Resource assessment needs, sustainability issues, and life-cycle standards associated with biofuels development

Agriculture's Role in the New Carbon Economy

CASMGS

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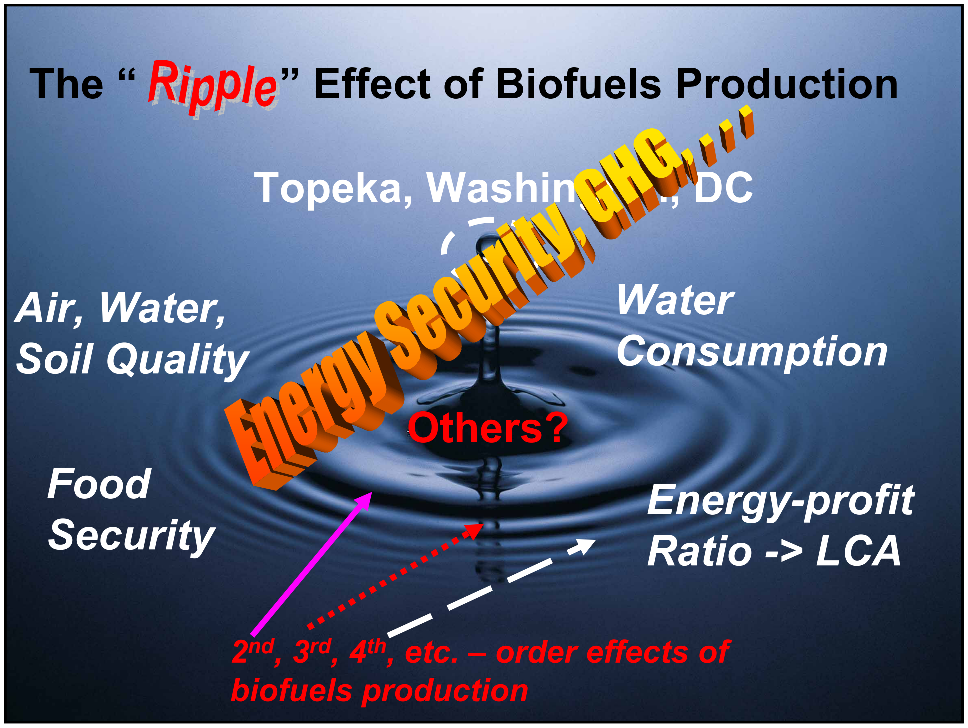
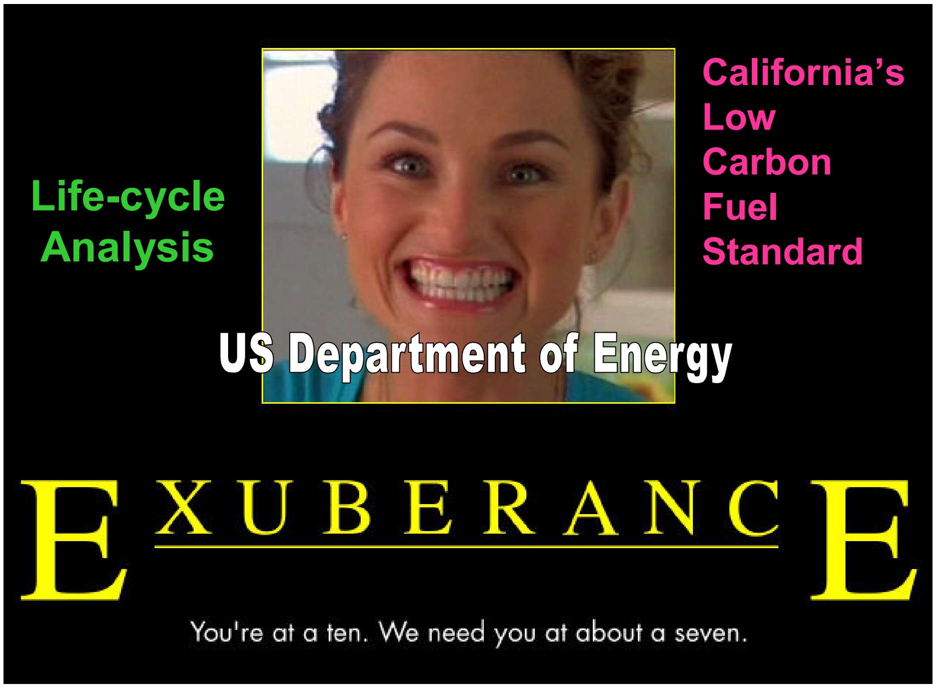


Resource Assessment & Supply Analyses – **Considering "Upstream" Effects**

- Resource Assessment & Supply Analysis is the most important factor in determining:
  - energy inputs and outputs ⟶ energy-profit ratio
  - environmental implications, and
  - economic feasibility of biomass-related production and utilization scenarios

- Many studies conducted and many assumptions made and applied - **it's time to get "very real" about agriculture's role to sustainably provide the resource if the world intends to go down this path**



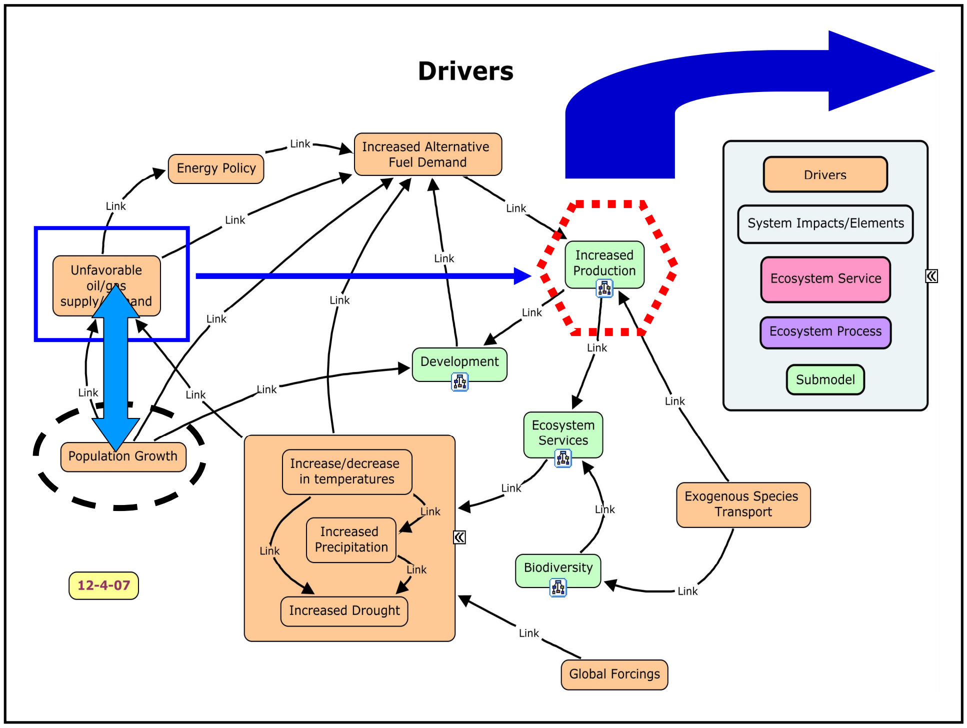
Exuberance: Government Biofuel Mandates

- US – 35 billion gallons (133 billion liters) by 2017 (20% of projected total consumption)
- EU – 5.75% by 2010; 10% by 2020; 25% by 2030
- China – 5% biodiesel
  - China has said it aims to use **2 trillion liters** by 2020.

(~ 530 million gallons of B100)

Why? Energy Security, "Peak Oil", & Climate Change

How will these intersect with market forces, where exactly will the feedstocks come from, at what price, and what affect on food security?



"Twenty in Ten"

In his 2007 State of the Union Address, President Bush set a goal of reducing America's gasoline consumption by 20 percent over the next 10 years.

Key Point:

"Increasing The Supply Of Renewable And Alternative Fuels By Setting A Mandatory Fuels Standard To Require **35 Billion Gallons Of Renewable** And Alternative Fuels In 2017 – Nearly Five Times The 2012 Target Now In Law."

http://www.whitehouse.gov/news/releases/2007/02/20070222-2.html

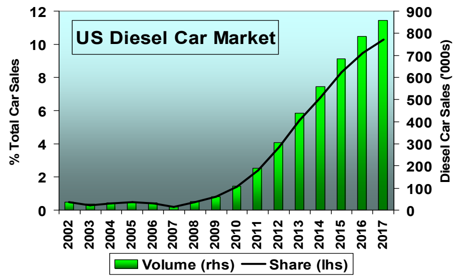
Nice Little Saying, but . . .

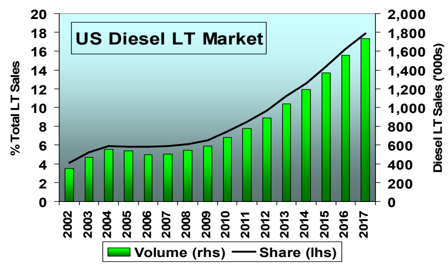
Concerns:

1) Land-base availability with detailed land capability class information (where **exactly** are we going to grow the biofuel crops?)
2) CRP pulled into production; release of C?
3) Sustainable feedstock production (yields) and supply (quantity at cost)
4) Allowances for seasonal variability due to climate, etc.
5) Sustainability metrics and consistent evaluation (C/GHG emissions, energy-profit ratio, and soil quality to just mention a few)

One Driver: World Transport Vehicle Trends – Diesel

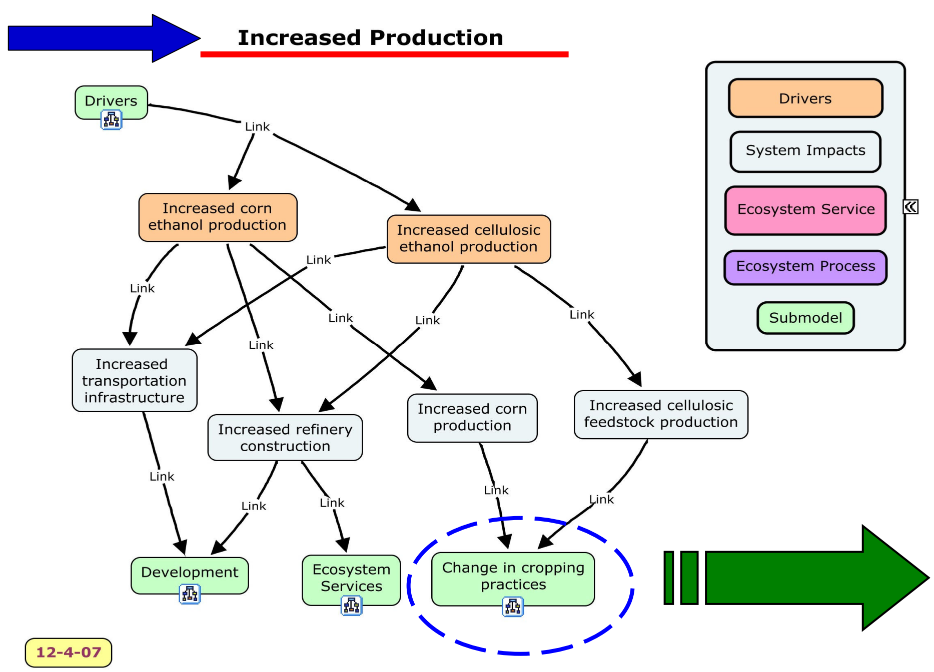
Direct Impact on Biofuels Production and Demand





- Global share of diesel market has increase 40% in the last 5 years
- Conditions for further expansion of diesel look right:
  - Global focus on CO_2 & Energy Security
    - ✓ High energy prices (diesel ~33% more efficient versus gasoline)
    - ✓ Diesel technology has come of age (not dirty diesels anymore)

Where are the oilseed feedstocks going to come from to "fuel" this increase if "green" fuels are demanded?



Background - Economics

- **Oil & Agriculture are commodity markets**
  - **supply and demand effect pricing**
  - in a given market, the lowest cost producer will always win

- Many factors affect the markets –
  - Currency
  - Trading
  - Interest rates
  - Fads and trends
  - Policy
  - Technology
  - Consumers
  - Emerging markets

There will be continued growth in renewable fuels

Annual Oils & Fats – **Increases** up to 2015

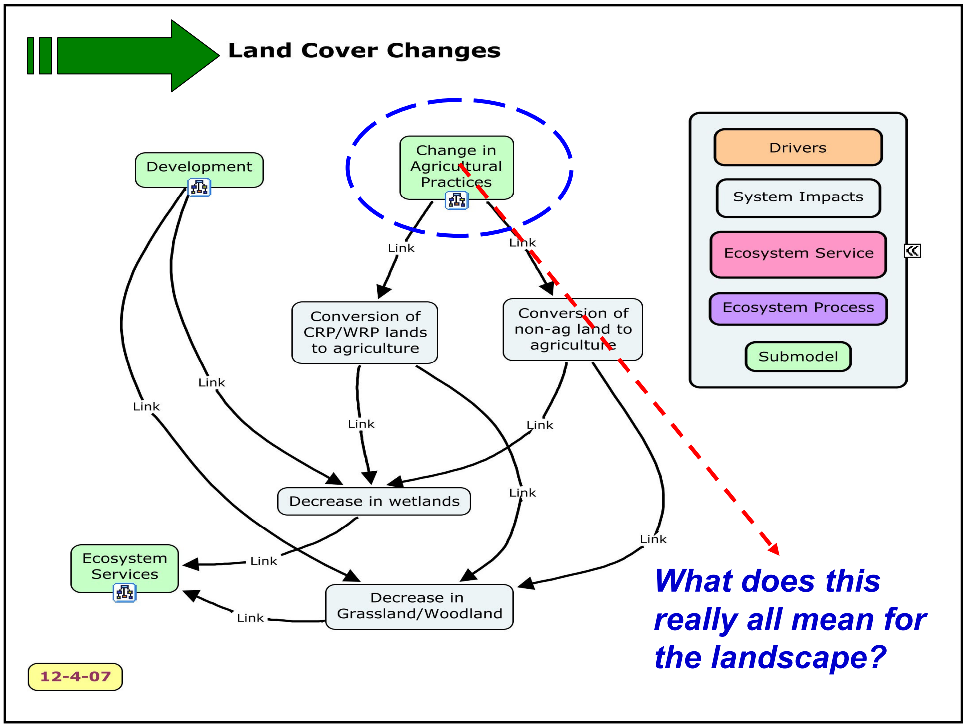
- Food use 4-5 million metric tonnes (mmt) Non-food use 5-6 mmt
- Biodiesel production projections:
  - 2015 ~ 50 million metric tonnes
- Annual requirement: **~10 million metric tonnes per year**

$US/tonne for 4 major world oilseeds

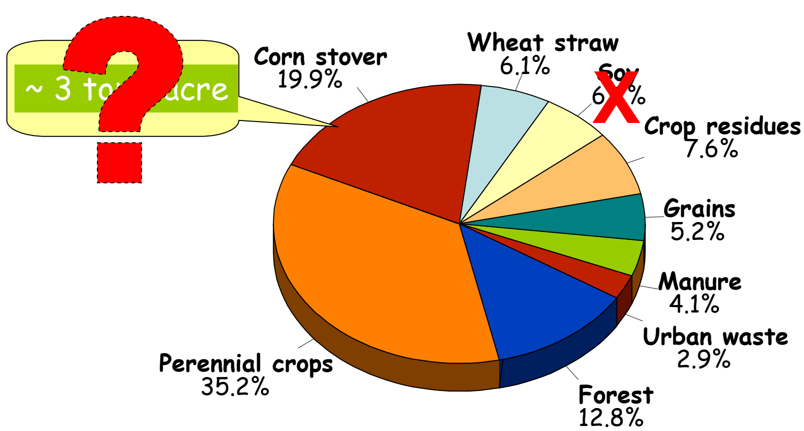
	palm	soya	rape	sun
05/06	416	573	770	635
06/07	655	771	852	846

These play havoc on world oils and fats markets for both food and fuel

source: Frank Gunderson, Scotland



US Biomass Inventory = 1.3 billion tons



From: Billion Ton Vision, DOE & USDA 2005

Life-cycle Analyses (LCA)

- What is the "best" model or is there one?
- What inputs are considered?
- How are these inputs estimated, determined, etc?
- Who are we doing this for and do they know what it really means?

Real need worldwide exists for standardization of input parameters and understanding of what output values really mean

Some Thoughts Regarding Resource Assessment & Biofuels Supply

- There is much we don't know about sustainable biofuels production
  - long-term effect (+/-) on soil tilth
  - what is the "net" effect versus the current alternatives
- National studies are <u>possibly</u> o.k. to get an "order of magnitude" view, but all biofuels production (*<u>like politics</u>*) is local; need to evaluate all resources on a localized basis
- Kansas, I believe, has much to offer in the way of biofuel feedstock production, but it needs to be carefully examined in the context of "sustainability" and not quickly jump on the bandwagon because everyone else is doing it

Current (FY08) Bioenergy Resource Assessment Work at KSU through the CSE

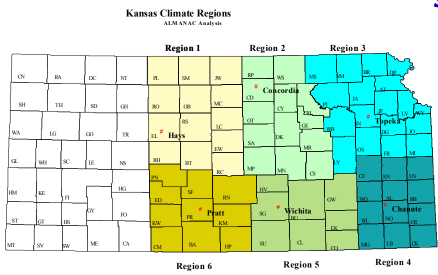
- Detailed Corn Stover and Wheat Straw Residue Retention and Removal Analysis with respect to:
  - soil erosion and carbon,
  - energy-profit ratio, and
  - yield variation
- Yield Analysis for Select Biomass Feedstocks in Kansas with respect to:
  - soil types and climate, and
  - production scenarios with varying field management scenarios → EPR

Continuous Corn Remaining and Removable Residue by Individual Soil Type

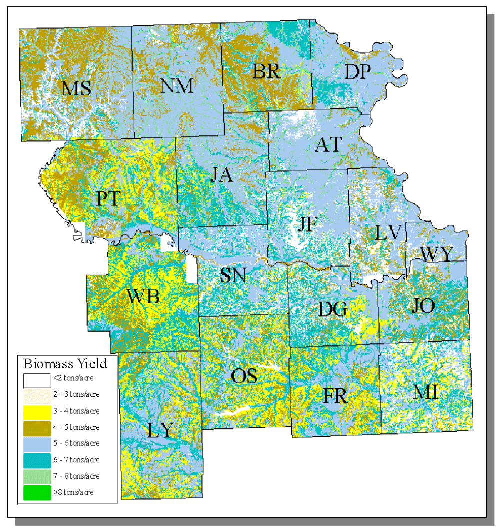
State	County	Corn Yield (bushels/ acre)	Corn Residue Gross (tons/acre)	CT Corn Annual Average Residue Remain (tons/acre)	CT Corn Residue Remove (tons/acre)	MT Corn Annual Average Residue Remain (tons/acre)	MT Corn Residue Remove (tons/acre)	NT Corn Annual Average Residue Remain (tons/acre)	NT Corn Residue Remove (tons/acre)	SSURGO Acres	T	Soil ID
KS	ALLEN	92.88	2.20	**1.235**	0.962	**0.639**	1.558	**0.093**	2.104	8,258	5	1
KS	ALLEN	92.88	2.20	**5.992**	0	**3.598**	0	**1.683**	0.515	7,897	3	2
KS	ALLEN	92.88	2.20	**4.752**	0	**2.792**	0	**1.1**	1.097	216	5	3
KS	ALLEN	92.88	2.20	**6.869**	0	**4.178**	0	**2.161**	0.037	295	2	4
KS	ALLEN	92.88	2.20	**4.366**	0	**2.545**	0	**0.942**	1.255	38,544	2	5
KS	ALLEN	92.88	2.20	**4.391**	0	**2.561**	0	**0.952**	1.245	22,660	5	6
KS	ALLEN	92.88	2.20	**1.657**	0.541	**0.882**	1.316	**0.16**	2.038	689	5	7
KS	ALLEN	92.88	2.20	**3.905**	0	**2.252**	0	**0.768**	1.429	517	3	8
KS	ALLEN	92.88	2.20	**0.67**	1.527	**0.328**	1.87	**0.03**	2.167	1,921	3	9
KS	ALLEN	92.88	2.20	**0.889**	1.308	**0.446**	1.751	**0.051**	2.146	12,218	5	10
KS	ALLEN	92.88	2.20	**0.202**	1.995	**0.088**	2.109	**0.003**	2.194	98	5	11
KS	ALLEN	92.88	2.20	**2.806**	0	**1.569**	0.628	**0.419**	1.778	29,705	5	12
KS	ALLEN	92.88	2.20	**7.347**	0	**4.497**	0	**2.444**	0	1	3	13
KS	ALLEN	92.88	2.20	**7.731**	0	**4.755**	0	**2.683**	0	4,968	3	14
KS	ALLEN	92.88	2.20	**7.347**	0	**4.497**	0	**2.444**	0	1,477	3	15
KS	ALLEN	92.88	2.20	**6.861**	0	**4.173**	0	**2.156**	0.041	16	5	16
KS	ALLEN	92.88	2.20	**8.418**	0	**5.219**	0	**3.136**	0	12,559	2	17
KS	ALLEN	92.88	2.20	**6.433**	0	**3.889**	0	**1.916**	0.281	1,763	3	18
KS	ALLEN	92.88	2.20	**5.191**	0	**3.075**	0	**1.293**	0.904	37	4	19
KS	ALLEN	92.88	2.20	**3.418**	0	**1.947**	0.25	**0.602**	1.596	438	3	20

6-year average yield used; need to use individual year data to judge sensitivities and get a true sense of the resource

Kansas Energy Crop Analysis



Switchgrass Yields NE Kansas – by individual soil type



- Performed an Environmental Analysis on Switchgrass Production versus Current Agricultural Cropping Practices on all LCC I-VIII Lands

One Strategy for Biomass and Soil and Water Quality

Selective Targeting of Soils within a County for Biomass Removal and Production

Jefferson County, Kansas (NE Kansas)

County & Soil	Area (acres)	Erosion Index (EI)	Maximum Switchgrass Yield (tons/acre)	Minimum Switchgrass Yield (tons/acre)	Average Switchgrass Yield (tons/acre)	Average Annual C Sequestration Potential (tons/acre/year)	Total Switchgrass Production (tons) at 25% Penetration	Total Gallons of Bioethanol
STEINAUER	10	24.06	12.44	0.25	5.22	0.7158	13	956
KONAWA	692	11.13	11.63	1.29	5.72	0.7600	990	74,220
MARTIN	38,493	14.97	12.82	1.48	6.29	0.8098	60,501	4,537,612
PAWNEE	100,805	11.97	10.99	1.25	5.57	0.7469	140,442	10,533,114
SHELBY	46,837	**12.99**	11.43	1.27	5.44	0.7349	63,657	**4,774,296**
OSKA	15,058	**37.28**	8.98	0.17	4.07	0.6151	15,337	**1,150,307**
SOGN	8,174	**28.93**	4.52	0.01	1.76	0.4110	3,587	**269,003**
JUDSON	2,314	9.06	13.78	0.78	6.30	0.8111	3,646	273,423
VINLAND	39,462	**47.62**	6.16	0.01	2.59	0.4846	25,569	**1,917,694**
SIBLEYVILLE	3,173	15.10	7.84	0.14	3.34	0.5505	2,650	198,749
KENNEBEC	16,988	**2.97**	14.87	1.52	7.03	0.8753	29,862	**2,239,626**
GYMER	3,647	4.74	12.85	1.45	6.43	0.8223	5,862	439,639
WABASH	8,379	**3.93**	12.16	1.32	5.81	0.7675	12,163	**912,190**
EUDORA	7,675	7.63	10.71	1.18	5.34	0.7264	10,246	768,428
READING	6,137	**3.40**	12.45	1.43	6.24	0.8055	9,571	**717,827**
GRUNDY	28,986	**3.93**	11.72	1.40	5.89	0.7746	42,664	**3,199,816**
KIMO	4,400	3.40	11.59	1.26	5.62	0.7508	6,178	463,335
MORRILL	2,572	7.63	10.68	1.27	5.40	0.7320	3,475	260,624
HAIG	1,622	3.93	10.59	1.03	5.30	0.7229	2,149	161,199
WYMORE	320	6.68	9.85	1.10	4.98	0.6945	398	29,833
SARPY	1,404	5.48	8.70	0.96	4.48	0.6510	1,574	118,045

Possible Candidates for ACR Removal on these Soil Types

Begin Targeting Herbaceous Energy Crop Production on these Soil Types