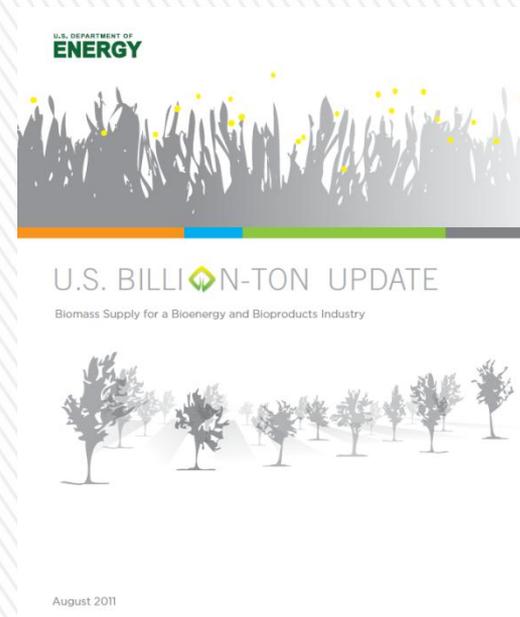




Modeling Bioenergy Policies with POLYSYS: Review of Economic Assumptions

**Burton C. English,
Chad Hellwinckel, and
Daniel De La Torre Ugarte**
The University of Tennessee

Department of Energy
ORNL Billion Ton Update Forum
Oak Ridge, TN
September 29, 2011



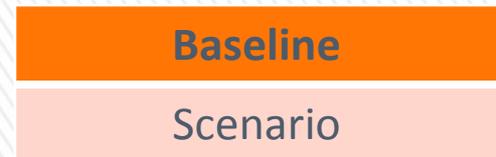
UP Agricultural Policy
Analysis Center



- » USDA Baseline established and then extended to 2030
- » Measures needed for scenario implementation developed
- » Model revised to reflect measures



erview



Overview

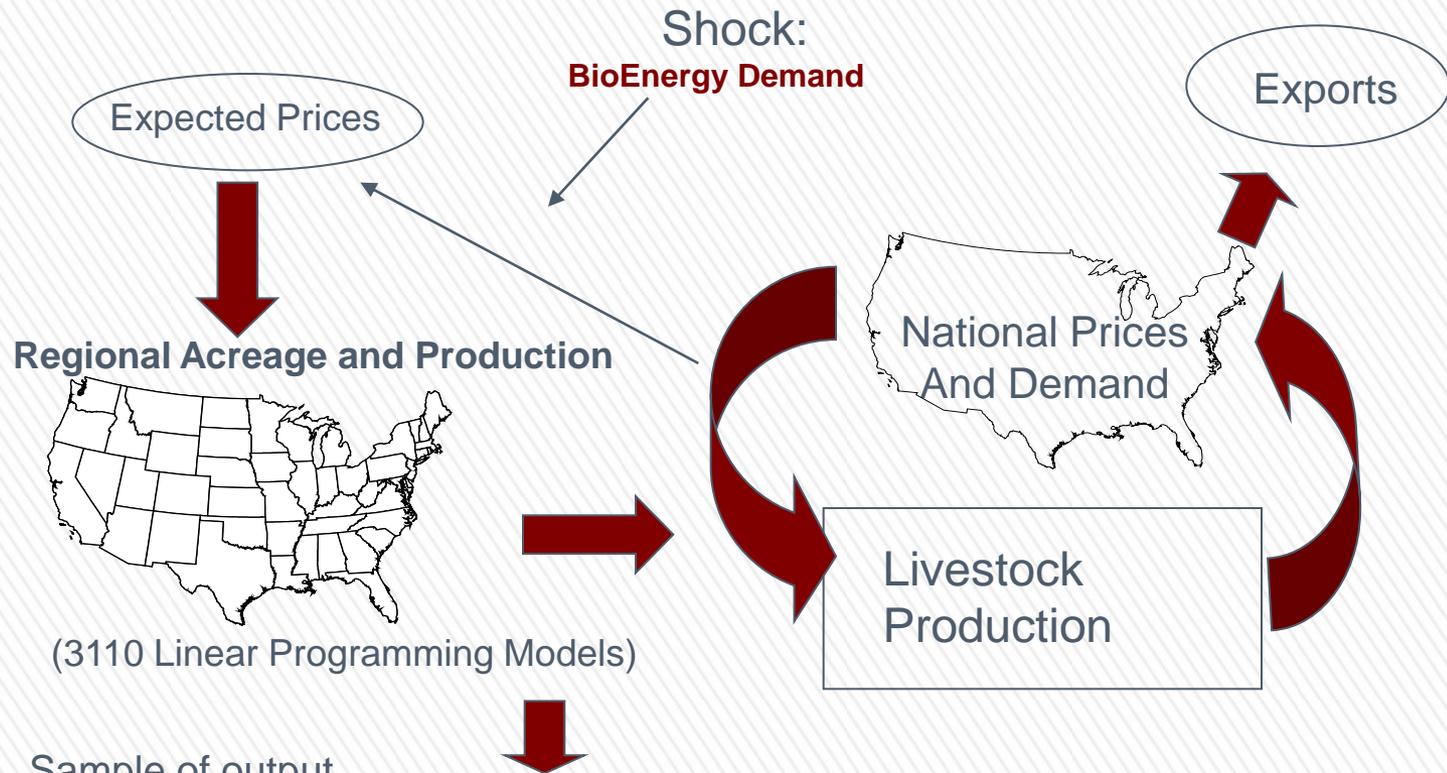
» POLYSYS model

- Partial equilibrium model, with market-clearing conditions.
- POLYSYS iterates annually, for 20 years.
- Linear programming model solves supply side at county level.
- 9 major crops (3 tillage types) + bioenergy crops.
- Bioenergy crops include
 - + Perennial Grasses
 - + Woody Crops
 - + Energy Sorghum
- Biomass can come in on both cropland and pasturelands.
- Can harvest crop residues under erosion and carbon constraints.
- Can meet a national demand level for bioelectricity or ethanol and estimate market feedstock price endogenously.



How POLYSYS Works

Structure and flow



Sample of output

Item	2012	2013	2014	2015	2016	2017	2018	2019
Biomass (\$/dt)	30	30	39	40	43	45	49	51
Corn (\$/bu)	4.36	4.27	4.21	4.21	4.25	4.31	4.33	4.33
Stover(Mil.tons)	0	0	10.4	22.3	51.6	68.7	87.4	95.1
Switchgrass(Mil.tons)	0	0	0	0	0	0.1	0.5	1.5
REALIZED NET INCOME	75908	76252	76287	77039	78220	79419	81423	84114



Pastureland

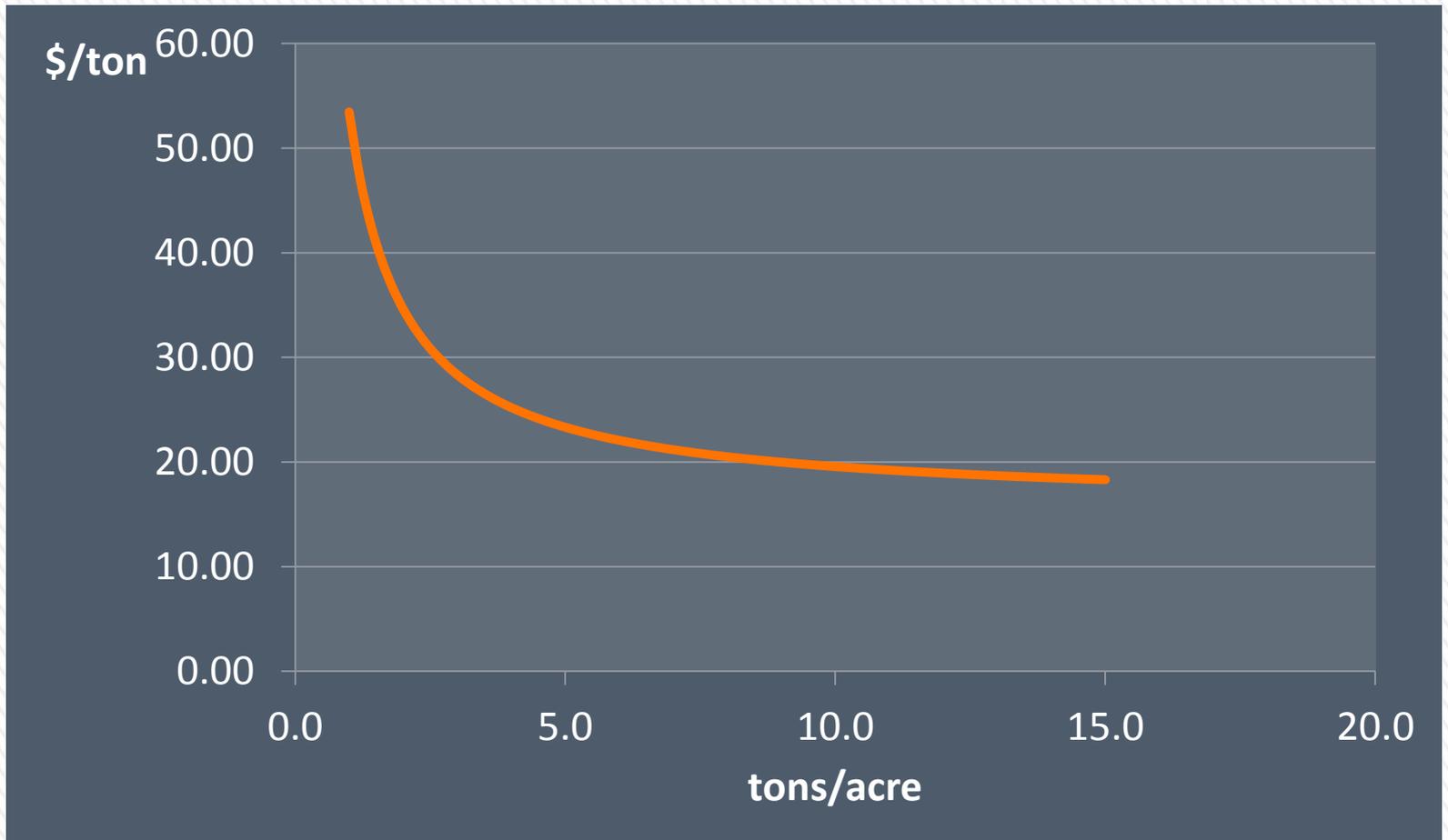
Results indicate ~ 40 million acres of biomass on pastureland

- Similar to cropland LP in structure
- Competing land uses
 - Pasture rental for livestock, Switchgrass, Poplars, Willows
 - Out of 440 million acres, 140 million suitable for conversion
 - No irrigated pastureland
 - No arid pastureland (roughly 100th meridian)
- Biomass can come into production if:
 - Net returns of biomass outcompete ‘pasture rental rate’ + ‘cost of intensification’
 - Assume that for every acre of biomass crop coming in, an additional acre of pasture must be ‘intensified’
 - Intensification costs = \$50ac⁻¹ first year, and
\$10ac⁻¹ for subsequent years
 - **Implication: no herd reduction.**
- Alternative way to implement
 - Assume that no intensification happens and herd must be reduced by lost forage.
- Truth likely between these two modeling strategies



- » Planted, managed, and harvested like hay
- » Established using no-till
- » Reduced yields the first and second years
- » Ten years before replanting
- » Productivity is a function of precipitation, temperature, soils, and local site factors
- » No irrigation

Perennial Grasses >



Cost of Perennials >

Perennial Grass Yields



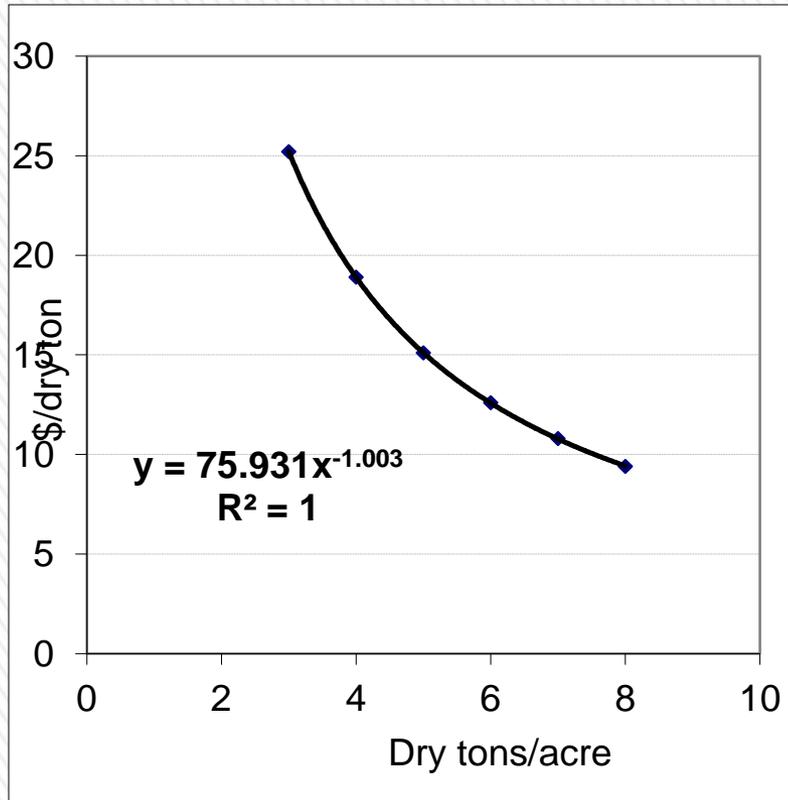
- » Single rotation or coppice
- » Established and maintained with typical ag. equipment
- » Harvested using conventional forestry equipment
- » Coppice will occur up to 7 stands before re-establishment

Woody Crops

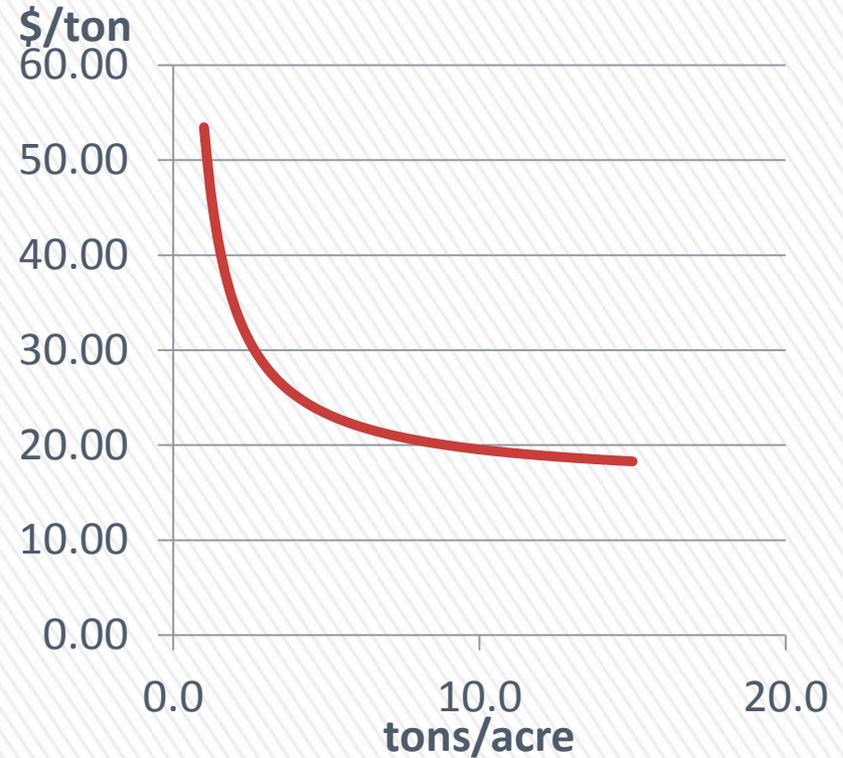


Yield set at 5.1 tons/year for Willow with limited area

Based on this equation



Used in model Adjusted by region



Cost of Woody Crops



- » Annual Crop
- » Only planted on non erosive land
- » Part of a rotation

Energy Sorghum



- » Average yield 7.5 tons/acre
- » Range from 6 to 9 tons/acre depending on the state
- » Per acre costs range from \$276 to \$361 per acre.

Sweet Sorghum Yields



Thank you.

- Recent analyses in addition to Billion Ton Update

- De La Torre Ugarte, DG, BC English, CM Hellwinckel, TO West, KL Jensen, CD Clark, RJ Menand (2009) **Analysis of the Implications of Climate Change and Energy Legislation to the Agricultural Sector**, Publication of the 25x'25 Working Group, Washington DC, November.
- Hellwinckel, CM, TO West, DG De La Torre Ugarte, R Perlack (2010) **Evaluating Possible Cap and Trade Legislation on Cellulosic Feedstock Availability**. *Global Change Biology Bioenergy* 2:278-287.
- English et al. (November 2010) **Implications of Energy and Carbon Policies for the Agriculture and Forestry Sectors**, 25x'25 Working group, Washington DC.
 - 36 bil gallons ethanol + 400 billion KWH bioelectricity.
 - Biomass price of ~ \$50.
 - ~ 50 million acres of pasture convert.

