Sensitivity analysis of BT16 scenarios

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Acknowledgements:

Mark Elless, Steve Thomas (DOE-BETO), Matthew Langholtz, Maggie Davis (ORNL)

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Today's presentation

- Why are energy crops important to the bioeconomy?
- What are price and land impacts of energy crop scenarios to traditional crops?
- What is sensitivity of energy crops to alternate assumptions of yield and land elegibility?

Miscanthus* x *giganteus

Source: http://articles.extension.org/pages/26625/miscanthus-miscanthus-x-giganteus-for-biofuel-production

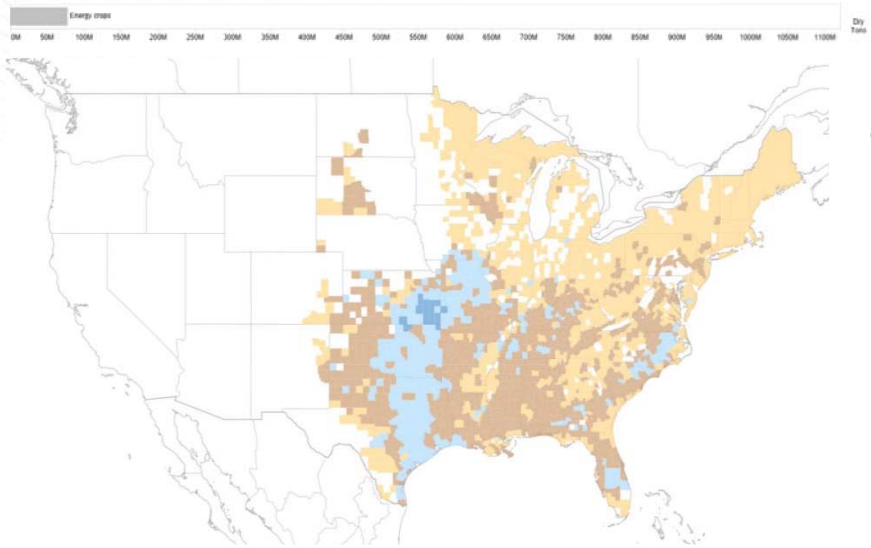
Biomass sorghum

Source: http://www.nexsteppe.com/a-new-sorghum-for-biofuels/

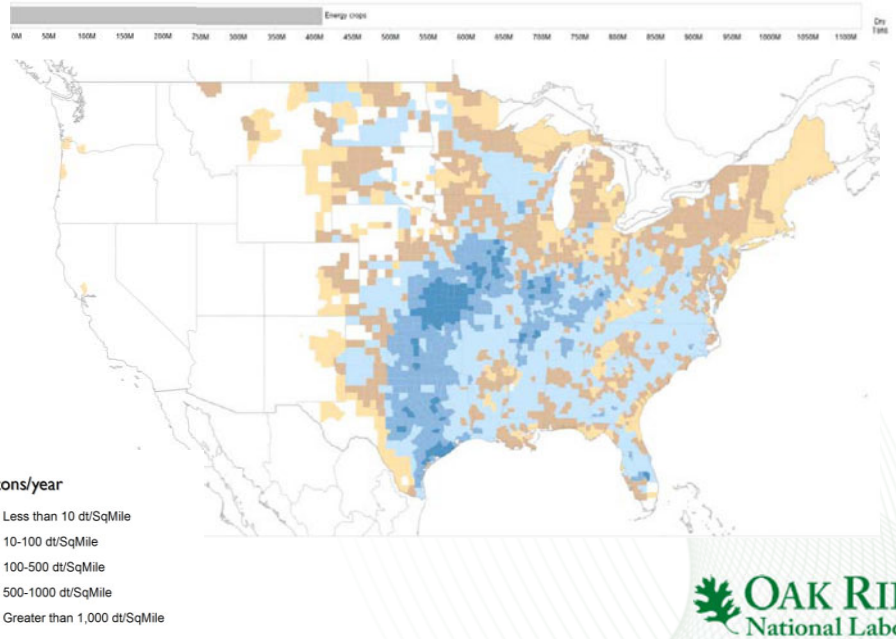
Why energy crops?

- Energy crops fill supply gap to a billion ton annual supply
- Competitive across crop and pastureland, even in Corn Belt
- Measured market impacts

Base-case scenario, $60/dt 2022



Base-case scenario, $60/dt 2040



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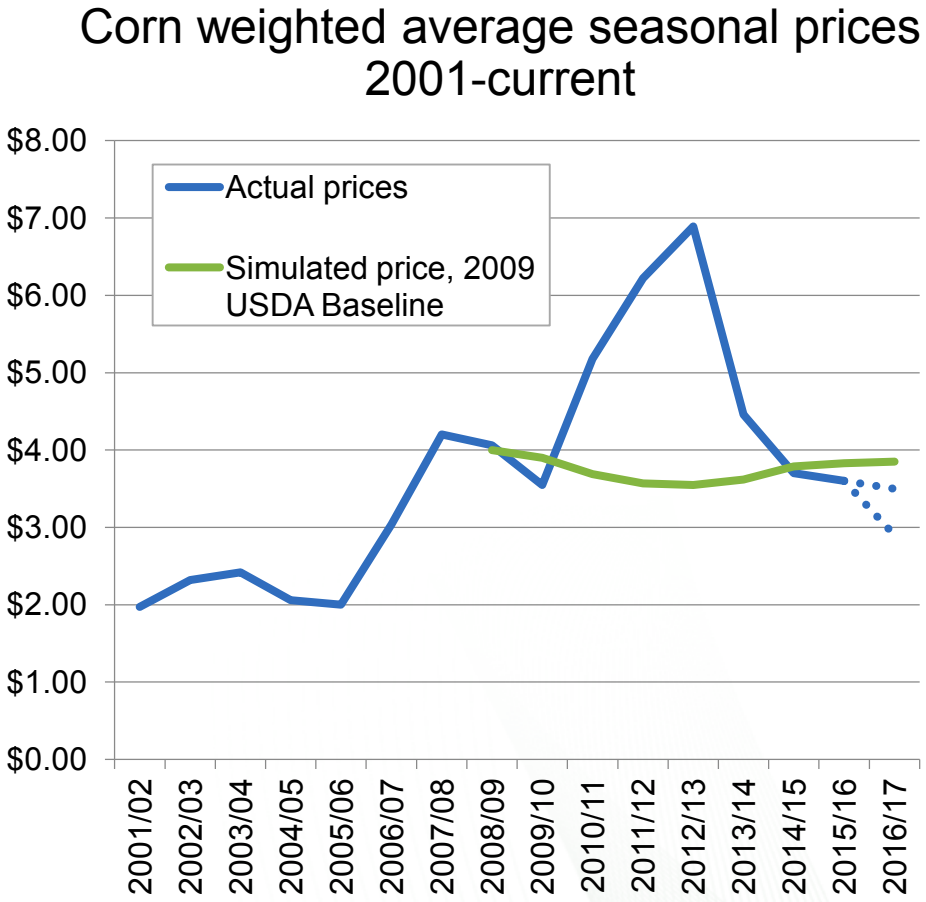
Relation of BT16 results to historical and future commodity prices

- Baseline scenario as reference without shocks
- Corn futures March 1, 2017= $3.72/bu,
  - 1-year range: $3.25-4.50/bu
  - 3-year range $3.10-7.20/bu
- BT16 results
  - Baseline, 2016: $3.50, 2040: $3.77
  - Basecase, 2040: $4.03
  - Crossprice elasticities of biomass to commodity crops all <1



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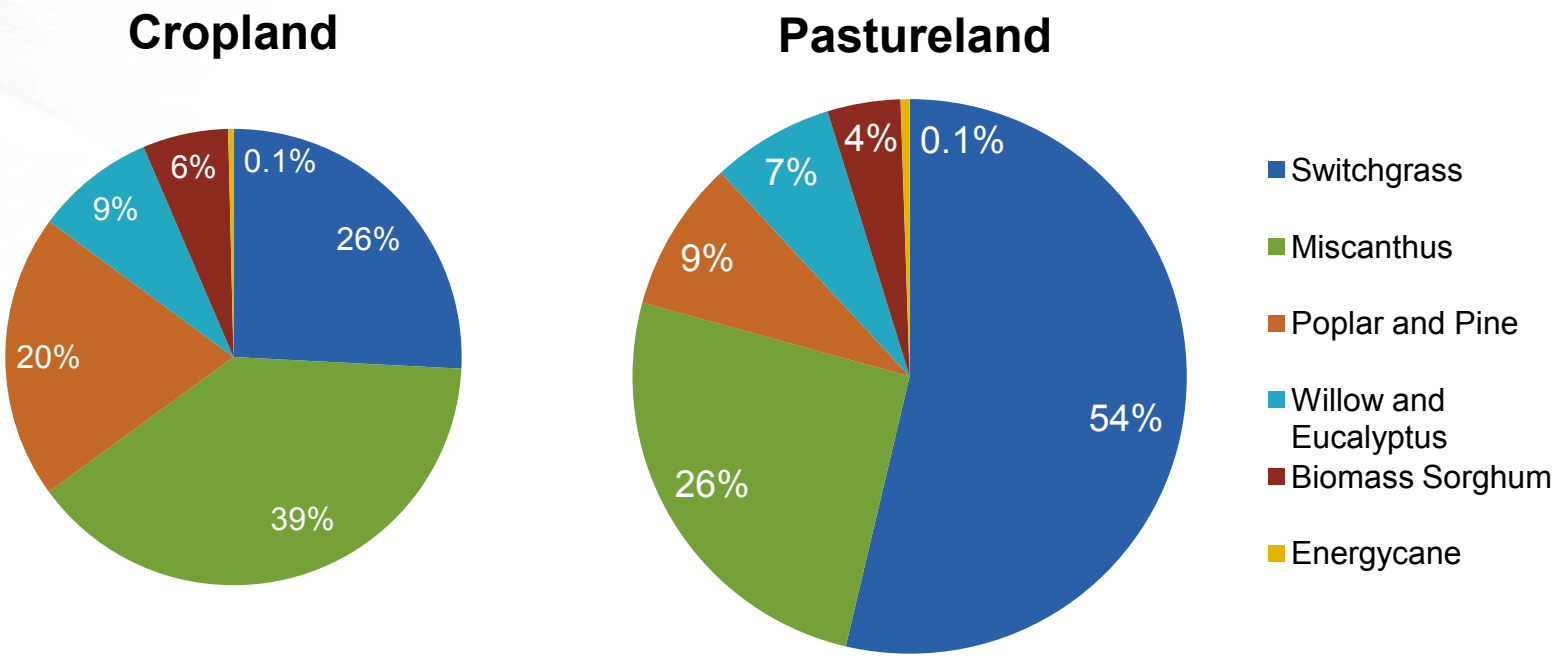
Land allocation of energy crops, base case



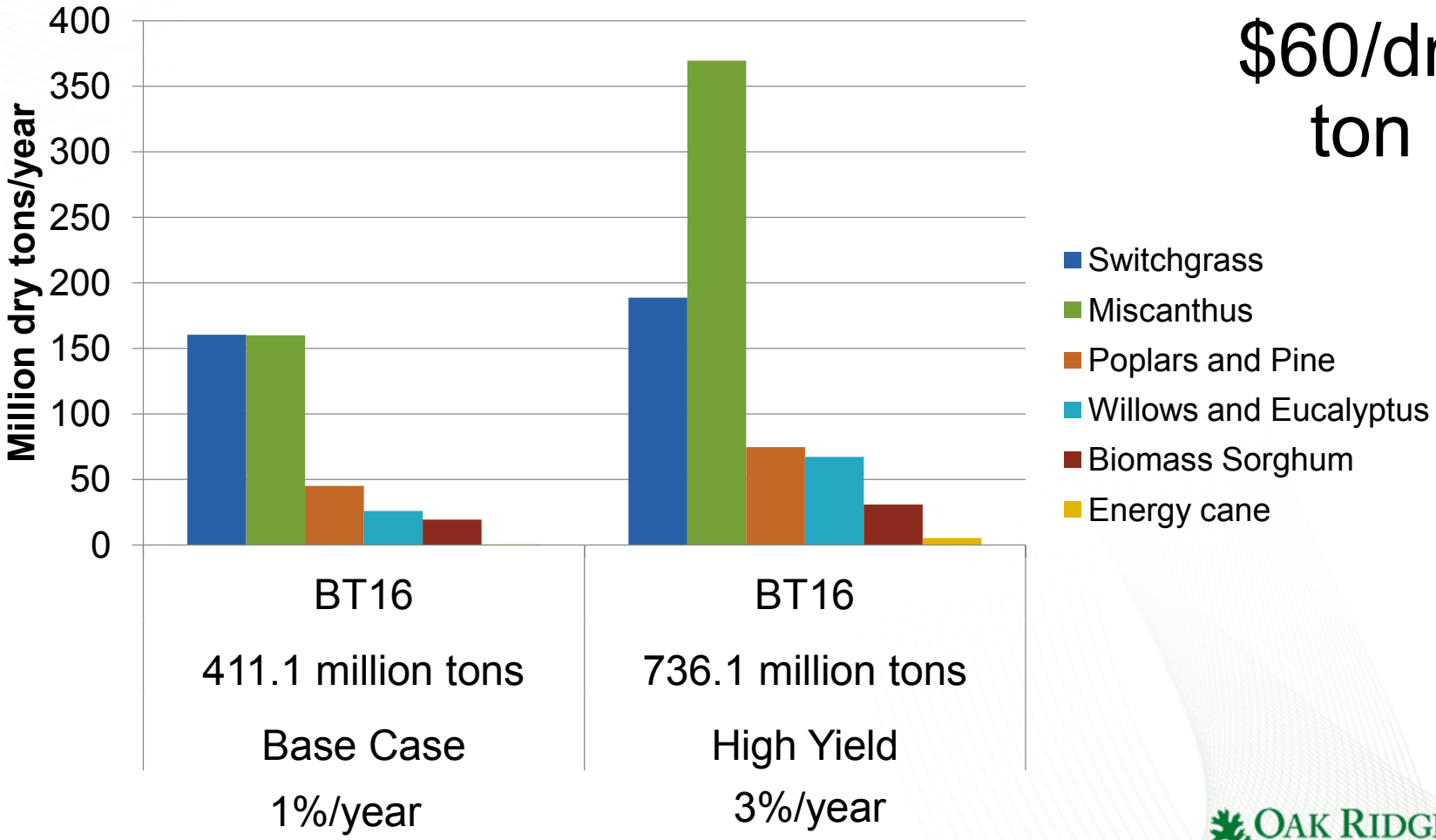
- Differential response of across energy crops to $60
- Energy crops competitive across ag land
- Switchgrass represents largest pastureland holder, miscanthus cropland holder
- Represents only 8.3% of pastureland and cropland

Stakeholder feedback received in BT16 rollout

- Miscanthus yield growth and supply too optimistic
  - *Miscanthus* x *giganteus* (MxG) sterile triploid
  - Future improvements will require new varieties
- Sorghum supply too pessimistic
  - New varieties already exist
  - “Plug-and-play” annual crop
- Mix of feedstocks in BT16 can change with R&D improvements

BT16 Agricultural Results, 2040

All crops increase in supply from base to high yield; MxG benefits disproportionately relative to other energy crops from yield growth assumptions



$60/dry ton

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Alternate scenarios descriptions

Scenario	Description
Base case	**BT16 scenario, MxG and biomass sorghum at 1%, biomass sorghum on 1 in 4 year rotation**
Miscanthus focus, base case	*Miscanthus at 0% annual yield gain*
Sorghum focus, base case	*Biomass sorghum at 1 in 2 year rotation and on pastureland*

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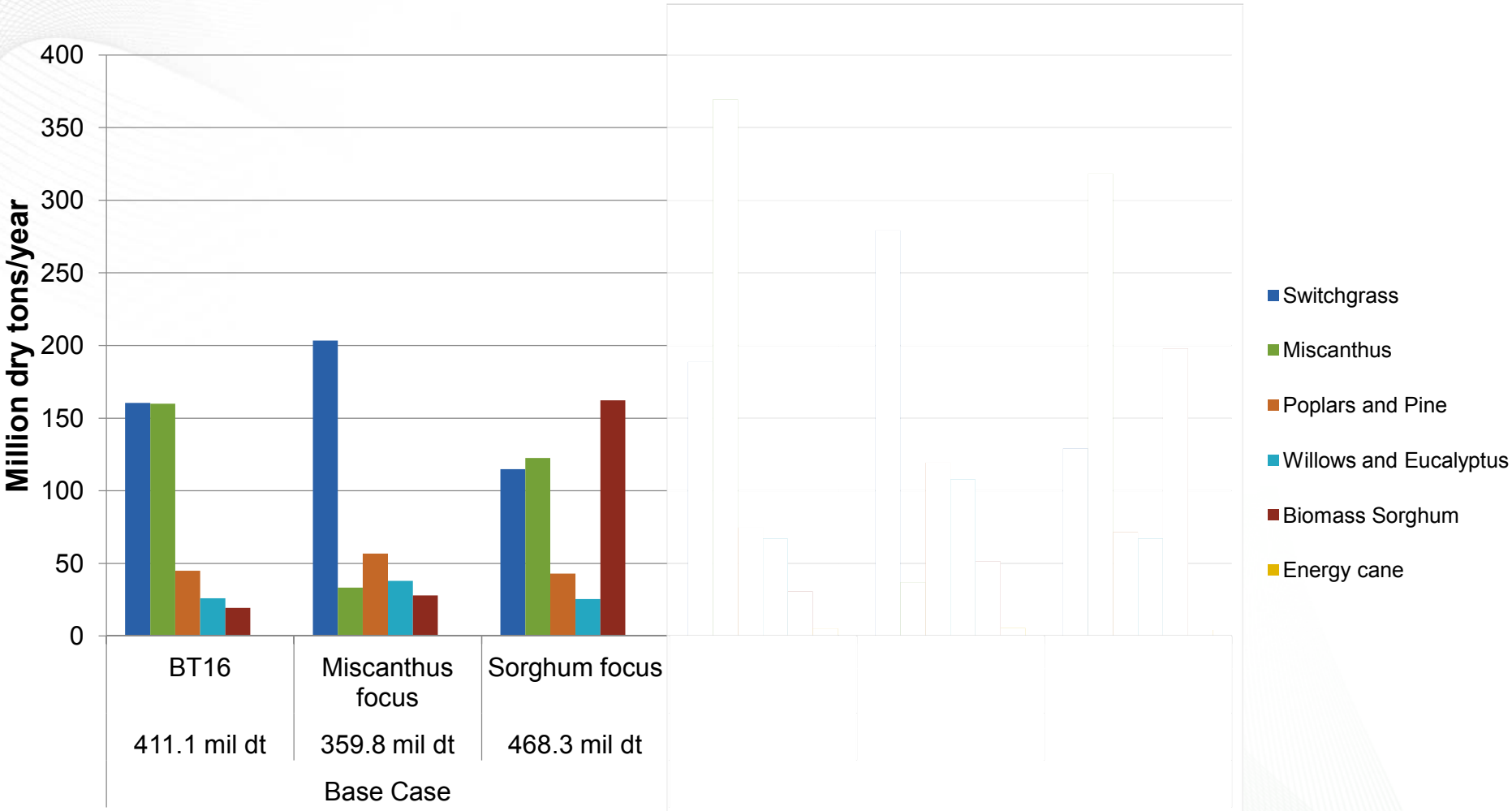
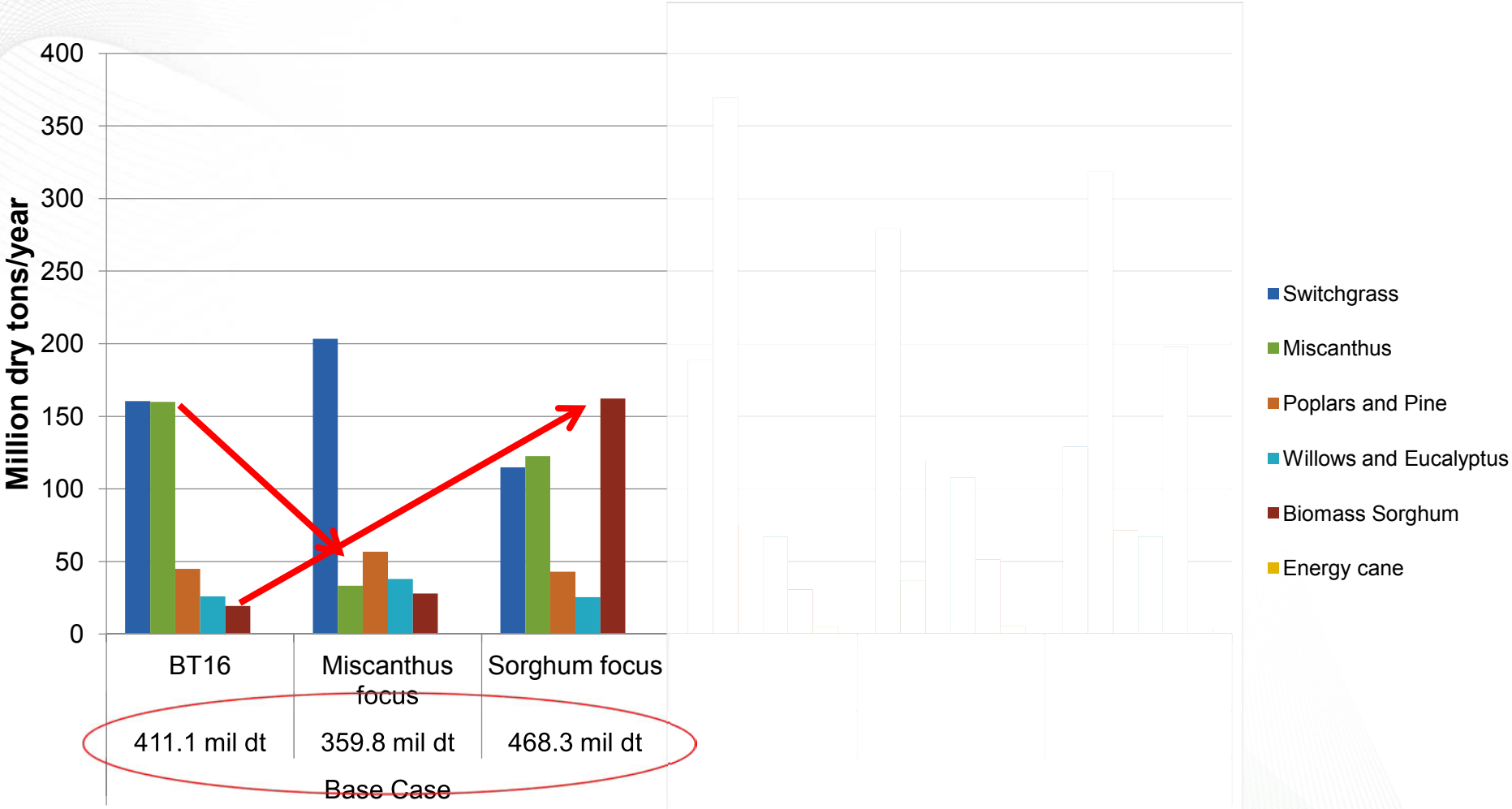
Miscanthus focus, base case	*Miscanthus at 0% annual yield gain*
Sorghum focus, base case	*Biomass sorghum at 1 in 2 year rotation and on pastureland*
High Yield	**BT16 scenario, MxG at 3% per year and biomass sorghum at 1.75% per year, biomass sorghum on 1 in 4 year rotation**
Miscanthus focus, high yield	MxG at 1% annual yield gain
Sorghum focus, high yield	Biomass sorghum at 3% per year and 1 in 2 year rotation and sorghum on pastureland

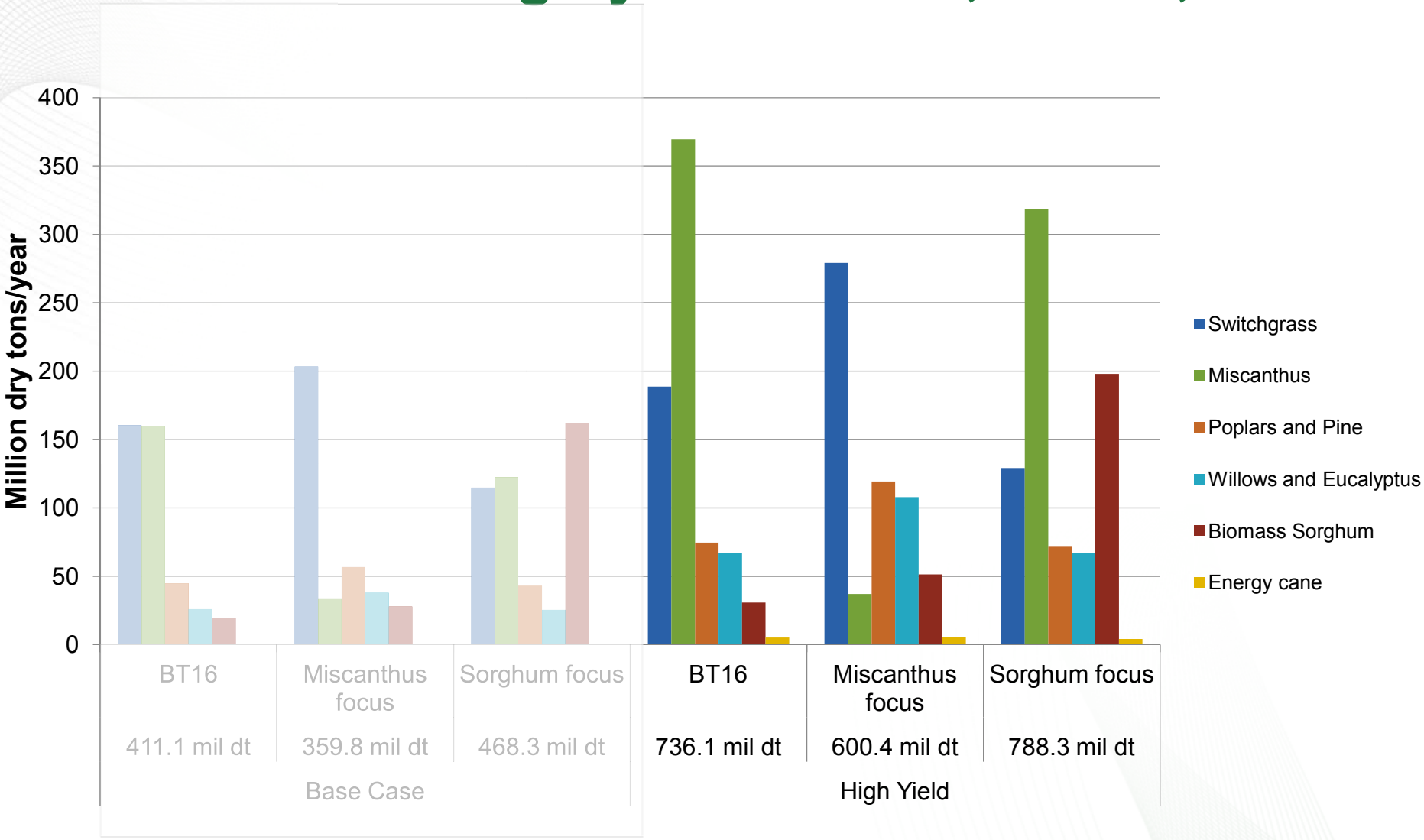
Basecase and high yield results, $60/dt, 2040



Basecase and high yield results, $60/dt, 2040



Basecase and high yield results, $60/dt, 2040



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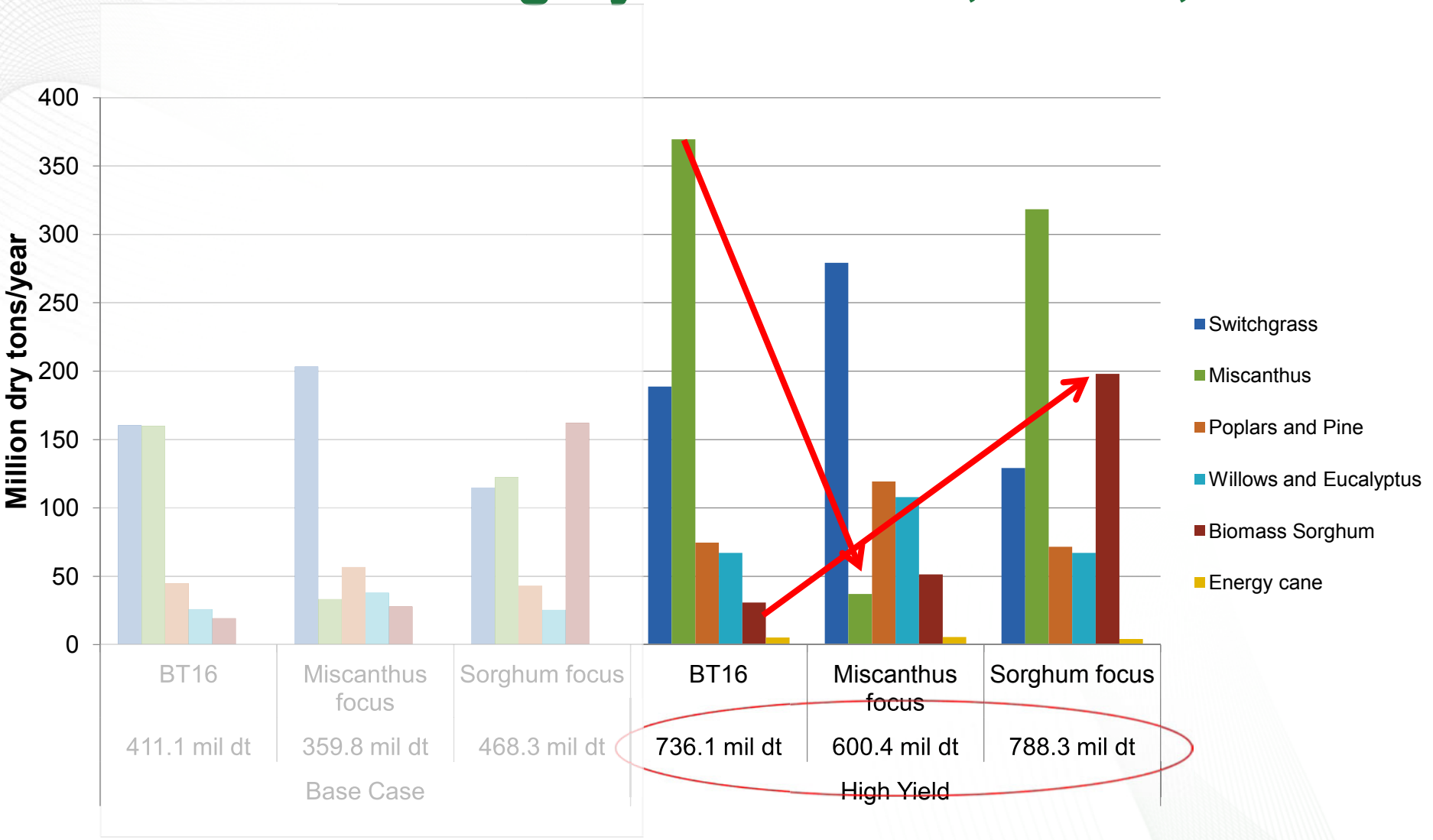
Basecase and high yield results, $60/dt, 2040



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Conclusions

- Market effects of energy crops are measured in BT16 and fall within recent historical variability
- Land allocation of energy crops is diverse
- Small changes in feedstock growth parameters and land eligibility result in significant changes in feedstock mix
- BT16 scenarios capture reference case, but may not be “one size fits all” resource assessment

Thank you for your attention!

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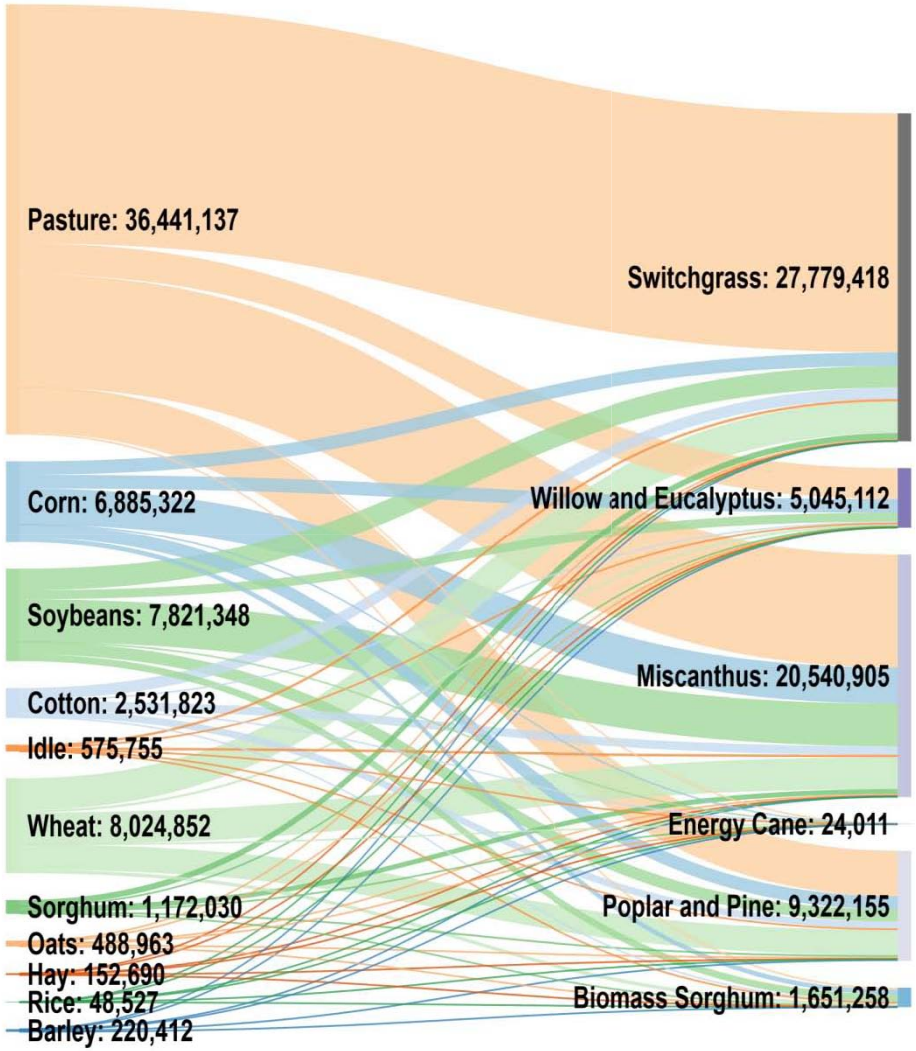
Additional Slides

Land allocation of energy crops, base case



National acreage transitions 2017-2040, Base case

- Differential response of across energy crops to $60
- Energy crops competitive across ag land
- Switchgrass represents largest pastureland holder, miscanthus cropland holder
- Represents only 8.3% of pastureland and cropland

Note: figure doesn't include crop rotations rather transitions of county acreage allocated to crops in beginning and ending year

Supply comparison to BT16, $60, 2040

	Comparison to Base case		Comparison to High yield	
	Miscanthus focus	Sorghum focus	Miscanthus focus	Sorghum focus
Stover	0%	0%	2%	2%
Straw	0%	0%	4%	4%
Switchgrass	27%	-28%	56%	-6%
Miscanthus	-79%	-23%	-208%	-215%
Poplars	26%	-4%	99%	80%
Willows	46%	-2%	157%	140%
Biomass Sorghum	45%	740%	106%	1156%
Energy cane	0%	0%	133%	-367%

Reformat table to be same as slide 6 color scheme; highlight notable results here. How does this support