Crop Yield Calculations for Estimating Nutrient Application and Long-term Loads

Informational, 04/11/25

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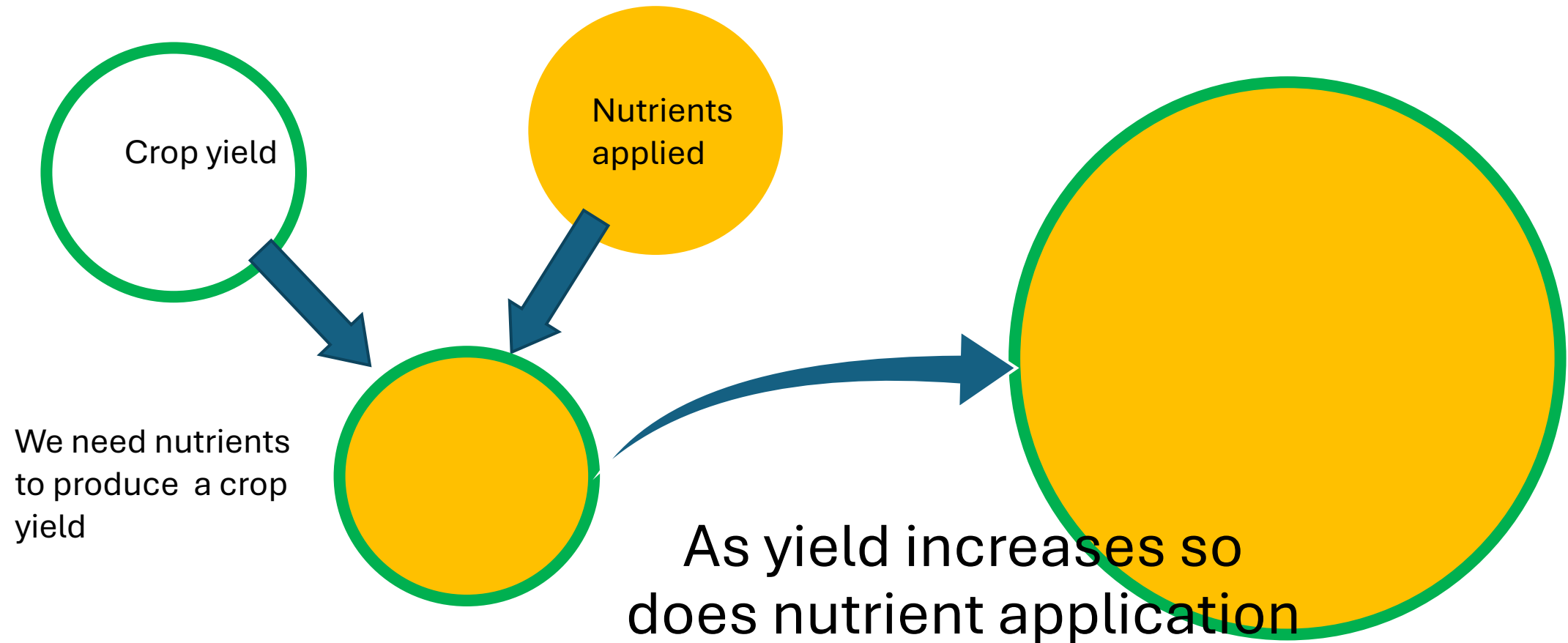
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Agenda

- Quick overview of the method

- Comparison of results to P6

- Addressing crops without application goals for true yield units?
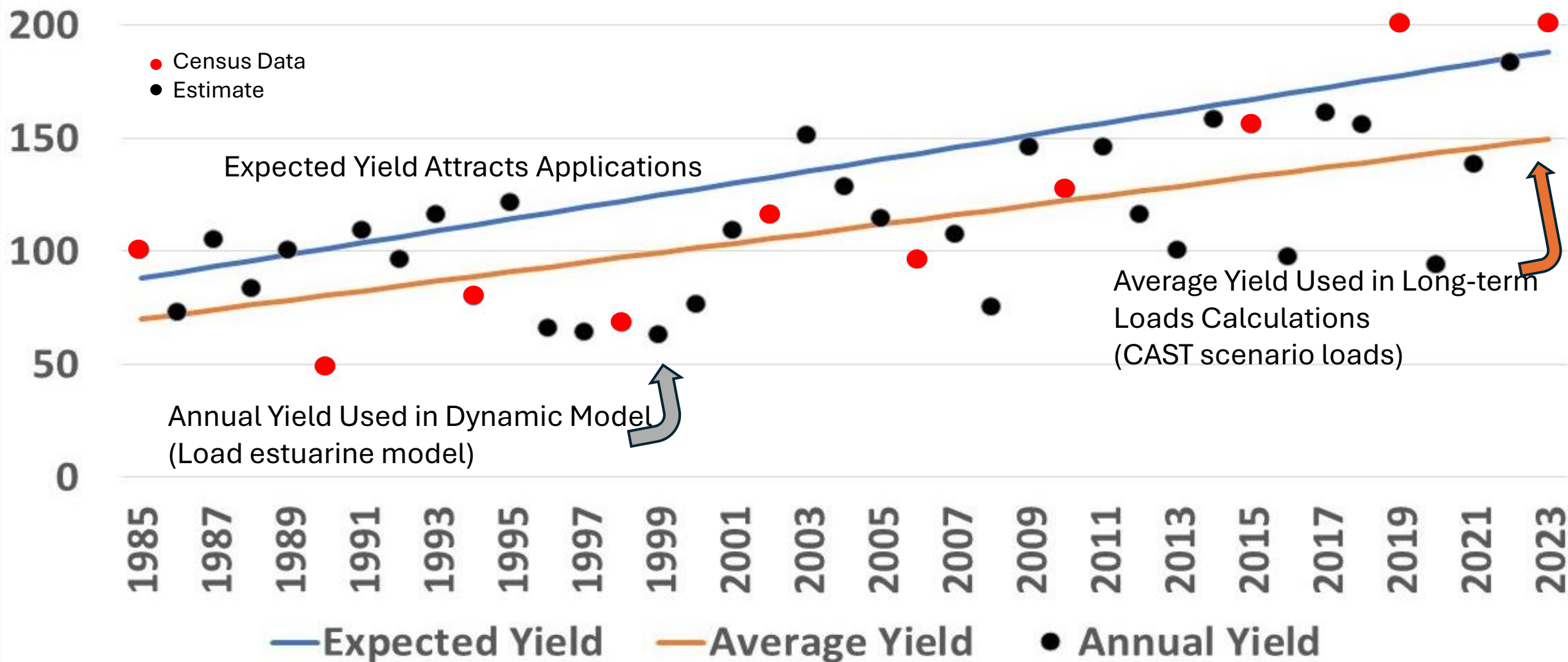
- What is needed to decide on yields for P7?

Why crop yields matter

- Yields and nutrient applications are tied together

Models can be used to estimate the yield that attracts nutrient application, isolate the effects of management by accounting for weather

*EXAMPLE DATA ONLY

- Census Data
- Estimate

Expected Yield Attracts Applications

Average Yield Used in Long-term Loads Calculations (CAST scenario loads)

Annual Yield Used in Dynamic Model (Load estuarine model)

—Expected Yield —Average Yield • Annual Yield

# Issue were identified with P6 yields

- Often too low
- Didn't not capture the trend (or muted trend)
- Often very variable from year to year

Statistical modeling method estimating yields

multivariate linear models, bootstrapped (LOO) BIC and conceptual model selection

$Yield_{crop\ i,\ county\ j} \sim f(time,\ weather,\ climate,\ Survey\ economics)$

When needed, counties are aggregate to growth regions or the watershed…
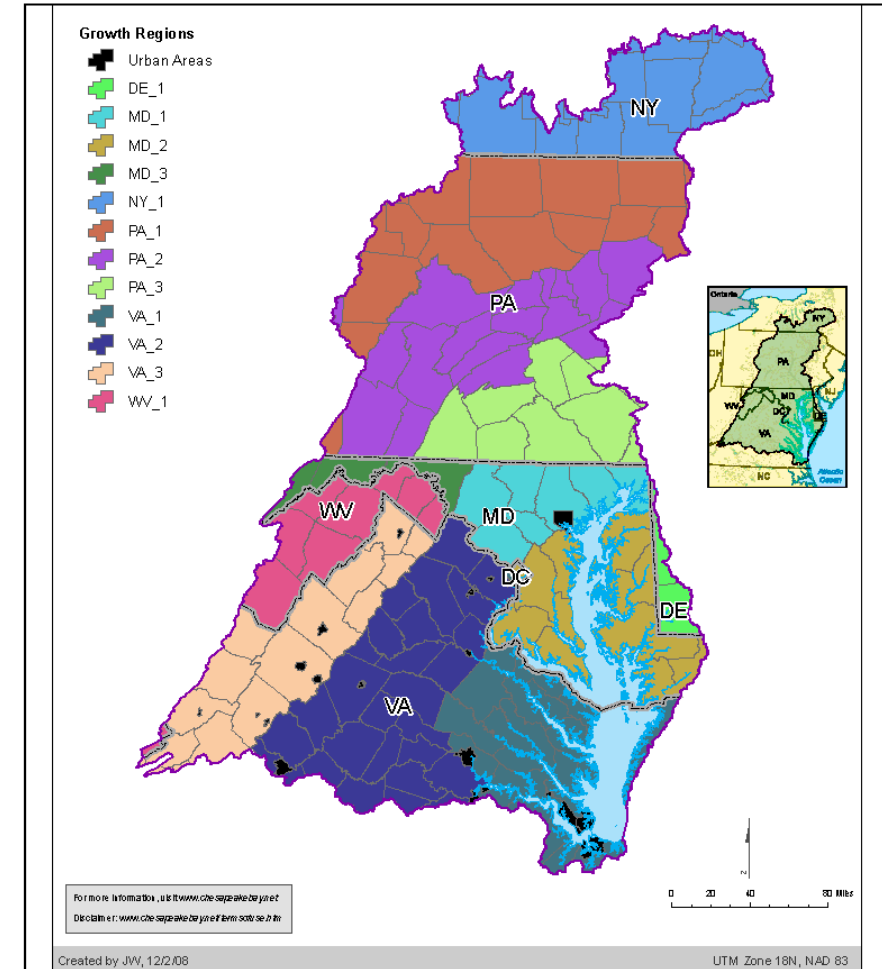
Model is fit to COA and Survey data

- This is a change in 2025
- COA and Survey are weighted based on estimate of uncertainty
- Generally, the Survey is weighted 20% of the COA

- Using both the weighted Census and Survey reduces the negative impact of any bad Census data without substantially decreasing model fit or consistency

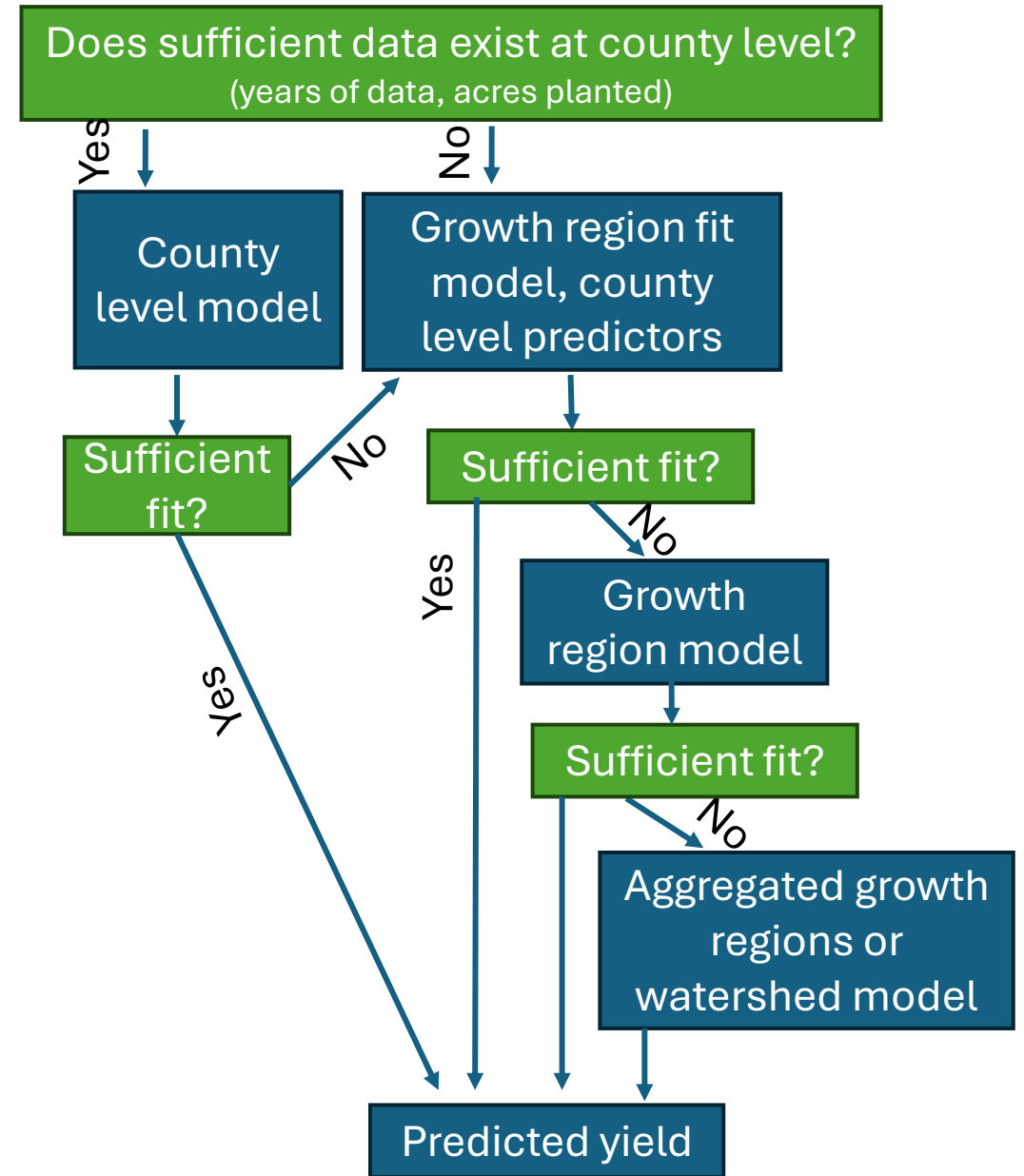# Fitting prioritizes consistency

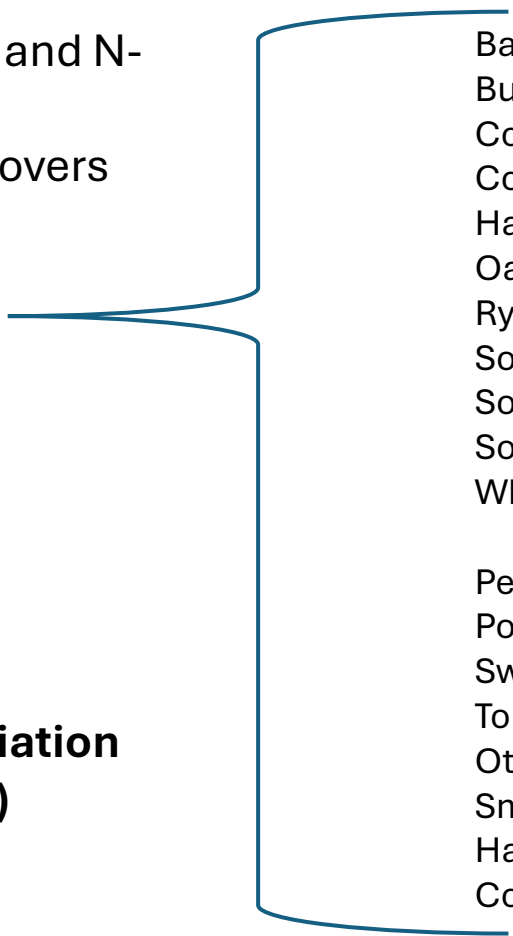Least squares fit
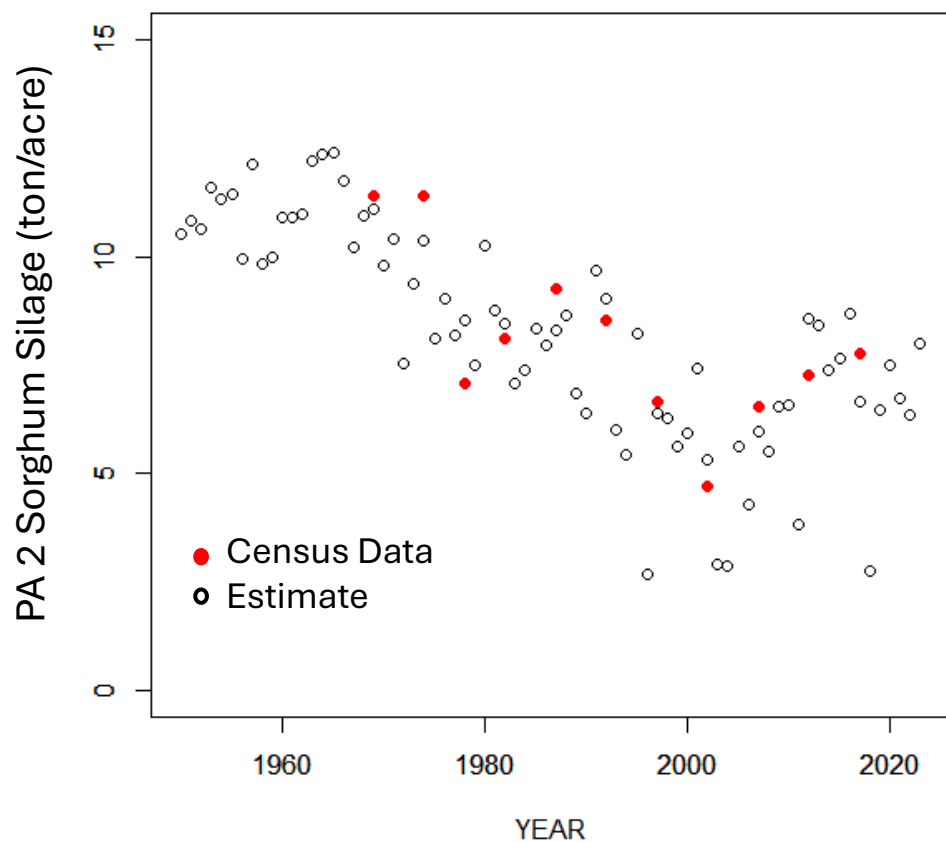
Outlier resistant fitting
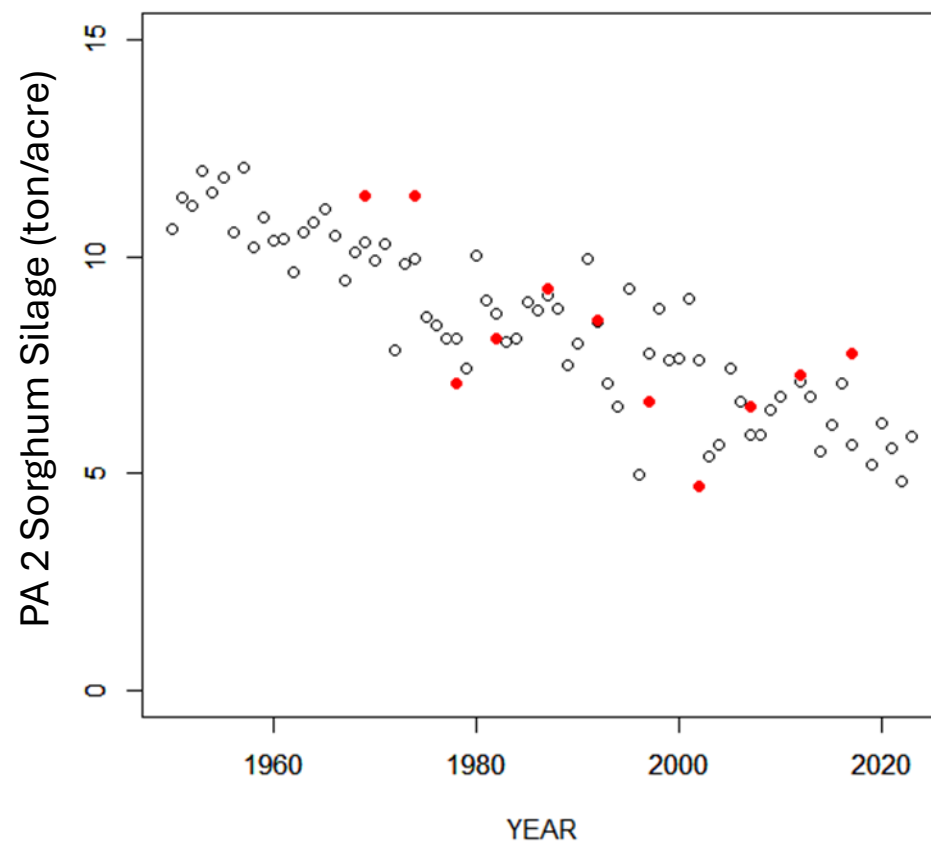
Modeling crop yields, proposed P7 approach

- A county level model is preferred, but there are a total of four models generated to predict yields based on available data and fit.

Does sufficient data exist at county level?
(years of data, acres planted)

Yes → **County level model** → **Sufficient fit?**

No → **Growth region fit model, county level predictors** → **Sufficient fit?**

Sufficient fit? (county) → No → Growth region fit model, county level predictors

Sufficient fit? (county) → Yes → Predicted yield

Sufficient fit? (growth region fit) → Yes → Predicted yield

Sufficient fit? (growth region fit) → No → **Growth region model** → **Sufficient fit?**

Sufficient fit? (growth region model) → No → **Aggregated growth regions or watershed model** → Predicted yield

Predicted yield

Crops modeled

- There are 94 CAST-crops with both a potential yield and N-application
  - Excludes pasture, fallow, unmanaged or wild covers

- 19 crops are well modeled
  - **>87% of N, P, and acres**

- 11 of these crops have true yield units in CAST
  - Application per unit actual yield
- 8 currently substitute acres for yield
  - **Application per true yield units are needed**

- **The proposed P7 method explains 73% of the variation in annual crop yields (weighted by cropland area)**

Barley
Buckwheat
Corn for grain
Corn for silage
Hay alfalfa
Oats for grain
Rye grain
Sorghum grain
Sorghum silage
Soybeans
Wheat grain

Peanuts
Potatoes
Sweet potatoes
Tobacco
Other managed hay
Small grain hay
Hay silage
Cotton

Trend analysis of crop yields

Weather independent yield -10 yr averaged inputs applied to annual yield model

Yield attracting application – Model is weighted towards higher yields
- weighting is calibrated to the best 3 of 5 average method

"Expected yields must not go down" Applied only to crops with strong trends, corn, wheat, soybeans.
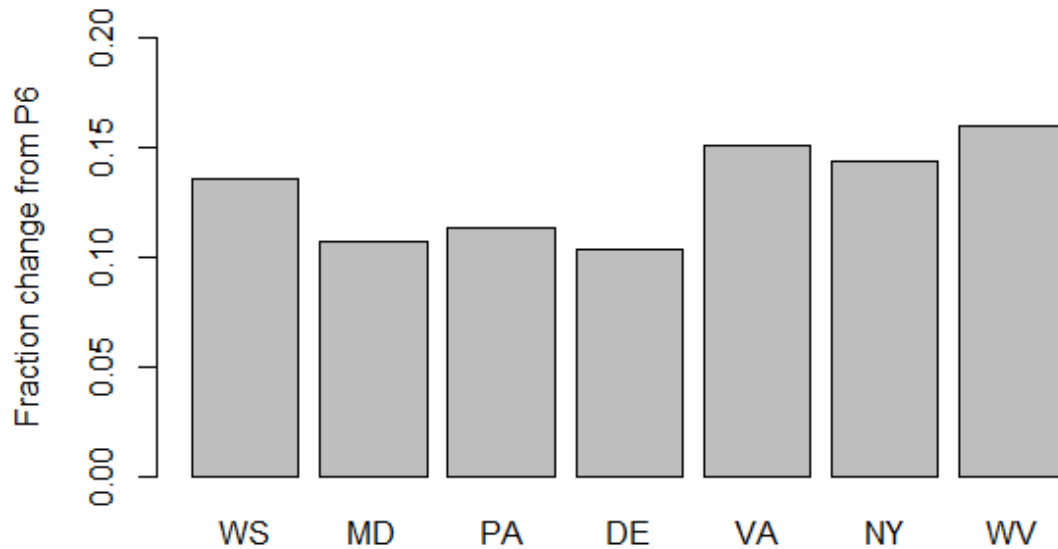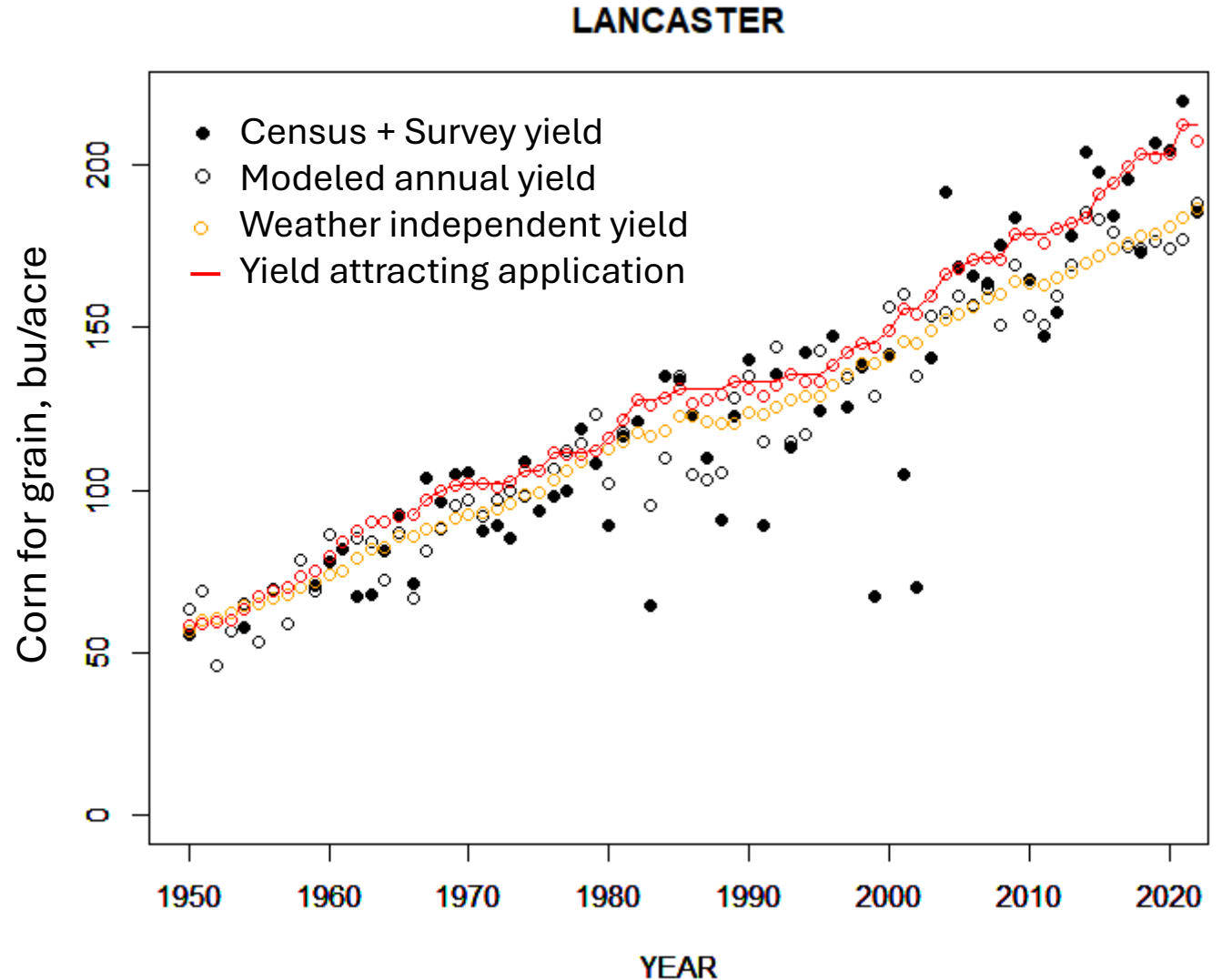

LANCASTER

Issue were identified with P6 yields

- Often too low
- Didn't not capture the trend (or muted trend)
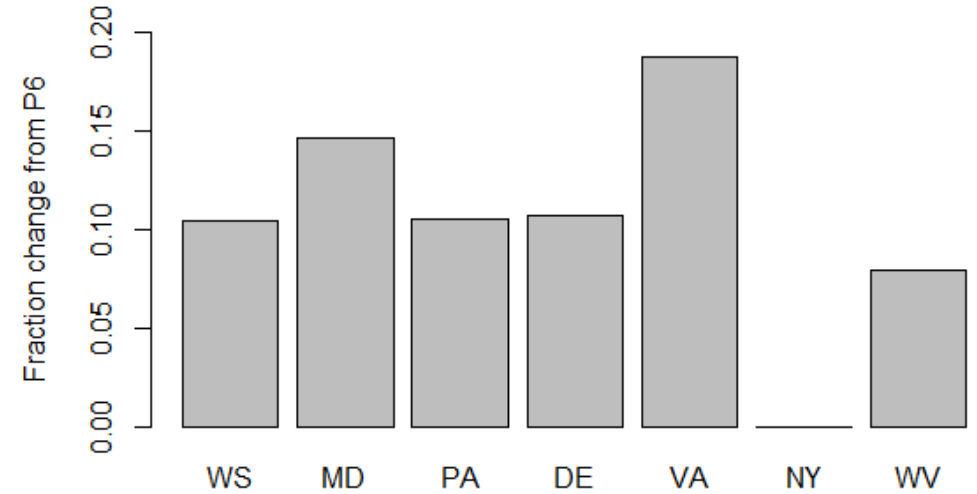- Often very variable from year to year

Phase 6 yields were too low

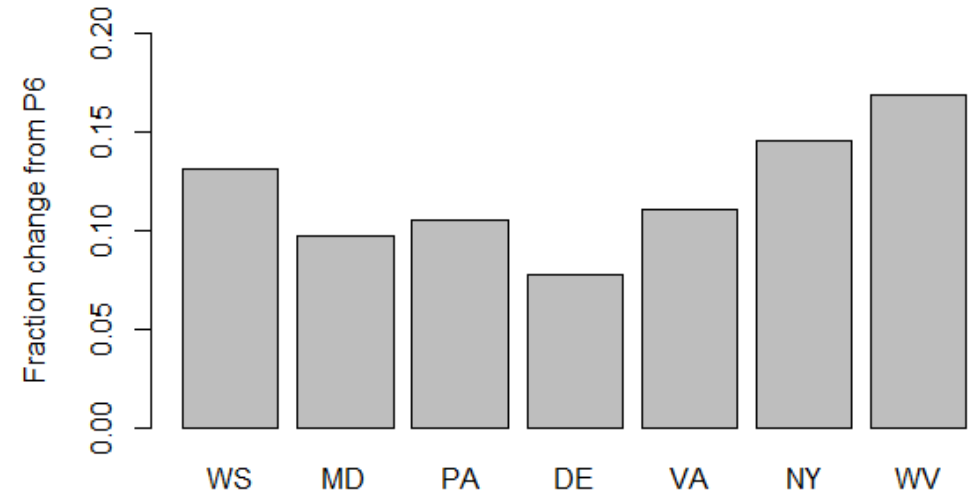- Proposed P7 yields attracting application are generally higher

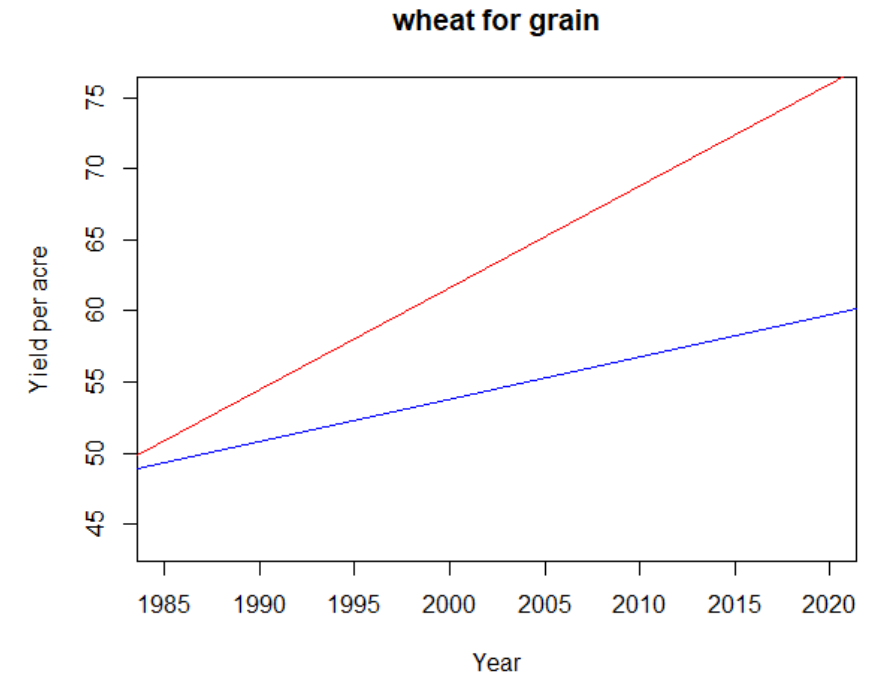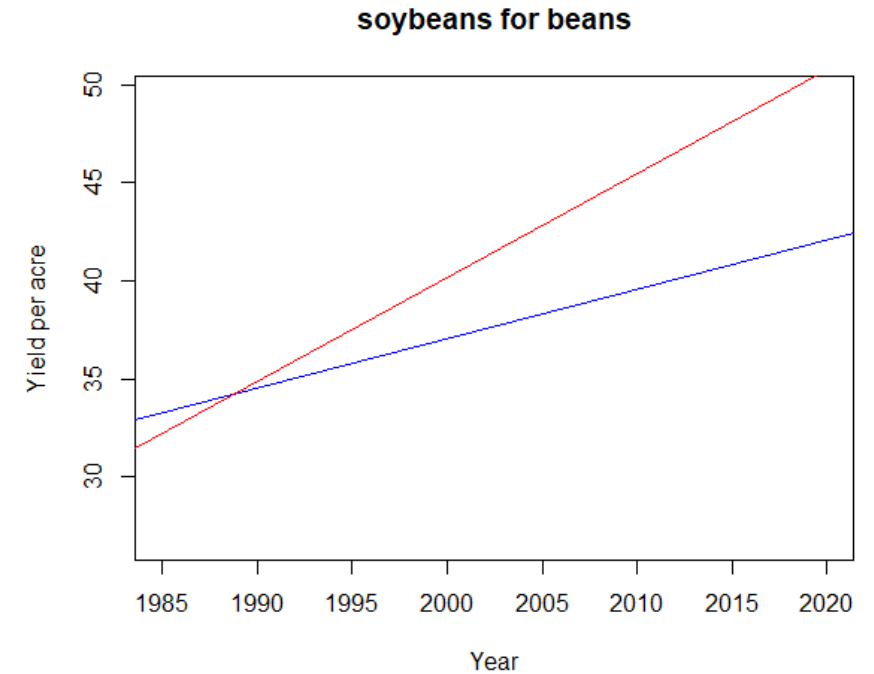Yield change, soybeans for beans
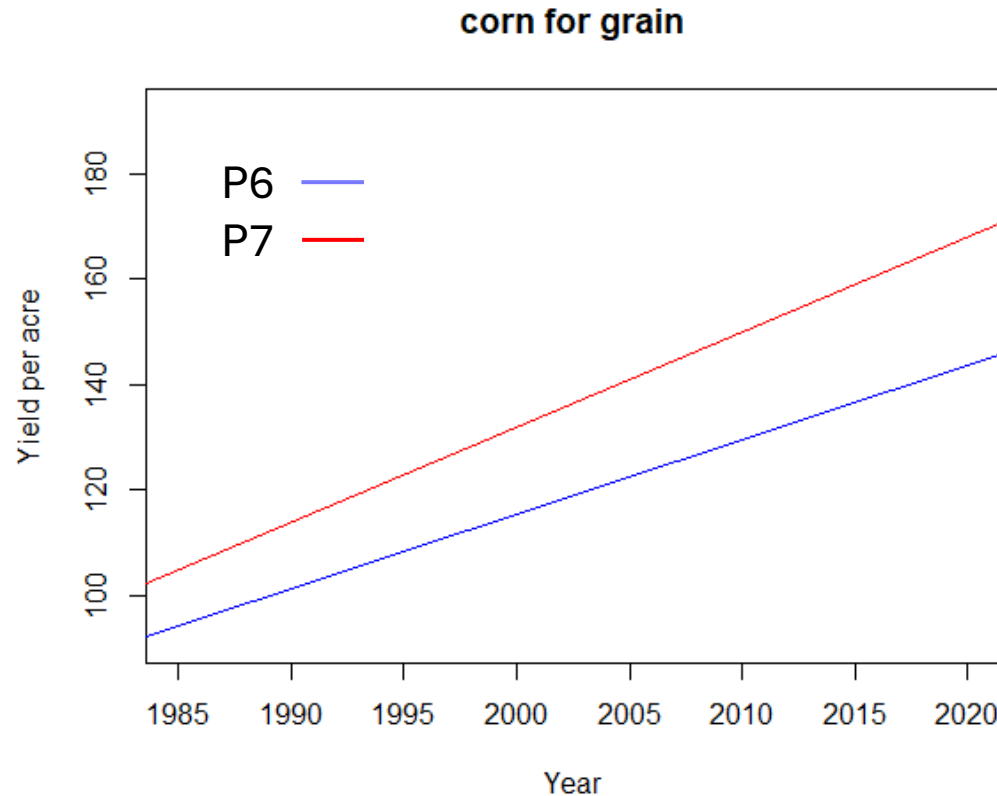

Yield change, corn for grain

Yield change, wheat for grain

Phase 6 yields didn't capture the trend

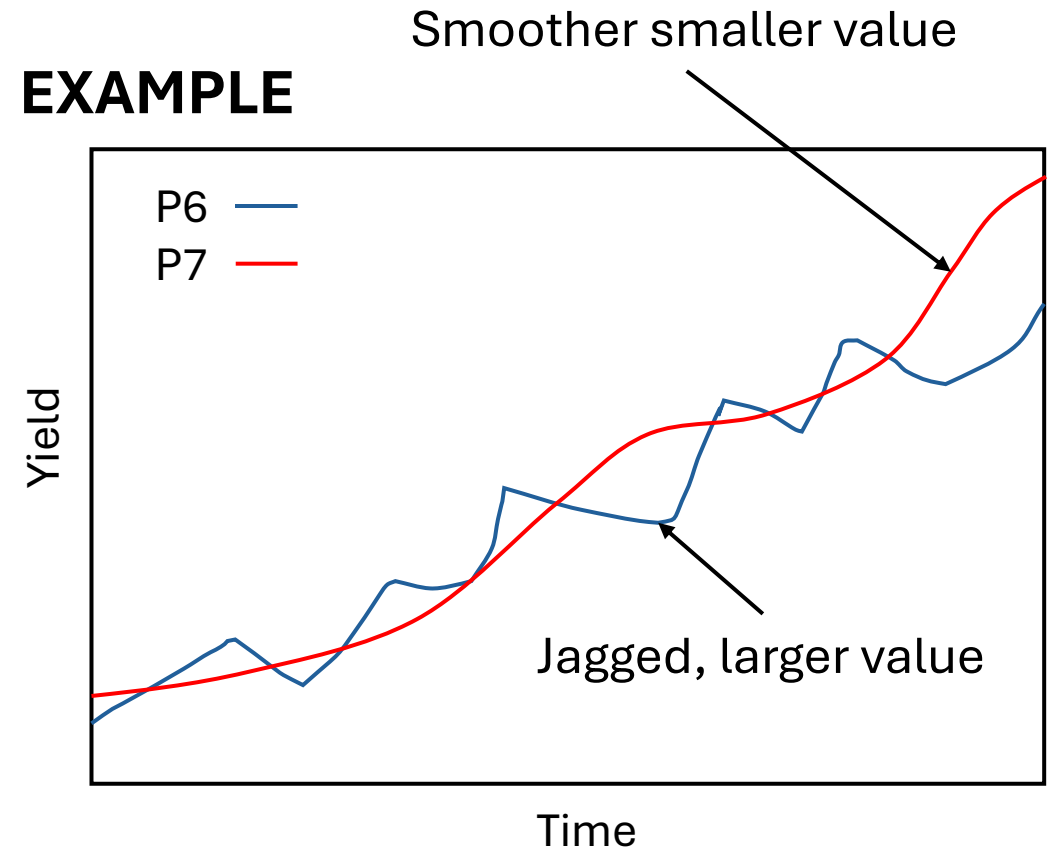- Proposed P7 yields attracting application trend higher

Phase 6 yields were too variable from year to year

- Year to year variability is lower in the proposed P7 yields

Crop	P6 variation value	P7 variation value
Corn	1.87	0.94
Wheat	0.69	0.56
Soybeans	0.40	0.35

EXAMPLE

Smoother smaller value

P6 ——
P7 ——

Yield

Jagged, larger value

Time

Crops needing application per yield unit

- Peanuts
- Potatoes
- Sweet potatoes
- Tobacco
- Other managed hay
- Small grain hay
- Hay silage
- Cotton

- These crop are currently considered in CAST using acres as yield units.
- The method estimates true yields sufficiently, and application per true yield unit are needed to incorporate in CAST.
- Many of these crops only have distinct trends in specific regions of the watershed.

Questions and discussion

- What is need for final decision?