National Biodiesel Board: Food and Fuel

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May 24, 2011

Food and Fuel

- The objectives of agriculture
- Land use in the United States and agricultural surpluses
- Feed vs. Fuel?
- Efficiency and agricultural progress
- Diverse landscapes and adaptable cropping systems_ California examples

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CALIFORNIA biomass COLLABORATIVE

The objectives of agriculture:

1. To provide an adequate food supply for a growing human population at a reasonable price.
2. To provide an increasingly high quality diet for all the world's people.
3. To maintain the income of farmers at levels comparable to that of the urban population
4. To maintain the natural resource base of agriculture.
5. To use non-renewable resources prudently.
6. To maintain and provide habitat and resources for other species, and to maintain the function of supporting natural ecosystems.

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6. To maintain and provide habitat and resources for other species, and to maintain the function of supporting natural ecosystems.
7. To produce transportation fuels and other forms of surplus energy from crops and crop residues.

Adding this additional objective requires a rebalancing of all objectives.

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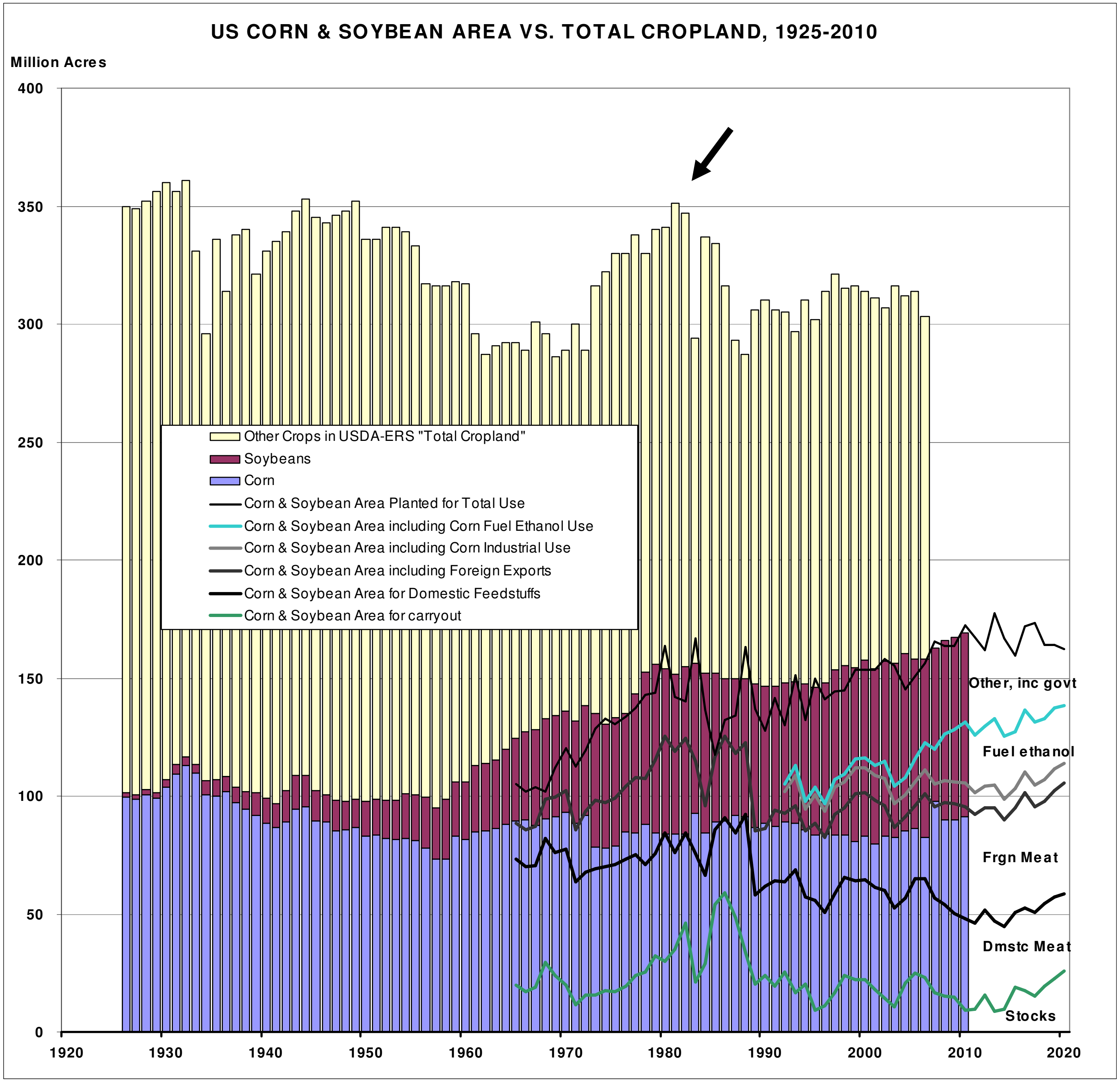
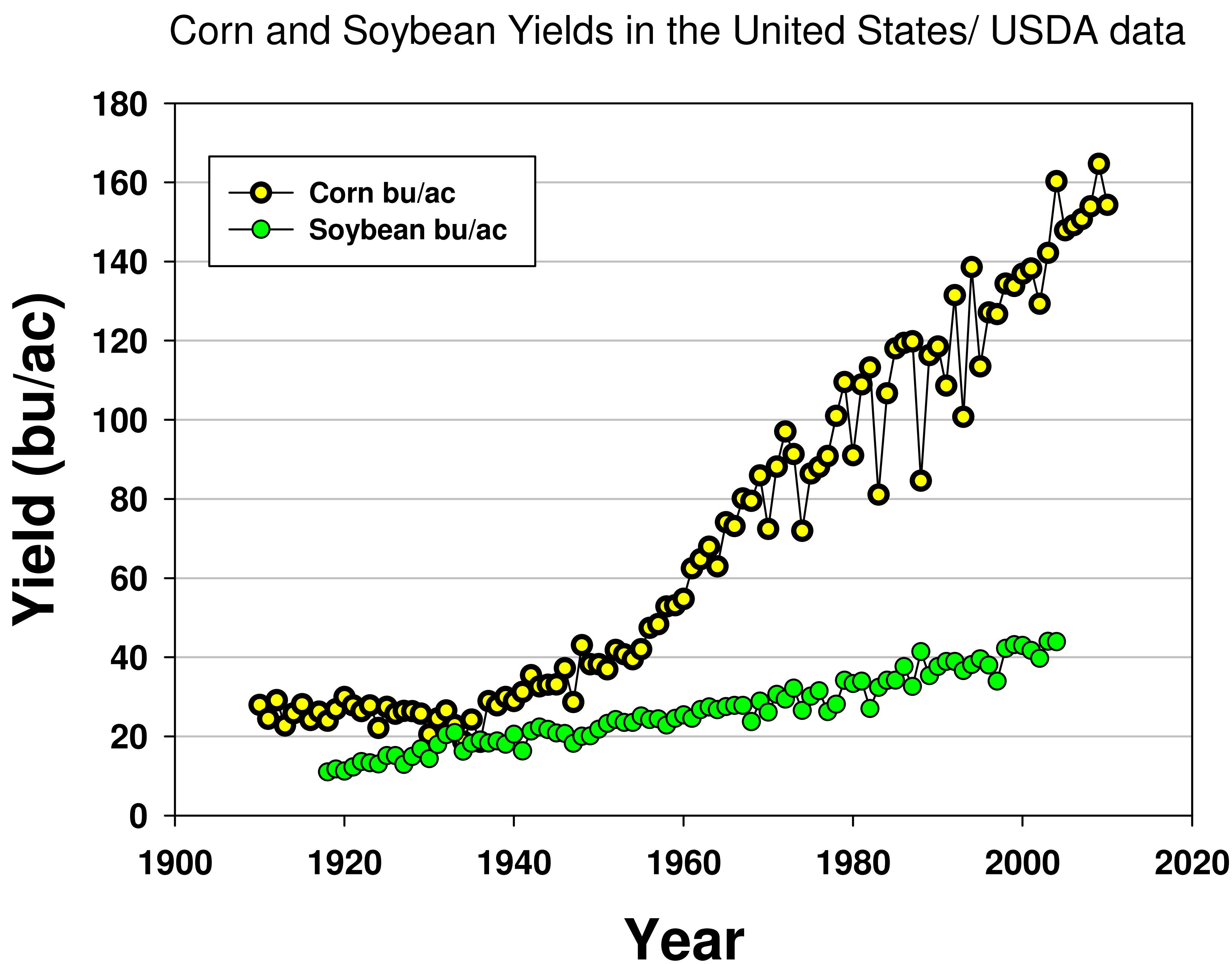


Courtesy of W. Hudson, PRX 2011

Food vs Fuel

- Total Farmland in the US has declined. Causes: urbanization and other land conversion, government policy (CRP), improved efficiency, retirement of marginal farms and farmland.
- The amount of land devoted to soybeans has increased at the expense of other crops like wheat and cotton. Soybean demand in recent years has been increasingly driven by international markets.
- Yields have increased significantly for most basic US crops, but especially corn and soybeans.


Corn and Soybean Yields in the United States/ USDA data
Corn bu/ac
Soybean bu/ac
Yield (bu/ac)
Year
0
20
40
60
80
100
120
140
160
180
1900
1920
1940
1960
1980
2000
2020

CRITICISM OFF THE ADVERSE EFFECTS OF CHEAP US GRAIN:

"Since the US is the world's largest exporter of cereal grains, its domestic and foreign policy has as significant impact on the world market.

US agricultural policy is (was) aggressively targeted at building new market share and promoting international reliance on US food exports.

Import dependency undermines international goals … to encourage food self-reliance and security from hunger.

US export-expansion policies have undermined foreign production capacity, altered consumer preference, and … created dependencies on imports of … grains.

The US …should abandon export subsidies and other practices harmful to international food security."

G. DiGiacomo, Institute for Foreign Policy Studies_1996

CRITICISM OFF THE ADVERSE EFFECTS OF CHEAP US GRAIN:

"NAFTA took a big toll on Mexico's small corn farmers"

…The agricultural elements of NAFTA were brutal on Mexico's corn farmers… A flood of US corn imports are blamed for the loss of 2 million farm jobs in Mexico…

_T. Johnson, McClatchy Press/February 5, 2011.

Its been a tripling, quadrupling, quintupling of US corn exports to Mexico, depending on the year… "

(T.A. Wise, Global Development and Environment Institute, Tufts Univ.; cited by Johnson)

"In the rain-fed corn areas of Oaxaca…one sees few young people…the men have gone to the United States."

_T. Johnson, McClatchy Press/February 5, 2011.

Feed vs Fuel ?

Greenhouse gas taxes on animal food products: rationale, tax scheme, and climate mitigation. Wirsenius et al., 2010. **Climate Change** (on-line):

"Agricultural emissions in the EU27 can be reduced by approximately 32 million tons of CO2eq with a GHG-weighted tax on animal food products corresponding to 60 euros/ton CO2eq. The effect of the tax is estimated to be six times larger if ligno-cellulosic crops are grown on the land then made available and used to substitute for coal in power generation…Most of the effect of a tax on animal food can be captured by taxing the consumption of beef."

"There should be a sustainability tag on every hamburger … !"

R. Vierhout

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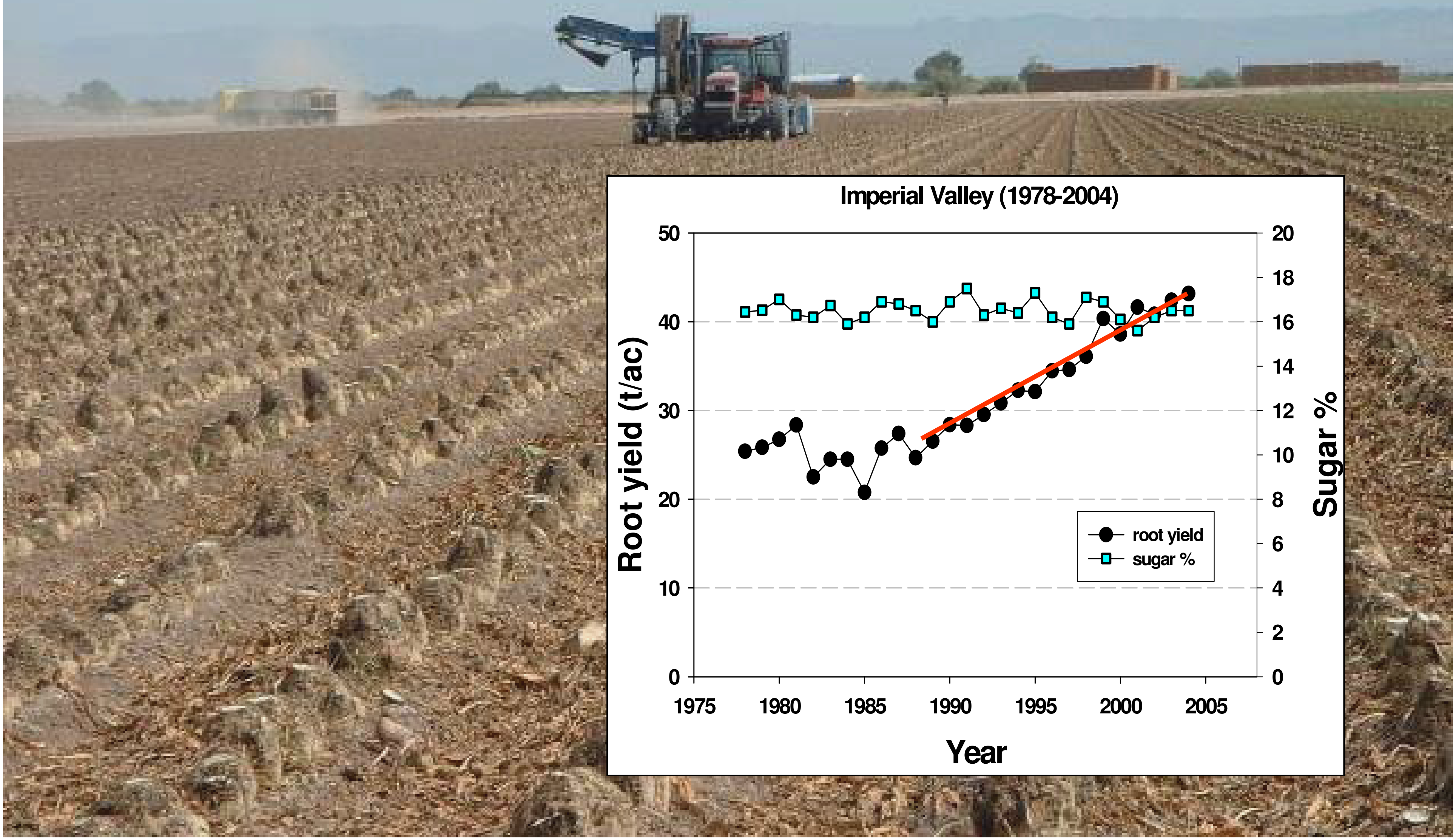
Corn’s Impacts, 1987-2007

Land Use	Soil Loss	Irrigation	Energy	Climate
Amount of land to produce one bushel of corn	Soil loss per bushel, above a tolerable level	Irrigation water use per bushel	Energy used to produce one bushel	Emissions per bushel
37%	69%	27%	37%	30%

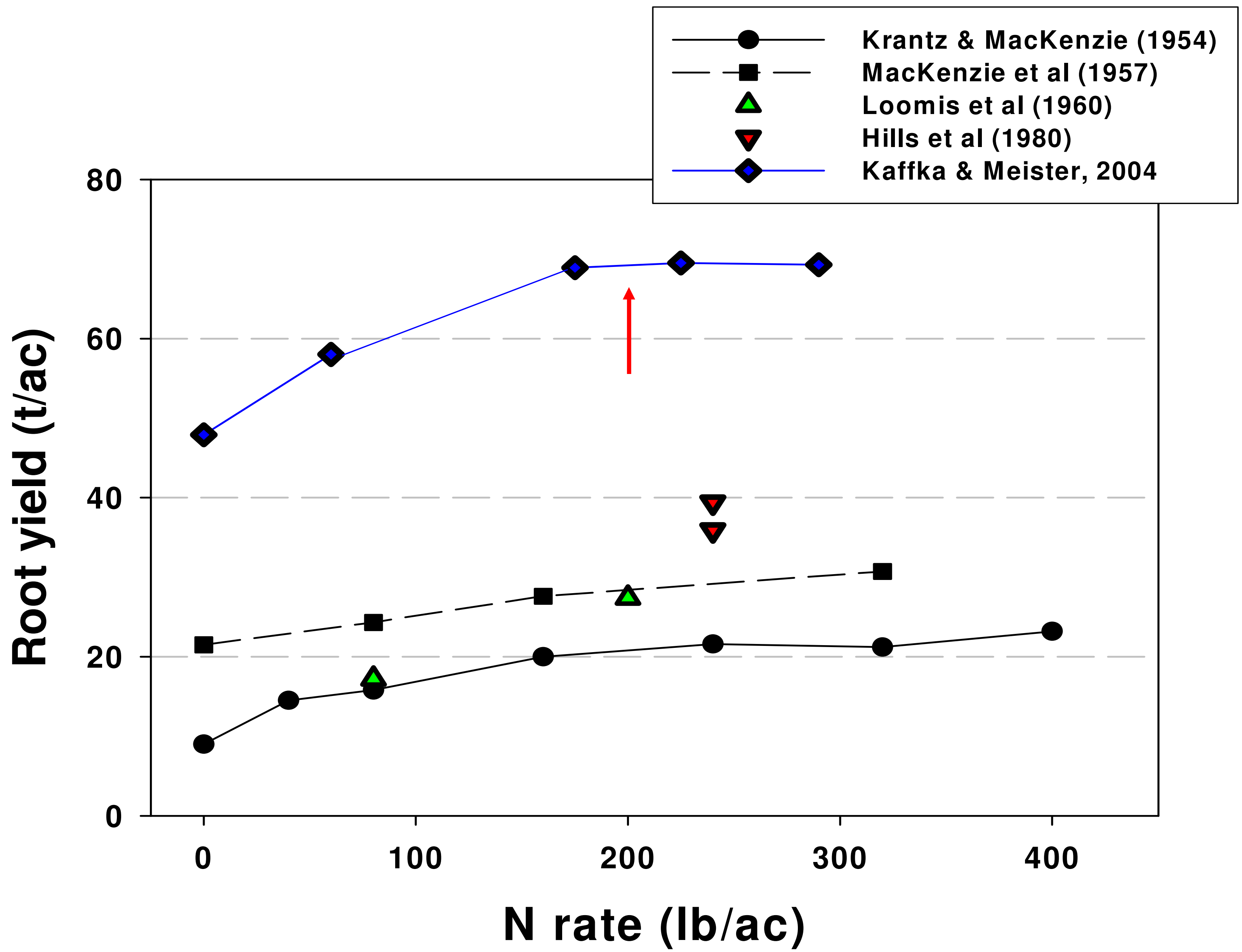
NCGA
www.ncga.com

Imperial Valley, August 2011 harvest

69.6 t/ac roots and 24,550 lbs sugar/ac



Sugar beet yields in the Imperial Valley

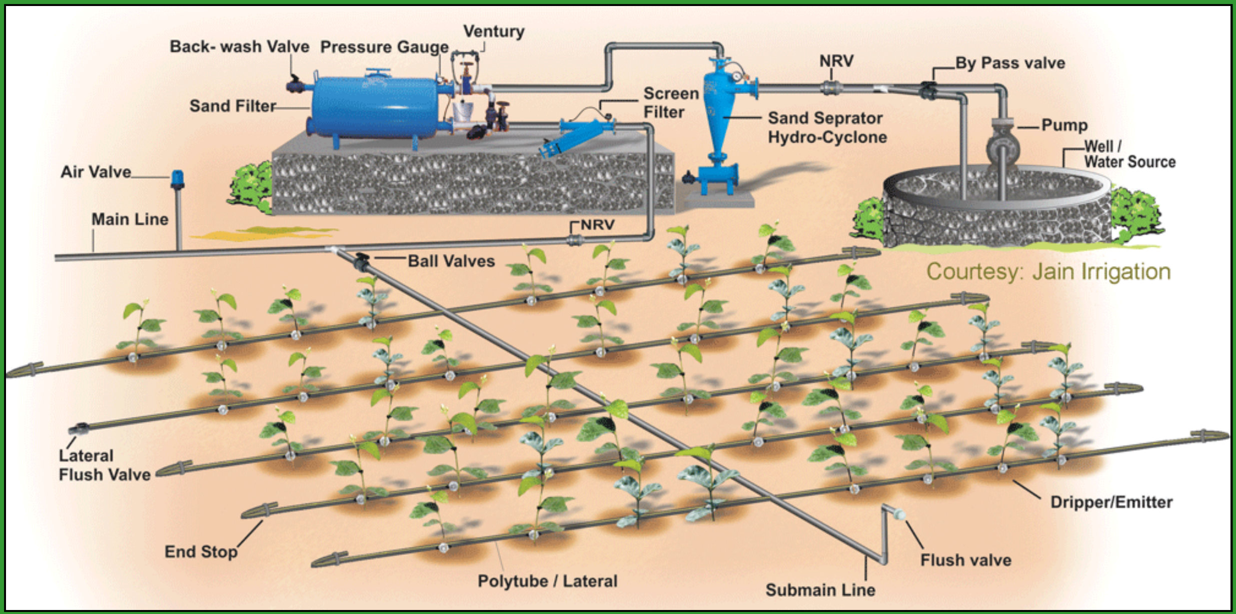


De Wit, 1992, Agric. Sys.

"… a feature of (agricultural) intensification is that it is not the improvement of one growing factor that is decisive, but the improvement of a number of them."

This leads to positive interactions that result in the total effect of all these improvements being larger than the sum of the effects adopted separately.

Drip irrigation



Increasing returns to total factor productivity :

The need for nutrients and water, expressed per unit surface area, increases with the yield level,

but decreases when expressed per unit yield.

De Wit, 1992

The overall environmental impact of food production is minimized via intensification.

But while the need for energy, fertilizers, and biocides per unit product is lowest, local environmental standards may be threatened … and

Cropping systems tend to become specialized, with fewer crops grown in the areas where it is most efficient to produce them.

Food vs Fuel ?

"…We estimate the net effect on GHG emissions of …agricultural intensification between 1961 and 2005...

While emissions from factors such as fertilizer…have increased, the net effect of higher yields has avoided emissions of up to 161 GtC (590 GtCO2eq) since 1961.

(Investments in)… yield improvements should be prominent among efforts to reduce future GHG emissions."

Greenhouse gas mitigation by agricultural intensification. Burney, J.A., et al., 2010. PNAS. On-line

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USDA Roadmap Estimates

Advanced Biofuel Production from New Capacity (billion gallons)

Region	% of Total Advanced Volume	Advanced Biofuels		Total Advanced Volume	Total Advanced RFS2 Basis (1)
		Ethanol	Biodiesel		
Southeast (2)	49.8	10.45	0.01	10.46	10.47
Central East (3)	43.3	8.83	0.26	9.09	9.22
Northeast (4)	2.0	0.42	0.01	0.42	0.43
Northwest (5)	4.6	0.79	0.18	0.96	1.05
West (6)	**<0.3**	**0.06**	**0.00**	**0.06**	**0.06**
United States		20.55	0.45	21.00	21.23

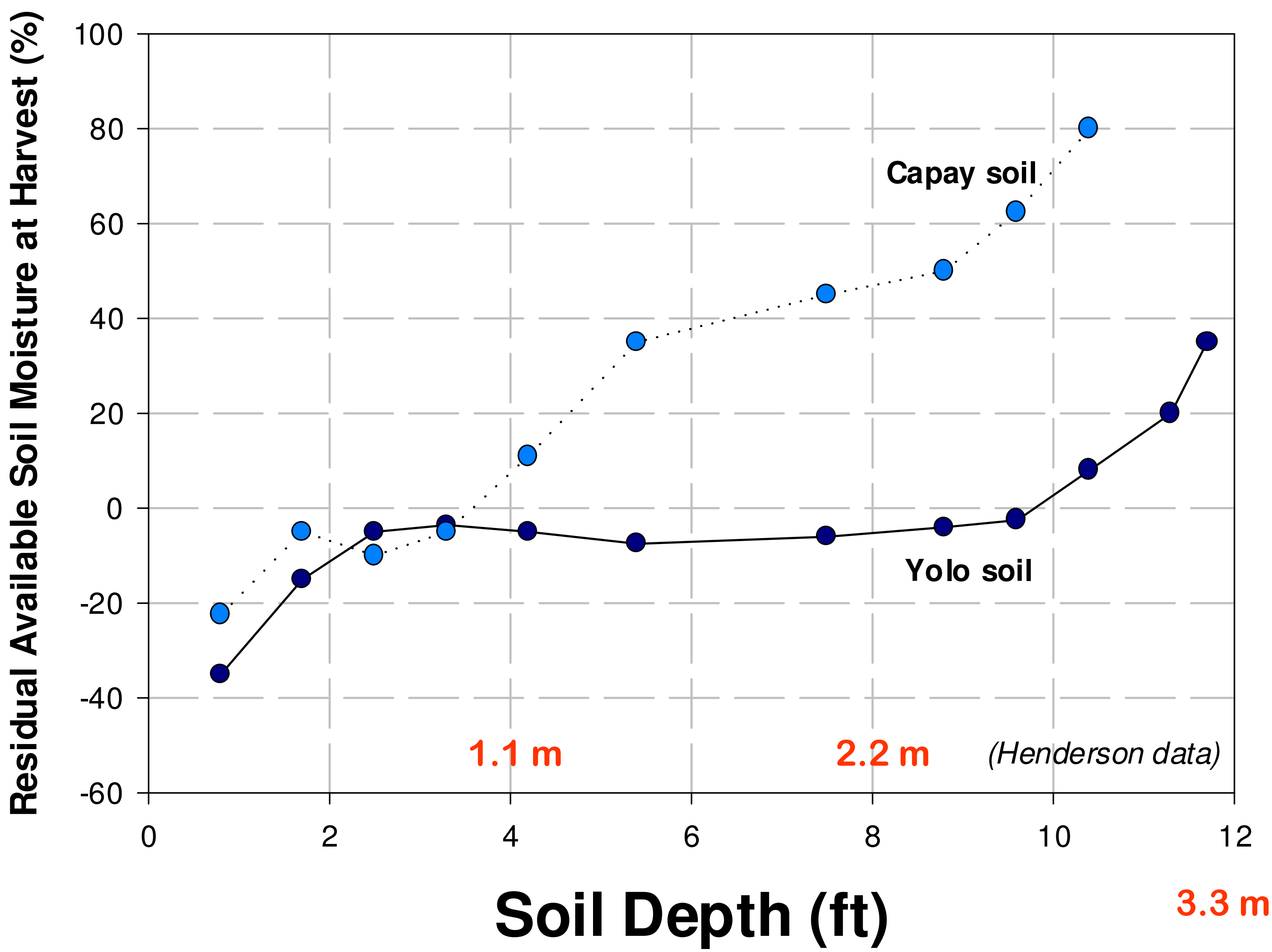
(1) RFS2 Basis - higher density fuels receive higher weighting relative to ethanol. Biodiesel is 1.5
(2) Feedstocks: Perennial grasses, soyoil, energy cane, biomass (sweet) sorghum, logging residues
(3) Feedstocks: Perennial grasses, canola, soyoil, biomass (sweet) sorghum, corn stover, logging residues
(4) Feedstocks: Perennial grasses, soyoil, biomass (sweet) sorghum, corn stover, logging residues
(5) Feedstocks: Canola,straw, logging residues
(6) Feedstocks: Biomass (sweet) sorghum, logging residues

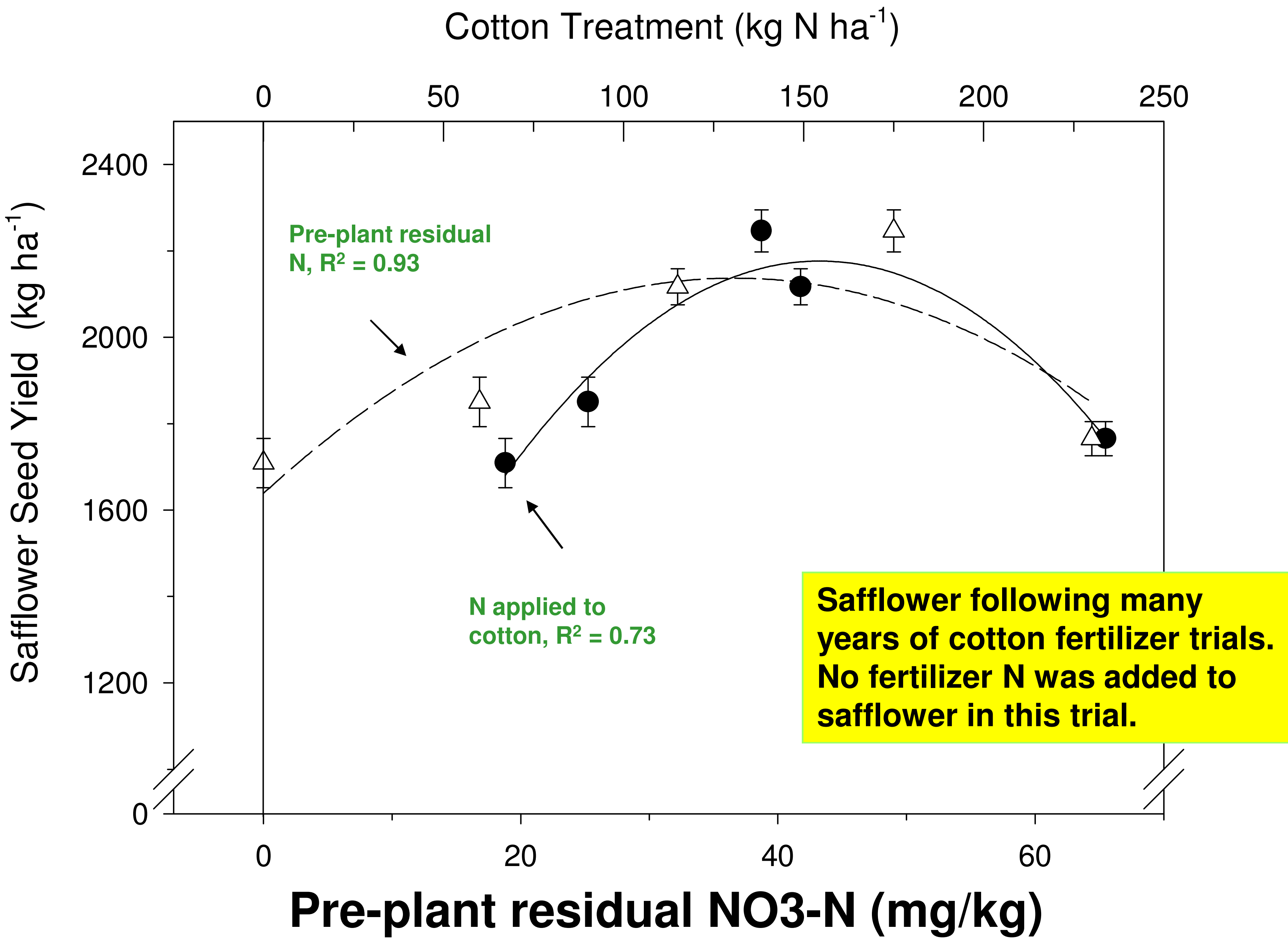
Safflower and Residual Nitrogen Management

Stephen Kaffka, Elias Bassil, Bob Hutmacher

Plant Sciences, UC Davis

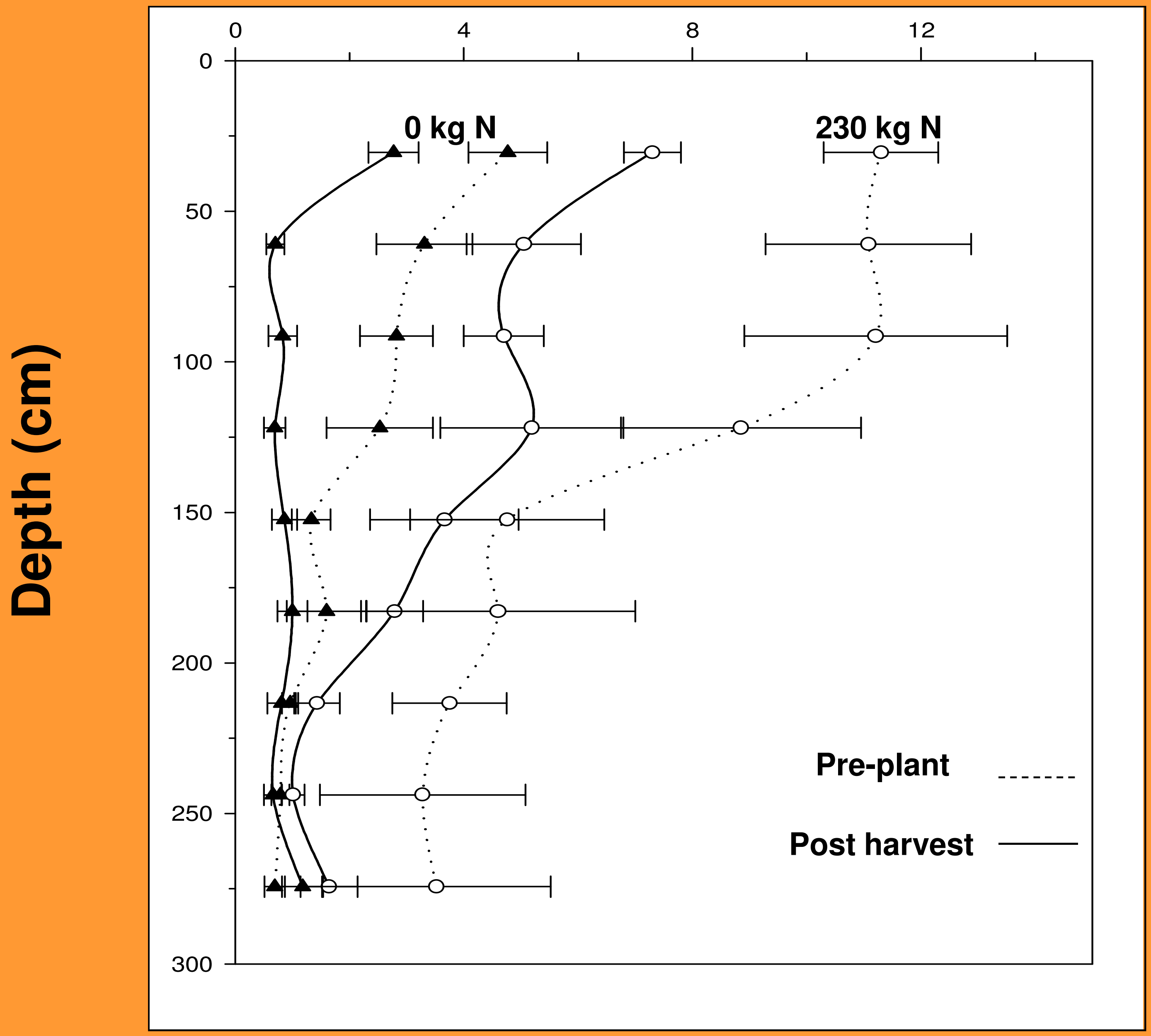
Soil Moisture Use and Soil Depth





Cotton Treatment (kg N ha-1)
0
50
100
150
200
250
Safflower Seed Yield (kg ha-1)
2400
2000
1600
1200
0
Pre-plant residual N, R² = 0.93
N applied to cotton, R² = 0.73
Safflower following many years of cotton fertilizer trials. No fertilizer N was added to safflower in this trial.
0
20
40
60
Pre-plant residual NO3-N (mg/kg)

Change in soil NO3-N during growth (mg/kg)



Food and Fuel:

Crops have multiple roles, and multiple effects in cropping systems, both positive and negative. In general, having more crop alternatives benefits agriculture and is widely considered to be a feature of agricultural sustainability.

It is important to think of biofuel crops and or crop uses in a cropping systems context.

Economic Simulation of Biofuel Crop Adoption

Mark Jenner, Fujin Yi, Maximo Alonso, and Steve Kaffka

A **B**ioenergy **W**ork **G**roup **P**roject

The Challenge…

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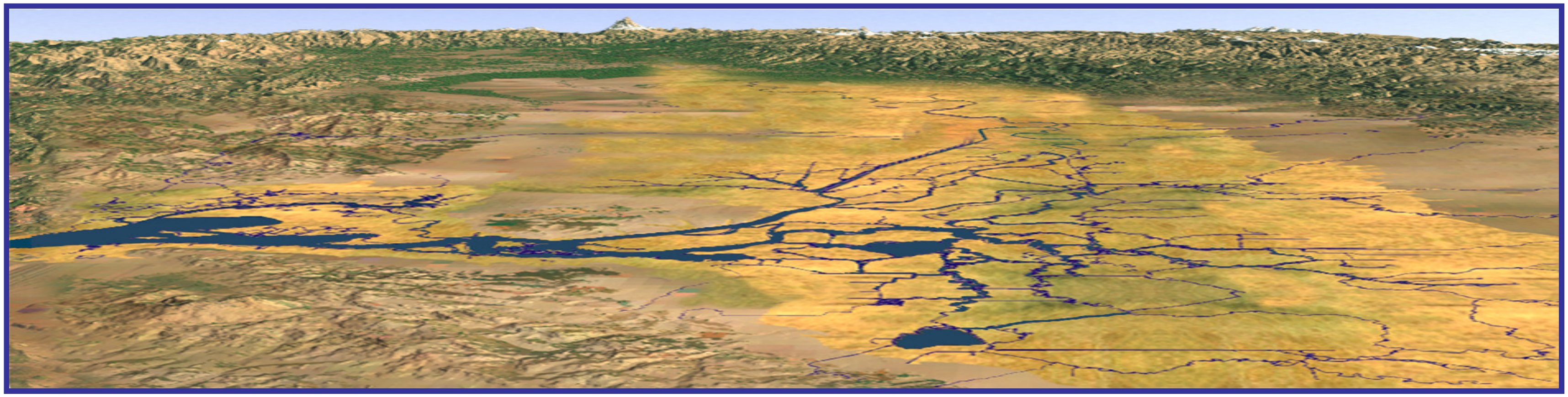
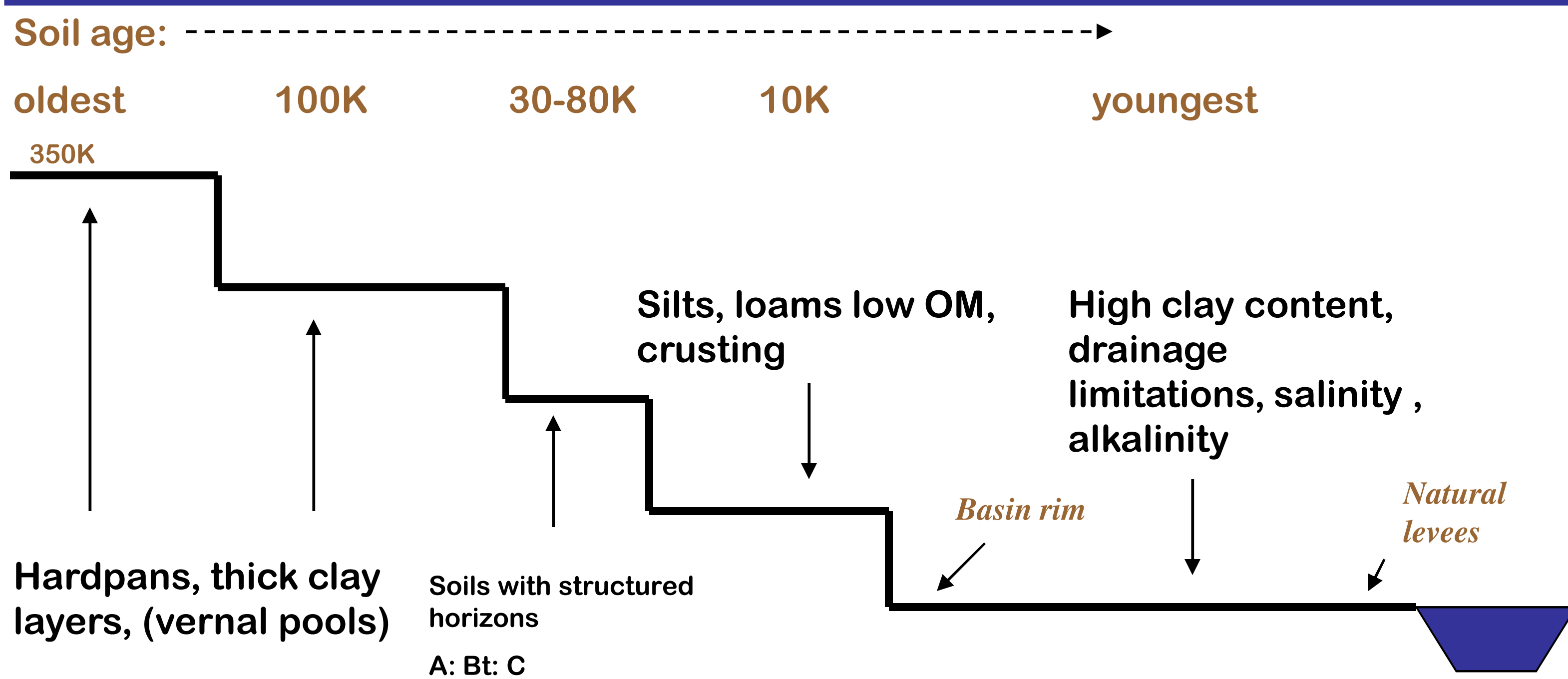
- To estimate more accurately the true potential of purpose-grown crops and crop residues for biomass energy in CA cropping systems.
- Existing national agricultural models do not model CA well. (REAP, POLYSYS, GTAP, FASOM). These national models are being used to predict future production of biofuels.
- Is there potential in CA for producing biomass feedstocks on farms?





Oak-savanna/rangelands

rangeland/pasture, some perennials

Soil use →

perennials, annuals

mostly annuals

Counties in Analysis Regions

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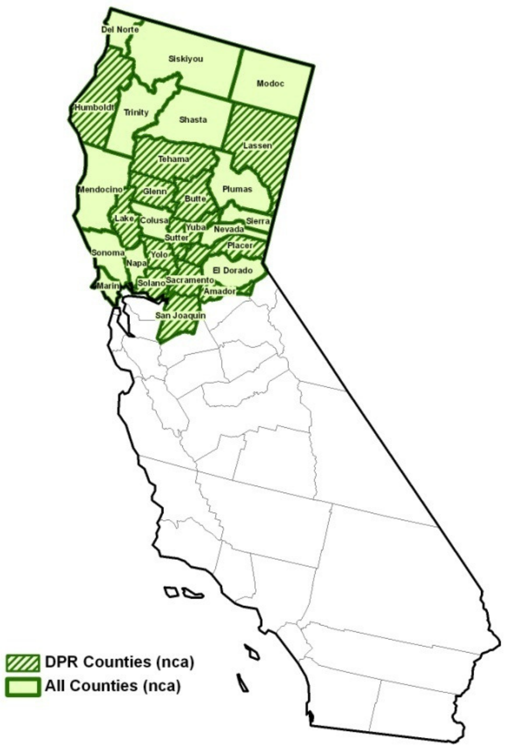

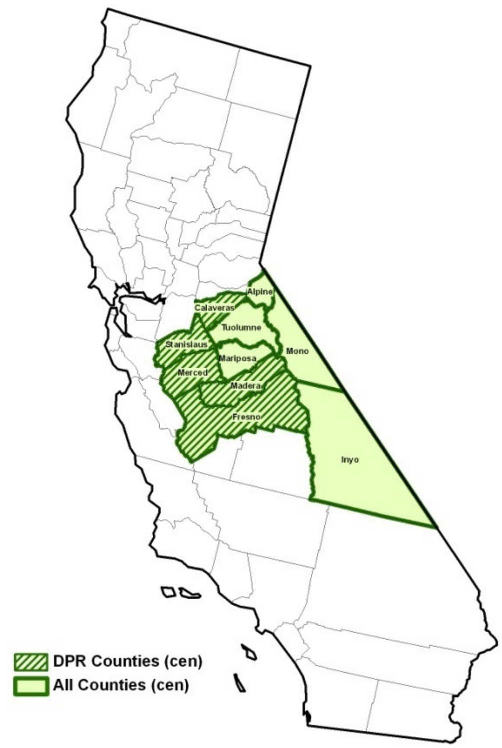

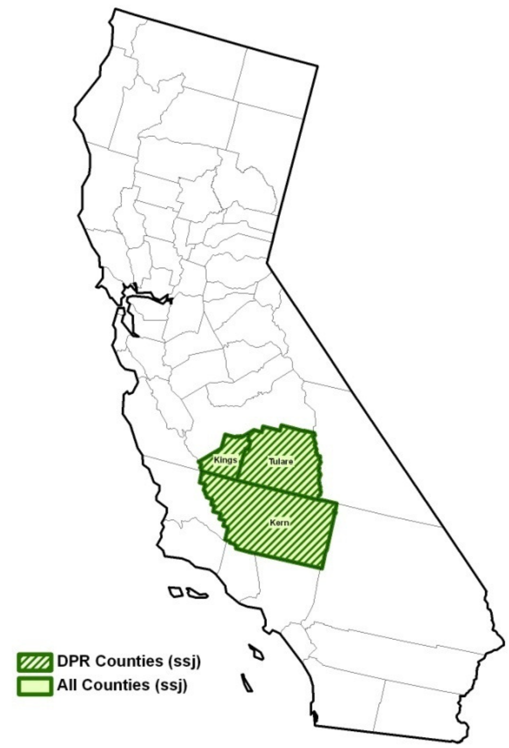

Northern California (NCA)

9 Cropping Clusters

Central California (CEN)

9 Cropping Clusters

South San Joaquin (SSJ)

8 Cropping Clusters

The Solution…

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- To develop a model with sufficient detail to capture the effects of region and landscape position.

- The goal is to run the model on as small a unit as the data allows, and then sum the results to aggregate regional and state level potential.

CBC Optimization Model

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$$\underset{X_{e,g,i,j}}{Max}\sum_{g}\sum_{j}\left[\begin{array}{l}\sum_{i}\left(P_{g,i,j}\times\overbrace{\left(\beta_{g,i,j}-\omega_{g,i,j}X_{g,i,j}\right)}^{\text{Production function}}-C_{g,i,j}\right)X_{g,i,j} \\ \qquad\qquad +\sum_{e}\left(P_{e,g,j}Y_{e,g,j}-C_{e,g,j}\right)X_{e,g,j}\end{array}\right]\begin{array}{l}\left.\right\}\text{PMP function} \\ \left.\right\}\text{Energy crop function}\end{array}$$

Subject to: $\sum_{i}\sum_{e}X_{g,i,e,j}\leq\overline{R_{g,j}}$ *j= {A(acres), w(ac-ft of water)}*

$\boldsymbol{P}_{g,i,e,j}$ = *farm price of crop, i, and energy crop e, in region, g, and resource, j.*

$\boldsymbol{Y}_{g,i,e,j}$ = *yield of crop, i, and energy crop e, in region, g, and resource, j.*

$\overline{\boldsymbol{R}}_{g,j}$ = *total availability of resource, j, (land, water) in region, g*

$\boldsymbol{X}_{g,i,j}$ = *level of inputs applied for crop, i, in region, g, and resource, j.*

$\boldsymbol{\beta}_{g,i,j}$ = *intercept of the quadratic (marginal) curve of crop, i, in region, g, resource, j.*

$\boldsymbol{\omega}_{g,i,j}$ = *slope of quadratic (marginal) curve of crop, i, in region, g, and resource, j.*

Cropping Pattern Identification

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- 10 years of pesticide use/crop choice data for most of the crop producing areas of California.
- Department of Pesticide Regulation (DPR) data is on 1-section units (640 acres).
- This translates to over 17,000 sections or land unit records across the state.
- A Multidimensional Scaling, Cluster Analysis was conducted to identify naturally occurring cropping patterns within five macro-regions of California.

Northern California
– 9 Clusters of Cropping Systems

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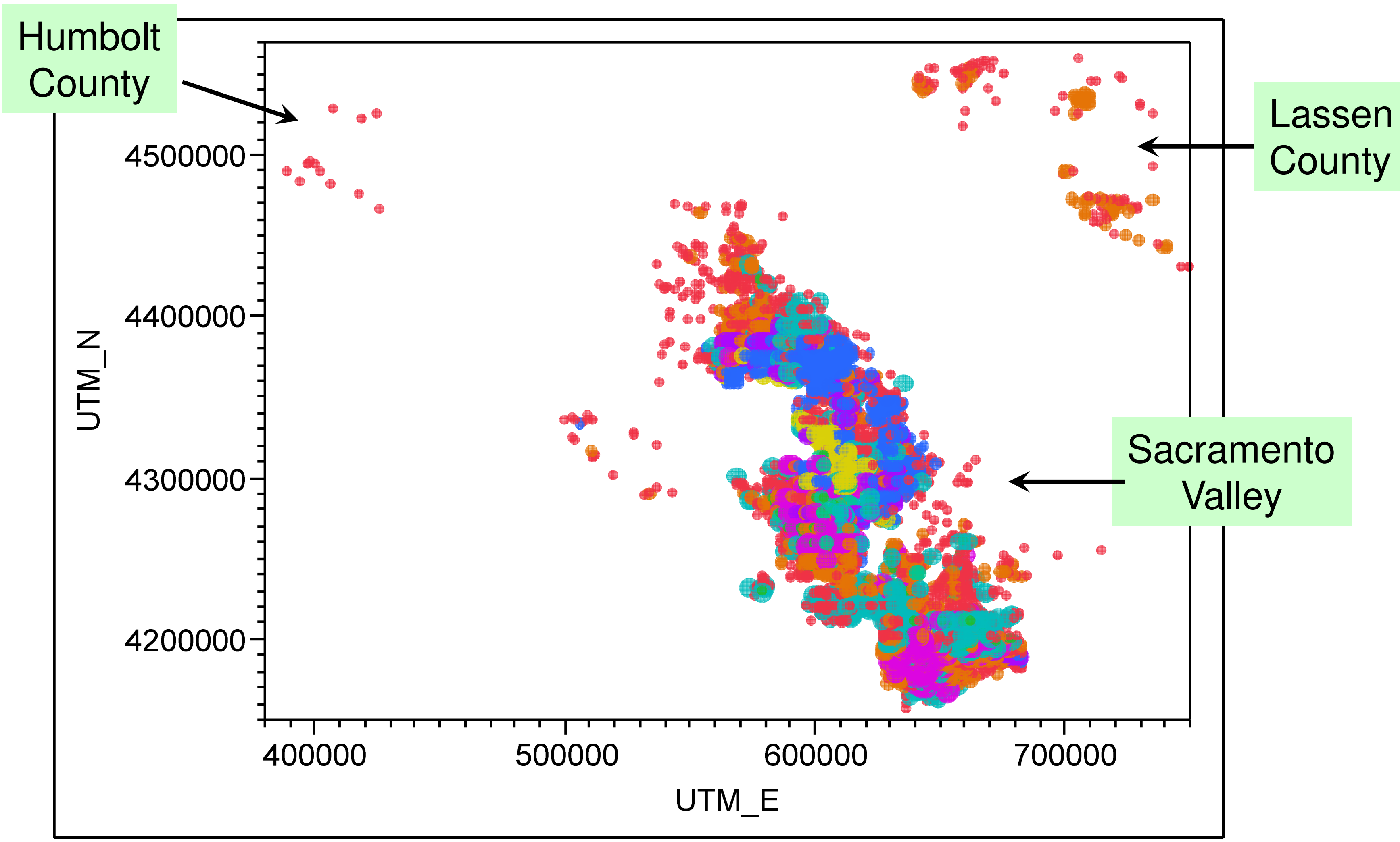

$40/acre Canola Profit Changes in Acres and Water Use

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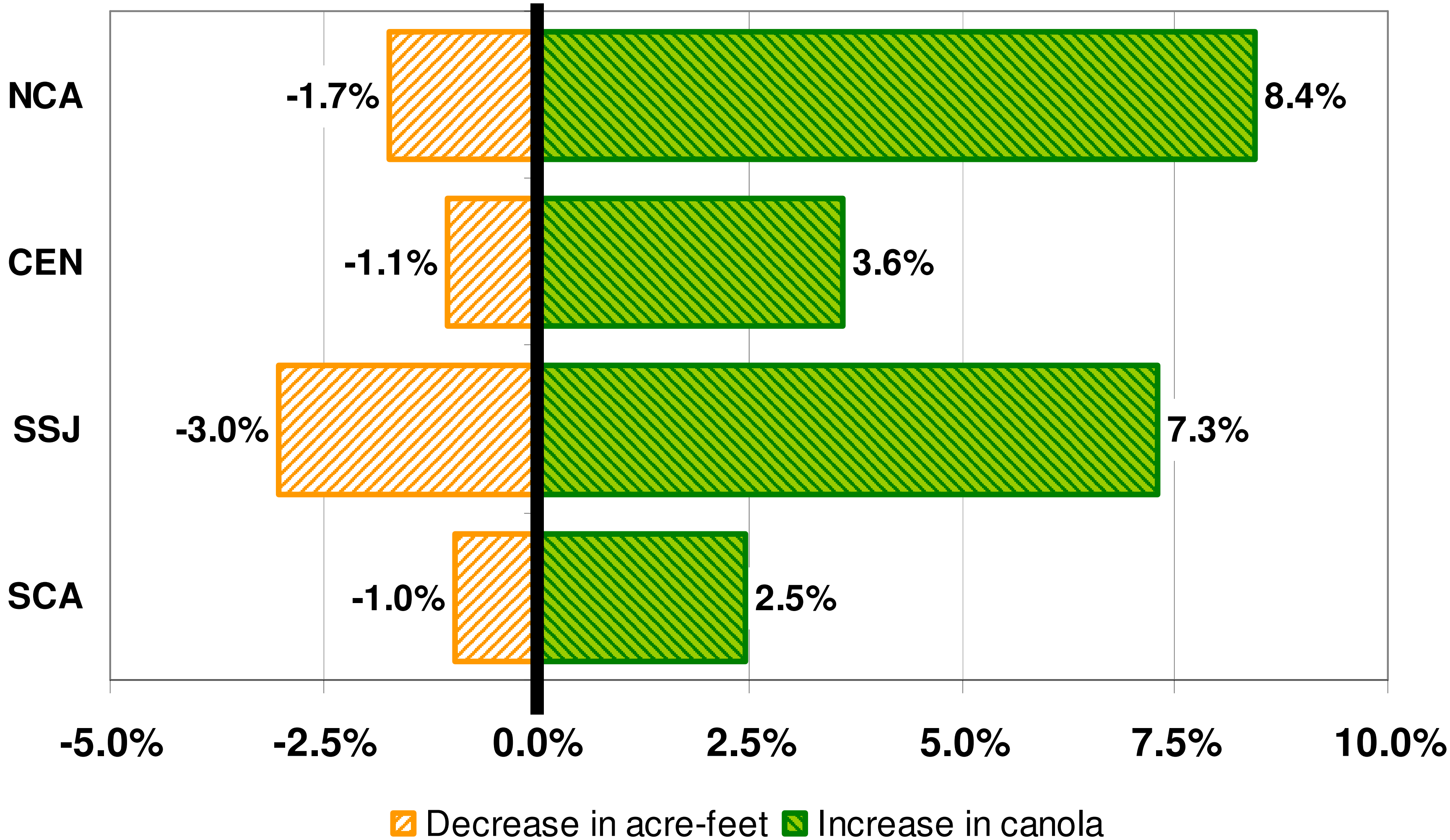
As canola acreage increased, regional water use decreased. No canola was grown in Coastal Region.



Acreage Changes from $40/acre Increase in Canola Profit

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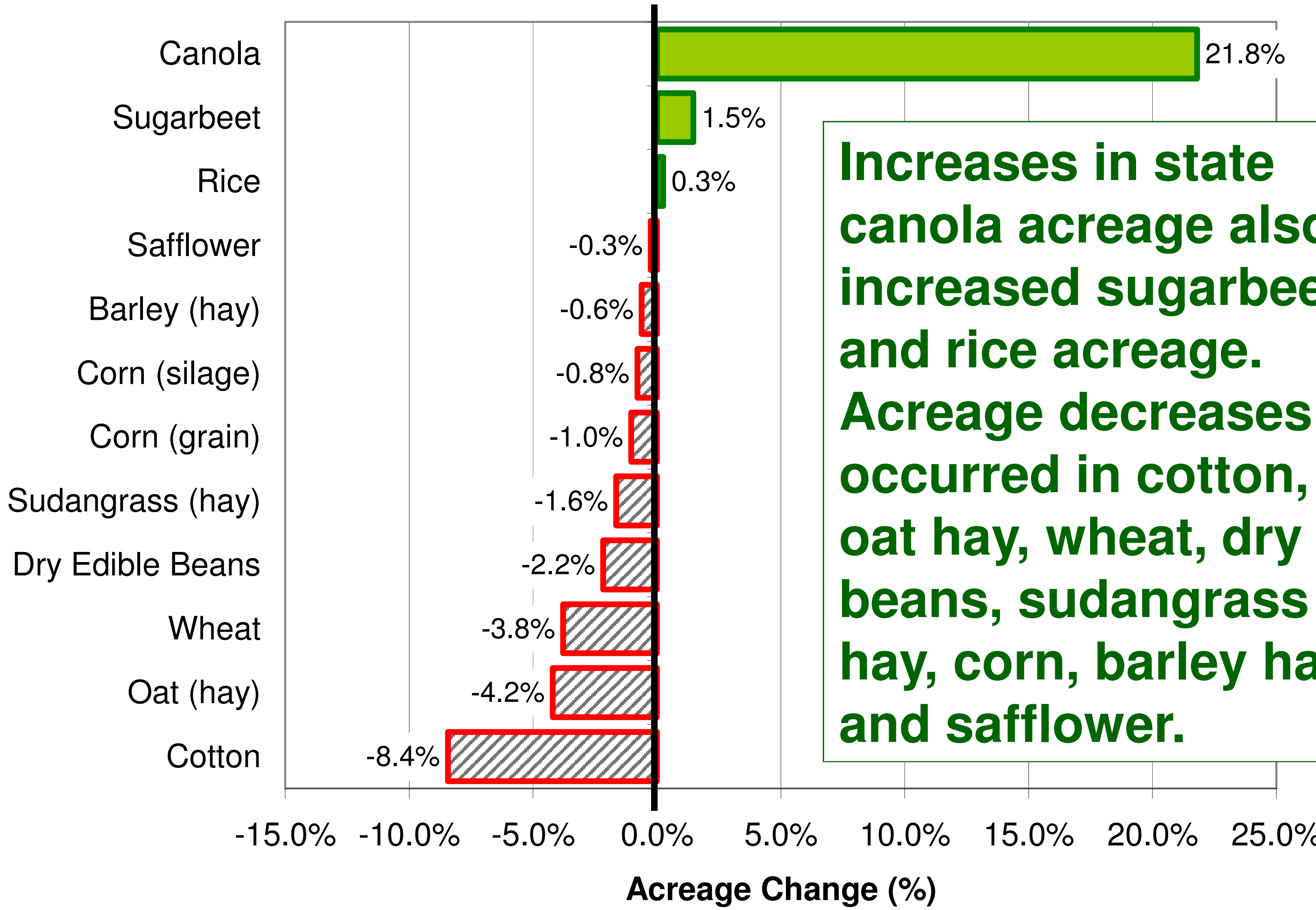

Increases in state canola acreage also increased sugarbeet and rice acreage. Acreage decreases occurred in cotton, oat hay, wheat, dry beans, sudangrass hay, corn, barley hay, and safflower.

Bio-energy Crop Price Response for Representative Growers

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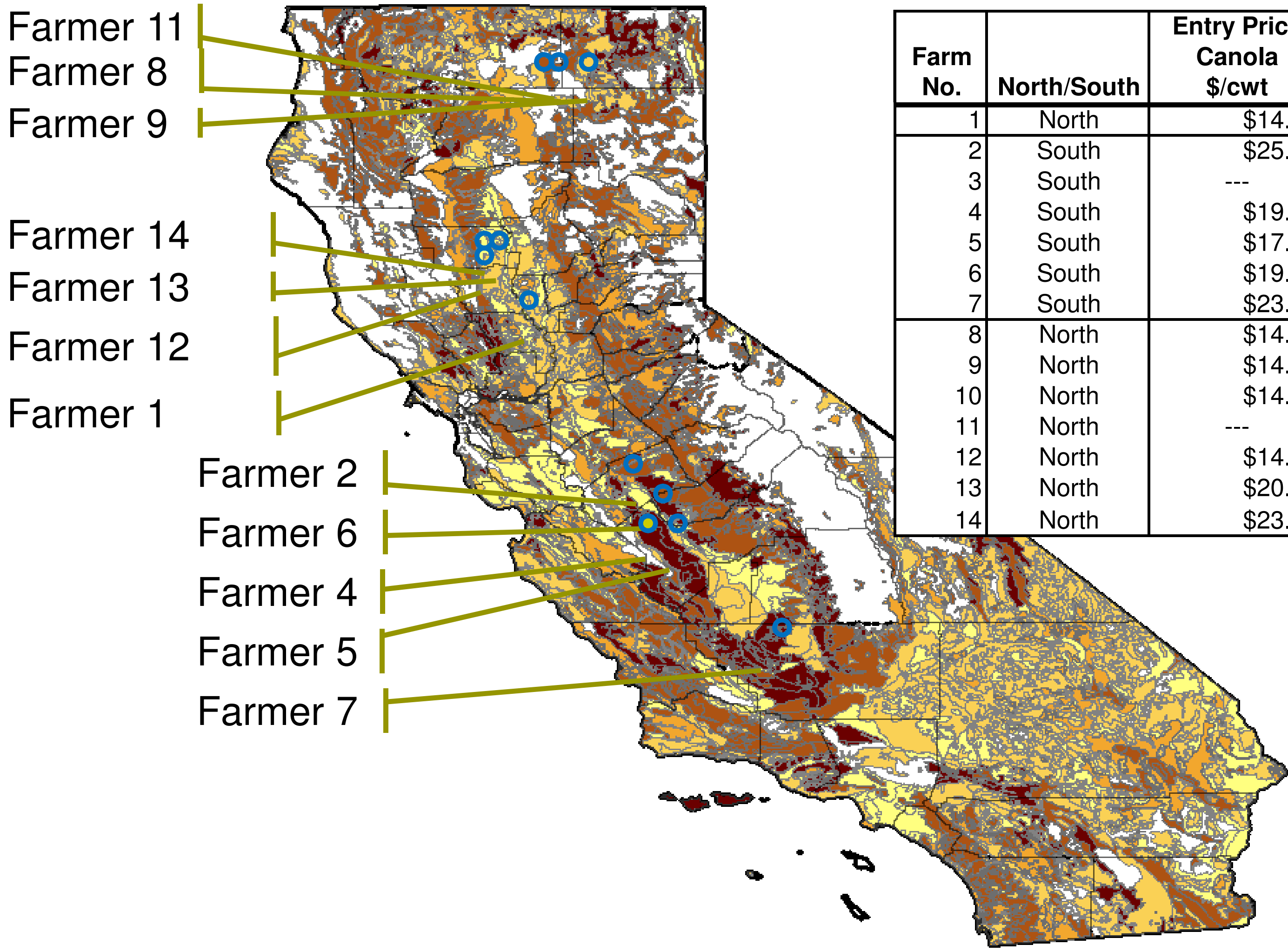

Farm No.	North/South	Entry Price Canola $/cwt	Entry Price Swt Sorghum $/ton
1	North	$14.50	$22.50
2	South	$25.00	$28.50
3	South	---	---
4	South	$19.50	$25.50
5	South	$17.00	$22.00
6	South	$19.50	$25.50
7	South	$23.50	$40.00
8	North	$14.50	$22.50
9	North	$14.50	$22.50
10	North	$14.50	$22.50
11	North	---	---
12	North	$14.50	$22.50
13	North	$20.00	$26.00
14	North	$23.00	---

Canola grown as bee pasture in young pistachio orchard, Kern County_2010

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Food and Fuel

- In the transition to a new energy future, society has decided to use the human talent for agriculture as part of the solution. This is challenging but possible. It necessarily will result in changes to the current agricultural and food system.

- Farmers think in terms of cropping systems. Biofuel feedstocks or residue use should be considered from a cropping system's perspective and not just as a separate enterprise.

- Biofuel crops may offer needed diversity in cropping systems, with agronomic, economic, and possible environmental benefits.

Food and Fuel

- If that is the case, it is not food vs. fuel, but more efficient and environmentally sound cropping systems vs. those that are less so. This is not easily accommodated in current LCA analyses.

- Cropping system adaptation is a local and regional optimization process and solutions will vary with the agricultural landscape.

CAN BIOFUELS IMPROVE WELL-BEING IN DEVELOPING COUNTRIES?

"Successful bioenergy industries bring significant job creation potential … and … because the vast majority of bioenergy employment occurs in farming, transportation and processing, most of these jobs would be in rural areas."

United Nations, 2007. Sustainable Bioenergy for Decision Makers

"Many developing countries have seen their domestic agriculture economy …destroyed because of dumping of subsidized grain surpluses into their market…which undercut domestic producers,…therefore many farmers stopped tilling their land and became dependent on food imports. Biofuels …take away the risk of subsidized surpluses and allow the agriculture of developing countries to flourish…

Biofuel production is a twofold chance for developing countries: It makes them less dependent on energy imports and revitalizes their domestic agriculture."

Robert Vierhout_Global Economic Symposium http://www.global-economic-symposium.org/solutions/the-global-environment/food-versus-fuel/strategyperspectivefolder/the-food-bio-fuel-hype