

# Challenges to mapping yields and modeling production of woody crops



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**October 19, 2010**

8<sup>th</sup> Biennial Short Rotation Woody Crops Operations Working Group Conference, 17-19 October, 2010, Syracuse, NY

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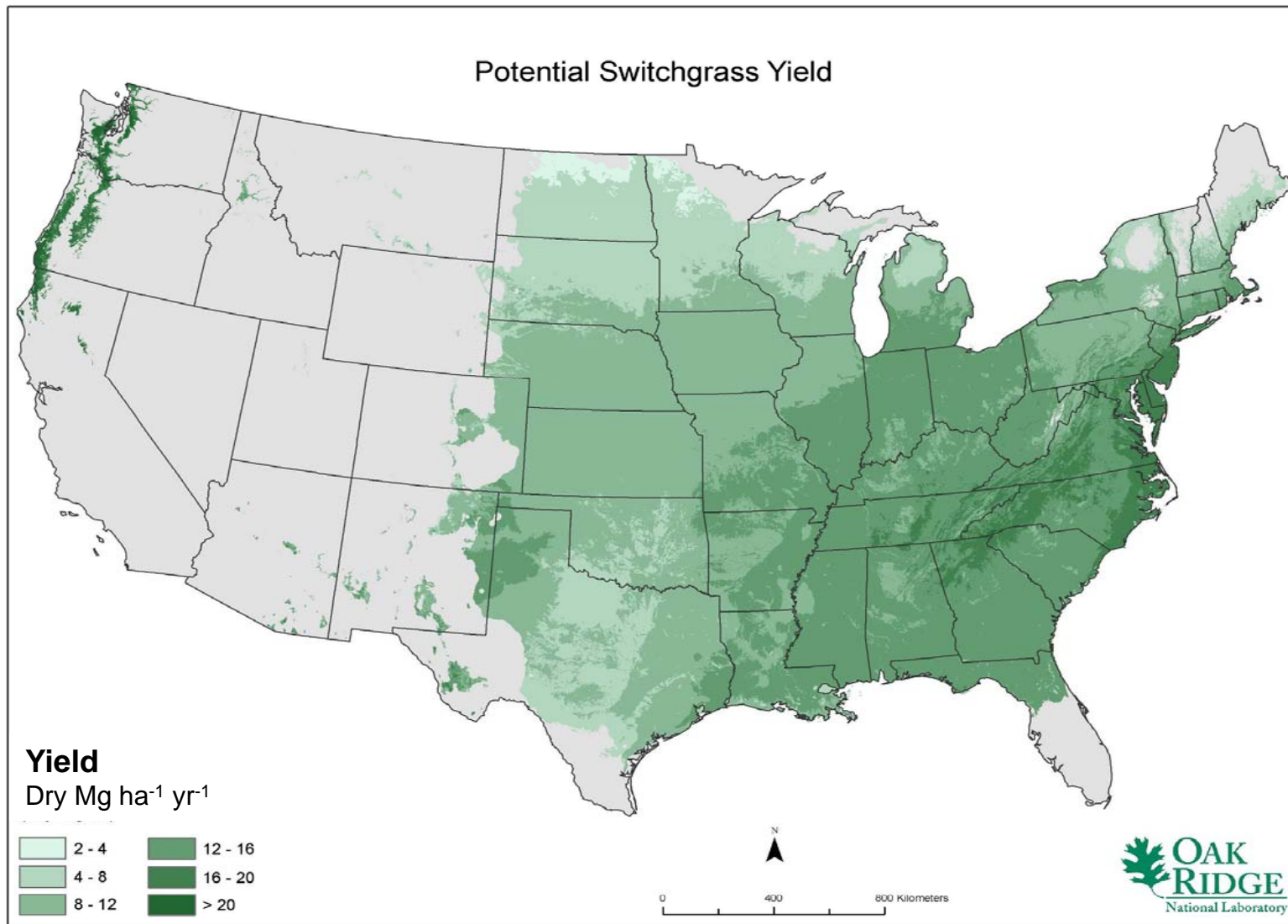
# Outline of presentation

- Determining, mapping yields
- POLYSYS baseline yields
- Analysis of baseline scenarios (years 2012-2030)
- Energy crops land competition
- Conclusion and next steps

# Determining tree yields

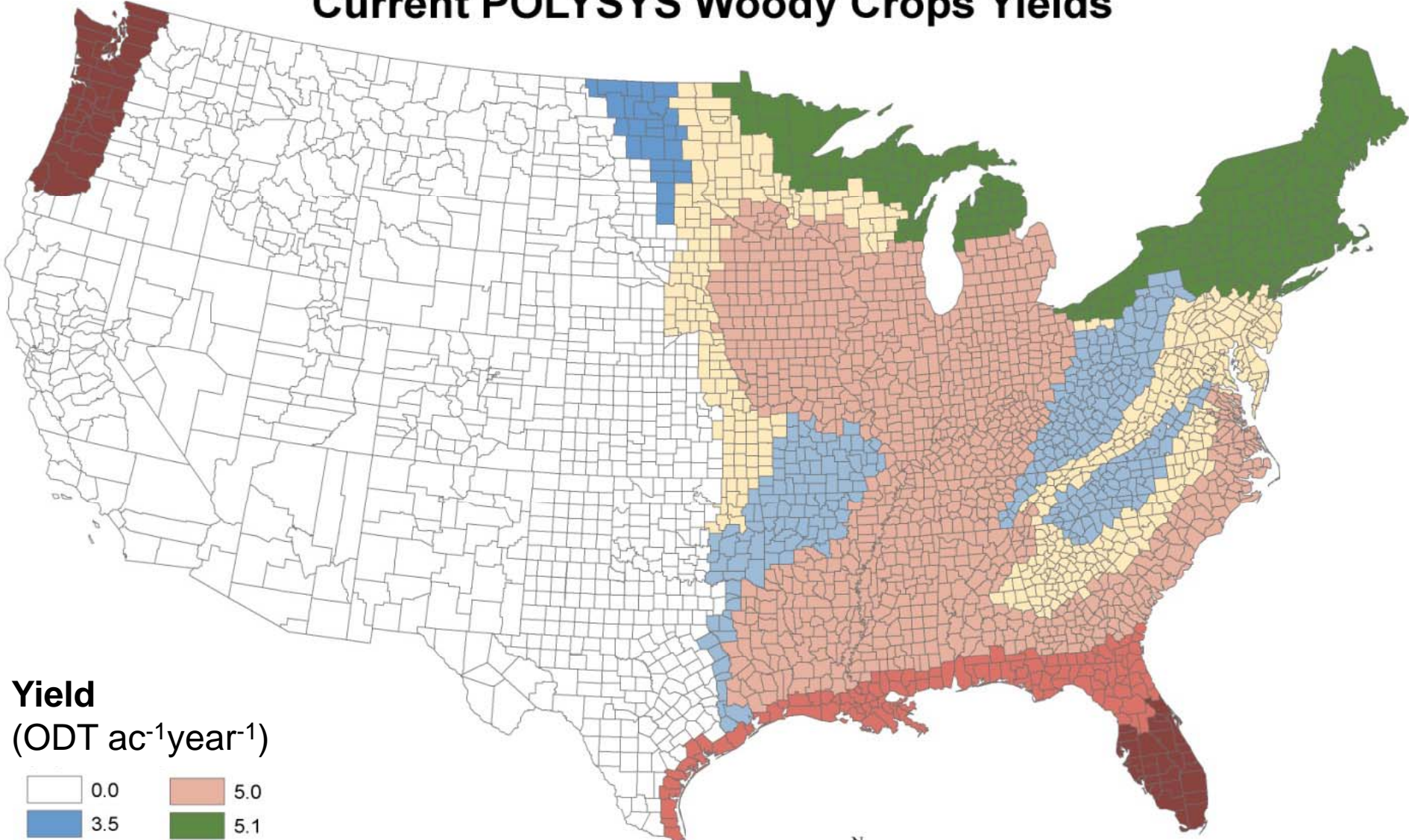
- Yield figures arrive in many forms
- Yield = fn(specie, genetics, harvest timing, existing site conditions, silviculture, irrigation/precipitation, rotation length, tree rooting, degree days, stand density)

# Current POLYSYS Herbaceous Crops Yields



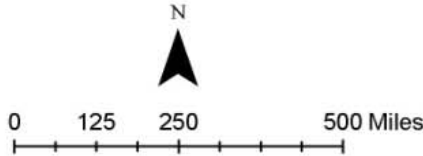
Source: Jager HI, Baskaran LM, Brandt CC, Davis EB, Gunderson CA, Wulschleger SD. 2010. Empirical Geographic Modeling of Switchgrass Yields in the United States. *GCB Bioenergy* 2:248-257, 2010.

# Current POLYSYS Woody Crops Yields



**Yield**  
(ODT ac<sup>-1</sup>year<sup>-1</sup>)

0.0	5.0
3.5	5.1
4.0	5.5
4.5	6.0



# Policy Analysis System (POLYSYS)

- Models entire U.S. agricultural sector (including exports)
- Optimizes land use across traditional and energy crops, after USDA baseline projections are met (food, feed, fiber, fuel)
- Land owners offered constant nominal biomass price across time sequence

# Policy Analysis System (POLYSYS)

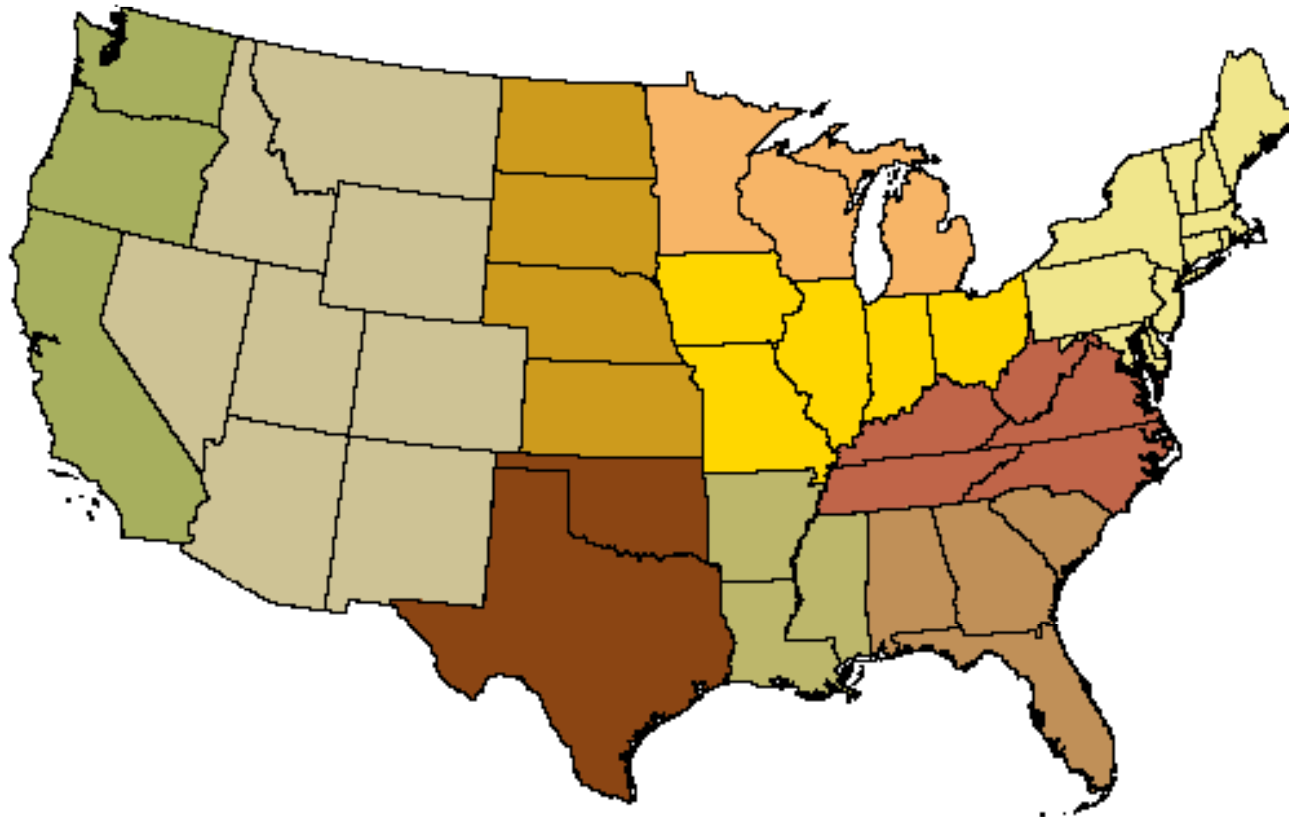
- Energy crops compete for cropland, cropland used as pasture, and permanent pasture
- Woody crops production budgets include
  1. Costs (planting, maintenance, harvest)
  2. Yield (MAI, Location, specie)
  3. Rotation length
- Published sources, expert opinion
- All costs are estimated to the farmgate

# Productivity Assumptions in Basecase

- **Energy crop productivity (ODT/acre/year) increases with time**
  - **Herbaceous crop yields**
    - **2010 yield = 3-9.9;**
    - **2030 yield = 3.6 – 12.0 (baseline scenario)**
  - **Woody crop yields**
    - **2010 yield = 3.5 – 6;**
    - **2030 yield = 4.2 – 7.2 (baseline scenario)**

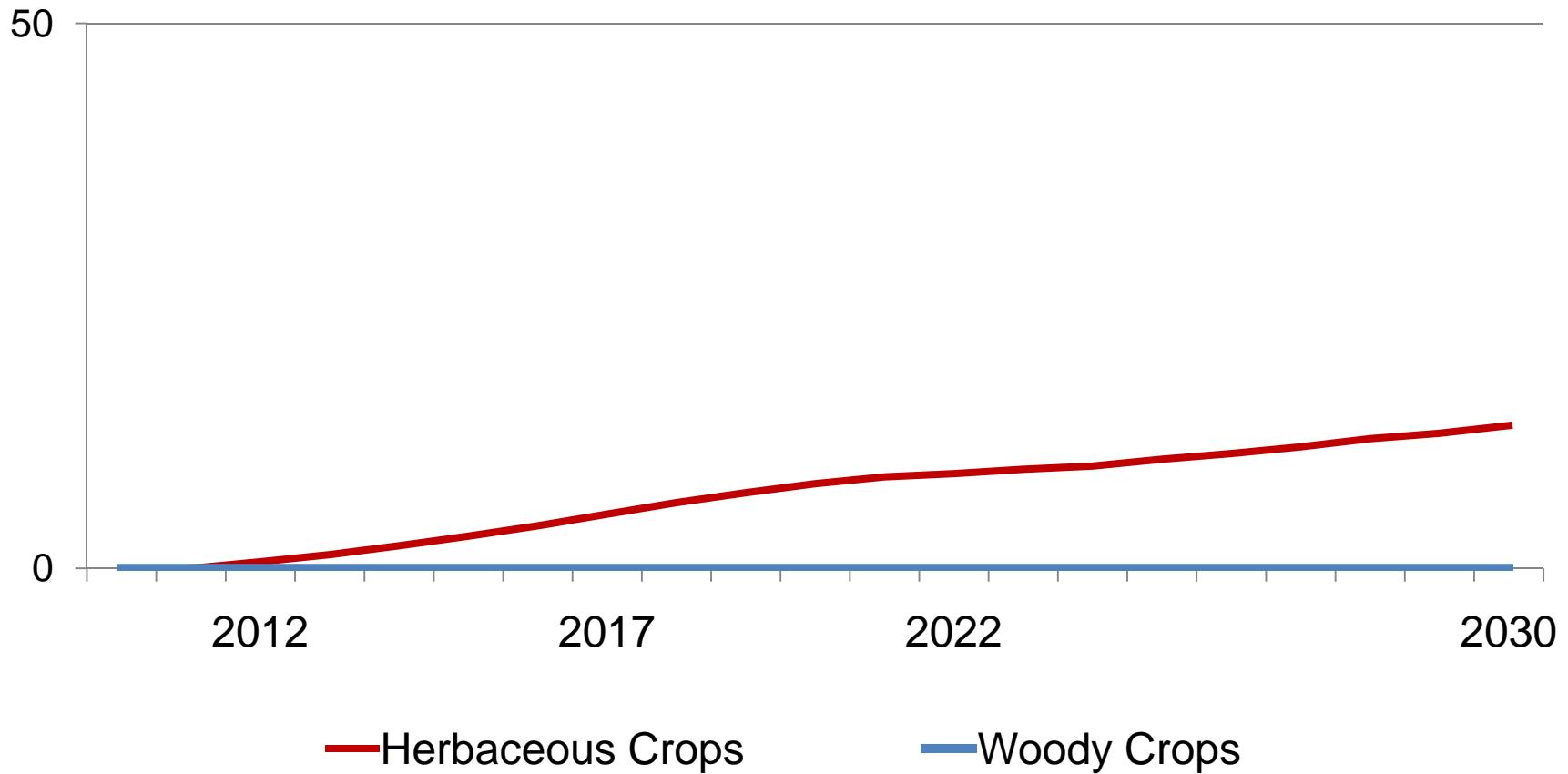
# Cropping budgets at USDA FPR level

## Farm Production Regions

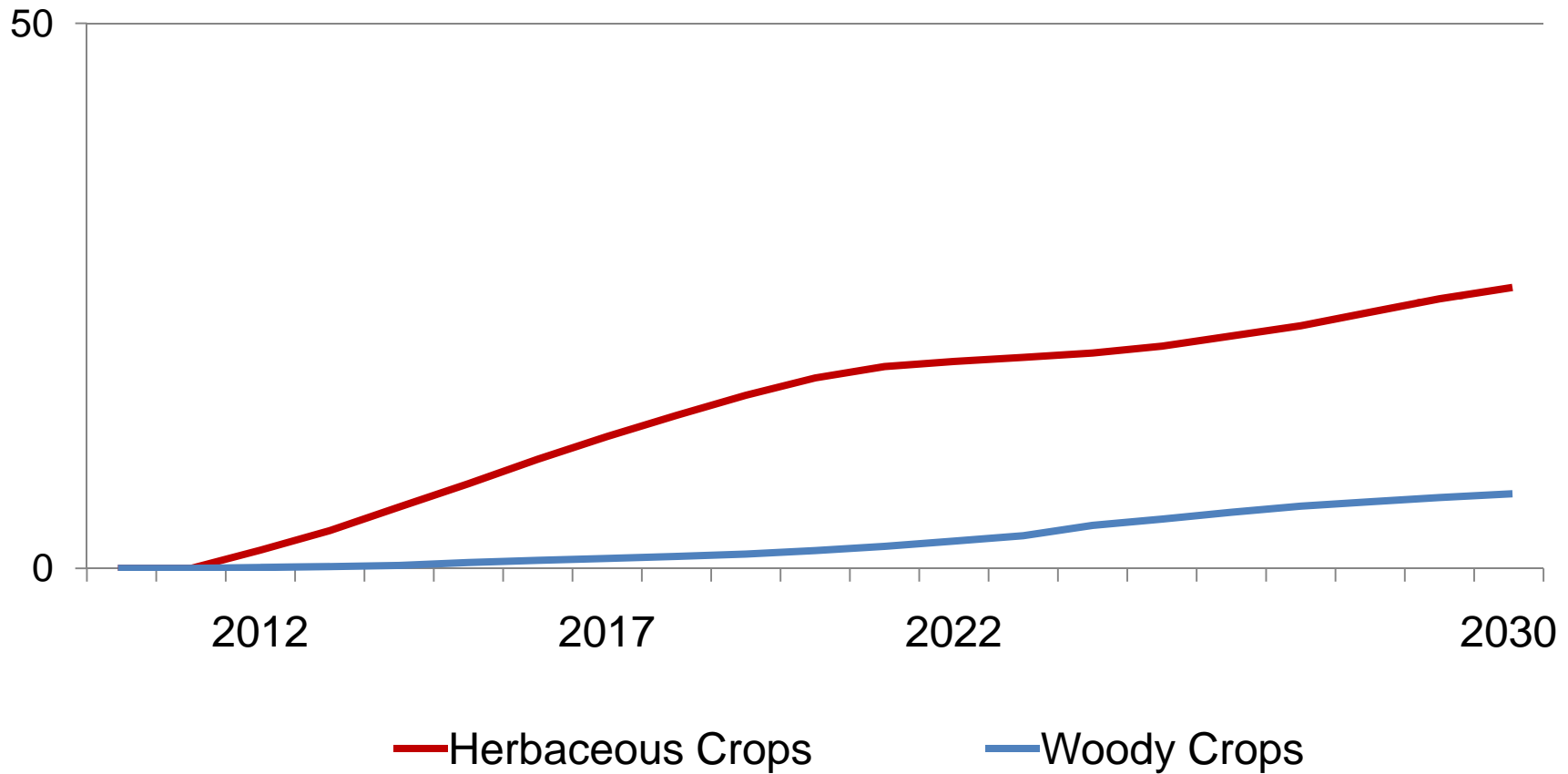


# BASECASE RESULTS

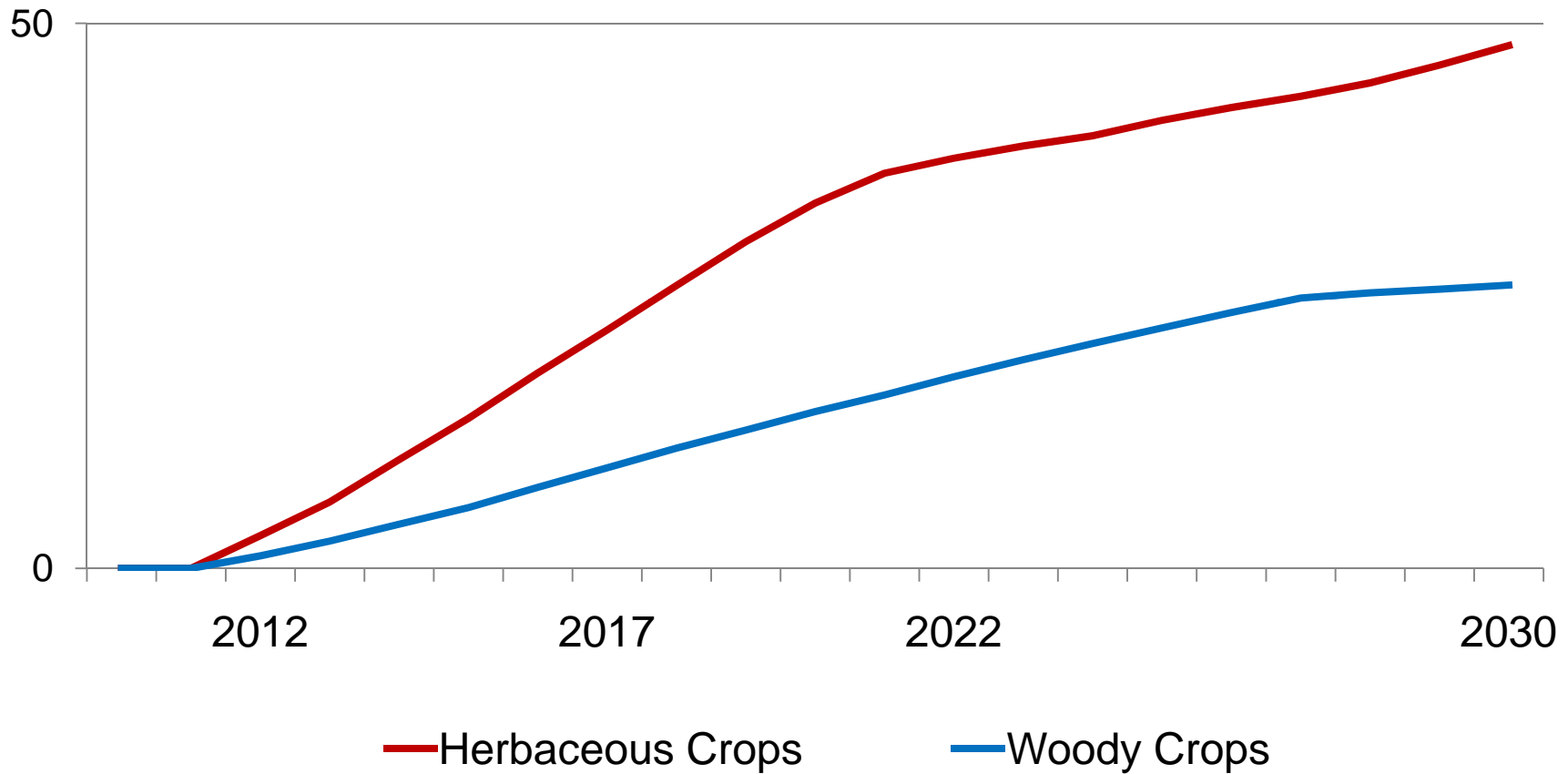
# Modeling: Basecase \$40/dry ton (farmgate)



# Modeling: Basecase \$50/dry ton (farmgate)



# Modeling: Basecase \$60/dry ton (farmgate)



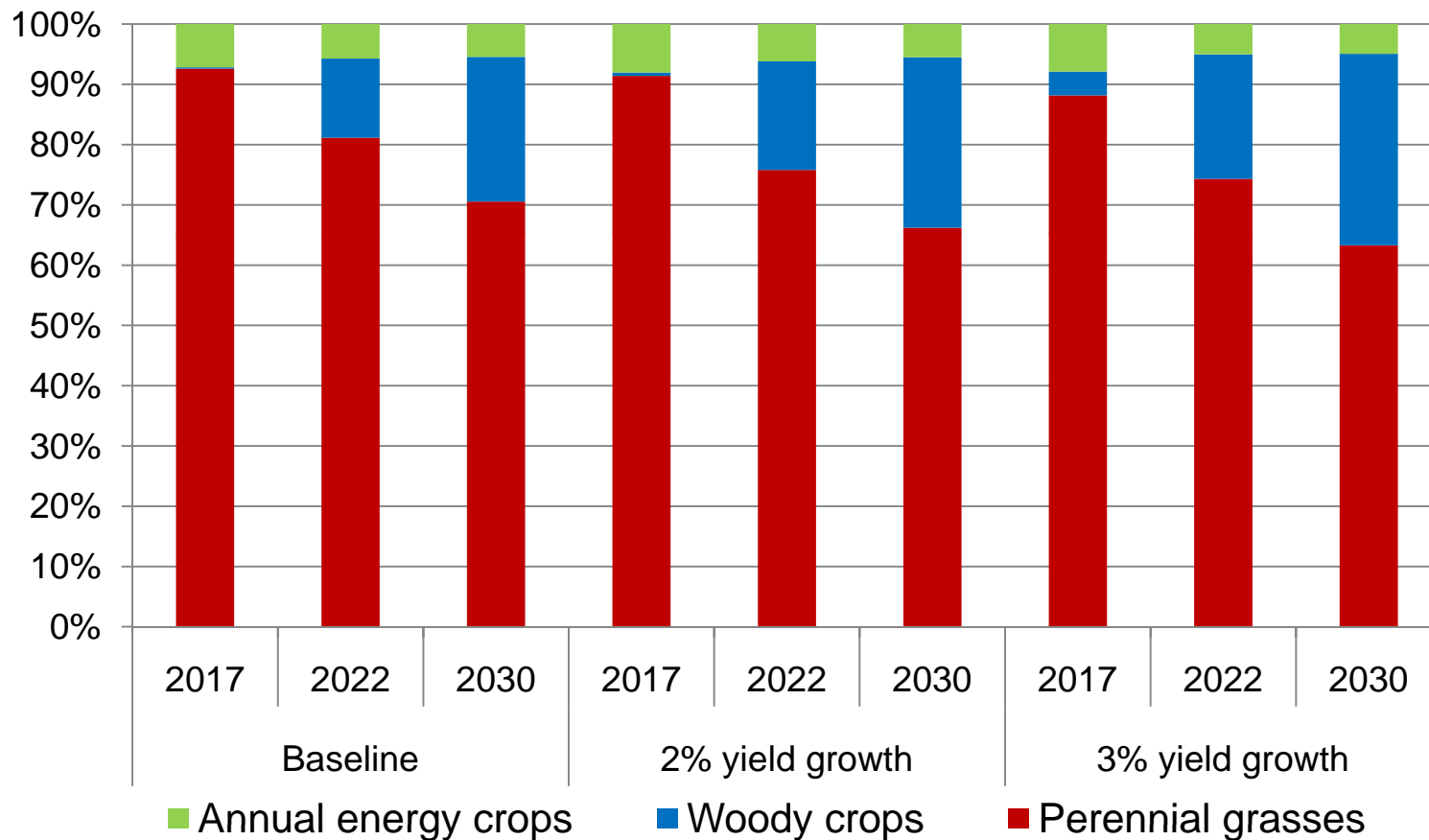
# Modeling: Baseline results

- At all feedstock prices in the baseline, planted acres of herbaceous crops exceed planted acres of woody crops at the national level
- The same conclusion results from increasing yield growth assumptions

# Modeling: Baseline results at different yield assumptions

Proportions of energy crops production with different yield growth assumptions

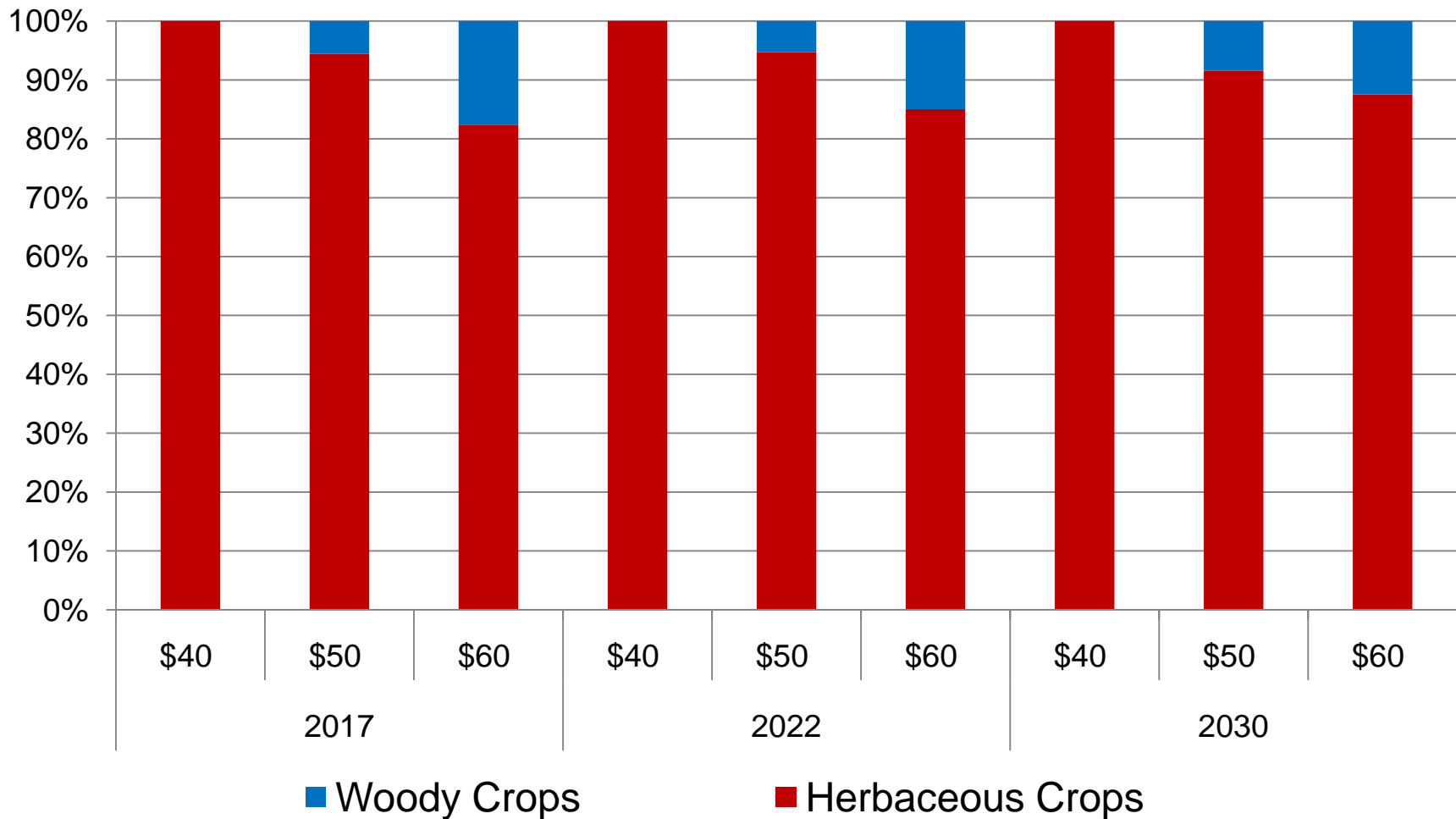
2030, \$50/dt (farmgate)



# BASELINE RESULTS VARY BY LAND CLASSIFICATIONS

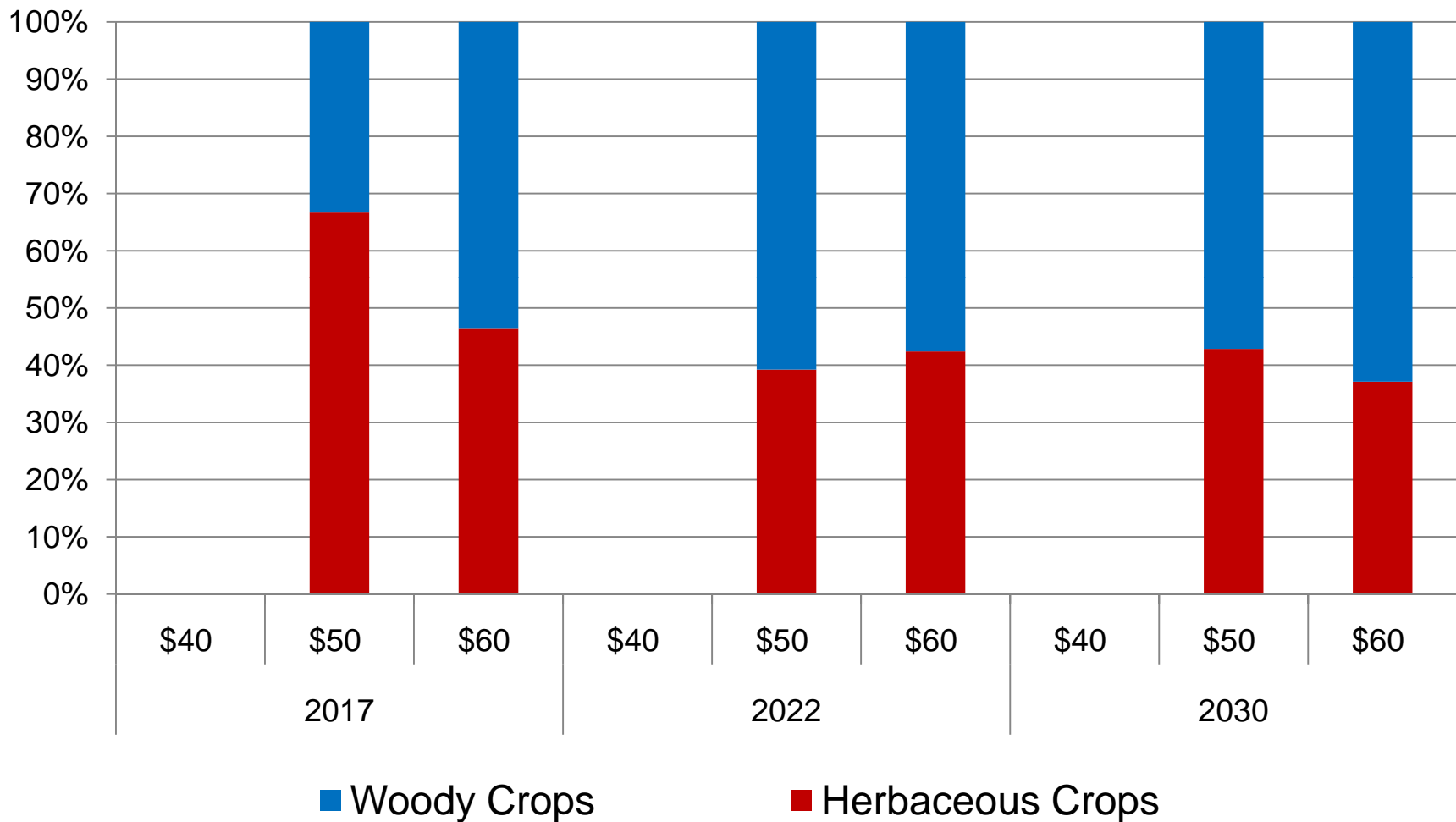
# Modeling: Baseline results for cropland

Proportion of planted acres of energy crops on cropland for 3 selected years at various prices



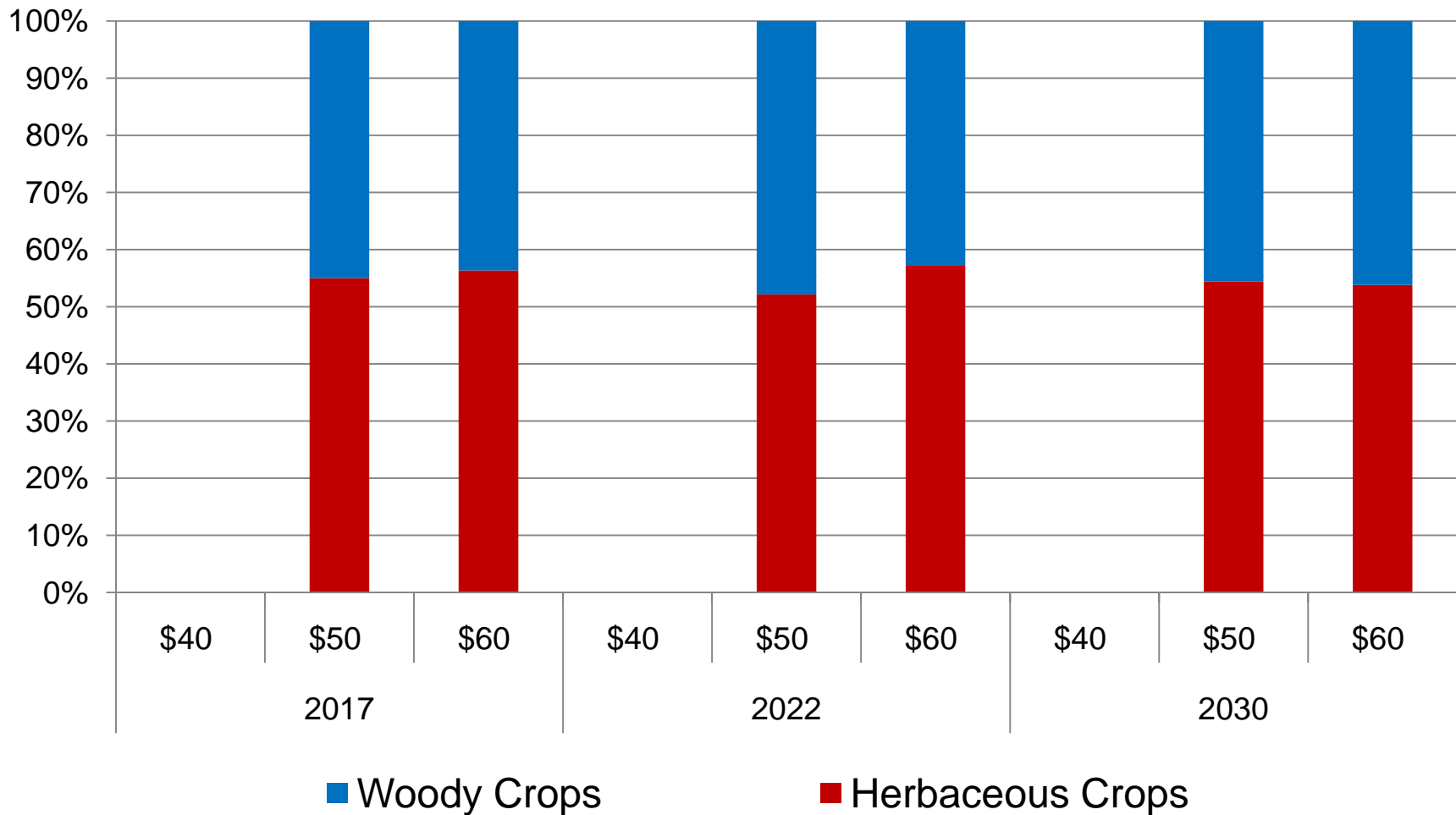
# Modeling: Baseline results for cropland pasture

Proportion of planted acres of energy crops on cropland pasture for 3 selected years at various prices



# Modeling: Baseline results on permanent pasture

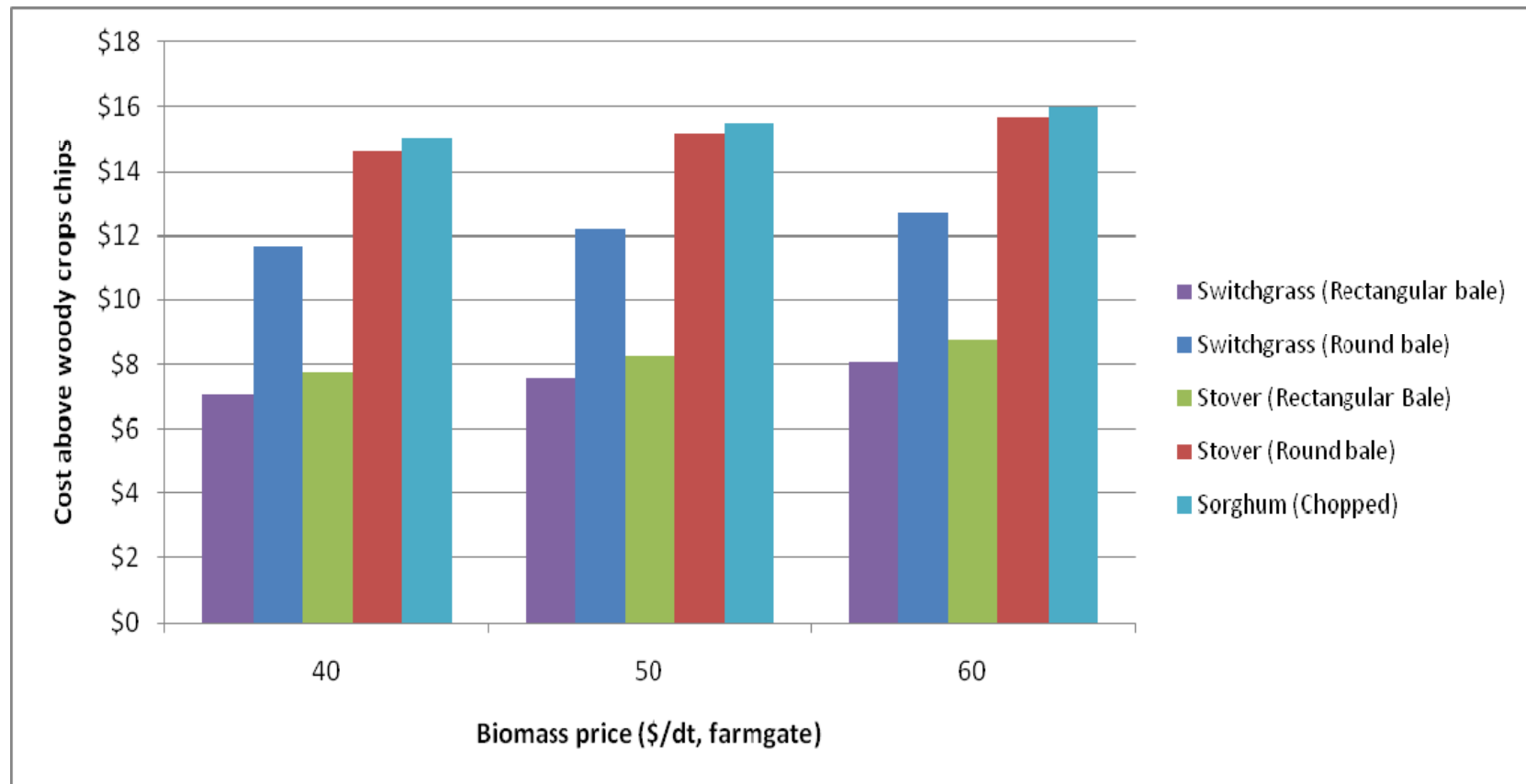
Proportion of planted acres of energy crops on permanent pasture for 3 years and various prices



# CHIPS VS. BALES

# Supply chain cost advantage of woody crops

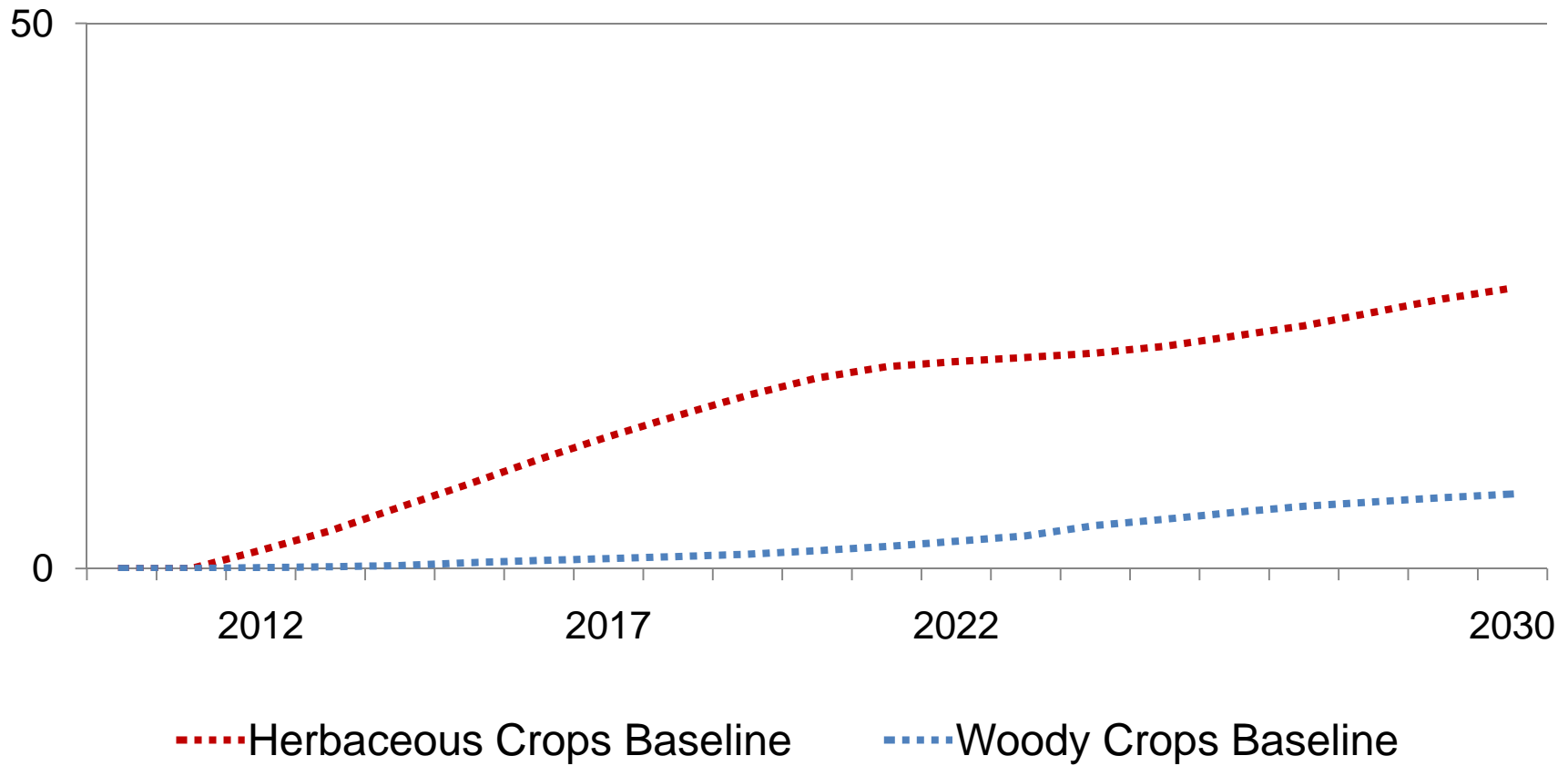
- Less complex storage and transportation process
  - Storage “on the stump” and just-in-time delivery to depot or processing facility
- Assuming the same offered price per dry ton, \$10/dt storage fee, and 5’ x 6’ round bale or 3’ x 6’ x 8’ rectangular bale



# INCORPORATING SUPPLY CHAIN CREDIT TO WOODY CROPS

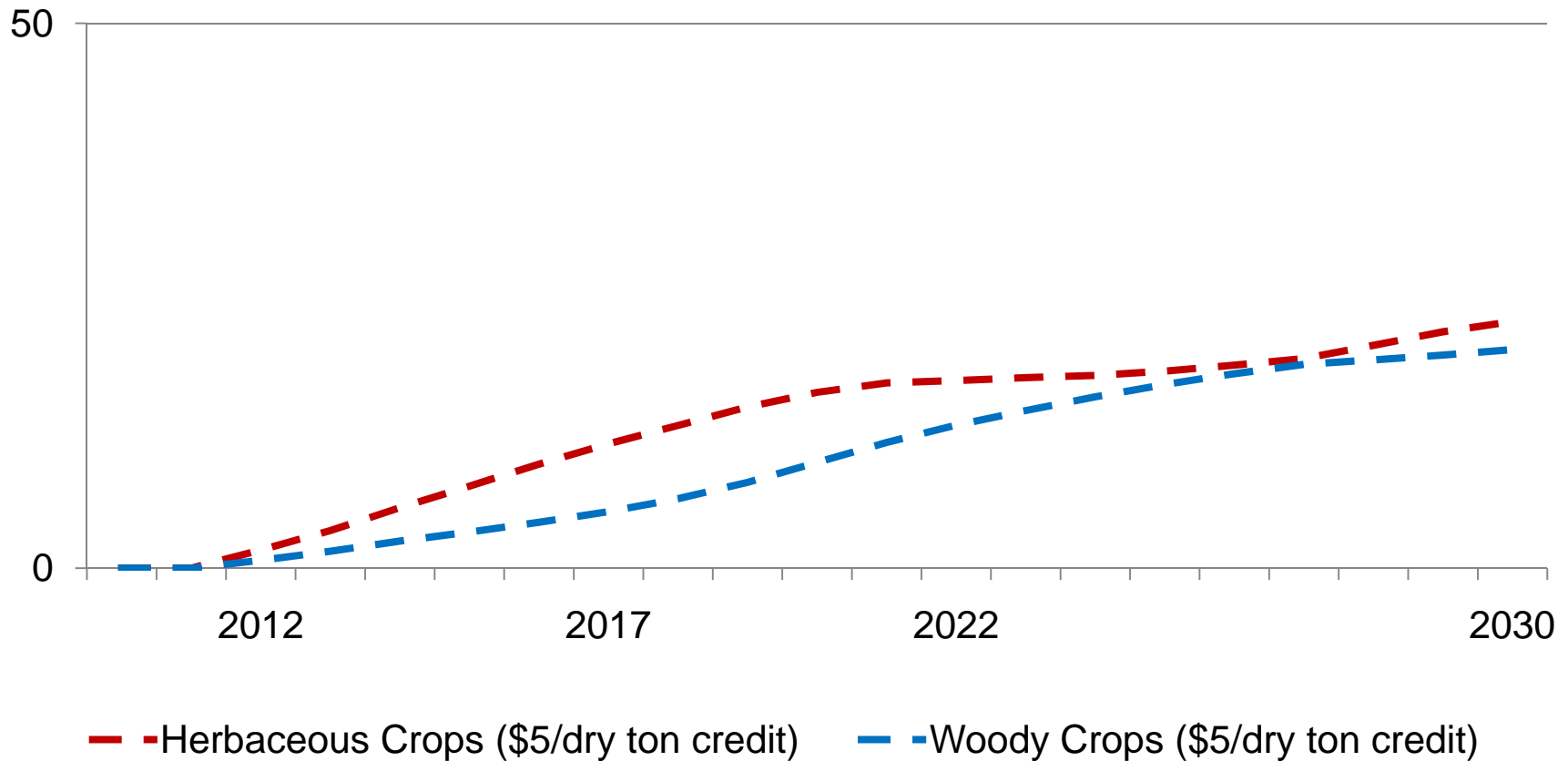
# Modeling: National results at \$50/dry ton

With no credit for woody crops



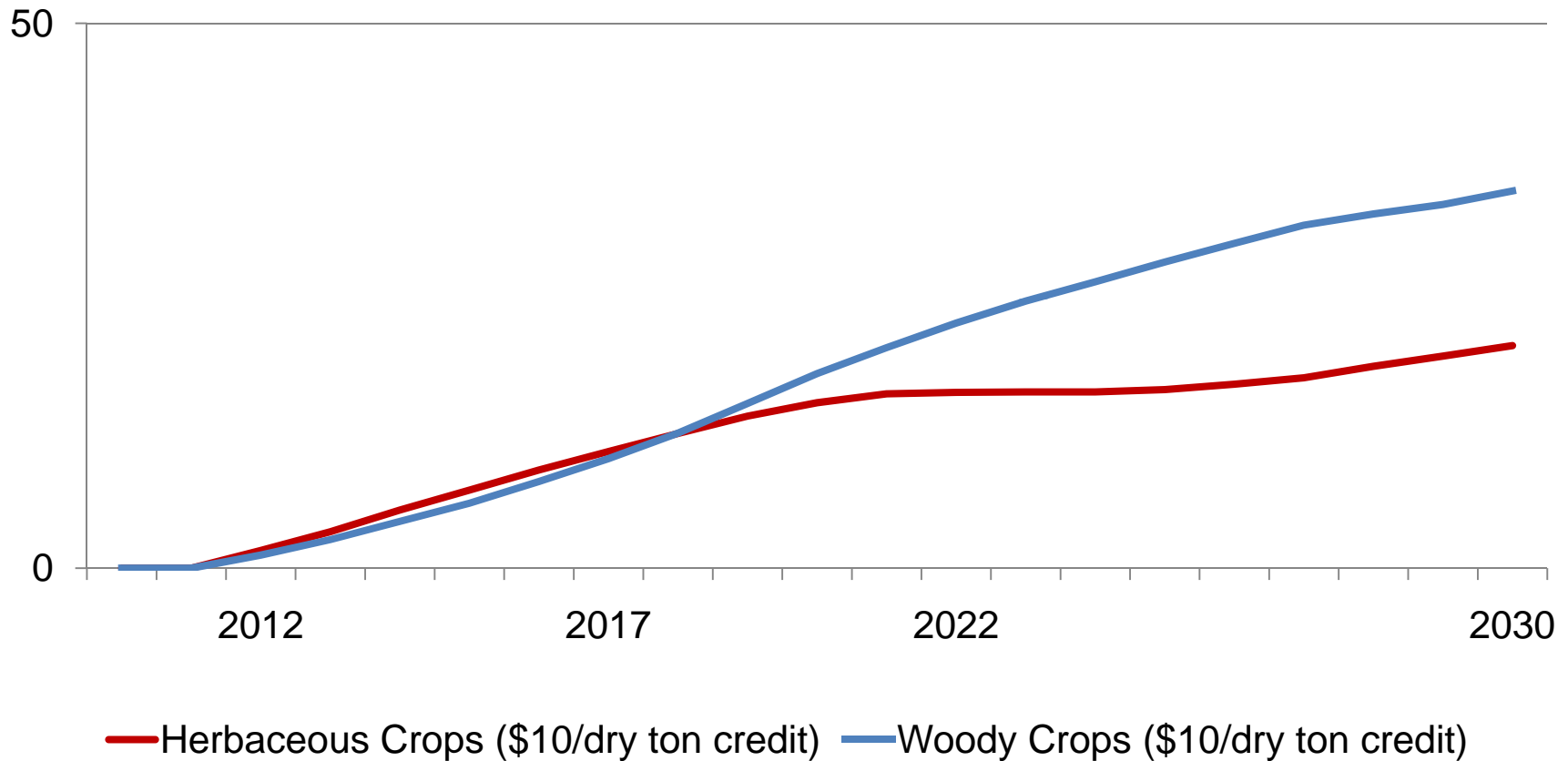
# Modeling: National results at \$50/dry

With +\$5/dry ton credit for woody crops

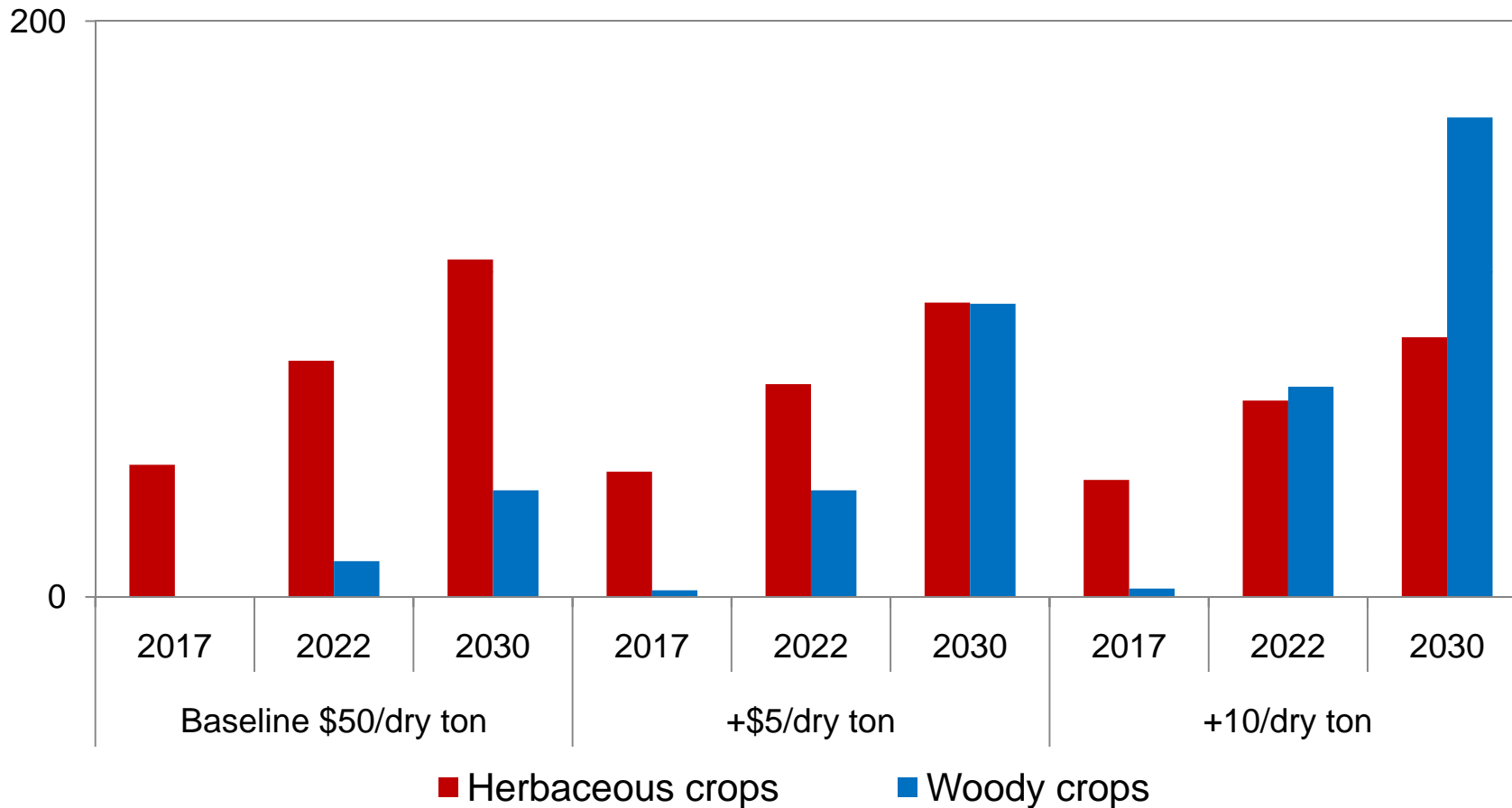


# Modeling: National results at \$50/dry

With \$10/dry ton credit for woody crops



# Baseline production results with supply chain credit to woody crops



# Conclusions

- In all baseline price and yield scenarios to 2030, modeling predicts herbaceous crops outperform woody crops (in total acres planted and production) at a national level
- In the \$10/dry ton woody crops credit scenario, woody acres exceed herbaceous acres in 2018, production in 2020
- Farmgate credits can increase deployment of woody crops, but acres planted still trail herbaceous crops plantings

# Future Analysis

- Improve yield estimates
- Identify regional competition parameters (land types, with/without woody crops credits)
- Cost comparisons of energy crops publication

# Thank you for your attention!

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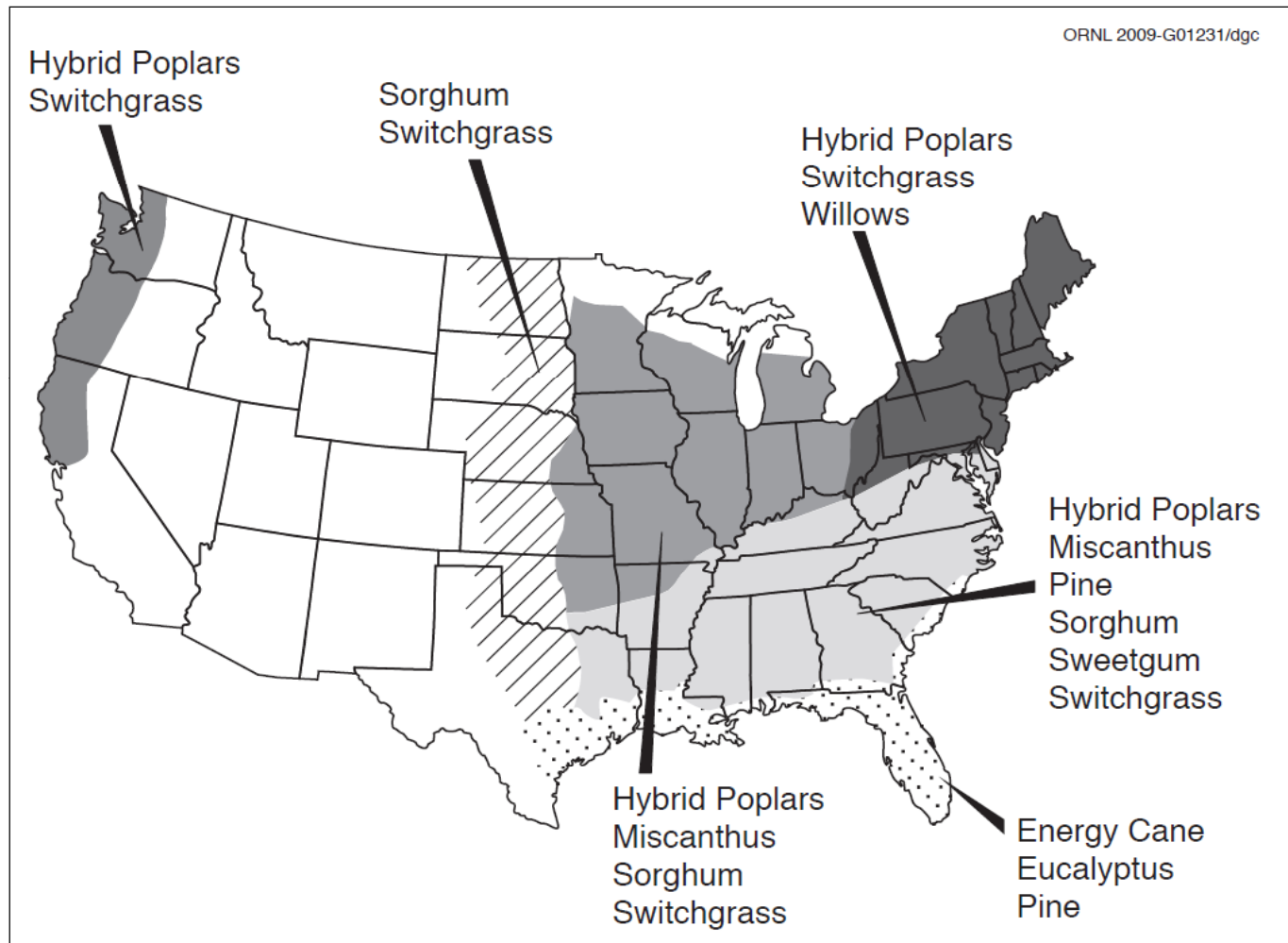
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## Questions?



# Additional Slides

# Potential range of various cellulosic crops



Source: Wright, 2009. ORNL TM.

# Modeling: Baseline results

Woody crops at \$55/ODT outcompete Herbaceous crops at \$40/ODT (~+\$15), and at \$60 outcompete Herbaceous crops at \$45 and \$50/ODT after 2019, 2023 (~+\$15, +\$10) *at the farmgate*

