Renewable fuel standard and future of biofuels

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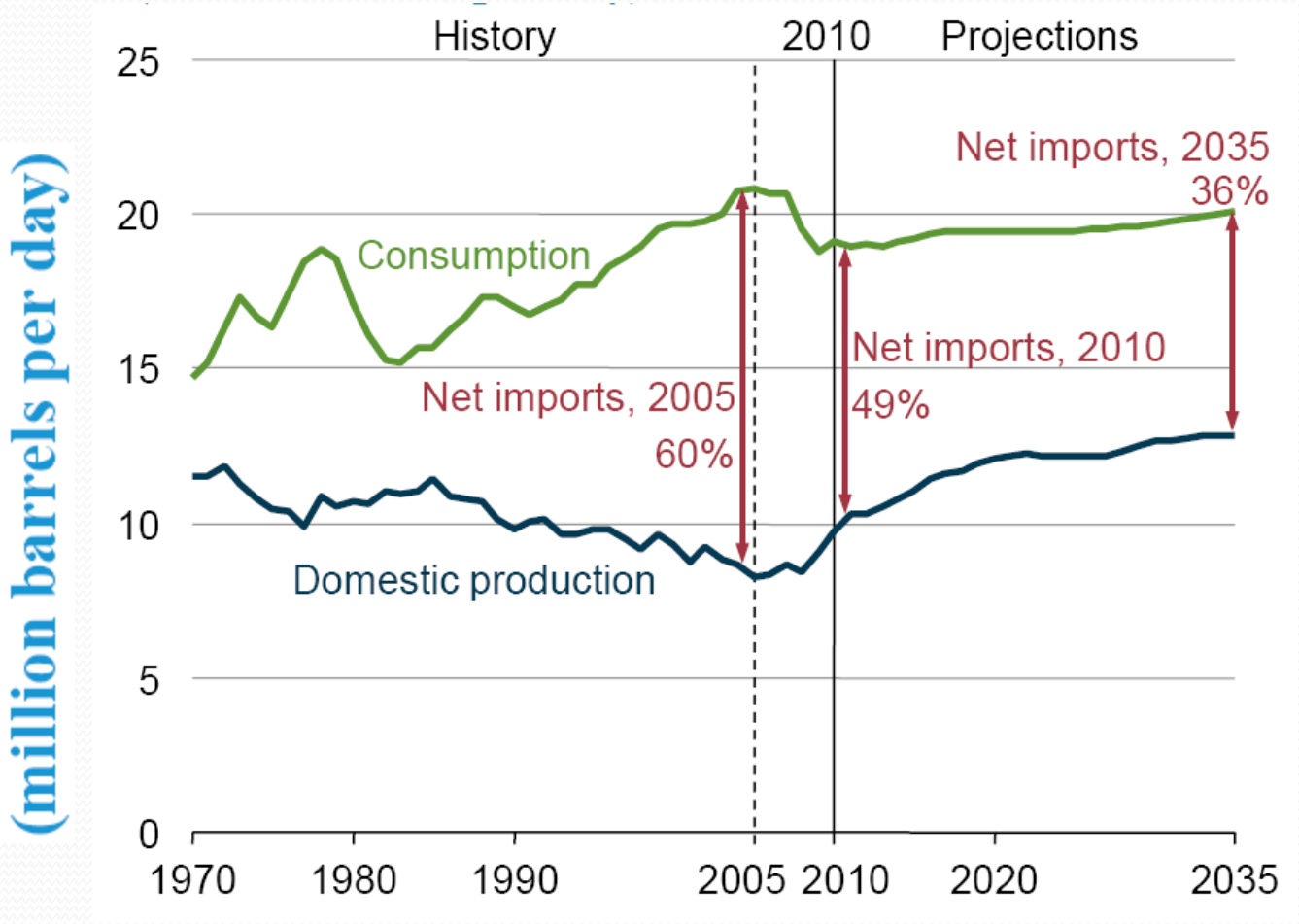
Crude oil supply and demand



This is one of the reasons for alternative fuel

Source: Annual Energy Outlook 2012

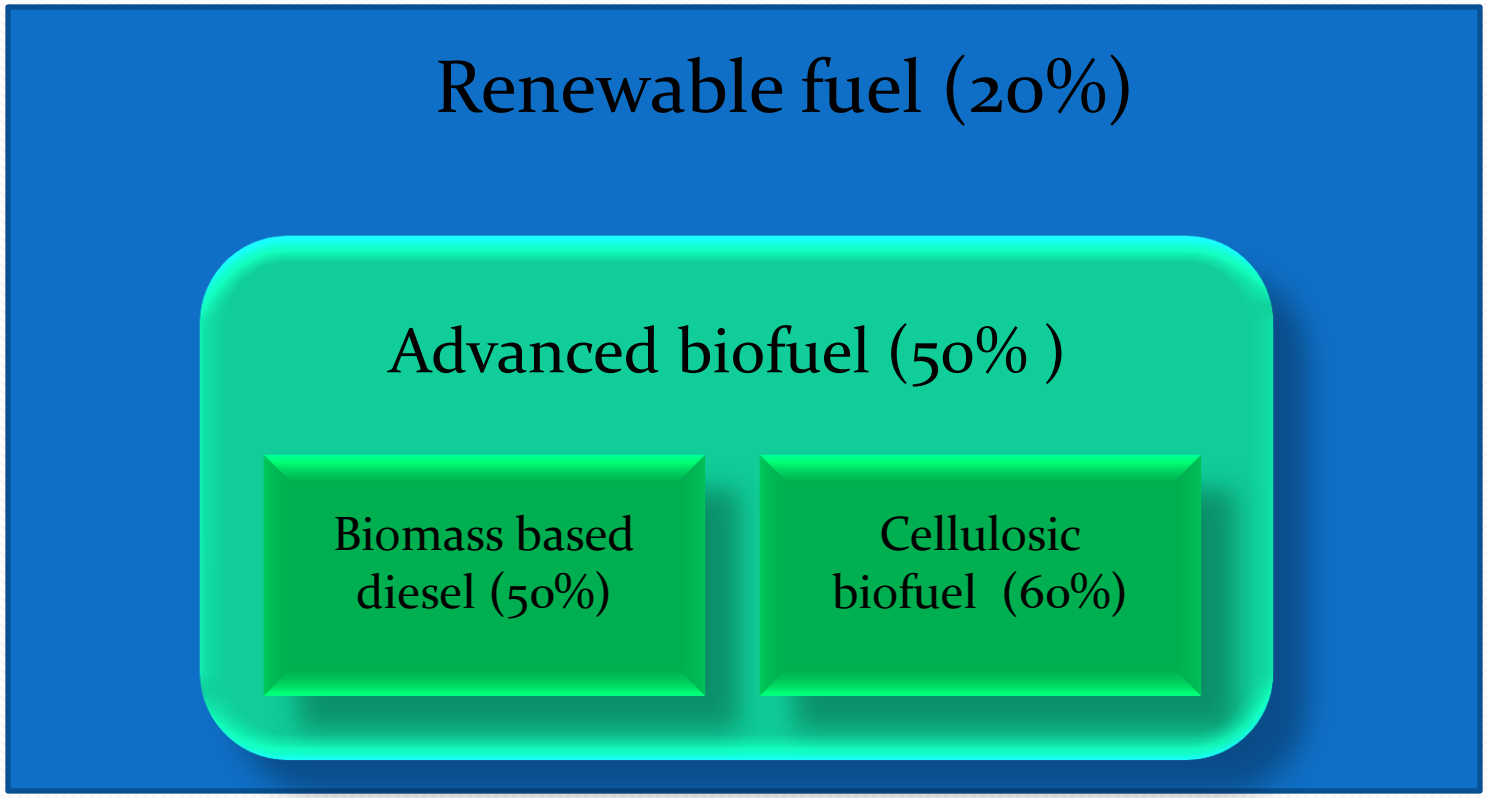
RFS1 and RFS2

- RFS1 enacted under EPAct of ‘05 required 4 bg of renewable fuel be used in ‘06 and 7.5 bg by ’12
- RFS1 was superseded by EISA of 2007 and now known as RFS2
- RFS2 is enacted by EPA
- RFS2 expanded the mandatory use of renewable fuel volume from 9 bg in ‘09 to 36 bg by ‘22.
- This volume in ’22 is expected to be about 20% of the national diesel and gasoline use.

Goals and Objectives

- Develop renewable source of energy
- Reduce environmental impact
- Energy Independence
- Boost local economy

Biofuel category is based on GHG reduction



Why LCA is important?

- Answers renewability
- Answers environmental benefits
- Answers sustainability
- Prevents investing extensive amount of money and resources in something that is not beneficial

Biofuel incentives

- Biodiesel tax credit -$1 / gallon extended to Dec 2013
- $1.01-per-gallon tax credit for cellulosic ethanol, biofuel made from sources other than corn kernels
- RIN equivalent gallon depends on energy density and LCA results –
  - Corn ethanol 1 physical gal = 1 RIN
  - Biodiesel, 1 physical gal = 1.5 RIN (eqv. ethanol gallons)
  - Cellulosic ethanol 1 physical gal = 2.5 RIN

LCA components

Attributional

Agriculture and Bean transport

↓

Crushing and oil transport

↓

Transesterification and Biodiesel transport

Consequential

Significant indigent land use change

Challenges in LCA

- Agricultural input categories

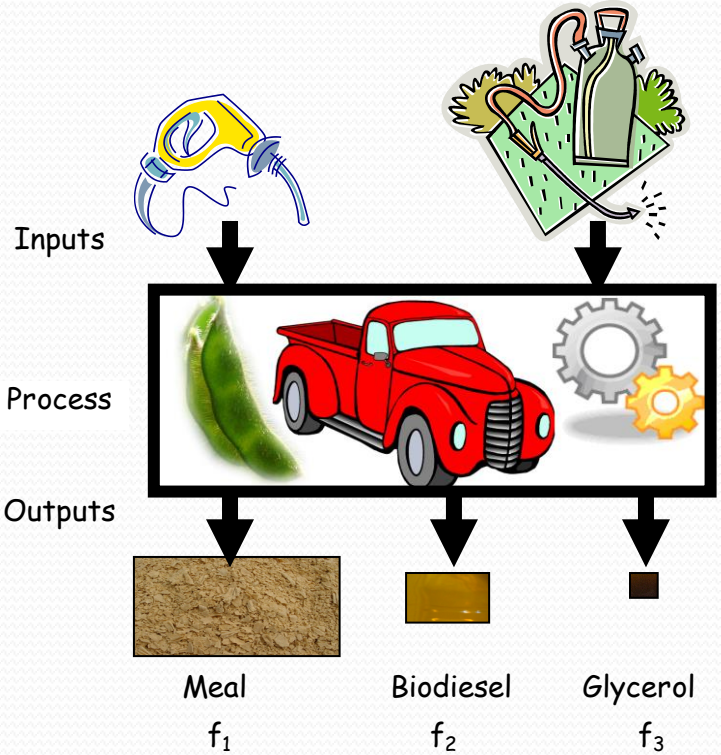
Diesel
Electricity
Gasoline
Herbicide
Insecticide
Labor
Lime
LP Gas
Machinery
Natural Gas
Nitrogen
Phosphorus
Potassium
Seeds
Transport

Inventory comparison (MJ/ha)

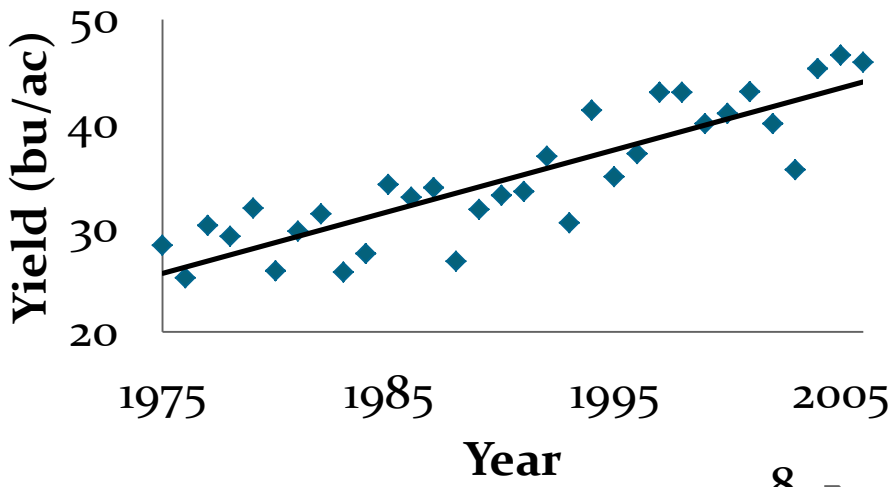
Inputs	Source 1	Source 2	Source 3	Source 4
Labor	-	-	-	1188.26
Machinery	-	-	-	1506.24
Diesel	2024.52	1933.40	2734.00	1849.33
Gasoline	-	864.48	1467.53	1129.68
LP Gas	-	75.93	103.91	104.60
Natural Gas	-	-	0.12	-
Nitrogen	263.36	502.04	761.02	246.86
Phosphorus	150.11	439.17	477.39	652.70
Potassium	206.18	460.36	282.61	200.83
Lime	-	-	-	5644.22
Seeds	-	-	315.69	2317.94
Herbicide	520.18	1231.28	1334.77	543.92
Insecticide		14.16	13.48	-
Electricity	-	46.73	160.70	121.34
Others	867.43	-	-	-
Sub Total	4,031.78	5,567.54	7,651.22	15,505.90

Co-product allocation

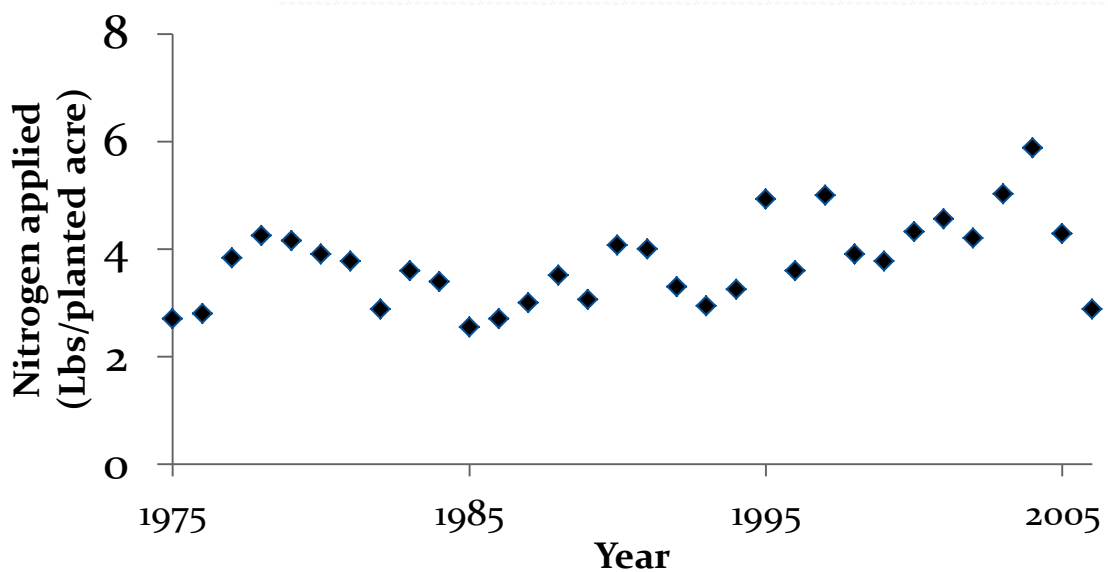
- Economic value basis?
- Energy basis?
- Replacement energy basis?
- Mass basis?



Temporal variation



When it come to agriculture,
It is important to use data from the same year



Past and current results

- NREL Results from using data from 1980-1990's
  - 3.21 units of energy output per unit of energy input for soybean biodiesel.
- Pradhan et al., Using data from 2002
  - 4.56
- Pradhan et al., Using data from 2006
  - 5.54

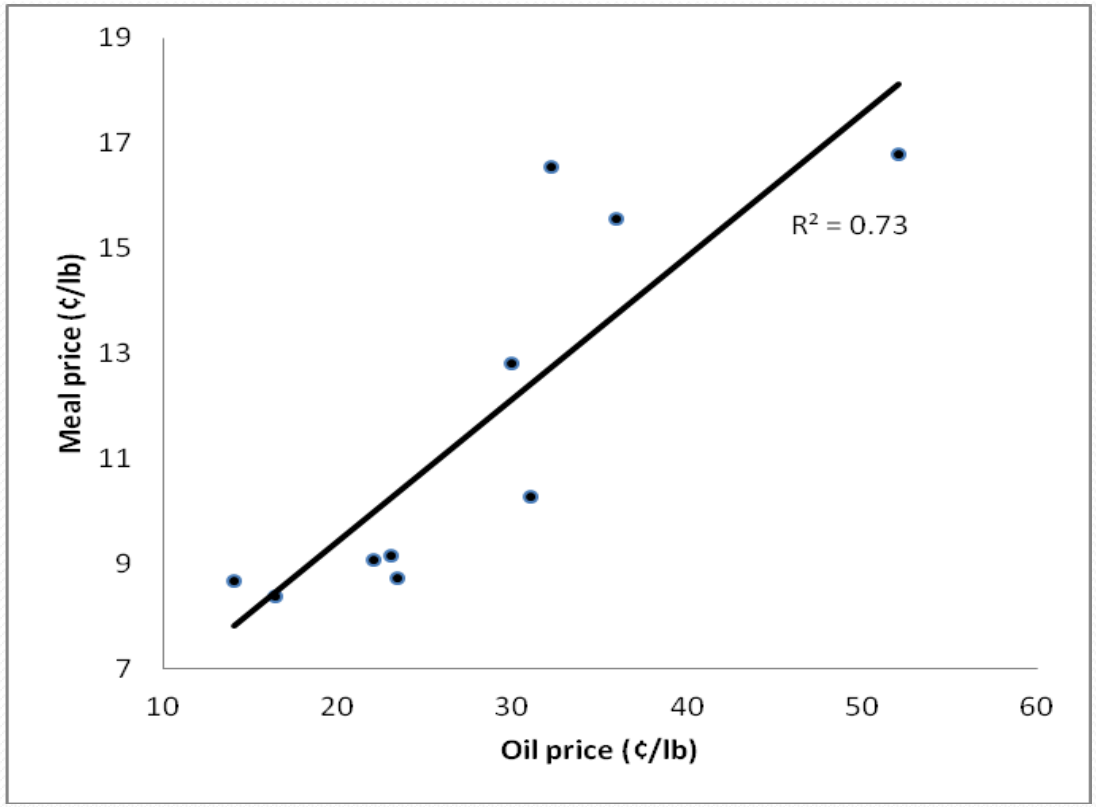
Consequential LCA

- Futuristic prediction
- Attempts to analyze the GHG impact of biofuels 30 years beyond year 2022
- Based on partial equilibrium model called GTAP (Global Trade Analysis Project) from Purdue University and FAPRI (Food and Agricultural Research Institute) from Iowa State University.

Co-product allocation

- The shift in equilibrium is coming from increased demand of oil for biodiesel.
- So the system is shocked with increased demand of biofuel to meet RFS2 mandate for 2022.
- Assumption,
  - Increased demand of oil is the driver is equilibrium shift so no co-product allocation is required

Assumption needs correction



Meal price increased $/$ of increase in soybean price.

Oil price increased only 94 ¢/$

Implications

- System expansion, is not adequate when underlying assumption does not hold.
- Blaming increase in Food price to biodiesel is not justified [at least at current level of production].

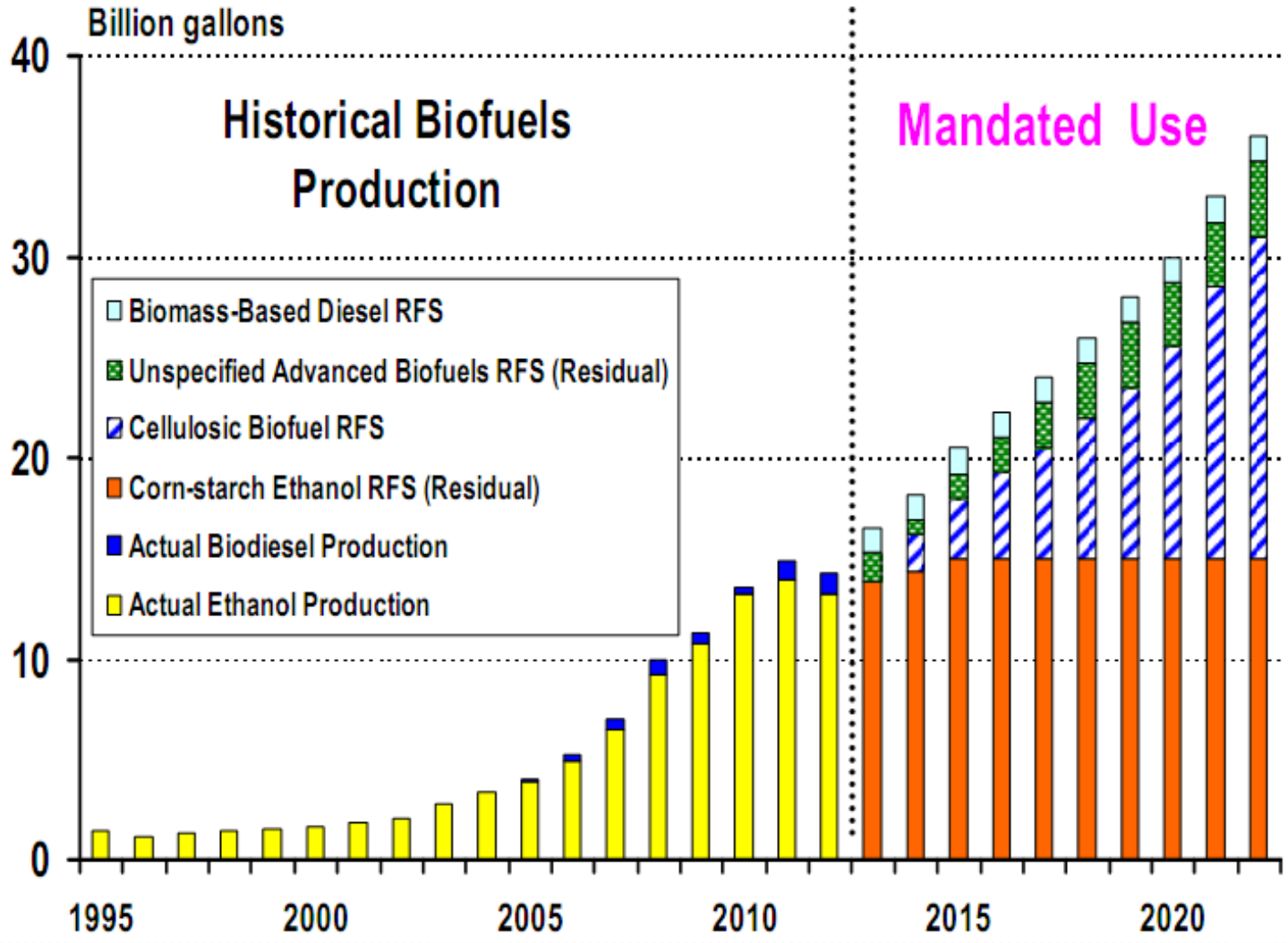
Change is results

- NREL 1998 report:
  - 78.5% reduction in GHG emissions form use of biodiesel.
- EPA Final rule in 2010:
  - 57% reduction in GHG emissions form use of biodiesel.
- Results using 2006 data
  - 81.2 % reduction in GHG emissions form use of biodiesel. Without consequential LCA
  - 76.4% reduction in GHG emissions form use of biodiesel. With consequential LCA & allocation

LCA Summary

- LCA results should be taken as grain of salts.
- LCA needs to be more regional and pathway specific.
- LCA needs more standardization and streamlined so that comparisons could be made.

Can we meet RFS2 mandate?



Cellulosic ethanol?

- In 2010 RFS2 mandate was lowered to 6.5 m gal from 100 m gal
- In 2011 RFS2 mandate was lowered to 6 m gal from 250 m gal.
- In 2012 RFS2 mandate was lowered to 10.45 m gal from 500 m gal.
- 2012 RINs registered for cellulosic ethanol was 20 k gal. API challenged EPA in court. In January of 2013 cellulosic ethanol requirement for 2011 and 2012 was reduced to 0.

For more information on biodiesel

- www.BiodieselEducation.org
- http://www.extension.org/ag_energy >> Biodiesel