

Spatial Heterogeneity in Corn–Soybean Planting Decisions and Price Responses

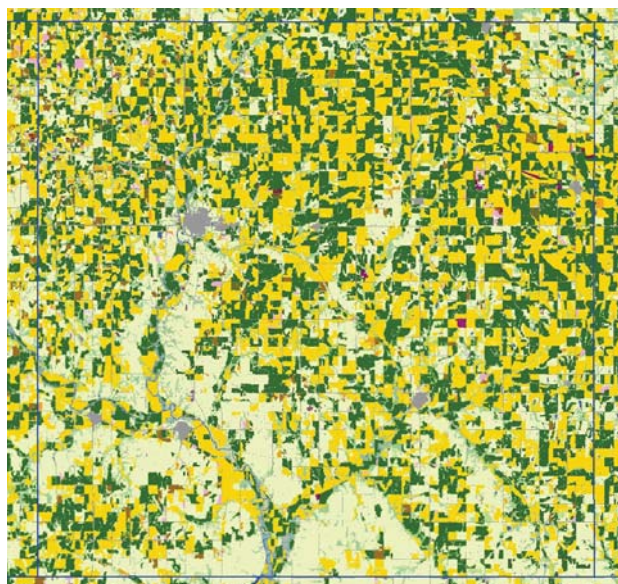
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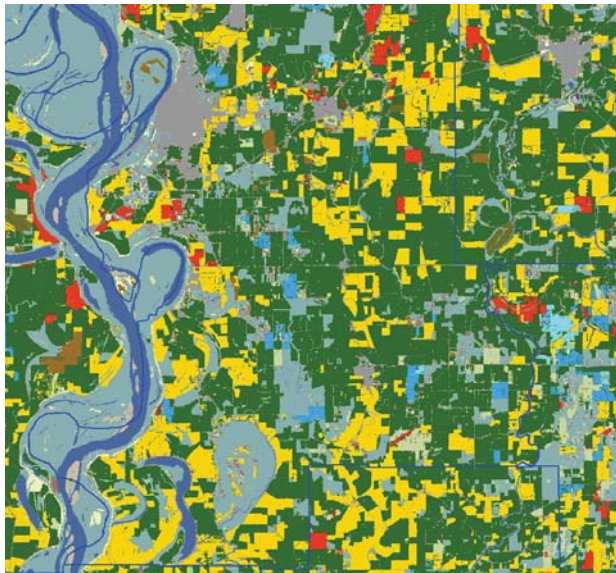
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Marshall County, Kansas



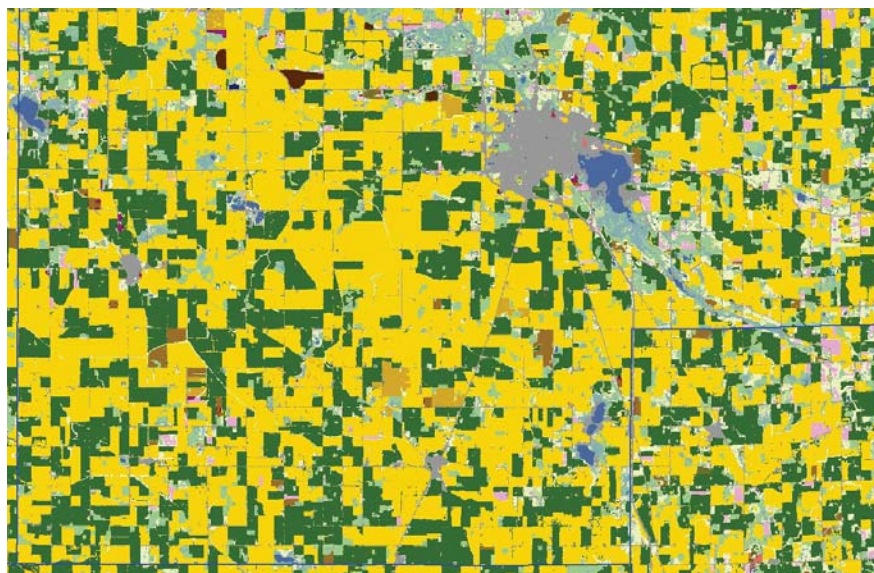
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Washington, Mississippi



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Fulton County, Indiana



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Factors Impacting Planting Decisions

- Crop Prices
- Input Prices
- Crop Yields
- Precipitation and Temperature
- Soil Characteristics
- Previous Planting Decisions



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Factors Impacting Planting Decisions

- **Crop Prices**
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Soybean to Corn Crop Price Ratio

$$\frac{\text{Soybean Price}}{\text{Corn Price}} = 2.5$$

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Soybean to Corn Crop Price Ratio of 2.5



MSU Extension
Farm Management

Meet Our Team

Understanding the corn-soybean ratio and its uses

Jonathan LaPorte, Michigan State University Extension · March 05, 2026

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How the corn-soybean ratio can influence your planting intentions.



A Way-Too-Early Soybean-to-Corn Price Ratio Analysis: Price Implications and Planting Decisions

Monday, January 29, 2024

In the March 13, 2023, Southern Ag Today article, Mark Welch discussed the soybean-to-corn price ratio and its implications for 2023 planting decisions. This article uses the same methods to examine the ratio and its impacts on 2024/25 new crop prices in the next few months, prior to USDA's Ag Outlook Forum, which releases the first crop estimates for the 2024/25 marketing year and could have an impact on nearby futures

Soybean-to-corn price ratio signals increasing soybean profitability

by Dana Golden
8/24/2020

Soybeans and Oil Crops Corn and Other Feed Grains



Weekly U.S. prices and price ratio for soybeans and corn, 2020

U.S. dollars per bushel Soybean/corn price ratio

Notes: Futures price quotes are for delivery months of December for corn and November for soybeans. Price ratio denotes soybean prices divided by corn prices.
Source: USDA, Economic Research Service, Season-Average Price Forecasts using data from the Chicago Mercantile Exchange.

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Empirical Evidence Supporting the Rule of Thumb

- Golden [2020] estimates the soybean to corn price ratio averaged 2.51 over the past 20 years. Its use 'can tell farmers whether planting, harvesting, and storing one or the other crop might be advantageous'.
- McWilliams and Balsamo [2026] indicate the long run (2010-2026) soybean to corn price ratio is 2.5 on average, but varies widely from year to year. 'The volatility inherent in these shifts is precisely why producers must look beyond simple historical averages when constructing their planting and marketing strategies'.
- Langemeier [2026] estimates average soybean to corn price ratio of 2.45 in Indiana from 2007-2025 but cautions that producers should also incorporate input costs into decision making.

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Limitations to the 2.5 Soybean to Corn Crop Price Ratio

Historical average [McWilliams and Balsamo, 2026, Langemeier, 2026]

- Does aggregation mask spatial and temporal differences?
- Kansas vs. Central Indiana vs. Mississippi
- Pates and Hendricks [2021] find that crop supply responses to price changes are significantly biased towards zero when aggregated at a national versus regional level.

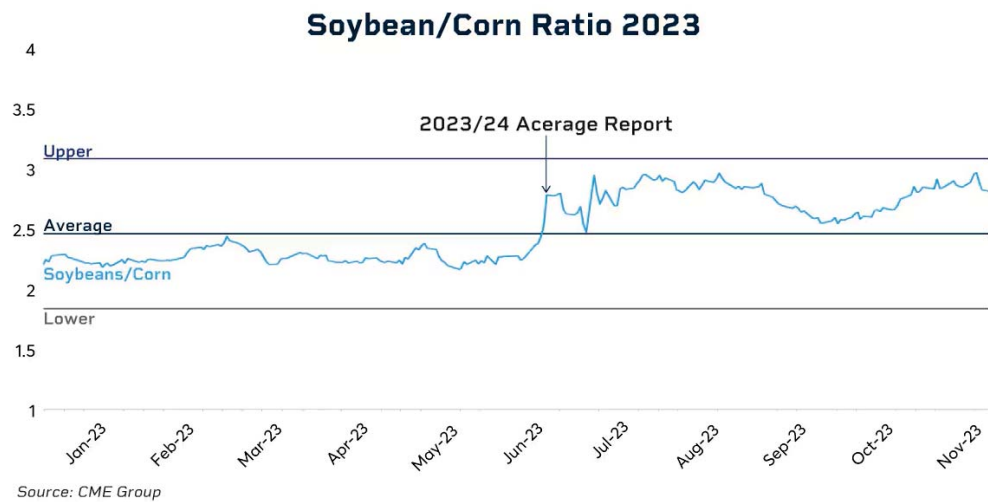
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Research Objectives

- Revise the Rule of Thumb
 - Estimate price ratio thresholds on a county by county basis
 - Estimate a national price ratio using acreage weighted county estimates
- Estimate crop acres and compare to the World Agricultural Supply and Demand Estimates
 - Estimate crop acreage at the end of February, months prior to June 30 Acreage Report
 - Provide more accurate estimates?
- Provide producers with a web tool to test price ratios and inform planting decisions

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WASDE Influence



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Data

- USDA Crop Sequence Boundaries, 2018–2025
 - field level planting decisions
- Corn and Soybeans Futures Prices (CBOT)
- Fertilizer Price Index (Green Markets)
- Crop Yields (USDA NASS)
- PRISM pre-plant precipitation and temperature
- NCCPI soil productivity

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USDA Crop Sequence Boundaries

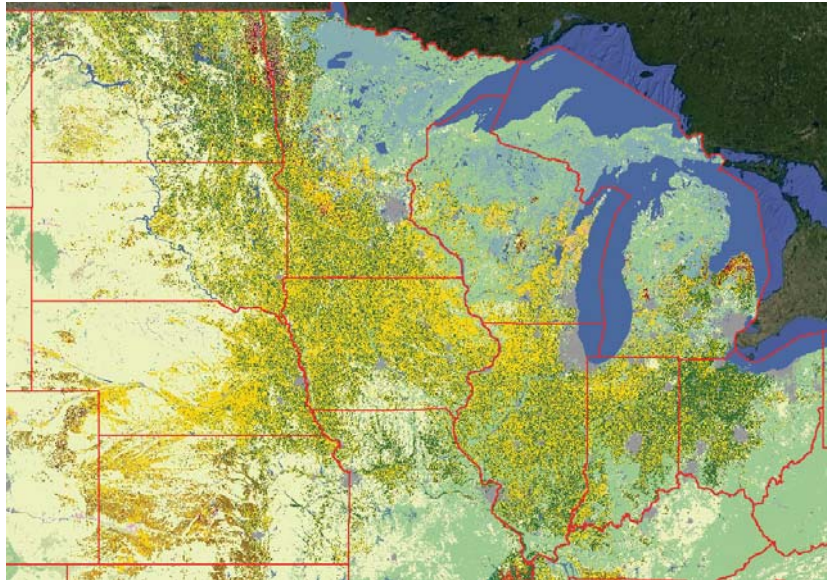
- Developed by USDA's Economic Research Service to identify field boundaries, planted acreage, and crop rotations across the contiguous United States.
- Supports analysis of:
 - Crop acreage and planting patterns
 - Common rotations, such as corn–soybean rotations
- Boundaries represent areas where crops are grown, not farm ownership boundaries, tax parcels, or Farm Service Agency records.

Data Coverage

The current release includes annual Crop Sequence Boundaries from 2018–2025 and was released on March 27, 2026.

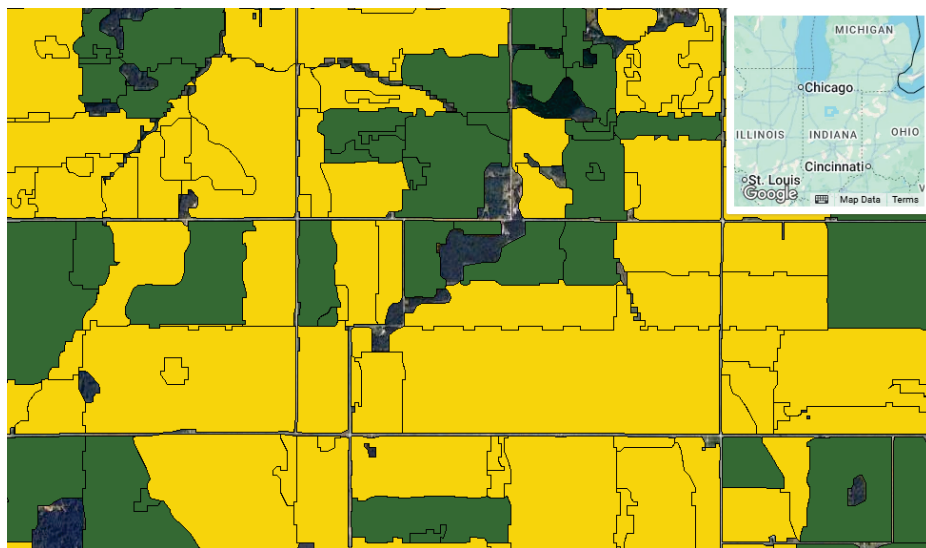
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USDA Crop Sequence Boundaries



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USDA Crop Sequence Boundaries



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CBOT Corn and Soybean Futures Prices

- Daily settlement prices for CBOT December corn futures and November soybean futures.
- Prices are collected throughout February, prior to spring planting decisions, to represent producers' expected relative crop returns.
- Our specification uses the **final (closing) trading price in February** for each year.
- Futures prices are combined to construct the expected soybean to corn price ratio used in the planting decision model.

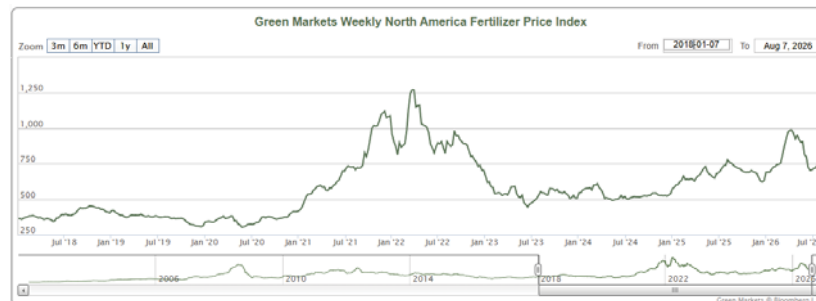
$$R_t = \frac{\text{Price}_t^S}{\text{Price}_t^C}$$

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Fertilizer Price Index

Green Markets Weekly North American Fertilizer Price Index

- Weighted prices of Gulf Coast Urea, Corn belt Potash, and NOLA Barge DAP
- Average February Fertilizer Price Index



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County Average Crop Yields

USDA National Agricultural Statistics Service (NASS)

- Annual county level corn and soybean yields (bushels per acre)
- Yield estimates are based primarily on USDA agricultural surveys and administrative data
- Measure realized crop productivity within each county

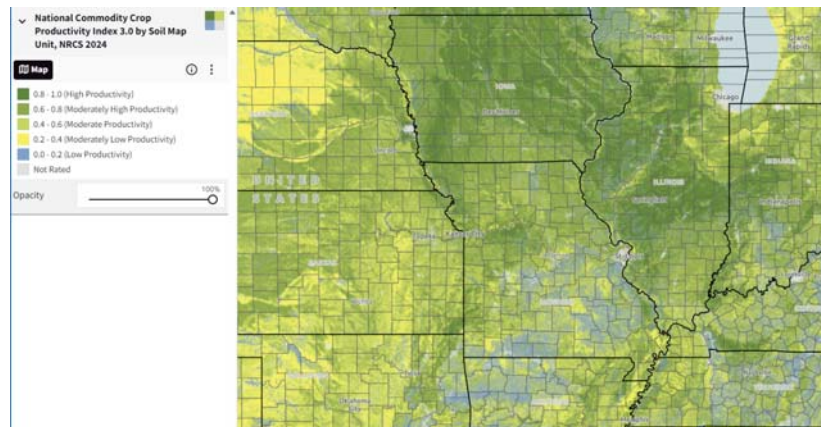
Why Include Yields?

- Capture differences in the relative productivity of corn and soybeans across counties
- Help separate planting responses to the soybean to corn price ratio from differences in underlying yield potential

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National Commodity Crop Productivity Index

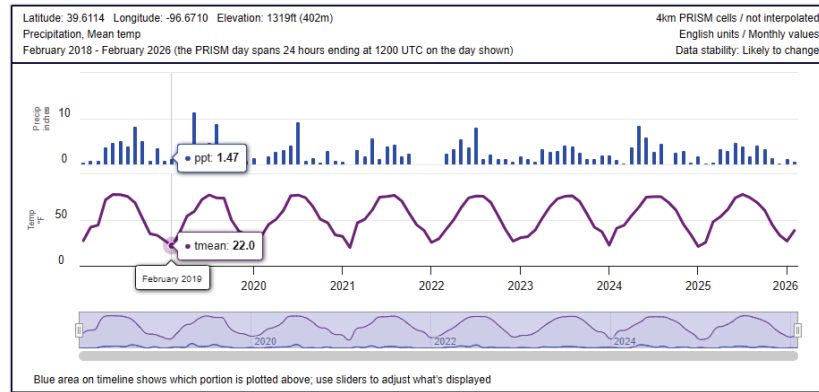
- Captures soil productivity without irrigation
- Ranks soil quality from 0-1



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PRISM Weather

- Field specific pre-plant precipitation and temperature (February - April)



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How Does the Model Predict Planting Decisions?

Historical Planting Decisions



Local Growing Conditions
(Soils, Precipitation, Temperature)



Input Costs
(Fertilizer)



February Price Signals



Estimated Probability of Planting

Corn Soybeans Other

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Modeling Crop Rotation Decisions

Planting decisions depend on last year's crop.

Each field is classified into one of three crops:

$$\{\text{Corn, Soybeans, Other}\}.$$

Planting decisions follow a first order Markov process:

$$P_{it}^{lk} = \Pr(y_t = k \mid y_{t-1} = l),$$

where the probability of planting crop k depends on the crop planted in the previous year.

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Modeling Crop Rotation Decisions

Planting decisions depend on last year's crop.

The transition probabilities form a county specific transition matrix:

$$M_i(R) = \begin{bmatrix} p^{CC} & p^{CS} & p^{CO} \\ p^{SC} & p^{SS} & p^{SO} \\ p^{OC} & p^{OS} & p^{OO} \end{bmatrix}$$

- Rows: previous crop
- Columns: current crop
- Each row sums to one

$$p^{CC} + p^{CS} + p^{CO} = 1$$

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From Annual Decisions to Long Run Planting Probabilities

Estimated transition probabilities define the county transition matrix:

$$M_i(R)$$

The long run planting shares are obtained from the stationary distribution:

$$\pi_i(R) = M_i(R)' \pi_i(R),$$

subject to

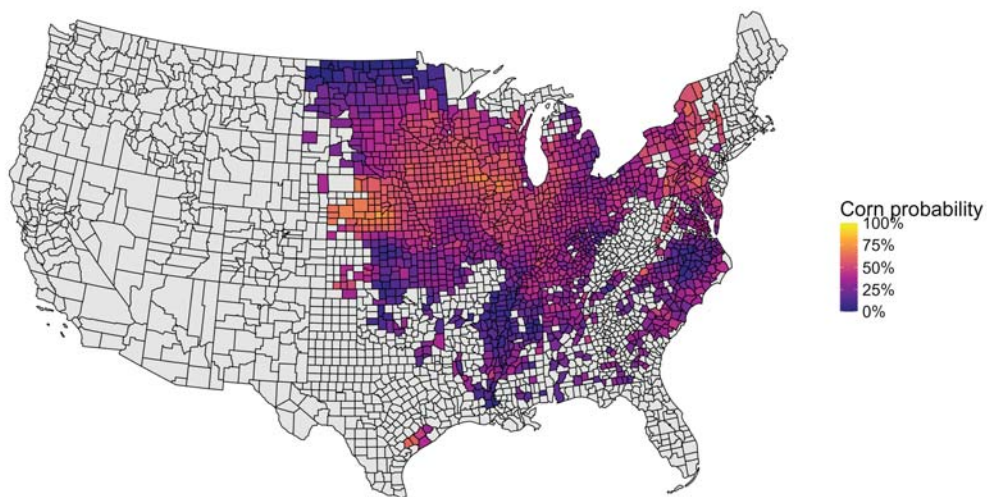
$$\pi_i^C + \pi_i^S + \pi_i^O = 1.$$

Interpretation

The stationary distribution, $\pi_i(R)$, represents the long run planting probabilities for each crop in a given county.

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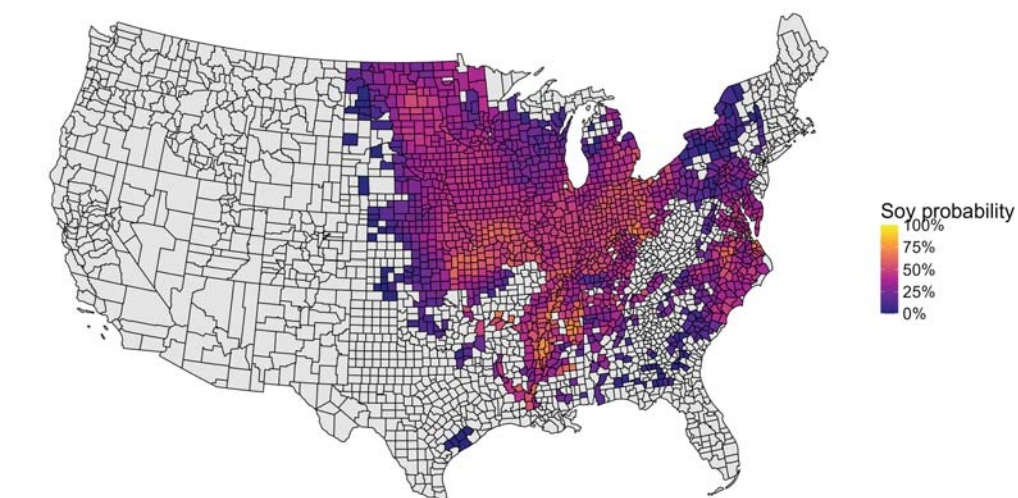
Corn Planting Probability, 2018-2025



Estimates from field-level crop transitions, 2018-2025

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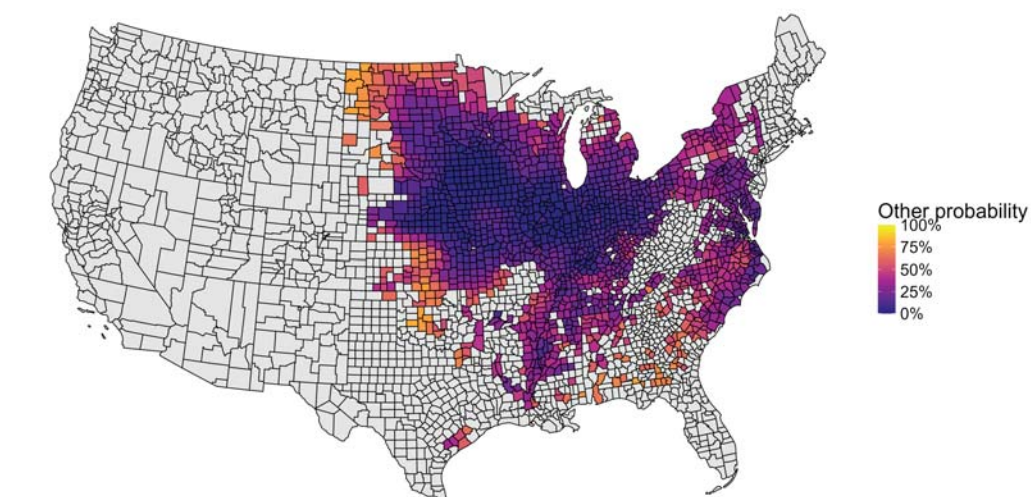
Soybean Planting Probability, 2018-2025



Estimates from field-level crop transitions, 2018-2025

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Other-Crop Planting Probability, 2018-2025



Estimates from field-level crop transitions, 2018-2025

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Estimating a County's Implied Price Ratio

Observed planting pattern

For each county, we calculate the historical share of corn and soybean acres planted to soybeans.

Modeled planting pattern

We use the crop transition model to estimate the long run soybean share associated with different soybean to corn price ratios.

Price Ratio $\longrightarrow$ Crop Transitions $\longrightarrow$ Long Run Crop Share

Implied Price Ratio

The county implied price ratio is the price ratio at which the model reproduces the county's historical corn–soybean acreage mix.

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Estimating a County's Implied Price Ratio

$$\bar{s}_i = \frac{\text{Soy Acres}_i}{\text{Corn Acres}_i + \text{Soy Acres}_i},$$

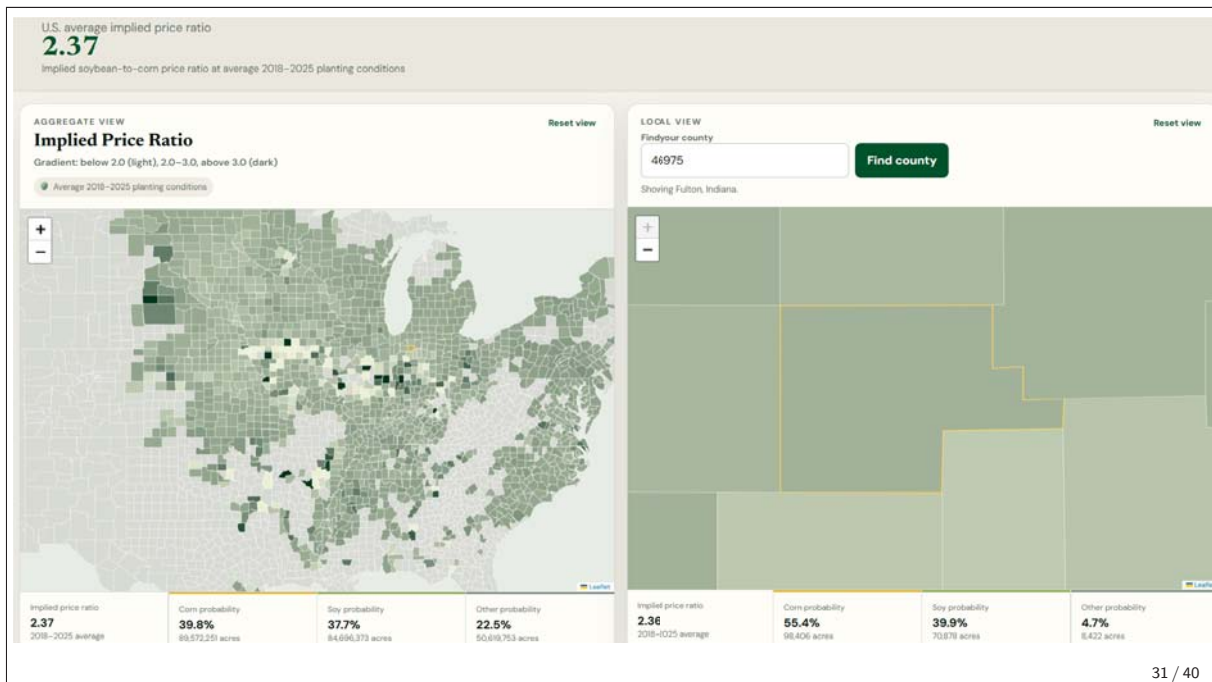
Find the soybean to corn price ratio that reproduces the observed long run crop mix:

$$\frac{\pi_i^S(R_i^*)}{\pi_i^C(R_i^*) + \pi_i^S(R_i^*)} = \bar{s}_i$$

Interpretation

R_i^* is the implied soybean to corn price ratio required for the model to match a county's average observed planting decisions.

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Revising the Rule of Thumb

Issues with the 2.5 Soy-Corn Price Ratio

- Limited empirical evidence
- Doesn't consider past cropping decisions or input costs
- Aggregation across time and space

Our revised estimates

- Suggest on average producers change cropping decisions when...

$$\frac{\text{Soybean Price}}{\text{Corn Price}} \approx 2.37$$

- Holding to the 2.5 price ratio rule would encourage producers to over plant corn
- Cropping decisions and switching thresholds vary by regions

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From the 2026 Price Ratio to Acreage

The February 2026 futures prices imply:

$$R_{2026} = \frac{\$11.28 \text{ soybean futures}}{\$4.69 \text{ corn futures}} = 2.41$$

For each county, the model uses this price signal to estimate the long run share of land planted to Corn, Soybeans, and Other Crops.

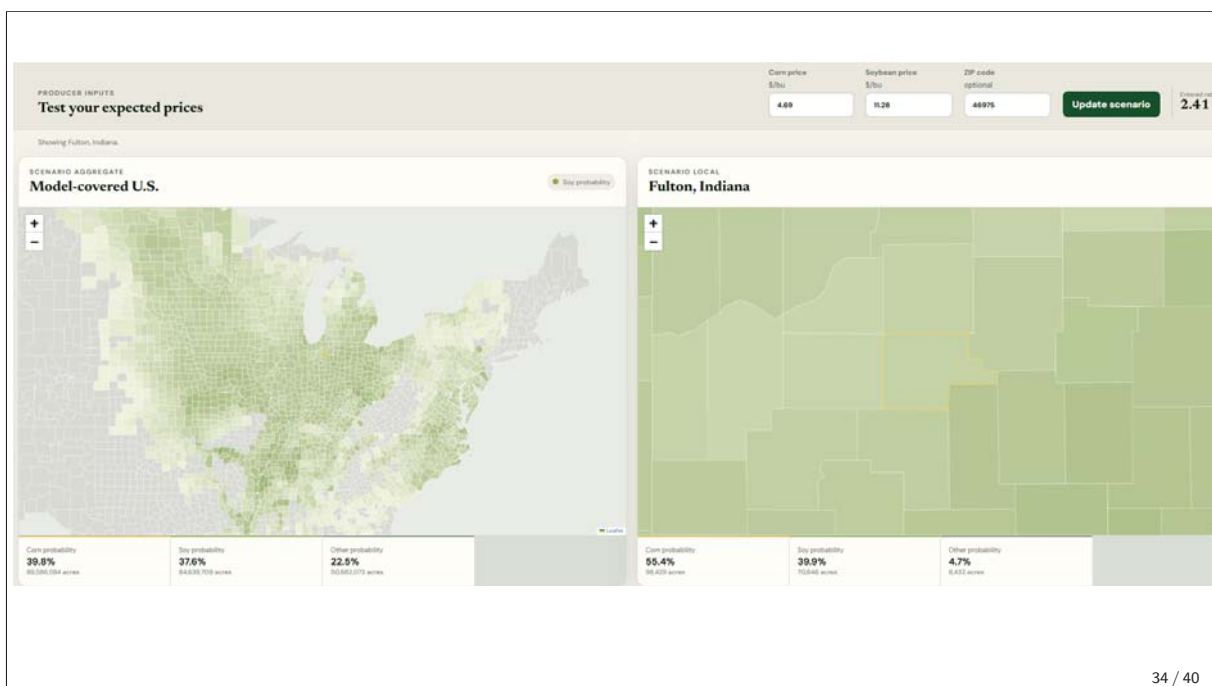
County crop shares are multiplied by the county's historical planted acreage:

$$\text{Projected County Acres} = \text{Predicted Crop Share} \times \text{County Acres}$$

County estimates are added to produce the national acreage projection.

$$\text{National Projection} = \sum_{\text{counties}} \text{Projected County Acres}$$

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Comparing Our Estimates to the WASDE (2025/2026)

	Our Model	WASDE	Actual
Harvested Corn Acres (million)	90.3	87.4	91.3
Harvested Soybean Acres (million)	81.7	82.7	80.4

Accuracy of Our 2025/2026 Acreage Estimates

- Corn acreage estimates were **74.4%** more accurate
- Soybean acreage estimates were **43.5%** more accurate

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Comparing Our Estimates to the WASDE (2026/2027)

$$R_{2026} = \frac{\$11.28 \text{ soybean futures}}{\$4.69 \text{ corn futures}} = 2.41$$

	Our Model	WASDE	WASDE	Actual
	(February)	(June)	(August)	
Harvested Corn Acres (million)	89.6	87.4	88.6	_____
Harvested Soybean Acres (million)	84.6	83.7	85.8	_____

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Research Objectives

- Revise the Rule of Thumb (**2.37 versus 2.5**)
 - Estimate the price ratio threshold on a county by county basis
 - Estimate a national price ratio using acreage weighted county estimates
- Estimate harvested crop acres and compare to the World Agricultural Supply and Demand Estimates
 - Estimate crop acreage using prices available in February; months prior to June 30 Acreage Report
 - Corn acreage estimates were **74.4%** more accurate
 - Soybean acreage estimates were **43.5%** more accurate
- Provide producers with a web tool to test price ratios and inform planting decisions

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Questions?

Margaret Lippsmeyer

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References I

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William McWilliams and Emily Balsamo. What the bean/corn ratio says about this year's planting season, 2026. URL <https://www.cmegroup.com/openmarkets/agriculture/2026/What-the-BeanCorn-Ratio-Says-About-This-Years-Planting-Season.html>.

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