Supply Forecast & Analysis

2011 Feedstocks Review

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Goal Statement

- Provide timely and credible estimates of feedstock supplies to support the data and analysis needs of OBP (e.g., MYPP analysis) and other feedstock projects and platforms – supply logistics, environmental sustainability, Bioenergy KDF

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Project Overview

- **History and accomplishments**
  - Are U.S. land resources capable of producing a sustainable biomass supply sufficient to displace 30% of current petroleum consumption?
    - Billion-ton resource assessment (2005)
  - Since publication of 2005 BTS efforts focused on
    - Developing a more spatially-explicit inventory of primary feedstocks,
    - Estimating price and available quantities (e.g., supply curves) for the individual feedstocks, and
    - Undertaking a more rigorous treatment and modeling of resource sustainability
  - BRDI Interagency feedstock report (2008)
  - Numerous enhancements to county-level modeling capability (2009)
  - Draft billion-ton update (2010)

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Project Overview (cont.)

- **High-level objectives**
  - Estimate county-level feedstock supply curves for major cropland and forestland resources
  - Account for environmental sustainability
  - Estimate prospective land use change
  - Assess how supplies are affected by crop management practices, productivity, sustainability, and commodity crop competition
  - Track use of fossil fuels (machinery, fertilizers, etc.) and carbon emissions
  - Disseminate through the Bioenergy KDF

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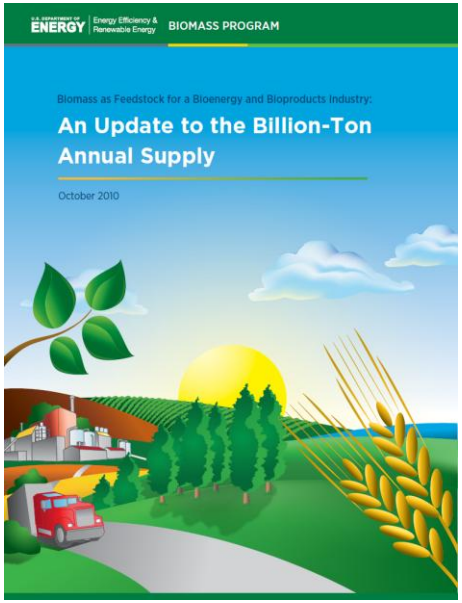
Approach to Supply Curve Estimation

- Agricultural land resources
  - POLYSYS model (OBP version operating at a county-level)
    - Data from NASS, USDA Baseline, Census of Agriculture
    - Key technical assumptions and environmental sustainability
      - Crop residue retention, tillage, rotations
      - Energy crop productivity
    - Costs
      - Grower payments for crop residues & production costs for energy crops
      - Collection and harvest costs based on INL and ORNL assumptions/modeling
- Forestland resources
  - Costs and quantities for forest residues
    - Data from FIA, TPO, RPA
    - Key technical assumptions and environmental sustainability
      - Forest residue access, recovery, operability, and merchantability
    - Costs
      - Stumpage (primary forest residues)
      - Harvest costs estimated from the Fuel Reduction Cost Simulator
- Contributing authors helped develop technical assumptions and input data and high-yield workshops used to develop scenarios

NASS – National Agricultural Statistics Service; FIA – Forest inventory and Analysis; TPO – Timber product Output; RPA – Resources Planning Act

Technical Accomplishments/Results

- Key milestone – Draft update to the 2005 billion-ton resource assessment



- Draft report reviewed by:
  - 3 USDA
  - 4 university
  - 2 national institute/council
  - 2 international

2005 BTS	2011 Update
National estimates – no spatial information	County-level with aggregation to state, regional and national levels
No cost analyses – just quantities	Supply curves by feedstock by county – farmgate/forest landing
Crop residue removal sustainability addressed from national perspective; erosion only	Crop residue removal sustainability modeled at soil – scale; erosion & soil C
No explicit land use change modeling	Land use change modeled for energy crops
Long-term, inexact time horizon (2005; ~2025 & 2040)	2010 – 2030 timeline (annual)
2005 USDA agricultural baseline and 2000 forestry RPA/TPO	2010 USDA agricultural baseline 2010 FIA inventory and 2007 forestry RPA/TPO
Erosion constraints to forest residue collection	Greater erosion plus wetness constraints to forest residue collection

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Technical Accomplishments/Results – Outline

- Scenarios
- Modeling (agriculture) framework enhancements and updates
- Crop residue sustainability and simulated results
- Energy crop modeling, sustainability, simulated results, and land use change
- Forest residues modeling, sustainability, and results
- Summary findings

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Scenarios

- Baseline scenario
  - USDA Baseline forecast for crop yields, acres, etc., extended to 2030
  - National corn yield of 160 bu/ac in 2010, increases to 201 bu/ac in 2030
  - Assumes a mix of conventional till, reduced till, and no-till
  - Stover to grain ratio of 1:1
  - No residue collected from conventionally tilled acres
  - Energy crop yields increase at 1% annually attributable to experience in planting energy crops and limited R&D
- High-yield scenario(s)
  - Same as Baseline Scenario except for the following
  - Corn yields increase to a national average of 265 bu/acre in 2030
  - Higher amounts of cropland in no-till to allow greater residue removal
  - Energy crop yields increase at 2%, 3%, and 4% annually (attributable to more aggressive R&D)

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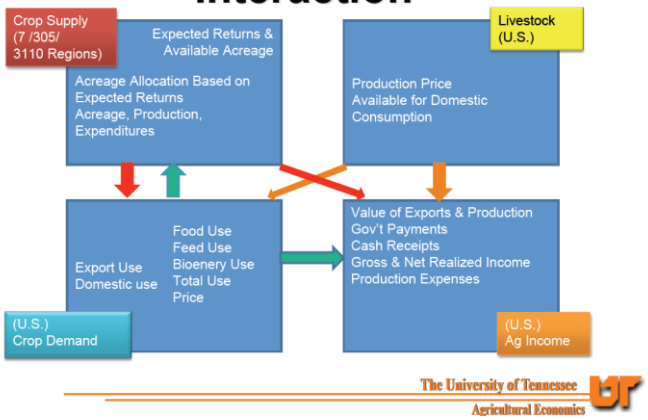
POLYSYS Modeling Framework

- County model anchored to USDA 10-year baseline & extended to 2030
  - 8 major crops (corn, soybeans, wheat, sorghum, oats, barley, rice, cotton) and hay, livestock, food/feed markets
  - USDA projected demands for food, feed, industry, and export
  - Land base includes cropland (250 million acres), cropland pasture (22 million acres), hay (61 million acres), permanent pasture (118 million acres)
    - Pasture can convert to energy crops if forage made up through intensification
    - Restraints limiting land use change
  - Biomass resources include stover, straws, energy crops (perennial grass, coppice and non-coppice woody, annual energy crop)
  - Supply or demand mode

POLYSYS Modules and Interaction



Chad Hellwinckel – University of Tennessee - Agricultural Policy Analysis Center (APAC) (http://www.agpolicy.org/)

For model background: Daniel G De la Torre Ugarte and Darrell E. Ray. 2000. "Biomass and Bioenergy Applications of the POLYSYS Modeling Framework," *Biomass & Bioenergy* 4(3):1-18.

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Enhancements & Updates to POLYSYS

- Crop residue retention coefficients
- Four energy crops
- Energy crop yields
- Grower payments and production costs
- Harvest and collection costs
- Model programming and output files
- Executable versions at ORNL

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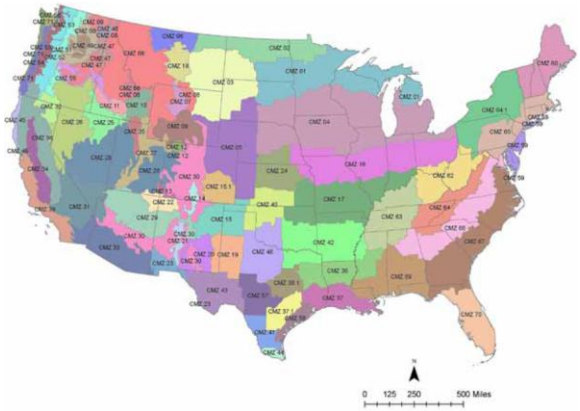
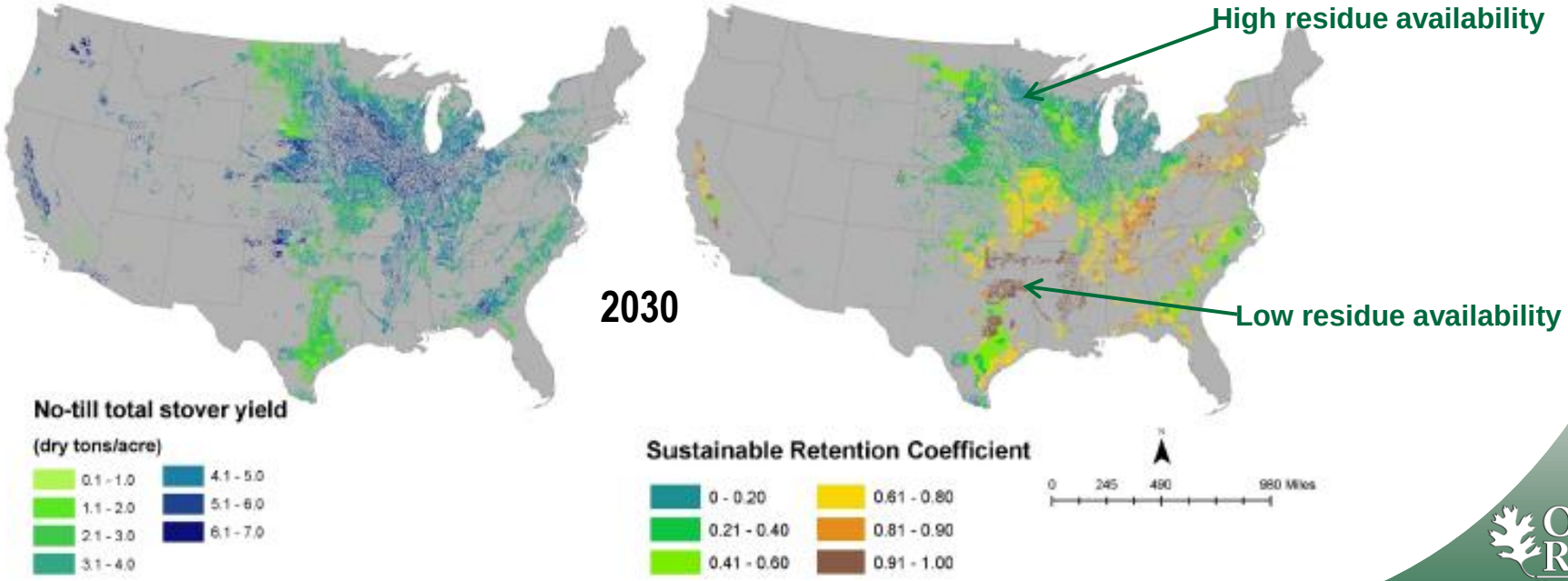
Crop Residue Sustainability

- Retention coefficients estimated for erosion and soil C
  - Separate coefficients for reduced till and no-till
  - No residue removal under conventional till
  - Yield and time dependent in POLYSYS
  - **Dave Muth** (INL), **Richard Nelson** (KSU) and others (ARS, NRCS, UTK)

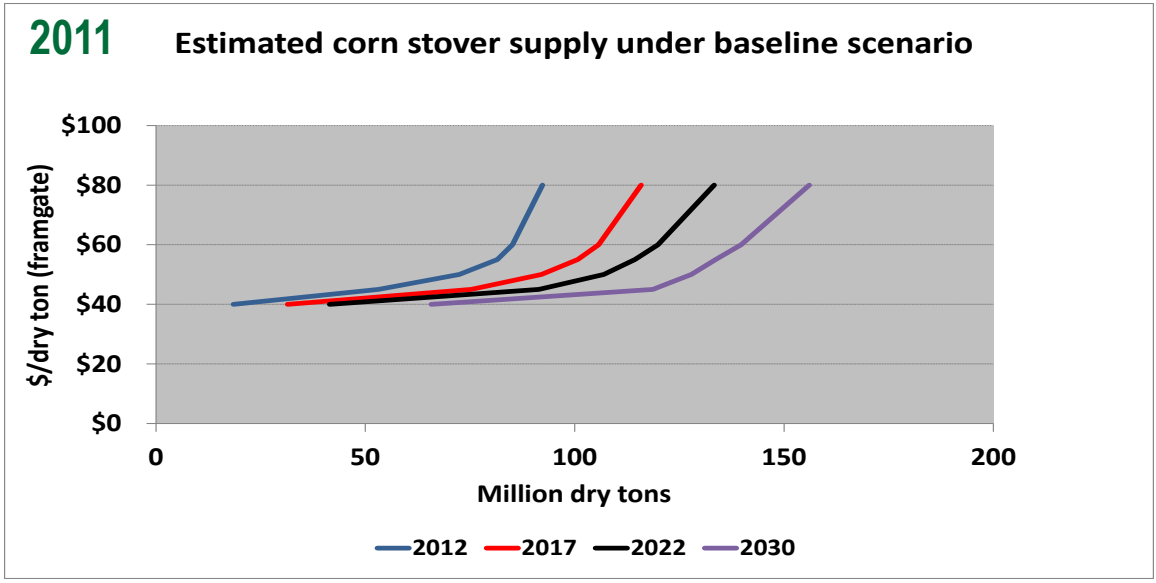
NRCS CMZs



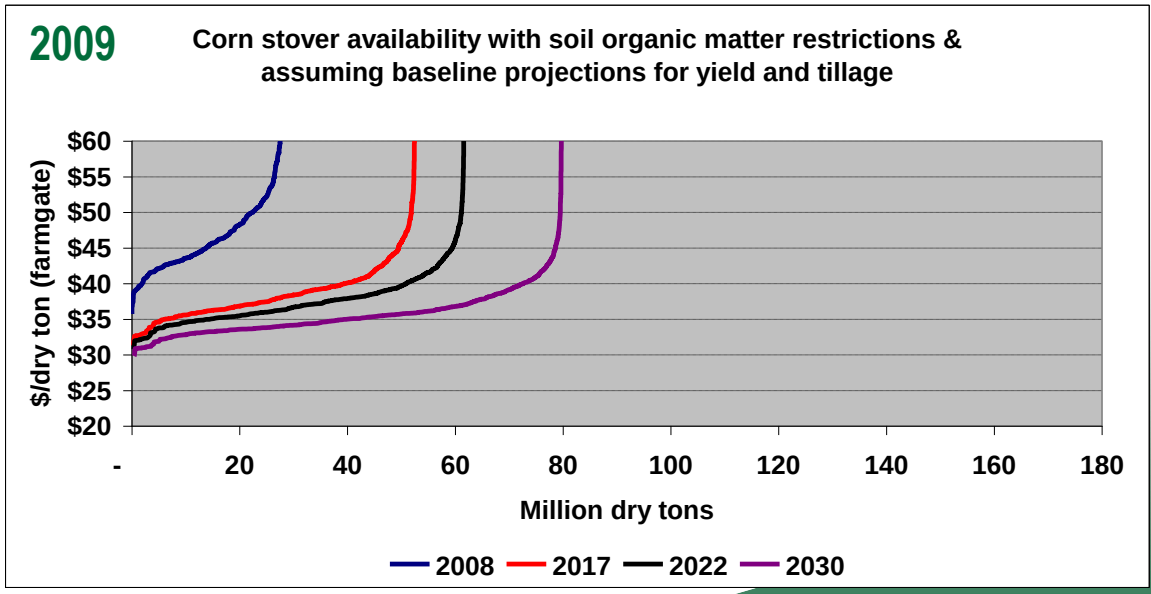


Crop Residue Simulated Supply Curves

- 2011 update results show more corn stover relative to the results presented at the 2009 review (and much more under the high-yield scenario)



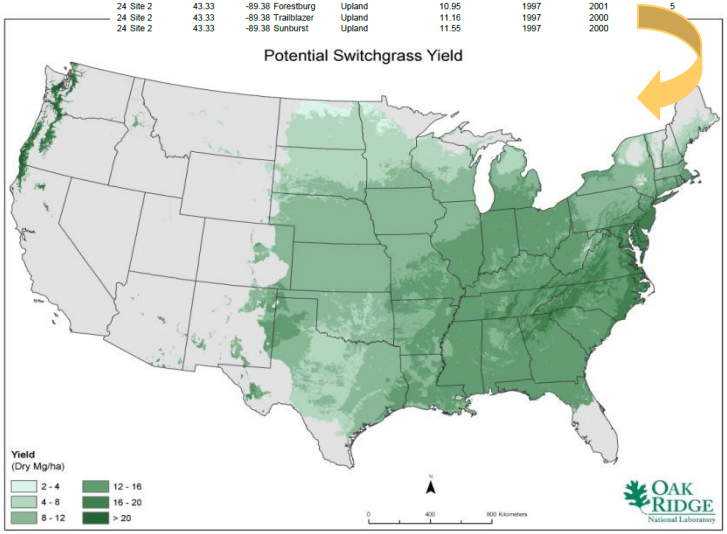
- 2009 feedstock review
  - Soil erosion from Graham et al., Agron. J. (2007)
  - Soil carbon from Wilhelm et al., *Agron. J.* (2007)



Perennial Grasses – Production Costs and Productivity

Item	Units	North-east	Appalachia	South-east	Delta	Corn Belt	Lake States	Southern Plains	Northern Plains
Stand life	Years	10	10	10	10	10	10	10	10
Productivity	dry tons/acre	4.0–7.5	5–9.5	3.5–9.5	3–7	4–7	3.5–5	2–6.5	2–6.5
Establishment									
Seed	$/lb.	$10	$22	$22	$22	$10	$10	$22	$10
Planting	lb./acre	5	5	5	5	5	5	5	5
Replants	percent	25	25	25	25	25	25	25	25
No-till drill	-	1-time	1-time	1-time	1-time	1-time	1-time	1-time	1-time
Total kill herbicide	No. applications	1-time	1-time	1-time	1-time	1-time	1-time	1-time	1-time
Pre-emergent herbicide	No. applications	1-time	1-time	1-time	1-time	1-time	1-time	1-time	1-time
Phosphorous	lbs P2O5/ acre	40	40	40	40	40	40	40	40
Potassium	lbs K2O/ac	80	80	80	80	80	80	0	0
Lime	tons/acre	1	2	2	2	1	1	0	0
Total establishment costs	**$/acre**	**$210**	**$340**	**$330**	**$330**	**$200**	**$200**	**$220**	**$150**
Maintenance years									
Reseeding	year applied	2	2	2	2	2	2	2	2
Pre-emergent herbicide	No. applications	0	0	0	0	0	0	0	0
Nitrogen	lbs/acre	60	70	70	50	60	40	40	40
Phosphorous	lbs P2O5/ acre	0	0	80	0	80	0	0	0
Potassium	lbs K2O /acre	0	0	80	0	80	0	0	0
Harvest costs	**$/dry ton**	**$19.50 – $21.00**	**$18.50 – $19.90**	**$18.00- $20.20**	**$18.60 – $20.60**	**$19.20 – $20.60**	**$20.60 – $21.90**	**$19.20 – $22.10**	**$19.40 – $22.30**

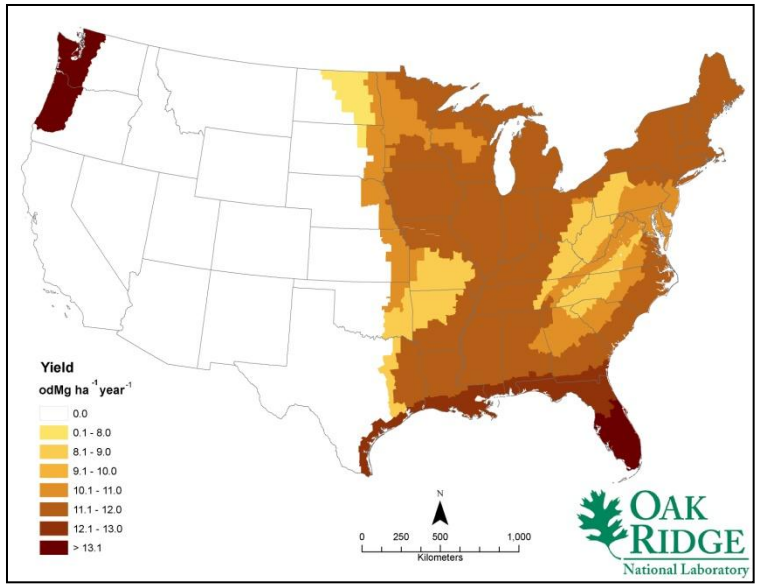
ID	SITE	DD_LAT	DD_LONG	CULTIVAR	ECOTYPE	YIELD_MG_HA	YEAR_PLNTD	YEAR_HAR	STAND_AGE
24	Site 2	43.33	-89.38	Dacotah	Upland	6.16	1997	1998	2
24	Site 2	43.33	-89.38	Dacotah	Upland	6.93	1997	1999	3
24	Site 2	43.33	-89.38	Forestburg	Upland	7.19	1997	1998	2
24	Site 2	43.33	-89.38	Dacotah	Upland	7.81	1997	2000	4
24	Site 2	43.33	-89.38	Sunburst	Upland	8.45	1997	1998	2
24	Site 2	43.33	-89.38	Dacotah	Upland	8.53	1997	2001	5
24	Site 2	43.33	-89.38	Forestburg	Upland	9.32	1997	2000	4
24	Site 2	43.33	-89.38	Cave-in-Rock	Upland	9.55	1997	1998	2
24	Site 2	43.33	-89.38	Trailblazer	Upland	9.98	1997	1998	2
24	Site 2	43.33	-89.38	Forestburg	Upland	10.00	1997	1999	3
24	Site 2	43.33	-89.38	Shawnee	Upland	10.20	1997	1998	2
24	Site 2	43.33	-89.38	Trailblazer	Upland	10.72	1997	1999	3
24	Site 2	43.33	-89.38	Sunburst	Upland	10.77	1997	1999	3
24	Site 2	43.33	-89.38	Forestburg	Upland	10.95	1997	2001	5
24	Site 2	43.33	-89.38	Trailblazer	Upland	11.16	1997	2000	
24	Site 2	43.33	-89.38	Sunburst	Upland	11.55	1997	2000	



- Herbaceous crop productivity
  - Varies geographically
  - Baseline yields (dry tons/acre)
    - 2014 – 3.0 - 9.9
    - 2030 – 3.6 - 12.0
  - Database available

Woody Crops – Production Costs and Productivity

Item	Units	Poplar	Pine	Eucalyptus	Willow (coppiced)
Rotation	Years	8	8	8	4[a] (5 harvests)
Spacing	sq. ft.	60	60	60	7.5
	trees/acre	726	726	726	5800
Productivity	dry tons/acre-year	3.5–6.0	5.0–5.5	6.0	5.1
Growing range	Region	Northeast, Lake States, Northwest, Midwest, Plains	Southeast	Sub-tropics	Northeast and Lake States
Establishment - year 1					
Cuttings	$/tree	$0.10	$0.06	$0.10	$0.12
Planting	$/tree	$0.09	$0.09	$0.09	$0.02
Replants	percent	5	5	5	0
Moldboard plow	-	1-time	1-time	1-time	1-time
Disk	-	1-time	1-time	1-time	1-time
Cultivate	-	2-times	2-times	2-times	2-times
Total kill herbicide	No. applications	1-time	1-time	1-time	1-time
	lbs a.i./acre	1.5	1.5	1.5	1.5
Pre-emergent herbicide	No. applications	1-time	1-time	1-time	1-time
	lbs a.i./acre	1.5	1.5	1.5	1.5
Phosphorous	lbs/acre	0	40	0	0
Establishment costs	$/acre	$310	$280	$310	$1120
Maintenance years					
Cultivate - year 2	-	2-times	2-times	2-times	1-time
Cultivate - year 3		1-time	1-time	1-time	None
Pre-emergent herbicide - year 2	No. applications	1	1	1	1
	lbs a.i./acre	1.5	1.5	1.5	1.5
Lime - year 3	tons/acre	90	90	90	100
	year applied	-	year3	year3	-
Nitrogen - year 4 and 6	lbs/acre	90	90	90	100
	year applied	4 and 6	2,4, and 6	4 and 6	4
	-	-	-	-	-
Phosphorous - year 3	lbs/acre	20	40	15	-
	year applied	3	3	3	-
Potassium - year 3	lbs/acre	35	40	25	-
	year applied	3	3	3	-
Maintenance costs – year 2	$/acre	$60	$100	$100	$30
Maintenance costs – year 3–8	$/acre	$220	$200	$200	$100[b]
Harvest costs	**$/dry ton**	**$20**	**$20**	**$20**	**$15**



- Woody crop productivity
  - Varies geographically
  - Baseline yields (dry tons/acre)
    - 2014 – 3.5 - 6.0
    - 2030 – 4.2 - 7.2
  - Database available

Energy Crop Sustainability & Restrictions

- Assumed BMPs for establishment, cultivation, maintenance, and harvesting of energy crops
- Energy crops not allowed on irrigated cropland & pasture
- Conversion of permanent pasture and cropland used as pasture constrained to counties east of the 100th meridian except for Pacific Northwest
- Energy crops returns must be greater than pasture rent plus additional establishment and maintenance costs
- A set of restraints used to limit the amount of cropland, cropland used as pasture, and permanent pasture switching to energy crops in a given year and in total (e.g., 10% of cropland per year and 25% in total)
- Annual energy crops (i.e., energy sorghum) limited to non-erosive cropland and part of multi-crop rotation

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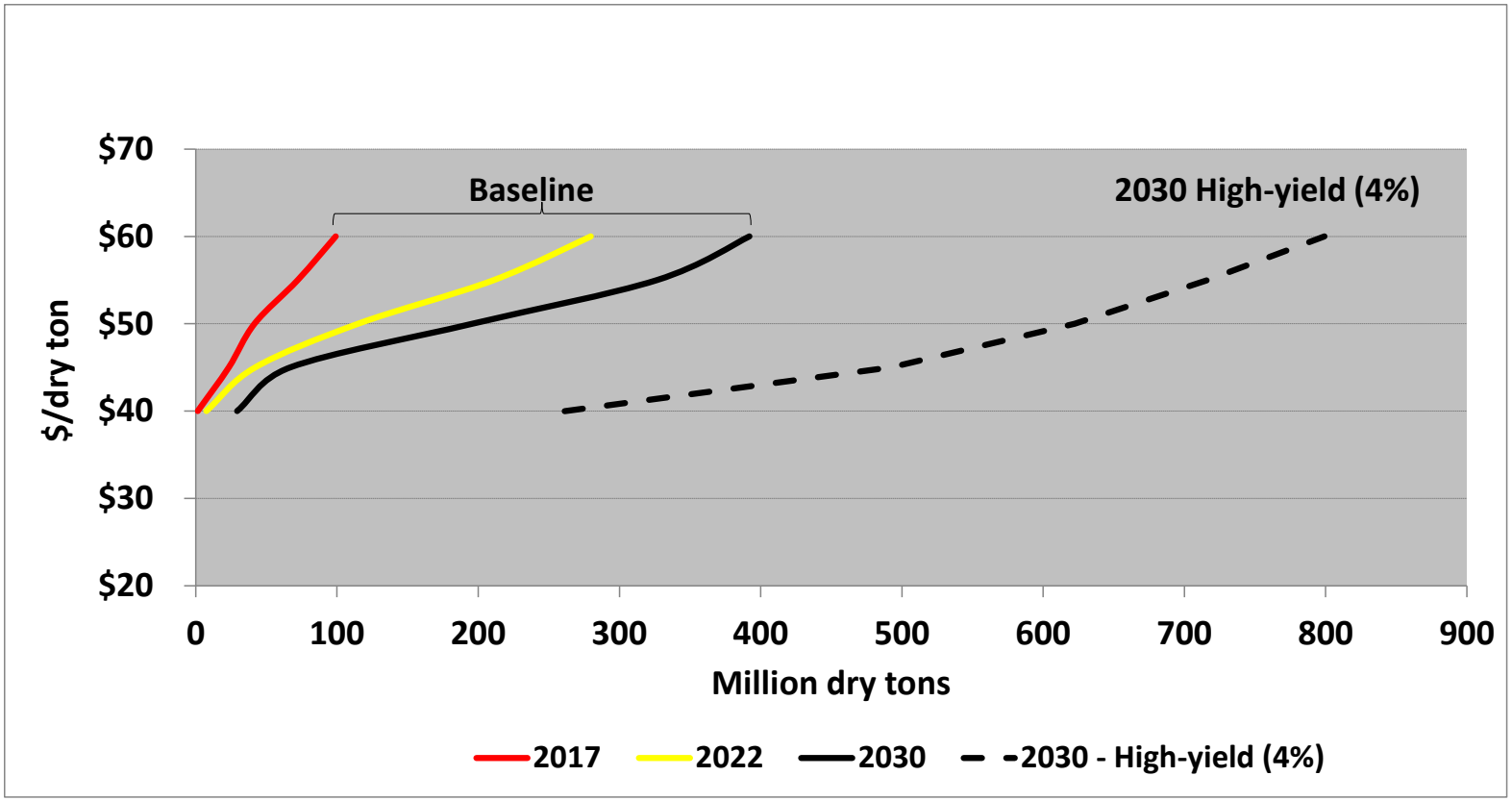
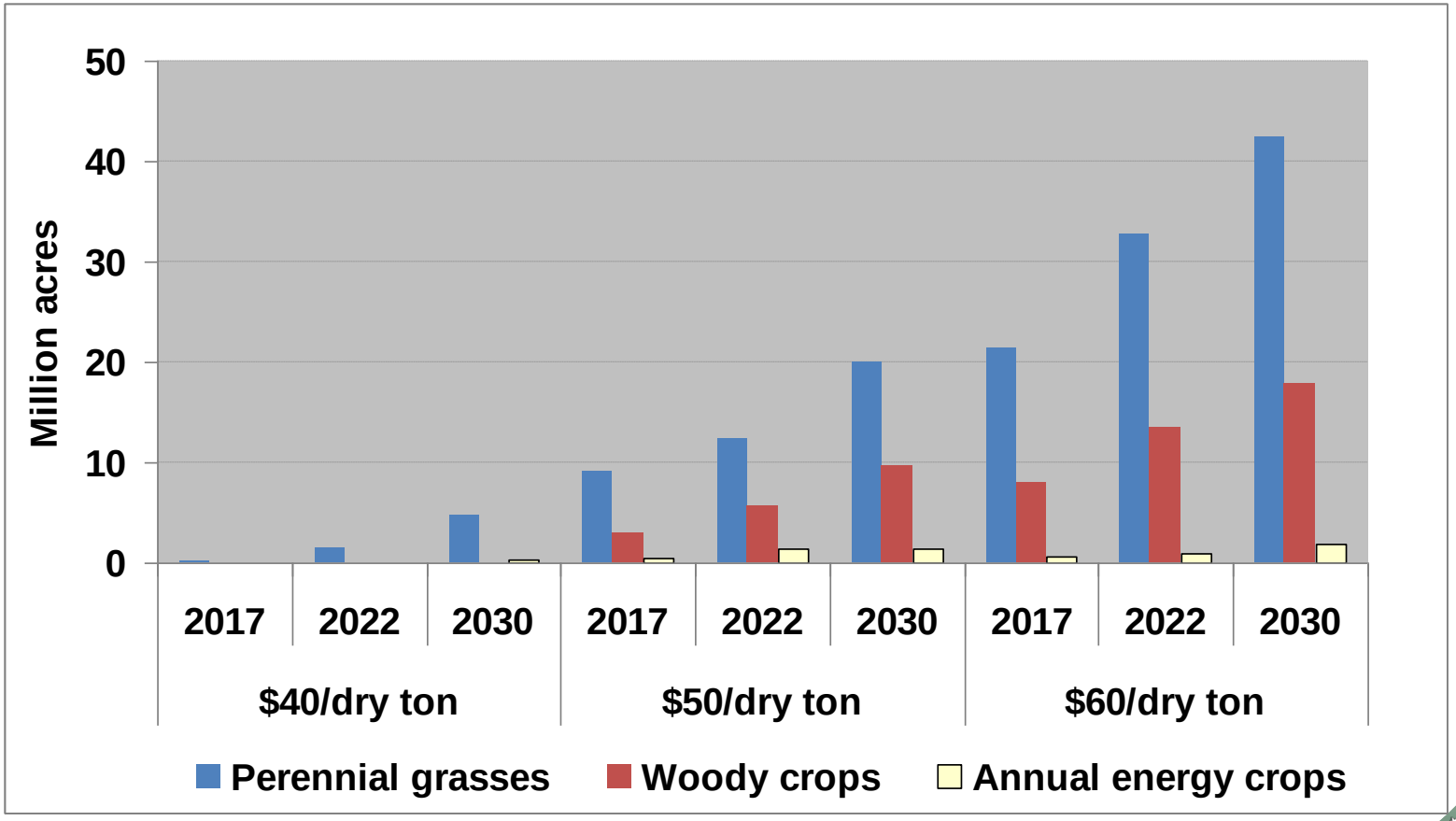
Energy Crop Simulated Supply Curves – Baseline Scenario

- Supplies increase over time due to yield growth and woody crop production
- Energy crops displace mostly commodity crops at low supply curve prices and move onto pasture at higher prices



Energy Crop Simulated Land Use Change

- Land use change at highest simulated prices by 2030
  - 22 to 30 million acres cropland
  - 40 to 50 million acres pasture



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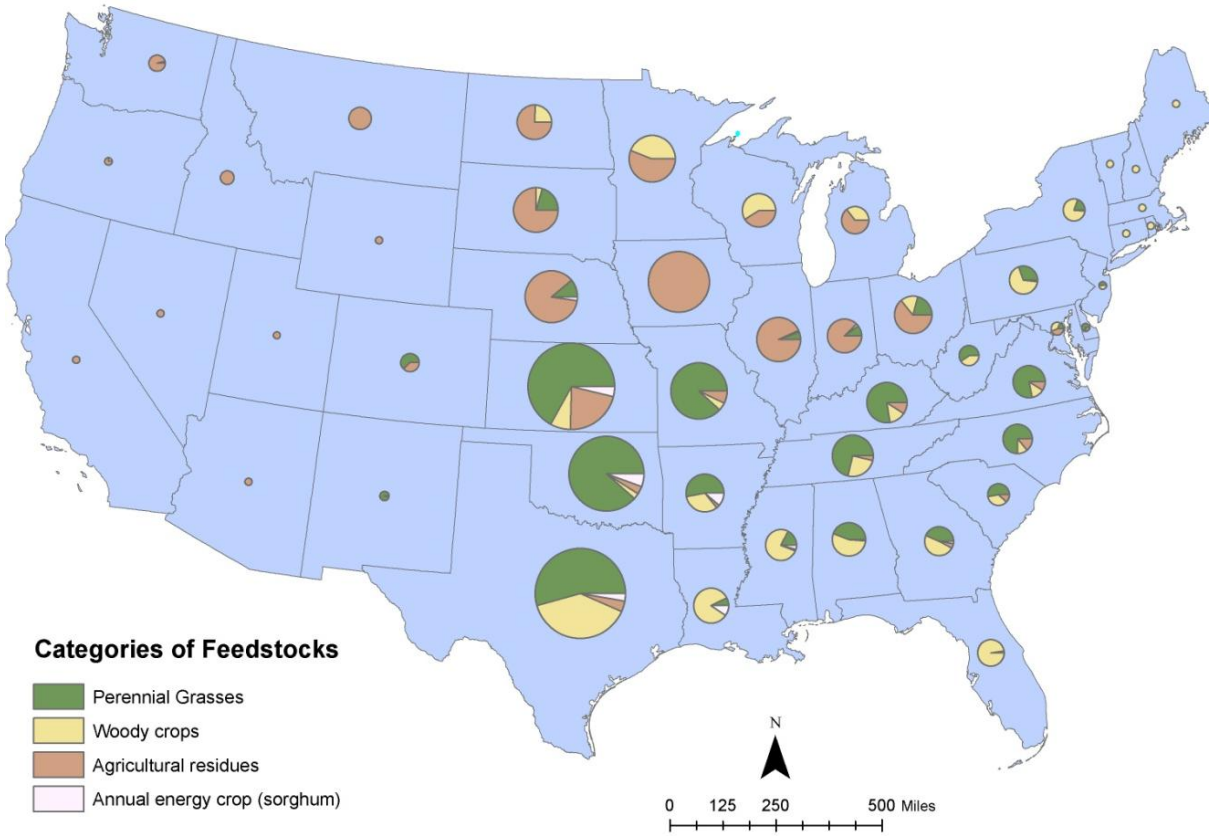
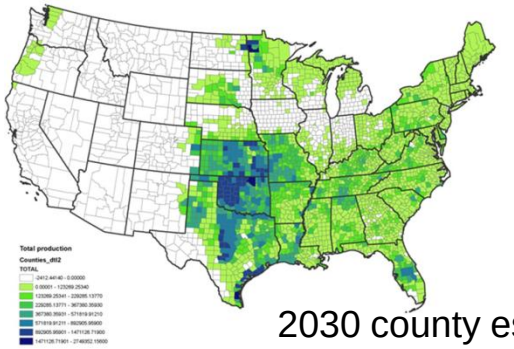
State Potential to Supply Crop Residues and Energy Crops

- Potential supplies are generally widely distributed
  - Considerable perennial grass potential in Southern Plains
  - Residue in Midwest and Northern Plains
  - Woody crops in the North and South



Baseline scenario - $60/dry ton; year 2030



2030 county estimates

Forest Residues Modeling and Sustainability

- Land base – 504 million acres of timberland & 91 million acres of “other forestland”
- Evaluated biomass removal sustainability (erosion, soil nutrients, biodiversity, soil-organic carbon, and long-term soil productivity)
- Accounted for changes in FIA database since 2009
- Re-estimated supply curves for integrated operations for logging residues and fuel treatment thinnings on timberland
- Estimated supply curves for conventionally sourced wood (i.e., pulpwood) from additional harvests and shift from current uses to bioenergy

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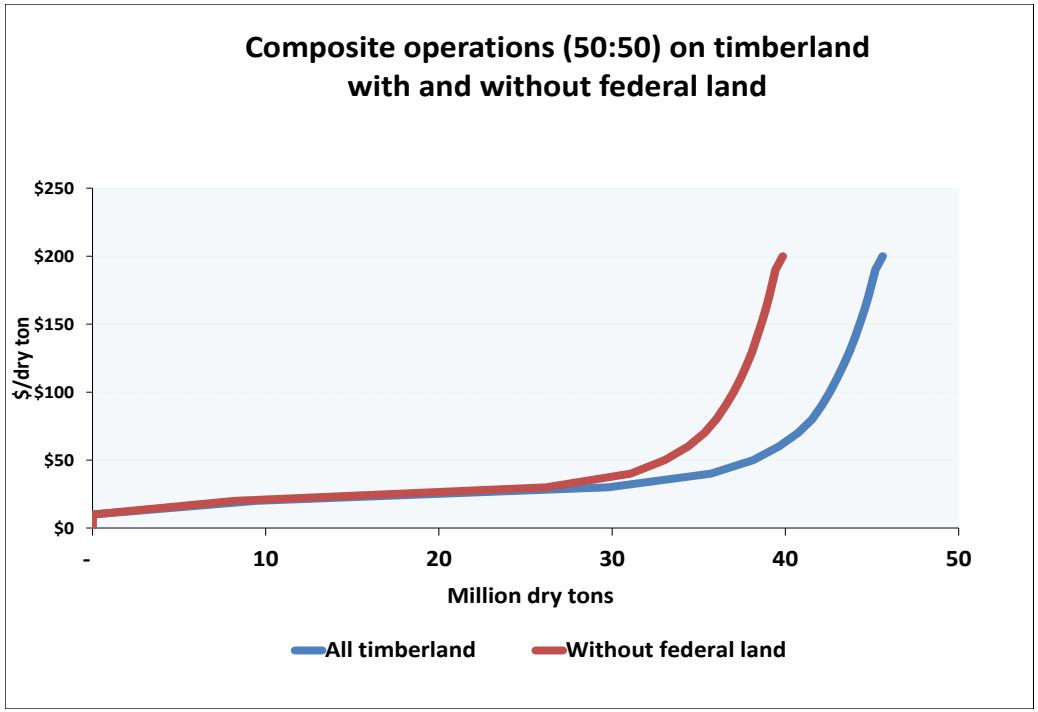
Forest Residues Results

- Sustainability based on biomass retention levels by slope class
  - Logging residues - 30% left on-site
  - Fuel treatment thinnings - Slope <40% = 30% of residue left on-site; Slope >40% to <80% = 40% of residue left on site; Slope >80% = no residue is removed (no limbs or tops yarded)
  - Removed steep, wet and roadless sites from consideration

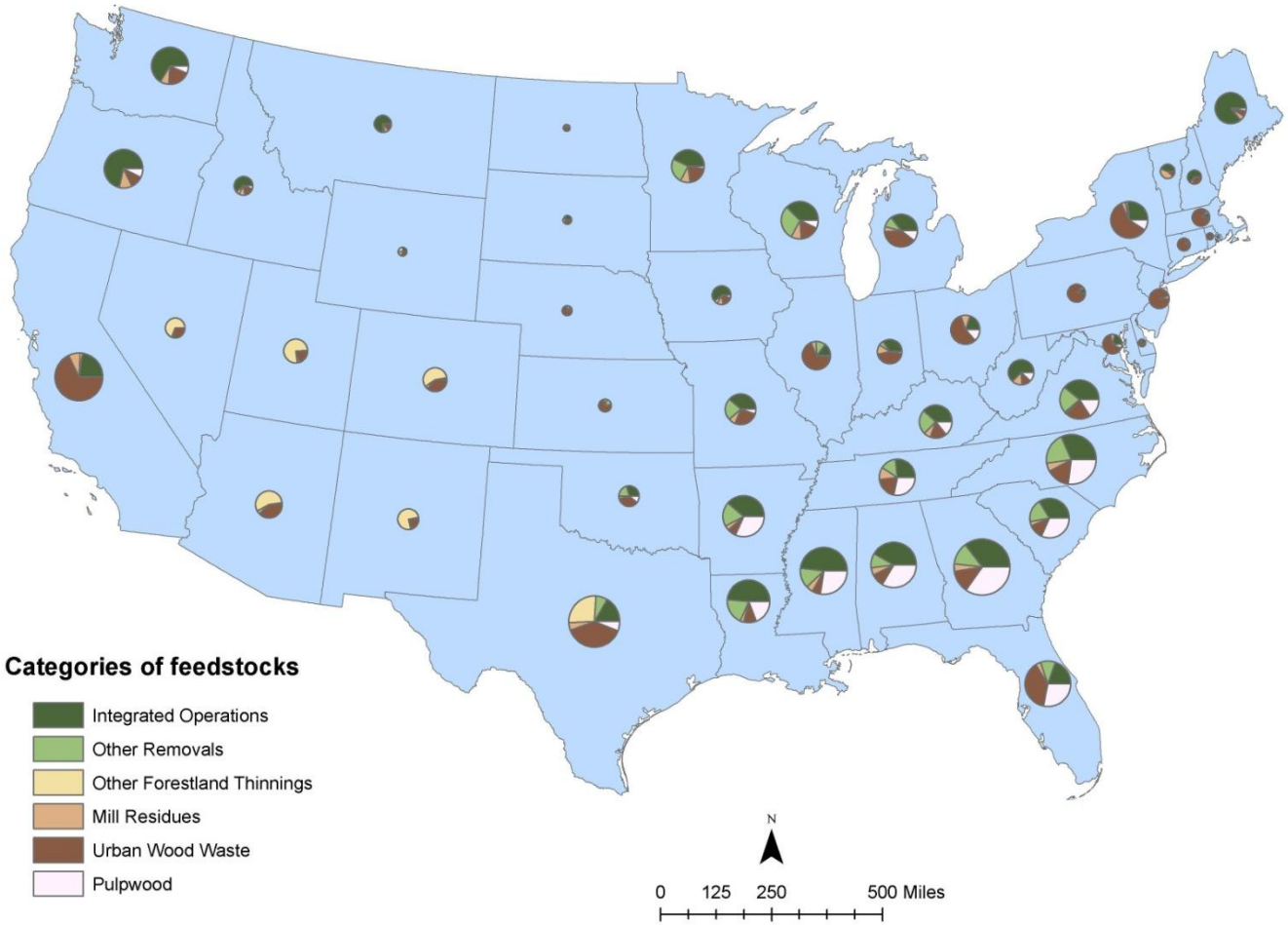
- Roadside supply curves
  - Includes stumpage & chipping costs
  - Fuel Reduction Cost Simulator model for harvesting
  - Projections based on latest RPA/TPO
  - With & without federal land



Significant contributions from USDA Forest Service:
Ken Skog, Dennis Dykstra, Patty Lebow, Pat Miles, others

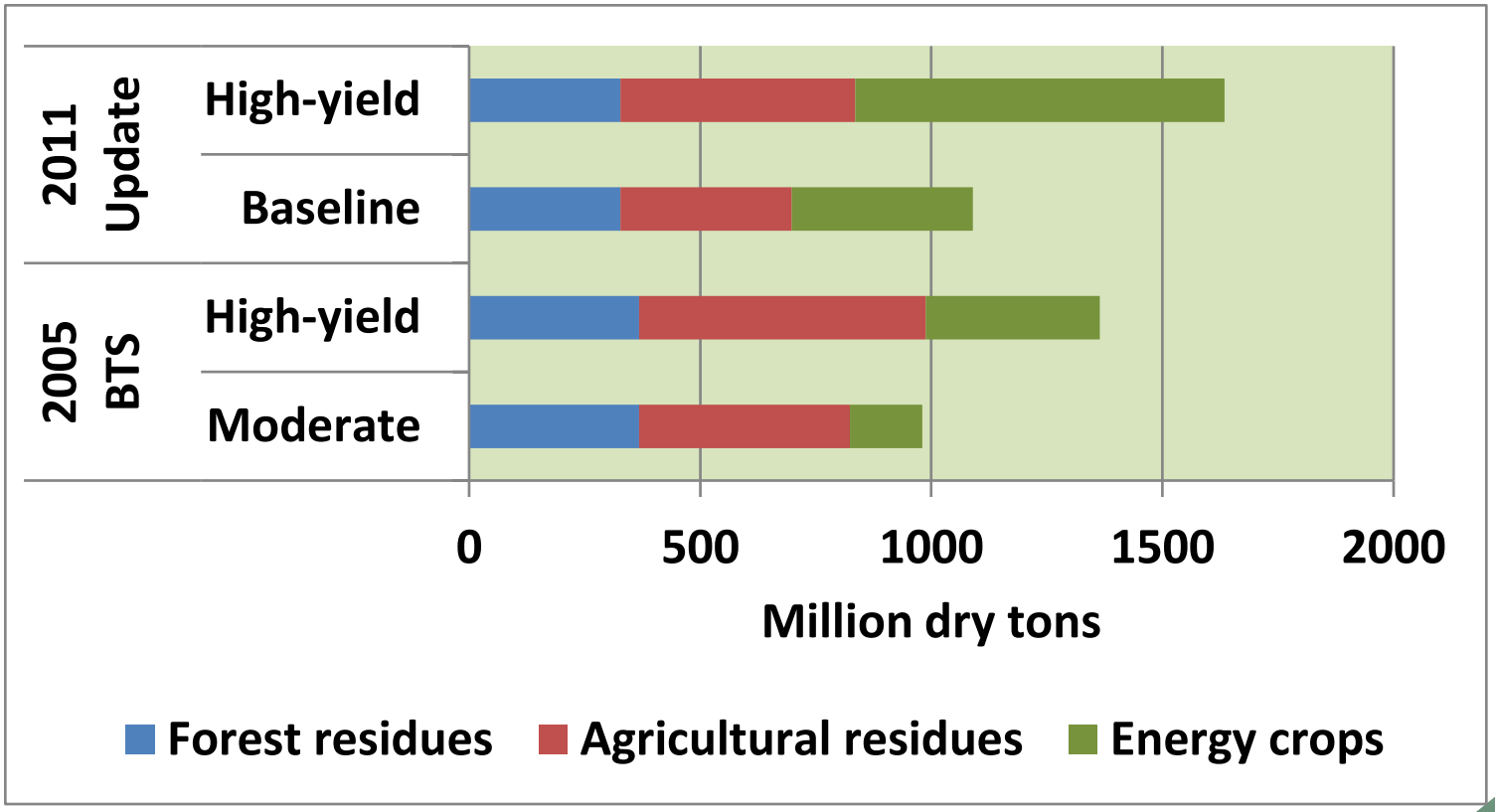
Forest Residues Results

- Forest residues are widespread in the Southeast, North, and Northwest



Summary Findings

- Forest residue biomass potential is somewhat less – removal of unused resources, decline in pulpwood and sawlog markets
- Crop residue potential is less – consideration of soil carbon, no residue from conventionally tilled acres
- Energy crop potential is greater – permanent pastureland, POLYSYS modeling



Relevance

- Project is an integral activity of the Biomass Program to identify a sustainable, high-quality feedstock supply system
  - MYPP (Nov 2010) “Biomass Program feedstock resource assessment activities include identification of the geographic location, price, and environmental sustainability of accessing existing and potential future feedstock resource, as well as projecting future supply availability and prices”
  - Project results include county-level estimates of feedstock supplies for all major primary agriculture and forest resources (farmgate or roadside)
- Project supports the setting of MYPP technical performance targets through the analysis of grower payments (farmgate cost less collection/harvesting)
  - Using the POLYSYS modeling framework, the project simulated farmgate prices and grower payments needed to procure sufficient biomass to meet EISA 2022 targets

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Critical Success Factors

- The modeling framework –
  - Operates at county-level and includes major crop residues and four energy crops
  - Includes environmental sustainability
  - Estimates land use change and economic impacts
  - Tracks use of fossil fuels and carbon emissions
  - Supports modeling of GHGs and water quality
  - Leverages other funded research with Agricultural Policy Analysis Center (University of Tennessee) UTK/APAC, other laboratories, and other agencies

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Critical Success Factors (cont.)

- Improvements can be made to input data and modeling
  - Energy crop productivity
    - Woody crops
    - Cropland vs pasture productivity
    - Spatial variability
  - Crop residues
    - Crop rotations
    - County residue retention coefficients
  - Land use data
    - NASS vs CDL (Cropland Data Layer)
    - Pasture
  - Integration of forest residues and conventional wood modeling

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Users of Data and Results

- Energy Information Administration (EIA) – annual energy outlook
- Western Governors' Association (WGA) – biorefinery siting model
- USDA – Renewable Energy Outreach and Marketing Tool (resource and economic tools to help meet the RFS2 challenge)
- National Research Council (NRC) – Committee on Economic and Environmental Impacts of Increasing Biofuels Production
- Intergovernmental Panel on Climate Change (IPCC) – bioenergy resources analysis
- National Renewable Energy Laboratory and National Bioenergy Center – life cycle assessment, Stochastic Energy Deployment System (SEDS), Biomass Scenario Model (BSM)
- Idaho National laboratory – uniform format and stranded resource analysis
- Argonne National Lab – water quality assessment project using SWAT
- DOE Loan Guarantee – County resource data for loan assessment
- News/conferences – Numerous invitations

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Future Work

- The project is ongoing and plans are to continue improving data and modeling with annual supply curve updates to the Bioenergy KDF
  - Modeling and data
    - Refine crop residue retention coefficients
    - Land use data
    - Crop productivity
    - Crop budgets and resource regions
    - New USDA Baseline Forecast
  - Assessing landscape factors for stranded resources and integration with logistics and supply chain analysis projects including alternative metrics
  - Supporting sustainability analysis project modeling
  - MYPP
- Key milestones
  - Publish report and prepare open literature publications
  - Annual release of supply curves to Bioenergy KDF

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Summary

- Project is an integral activity of the Biomass Program to identify a sustainable, high-quality feedstock supply system
- Modeling approach is well accepted and has involved numerous collaborators
- Update to the 2005 Billion-Ton Resource Assessment is complete and will be published soon
- Modeling framework is developed and can be adapted to wide range of analyses in addition to estimation of supply curves, land use change, etc.
- Modeling results are easily shared with other projects through the Bioenergy KDF

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Additional Slides

- Three responses to questions/criticisms from the 2009 review
- Publications and presentations
  - Those involving full or partial support from the Supply Forecast and Analysis project

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Responses to Previous Reviewer's Comments (1)

- Question/weakness – "*The speaker said that POLYSYS only considered soil erosion and wind -- nothing really on soil quality (carbon, etc.). IF TRUE, THIS IS A MAJOR WEAKNESS*."
- Response – Residue retention coefficients were estimated in collaboration with INL and KSU and with additional re-programming incorporated in POLYSYS model.
  - POLYSYS contains separate residue retention coefficients for water and wind erosion and soil carbon for acres under reduced-till and no-till cultivation.
    - Varies by county
    - Changes over time with yield growth
  - No residue is removed from conventionally tilled acres

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Responses to Previous Reviewer's Comments (2)

- Question/weakness – " *I consider the proposal that growers will take $15 per ton for their production [crop residues] to be preposterous. Won't argue with the 35 for logistics until we know better, but at 15 for the product, no one will be interested …*"
- Response – Grower payments for crop residue collection were revised. Current estimates not only include the value of nutrients and the residue as organic matter, but a flat $10/dry ton return.
  - A review of literature suggested a wide range of returns. A $10/dry ton return was used as an approximate average.
  - The new grower payment generally shifts estimated supply curves for residues by about $8-$9/dry ton.

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Responses to Previous Reviewer's Comments (3)

- Question/weakness – "*Validate annual yield growth assumptions" and "2% growth in yield????? Nothing about what seed corn companies are projecting the capability of future crops, which is much higher*."
- Response – High-yield workshops were held with industry participants "to identify and discuss the challenges associated with substantially increasing production of lignocellulosic biomass resources, such as agricultural crop residues (in particular, corn stover) and herbaceous and woody energy crops, to sustainably supply feedstock for biorefineries."
  - Baseline scenario reflects USDA Baseline Forecast
  - High-yield scenario reflects a workshop consensus national average corn yield of 265 bu/ac and growth in energy crop yields of 2 to 4% annually.

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Publications (since 2009 review)

- Wullschleger SD, Davis EB, Borsuk ME, C.A. Gunderson CA, Lynd LR., An Empirical Model of Biomass Production in Switchgrass: Database Description and Determinants of Yield. Agronomy Journal 102:1158–1168, 2010.
- Jager H., Baskaran L., Brandt C., Davis E., Gunderson C., Wullschleger S., Empirical Geographic Modeling of Switchgrass Yields in the United States. GCB Bioenergy 2:248–257, 2010.
- C.M. Hellwinckel, T.O. West, D.G. De La Torre Ugarte, and R.D. Perlack, Evaluating possible cap and trade legislation on cellulosic feedstock availability, *GCB Bioenergy*, 2(5):278–287, October 2010.
- Wright, L. and A. Turhollow, “Switchgrass selection as a ‘model’ bioenergy crop: A history of the process,” *Biomass and Bioenergy* 34(6):851-868, June 2010.
- Turhollow, Anthony, Erin Wilkerson, and Shahab Sokhansanj, *Cost methodology for biomass feedstocks: Herbaceous crops and agricultural residues*, ORNL/TM-2008/105, Oak Ridge National Laboratory, Oak Ridge, TN, December 2009.
- Hess, J. Richard, Kevin L. Kenney, Christopher T. Wright, Robert Perlack, and Anthony Turhollow, “Corn stover availability for biomass conversion: Situation analysis,” *Cellulose* 16(4):599-619, August 2009.
- Wilkerson, E. and R. Perlack, “Resource Assessment, Economics and Technology for Collection and Harvesting,” in Renewable Energy from Forest Resources in the United States, B. Solomon and V. Luzadis editors, Taylor and Francis, 2009.

Publications (since 2009 review)

- McBride, Allen C., Virginia H. Dale, Latha M. Baskaran, Mark E. Downing, Laurence M. Eaton, Rebecca A. Efroymson, Charles T. Garten, Keith L. Kline, Henriette I. Jager, Patrick J. Mullholland, Esther S. Parish, Peter E. Schweizer, John M. Story. *Indicators to support environmental sustainability of bioenergy systems* . 2011 Forthcoming (Ecological Indicators).
- Oladosu, Gbadebo, Keith Kline, Rocio Uria-Martinez, Laurence Eaton. *Sources of Corn for Ethanol Production in the United States: A Review and Decomposition Analysis of the Empirical Data.* 2011 Forthcoming (Bioproducts and Biorefining)
- U.S. Department of Energy. 2011. *Biomass as Feedstock for a Bioenergy and Bioproducts Industry: An Update to the Billion-Ton Annual Supply*. R.D. Perlack and B.J. Stokes (Leads), ORNL/TM-2010/xx. Oak Ridge National Laboratory, Oak Ridge, TN __ p.
- Langholtz, M., R. Graham; L. Eaton; Robert Perlack; C. Hellwinkel; D. De La Torre Ugarte, Price Projections of Feedstocks for Biofuels and Biopower in the U.S., 2011 forthcoming.
- Wright, L. L. Eaton, R. Perlack, and B. Stokes, *Woody biomass for energy applications: state of technology,* in Comprehensive Renewable Energy, Elsevier, London, forthcoming, 2011.
- Others awaiting release of the Billion-ton update report

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Presentations (since 2009 review)

- Eaton, L, Schweizer, P., Jager Y. Assessing watershed benefits of bioenergy crops: recreational and subsistence value of fishes, IALE, Athens, GA, April, 2010.
- Perlack R. B. Stokes, L. Eaton, J. Ferrell, M. Downing, Update to The Billion-ton Annual Supply, 8th Biennial Short Rotation Woody Crops Operations Working Group Meeting, Syracuse, NY, October 2010
- Perlack R., L. Eaton, C. Brandt, A.Turhollow, C. Hellwinckel, B. Stokes, Biomass Production – Agricultural Perspective, Renewable Energy Biomass Education Field Days, Farm Foundation, Knoxville, TN, November 2010
- Eaton L. R. Perlack, C. Brandt, M. Langholtz, A. Turhollow, M. Downing, R. Graham Bioenergy Resource Analysis at ORNL, US Biofuels Study Tour for the China NEA, Knoxville, TN, December 2010
- Eaton, L, Schweizer P, Jager Y. The economic effects of biofuel feedstock production on gamefish distribution, ACES 2010, Phoenix, AZ, December, 2010.
- Eaton L. L. Wright, R. Perlack, M. Langholtz, C. Hellwinckel, Challenges to Mapping Yields and Modeling Production of Woody Crops, 8th Biennial Short Rotation Woody Crops Operations Working Group Meeting, Syracuse, NY, October 2010
- Perlack R. and B. Stokes, Billion-ton Resource Assessment: Update, Wood to Energy Forum, Orlando, FL, January 2010

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Presentations (since 2009 review)

- Perlack R., Biomass Feedstock Resource Assessment: Update, UK General Counsel, Oak Ridge, TN, January 2010
- Perlack R. and B. Stokes, Update To Billion-ton Resource Assessment, NRC, Washington, May 2010
- Stokes B. and K. Skog., Woody Biomass Supply – Updating the Billion Ton Report, Smallwood Conference, April 2010 Hot Springs, AR
- Eaton, L., E. Webb, A. Turhollow, and R. Perlack. 2010. "A comparative cost analysis of perennial herbaceous energy crops and short rotation woody crops," 32nd Symposium on Biotechnology for Fuels and Chemicals, Clearwater, FL, April 2010.
- Symposium: Estimating Current and Future Biomass Feedstocks, ASA-CSSA-SSSA Annual Meeting Pittsburgh, PA, November, 2009
  - T. West (ORNL), C. Brandt (ORNL), C. Hellwinckel (APAC/UTK), R. Perlack (ORNL), and M. Downing (ORNL), Integrative Framework for Estimating Available Cellulosic Feedstocks: National Field Trials, Remote Sensing, and Economic Projections,
  - C. Hellwinckel (APAC/UTK), R. Perlack (ORNL), Daniel G. De La Torre Ugarte (APAC/UTK), and Tristram West (ORNL), Estimating Changes in Land Use Under EISA

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