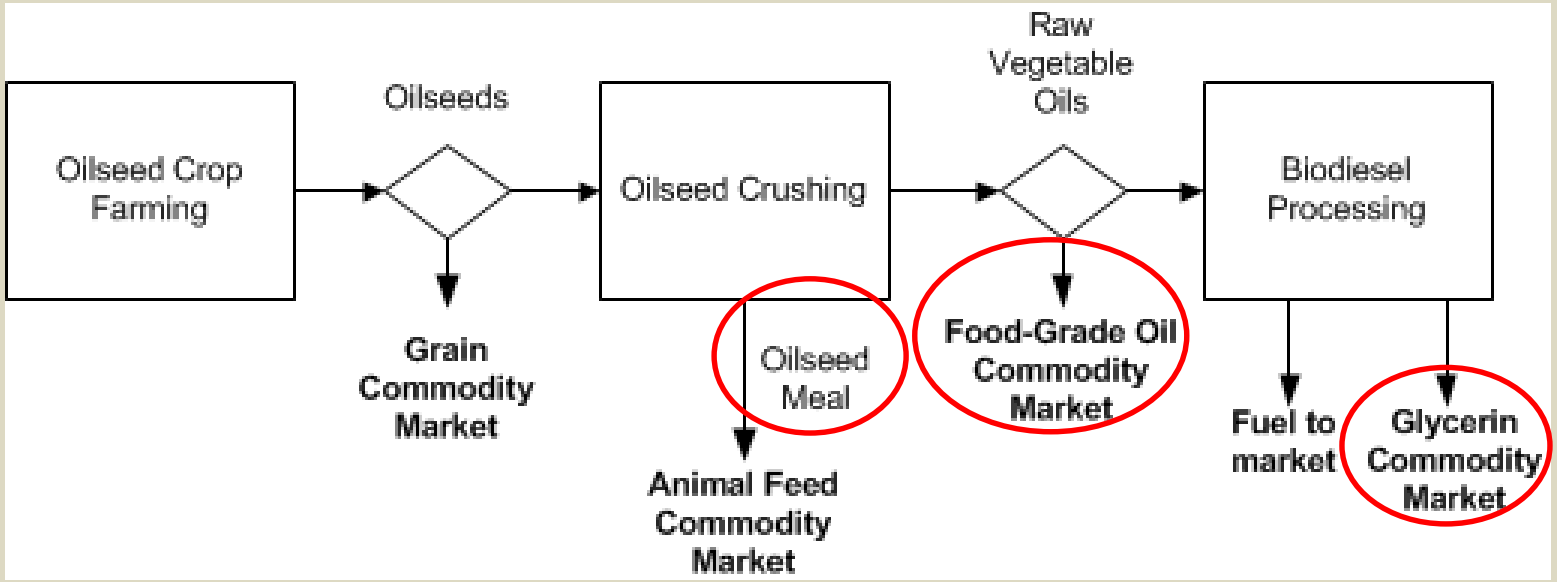
<u>Value-Adding:</u>

1) Food-Grade Vegetable Oil

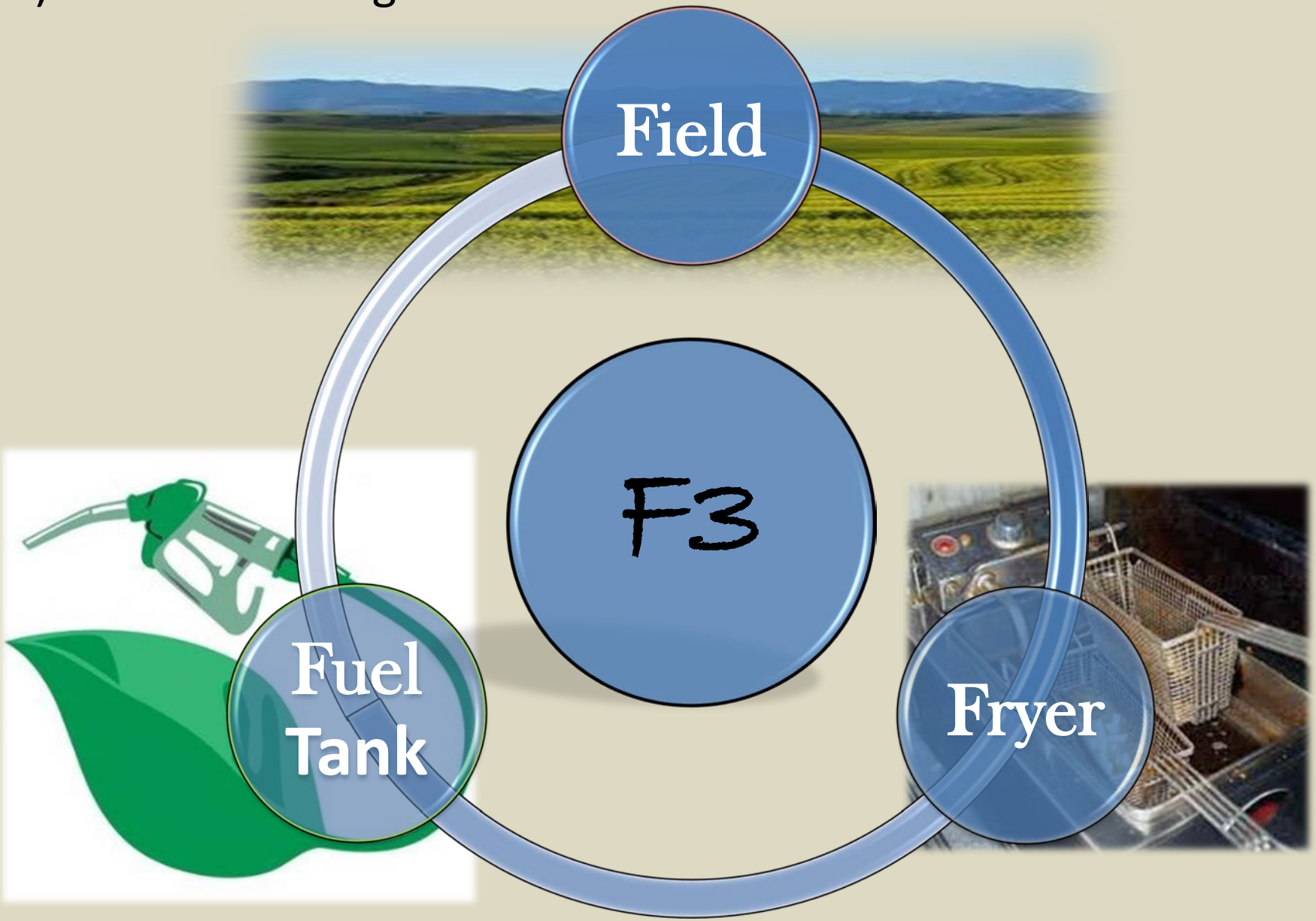
<u>Bioproducts Development:</u>

2) Nutraceuticals: *HPMC for Bio-based gel capsule*

3) Glycerin Soap



1) Food Grade Vegetable Oil



Food Grade Oil

Technology: Vegetable Oil Refining

Status: Pilot-Project

Businesses: Blue Ridge Biofuels, Agstrong, Virgin Oils

Partner Organizations: AdvantageWest, Appstate, Catawba County, Biltmore Estate, Blue Ridge Food Ventures

Raw Materials: Oilseed crops (canola, soybean, sunflower)

Supply Chain: Regional Farmers, Crush and Oil Refining Facilities.

2) Nutraceutical co-products *application: Biobased Gel Capsules*

Technology: Biomass fractionation, HPMC development (hydroxypropyl methycellulose,)

Status: R&D

Organizations: Bent Creek Institute, Virginia Tech,

Raw Materials: glycerol, oilseeds, oilseed meal, brewer spent grains, clean sawdust

Supply Chain Business: Biodiesel producers, farmers, crush facilities, breweries, sawmills

3) Glycerin Soap

Technology: Saponification of Fats/Oils

Primary Business: War Horse Solutions

Status: Start-up

Raw materials: biodiesel derived glycerin, free fatty acids, essential oils, potassium hydroxide

Supply Chain Business: Biodiesel producers, Certified Manufacturing Facility, Packing/Distribution

Biofuels Summary

- Use waste first then dedicated biomass energy crops for biofuel feedstock
- Improve technologies to diversify feedstocks, process low-quality low-cost materials, and produce higher value co-product streams.
- Spin-off businesses are emerging
- Need for Increased Ag Production
  - Oilseed crops (canola, soybean, sunflower) non-gmo, organic
  - Niche oilseed crops


Thank you!
Questions?
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