Biodiesel: Regional Challenges

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University of Idaho

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University of Idaho

30+ Years Biodiesel Research at University of Idaho

- UI is a pioneer in biodiesel research and utilization, the first biodiesel research was started in 1979 using cooking oil
- UI has been actively engaging in biodiesel research since then

Dr. Charles Peterson

Chuck Peterson

- Professor Emeritus, BAE
- Head, BAE (2003-2005)
  Interim Dean, COE (2005-2007)
- Fellow, American Society of Agricultural & Biological Engineers (ASABE)

Biodiesel Education Program

- **Farm Bill 2002 & 2007**
  - TITLE IX. Energy - Biodiesel Fuel Education Program
- **Biodiesel Education Grant**
  - Managed by the Office of Energy Policy & New Uses, USDA
  - University of Idaho
    - ✓ 2 phases: 2004-2008 ($.95M) & 2008-2013 ($1.0M)
    - ✓ **http//www.BiodieselEducation.org**
- **In first 5 years, the biodiesel program has**
  - Published 80+ peer-reviewed publications
  - Given 120+ technical presentations in various conference and technical meeting, and
  - Organized /co-organized 15+ workshops

Biodiesel Education Program

- **The current project team**
  - **Jon Van Gerpen** Professor, head; fuel quality/production, engine
  - **B. Brian He** Associate professor; production technology, byproduct utilization
  - **Doug Haines** Associate professor, head; business/ marketing
  - **Dev Shrestha** Associate professor; fuel quality, lifecycle analysis
  - **Joe Thompson** Eng. Support Scientist;
  - **John Herkes** Senior instructor


Dr. J. Van Gerpen


Dr. B. He

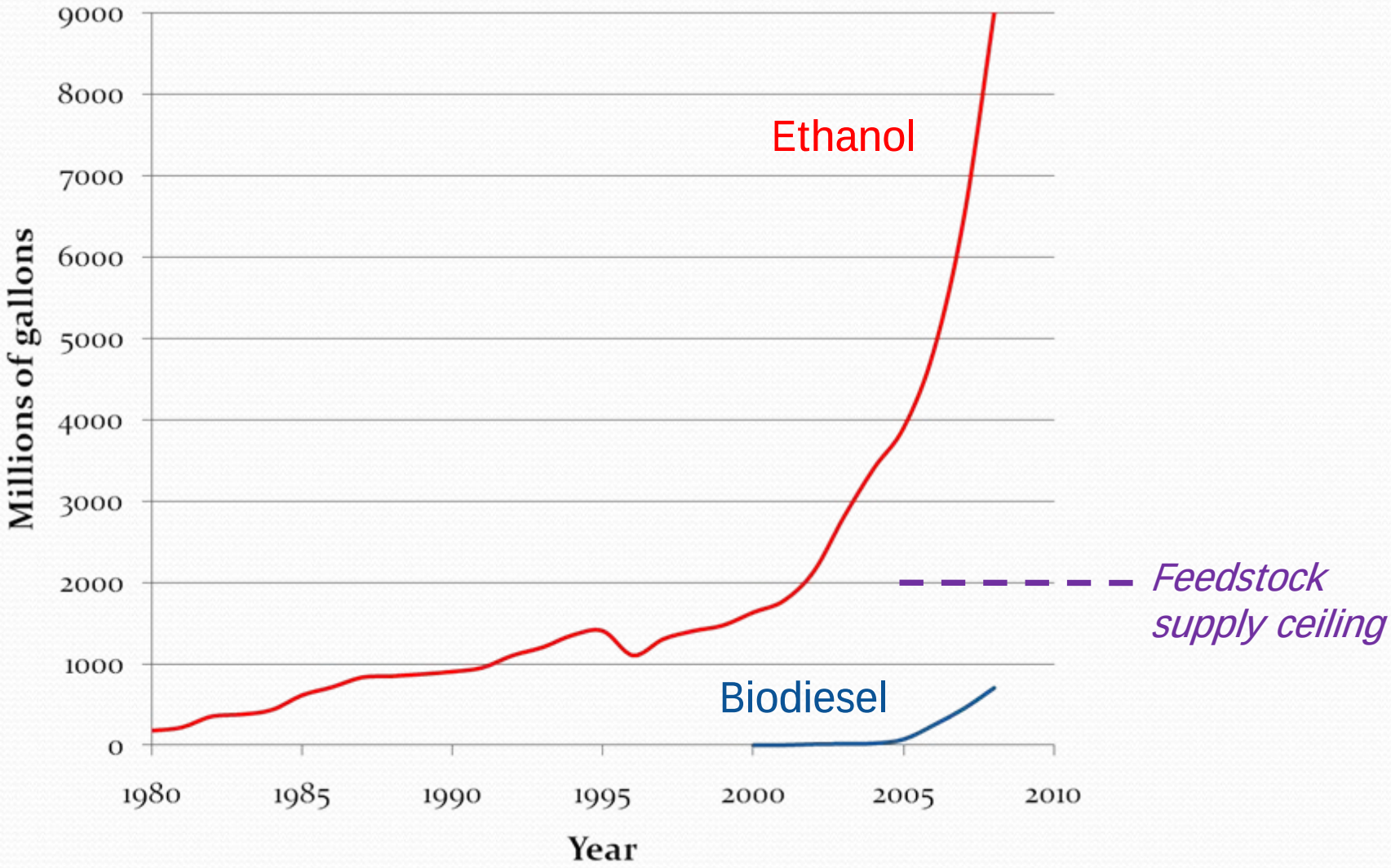

Dr. D. Haines


Dr. D. Shrestha

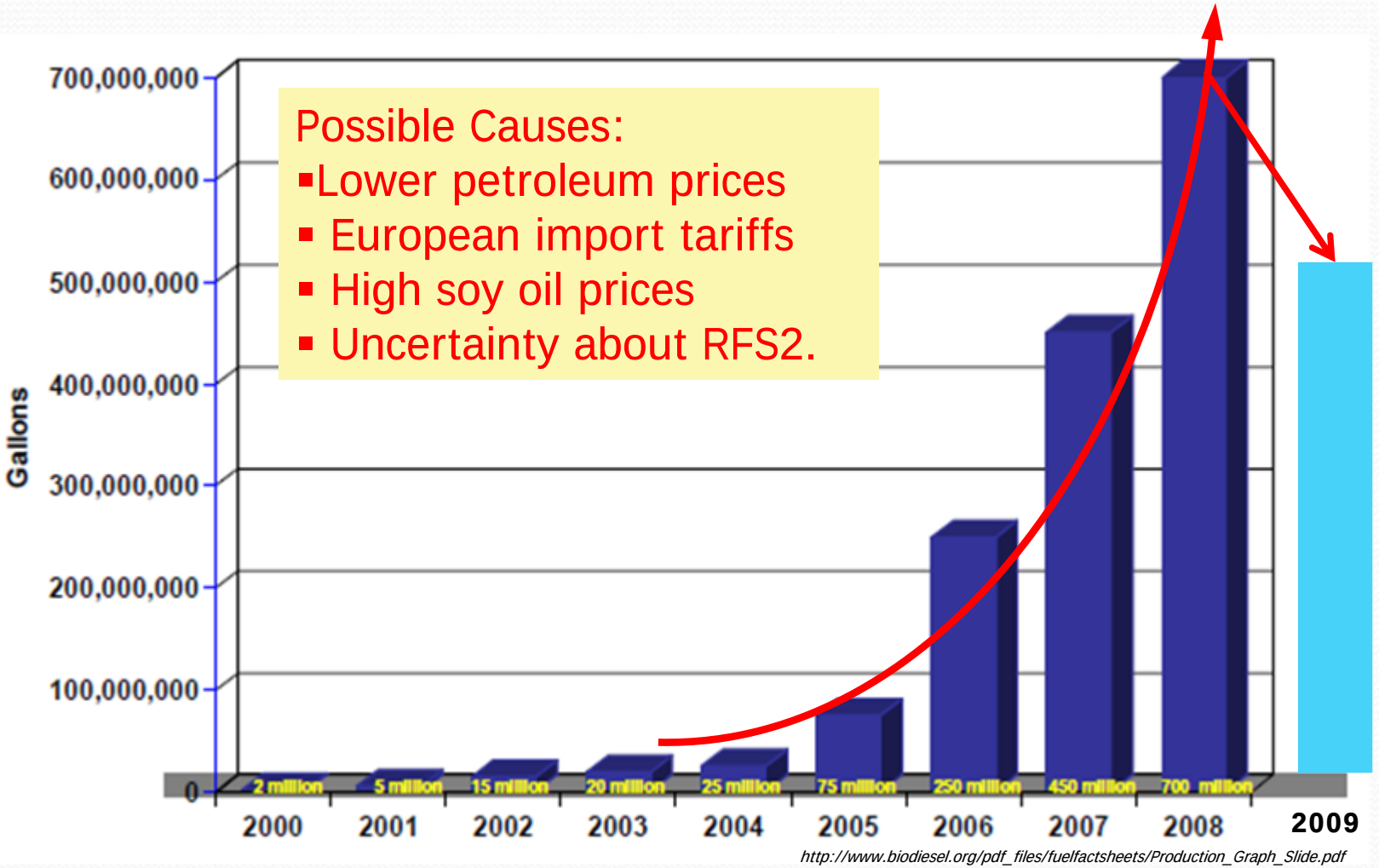

Dr. J. Thompson


John Herkes

Is Ethanol a Good Model for Biodiesel?



Estimated US Biodiesel Production by Fiscal Year (Oct 1 – Sept 30)



http://www.biodiesel.org/pdf_files/fuelfactsheets/Production_Graph_Slide.pdf

Soybean Oil

All fats and oils tend to track soybean oil

Chicago Board of Trade prices

U.S. Biodiesel Feedstock Supply

Source *(% of existing supply)*	Available for biodiesel
▪ **Soybean oil** *(30%)*	**800 million gallons**
▪ **Corn oil** *(1% of ethanol ??)*	**265 million gallons**
▪ **Palm** *(5% of world supply)*	**267 million gallons**
▪ **Tallow and lard** *(30%)*	**272 million gallons**
▪ **Yellow grease** *(50%)*	**173 million gallons**
▪ **Poultry fat** *(50%)*	**148 million gallons**
▪ **Camelina** *(100%; 1 m acres at 800 lb/ac)*	**32 million gallons**
▪ **Canola oil** *(10%)*	**19 million gallons**
▪ **Jatropha** *(100%; 100,000 acres at 600 gal/ac)*	**60 million gallons**
▪ **Algae** *(not ready)*	**0**
Total feedstock	***~2 billion gallons***

Feedstock is the Key

- Soybean oil and other food-grade oils make the economics very challenging:
  - ✓ Demand can quickly drive prices to high levels

- Non-edible products are more likely to be profitable:
  - ✓ Crops on arid lands (*avoids food vs fuel issue*)
  - ✓ Crops requiring low water consumption
  - ✓ Contaminated products (*e.g., inedible fats*)

Biodiesel Production Cost
(Vegetable oil)

	Unit Cost	$/gal
Oil	$0.30/lb	$2.25
Methanol	$1.50/gal	$0.18
Catalyst (25% $NaOCH_3$)	$0.55/lb	$0.08
Neutralizer (HCl)	$0.08/lb	$0.01
Nat. gas + electricity	$9./mmbtu, $0.05/kwh	$0.02
Labor	1 shift, 5 people	$0.04
Depreciation/interest	10 yr/6%	$0.15
Maintenance	3.8% of plant	$0.04
Admin. + overhead		$0.02
	Total:	*$2.79*

Note that the oil is 80% of production cost, infrastructure is only 5% of production cost. Production cost is $0.54/gal + oil.

Biodiesel Retail Cost

Producer

Production cost	$2.79/gal
Producer profit	$0.00
Small producer tax cr.	-$0.10
CCC credit	$0
Transportation	*$0.08*
Distributor purchase	*$2.77*

Distributor/blender

Purchase price	$2.77/gal
Excise tax credit	-$1.00
Idaho+Federal tax	$0.494
Freight	$0.08
Blender profit	*$0.05*
Retailer purchase price	*$2.39*

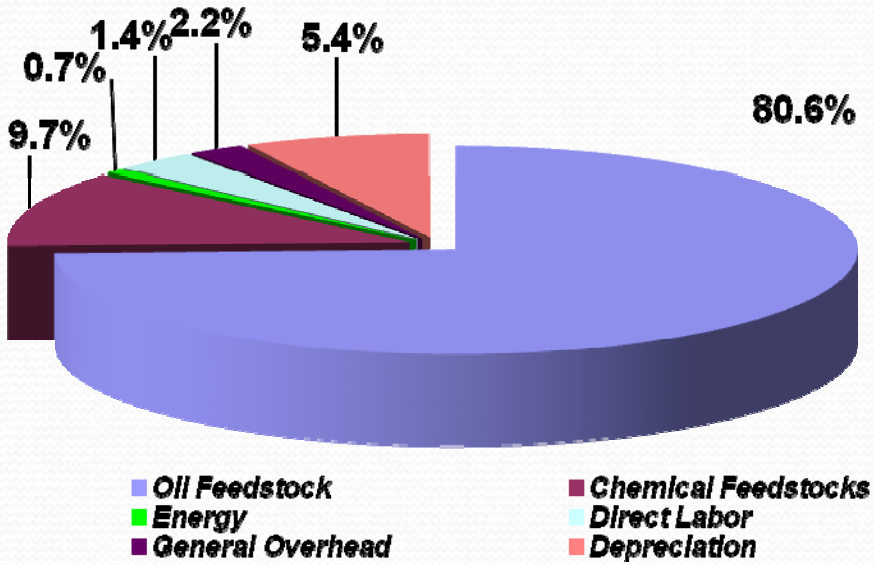
Retailer

Purchase price	$2.39/gal
Retailer mark-up	$0.12
Retail price (B100)	***$2.51***

- ***Assumes no credit for glycerin.***
- ***With current incentives, biodiesel should break even with diesel fuel when retail prices are above $2.51/gallon.***

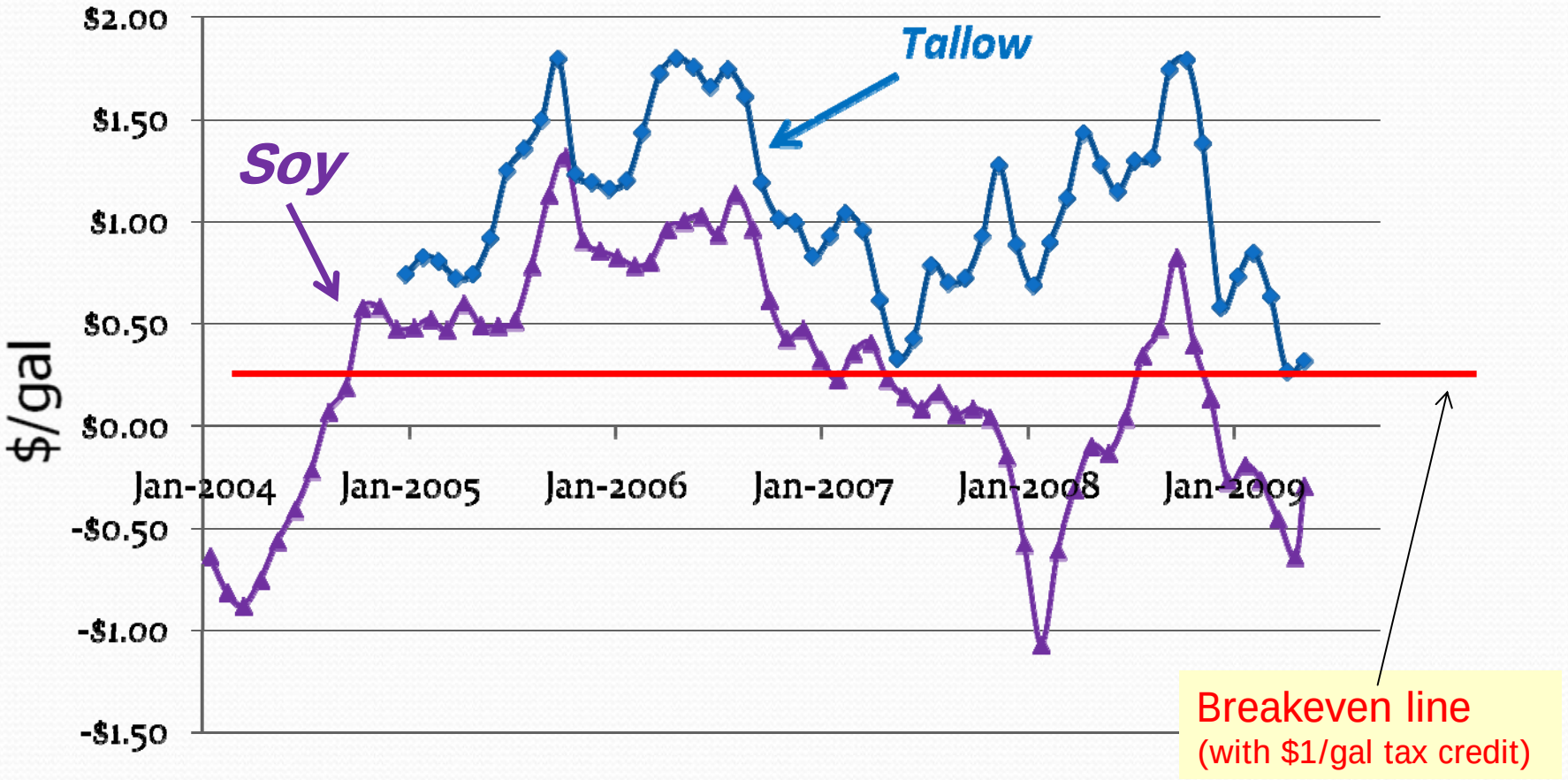
Biodiesel Production Cost

- Cost is very feedstock sensitive
- Virgin vegetable oils are more expensive than recycled oils
- Processing cost is generally estimated to be $0.50 - $0.60/gal
- biodiesel is **$2.50-$3.00/gal** without road tax
- Federal subsidies – $1 /gal



Biodiesel Production Margin

Margin = Diesel fuel ($/gal at retail) – 7.5 (lb/gal)x Oil or fat ($/lb)



Reason for Optimism

RFS2 requirements – EISA 2007 *(Billion gallons)*

Year	Renewable Biofuel	Advanced Biofuel	Cellulosic Biofuel	Biomass-based Diesel	*Undifferentiated Advanced Biofuel*	Total RFS
2008	9.0					9.0
2009	10.5	.6		.5	*0.1*	11.1
2010	12	.95	.1	.65	*0.2*	12.95
2011	12.6	1.35	.25	.8	*0.3*	13.95
2012	13.2	2	.5	1	*0.5*	15.2
2013	13.8	2.75	1		*1.75*	16.55
2014	14.4	3.75	1.75		*2*	18.15
2015	15	5.5	3		*2.5*	20.5
2016	15	7.25	4.25		*3.0*	22.25
2017	15	9	5.5		*3.5*	24
2018	15	11	7		*4.0*	26
2019	15	13	8.5		*4.5*	28
2020	15	15	10.5		*4.5*	30
2021	15	18	13.5		*4.5*	33
2022	15	21	16		*5*	36

Biodiesel

Current Industry Environment

- **Feedstock supplies are limited and prices are high**
- **Requirements for quality are increasingly strict**
- **The industry needs additional sources of oils and fats and more efficient ways to produce high quality fuel**

Oilseed Crops Growing Well in NW

Camelina

Mustard

Canola, rapeseed

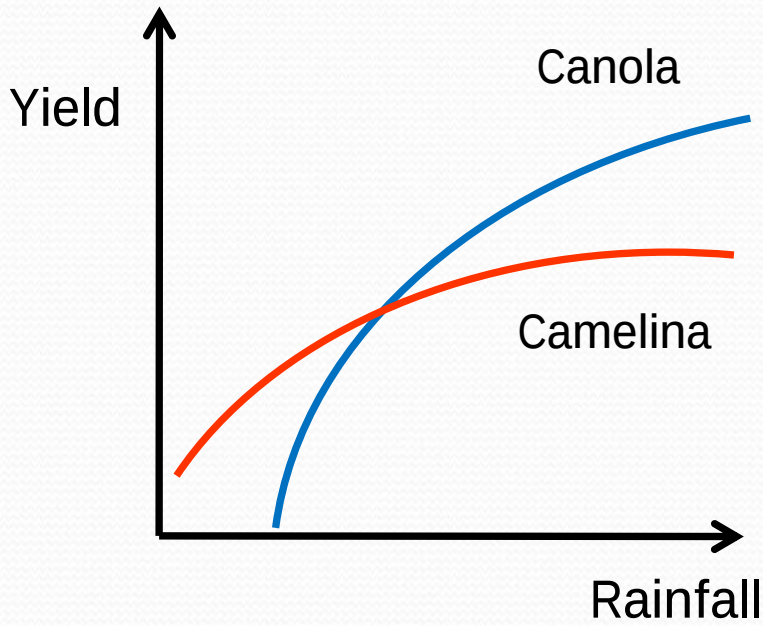
Camelina

- Promoted as an oilseed that will give canola-like yields, even on arid land
- Short growing season offers the potential for double cropping

Camelina

- Presents the potential for growing crops on acres that are not currently used for food production (*rangeland*)

- Experience has shown that if you want decent yield, you still need rain, but …



Corn oil from ethanol production

- Has free fatty acids of 10~12%
- Corn oil has high wax levels (so does sunflower oil), causes the fuel to be cloudy if not removed
- Removing oil from DDGS gives it less value as animal feed

- Some plants want to extract oil before fermentation. This gives a high-value edible oil

- **11 billion gallons of ethanol production should provide 265-800 million gallons of new oil for biodiesel**

Used Frying Oils & Trap Grease

Supply = 1 ~ 1.5 gal/person/year

Trap grease is highly degraded with free FA >80%.

Issues for Biodiesel

- **Direct land use changes**
  - Converting rangeland to camelina or desert to algae ponds changes those eco-systems
- **Indirect land use changes**
  - Converting rainforest or grassland to cropland
  - **EPA has proposed that soy-based oil biodiesel reduces GHG by 57%**
- **Hydrotreated vegetable oils and animal fats can be used as refinery feedstocks**
  - Moves industry from small decentralized plants close to niche feedstocks toward large refinery model

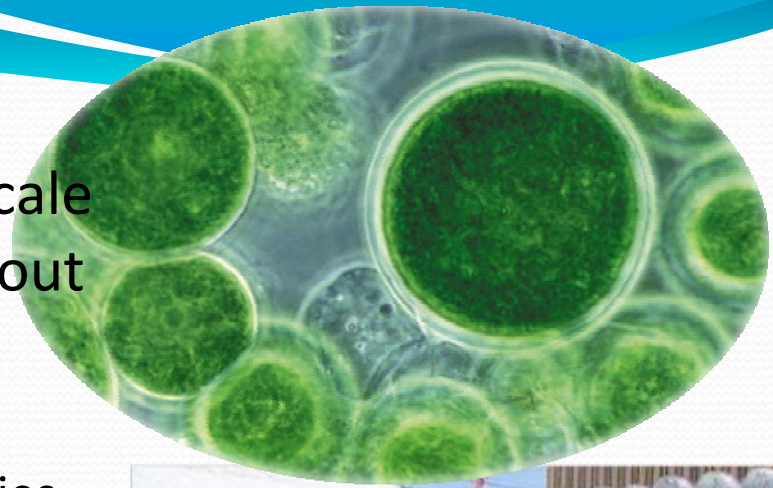
Our Perspectives

- A compromise has been reached with EPA that allows soybean oil biodiesel to qualify under RFS2
- Biodiesel production will grow as RFS2 mandates expand and world demand for diesel fuel picks up and the tax credit is renewed.
- U.S. biodiesel production will be feedstock limited to 1-2 billion gallons/year until sometime after 2015 when algae oil and/or mechanically harvested jatropha will become available

Jatropha

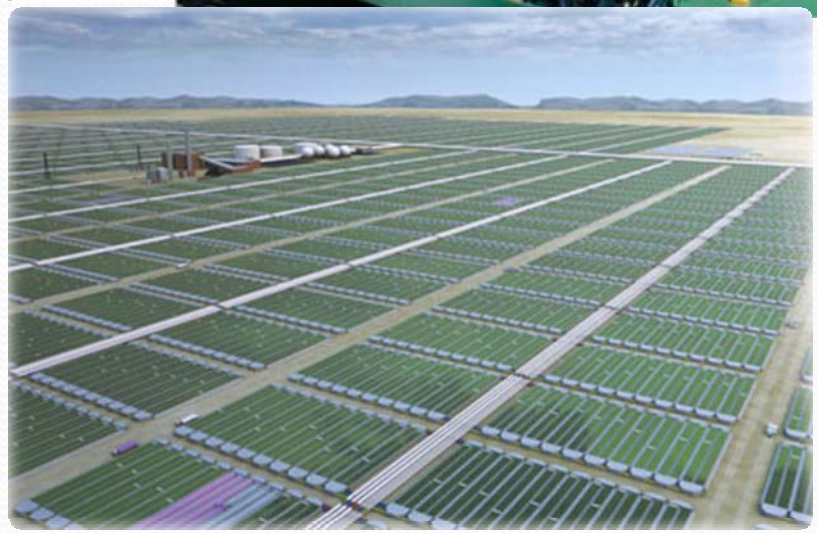
- Jatropha being proposed as an oil source for developing countries (grows on arid land, inedible, high oil yield).
- Needs to be domesticated (identify pesticides, diseases, fertilizer requirements).
- Meal contains toxins that prevent feeding it to animals.
- We are working with Matt Morra to measure the levels of toxins and how they are affected by processing.

Algae



- Still major technical issues with large scale cultivation. Probably at least 10 years out

- High cost of production is major issue.
  - High water consumption and invasive species require closed environment (bioreactor)
  - Closed environments are much more expensive than open ponds.
  - Solar-based systems are basically 2-D. They depend on surface area exposed to the sun They require lots of land.



- Other problems include:
  - Need for nitrogen stress cycle.
  - Oil extraction is difficult.