Crop Yields Continued

10/13/2023
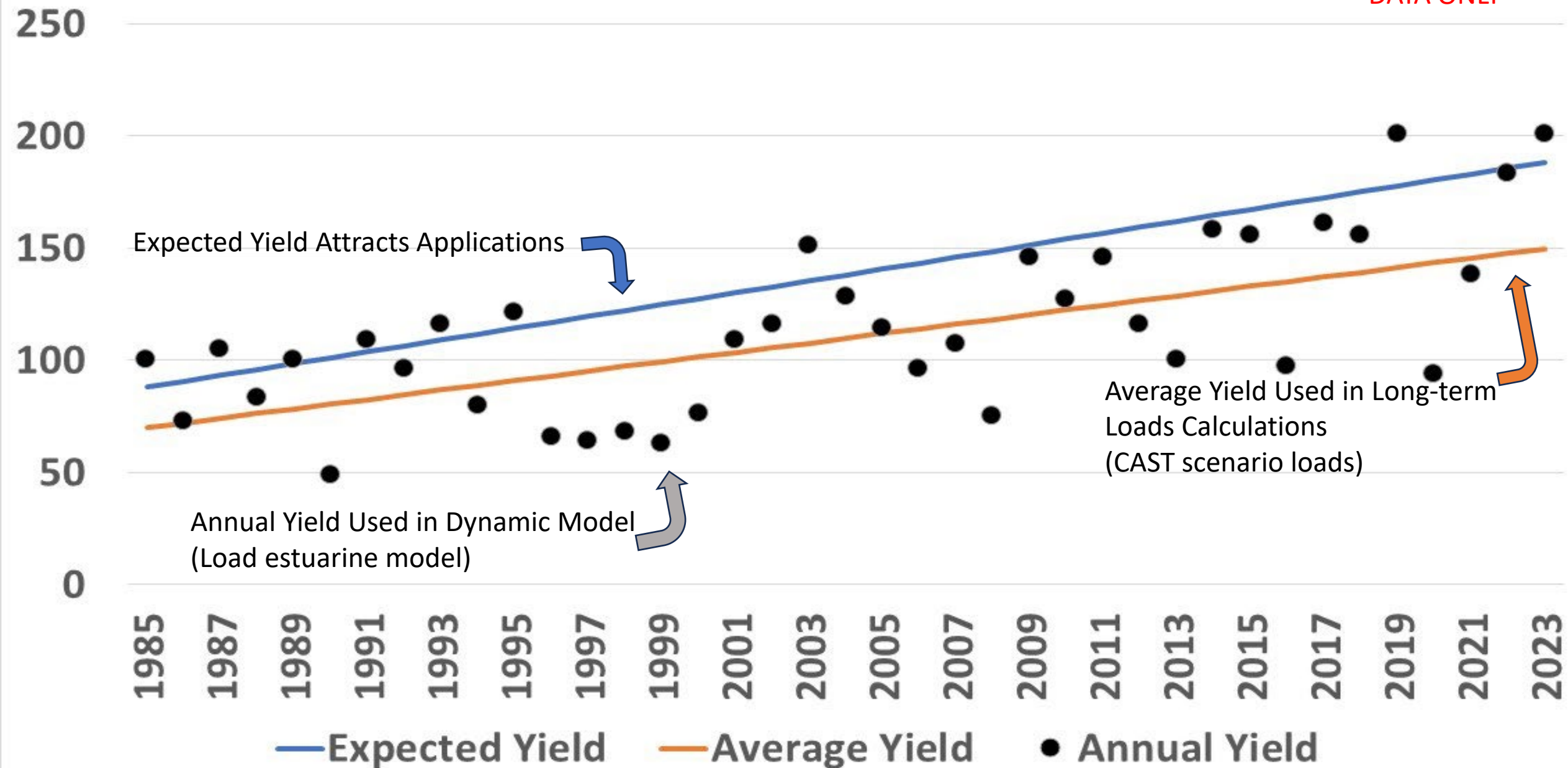
Recap

Crop yields are important

- Govern where nutrients go
- Govern uptake of nutrients

We need to know several things about yield:

- Long term trends over time (1985-Present)
- How a farmer views yields in relation to nutrient applications

Yield Values in CAST

*EXAMPLE DATA ONLY

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

Moving forward:

CAST currently has variable yield (e.g. Bu/acre) data on major crops (Corn)

- ~44% of ag acres
- ~73% Plant available Nitrogen

We can use existing methods to capture variability

- best 3 of 5
- trailing average
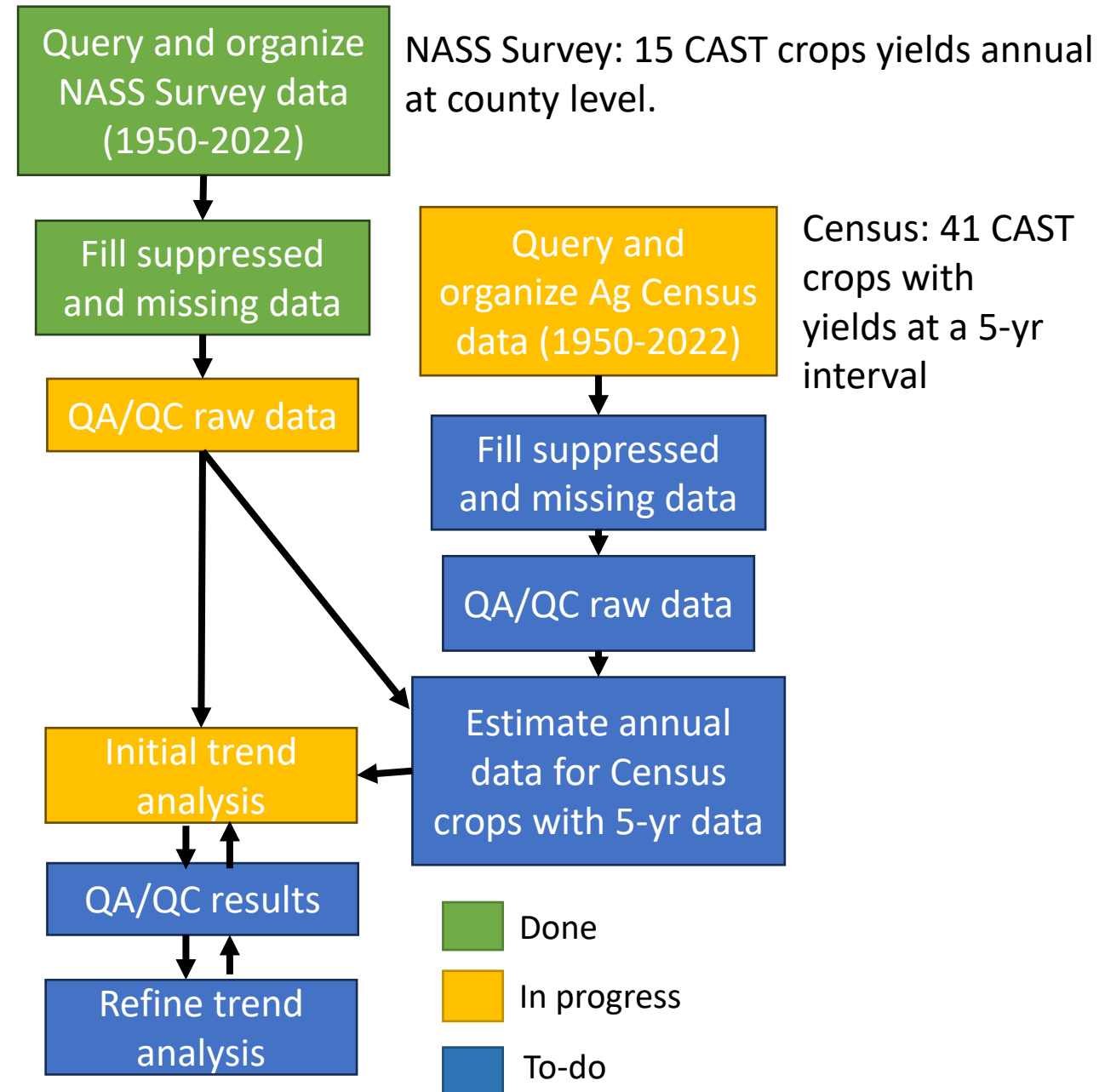- Does this do a good enough job of simulating farmer decision making?

There are more crops without yield data

- Is it ok to leave the other 27 % of PAN? 56% ag acres?

Planned Path for investigation

Goals: Estimate farmer yield expectations at the county level which drive the application of nutrients.

Approach: Use trend analysis of long-term annual crop yields to develop several potential scenarios of yield expectation at the county level.
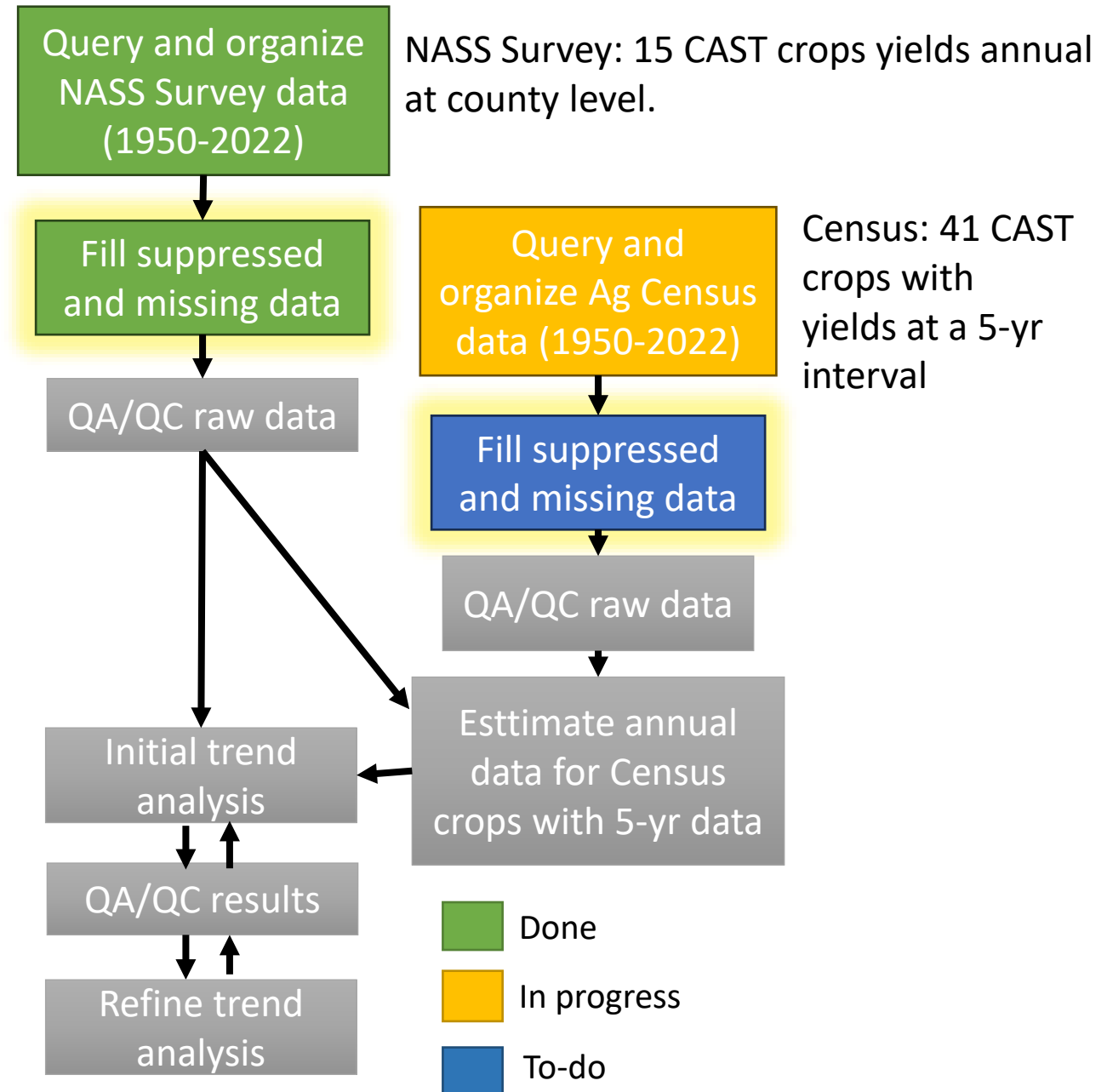
Planned Path for investigation

A long dataset, 1950 to present, provides
- greater statistical power for trend analysis and estimates
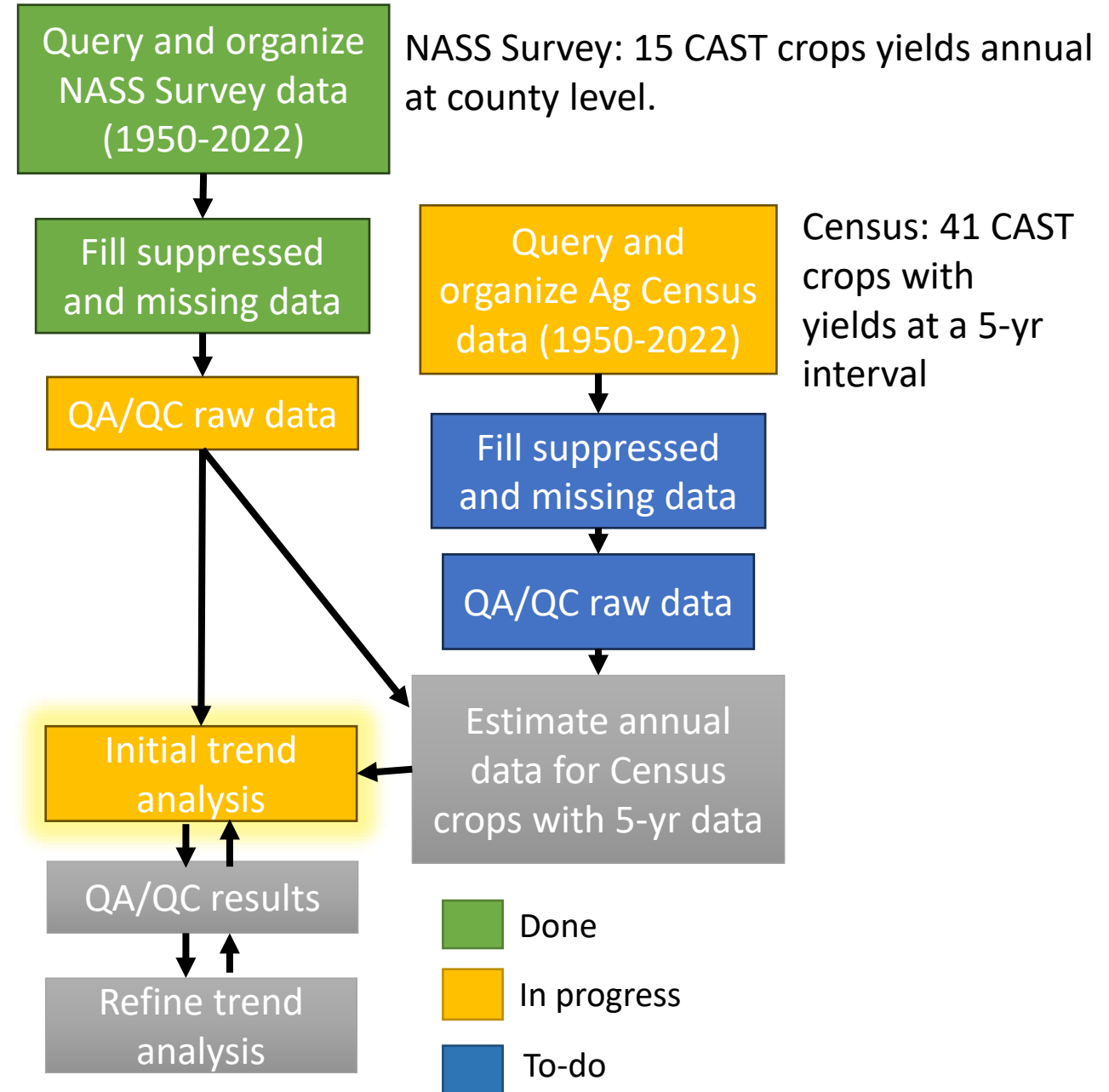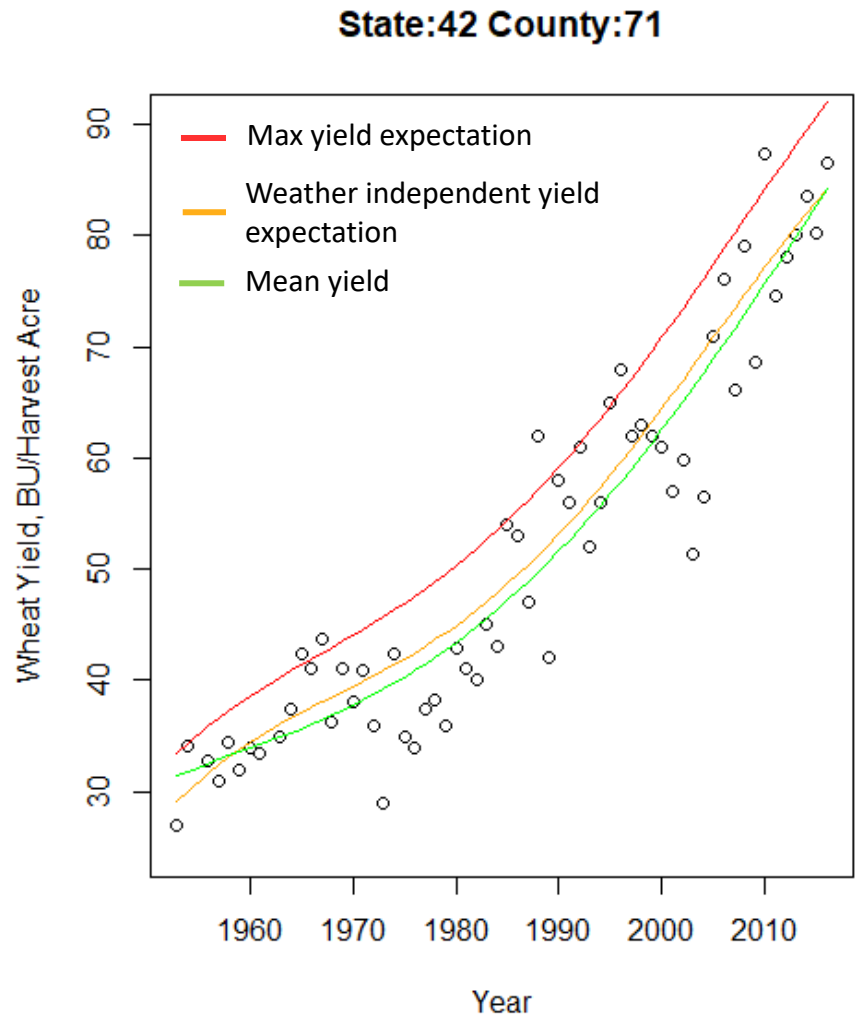- helps estimate legacy nutrients during the critical period.
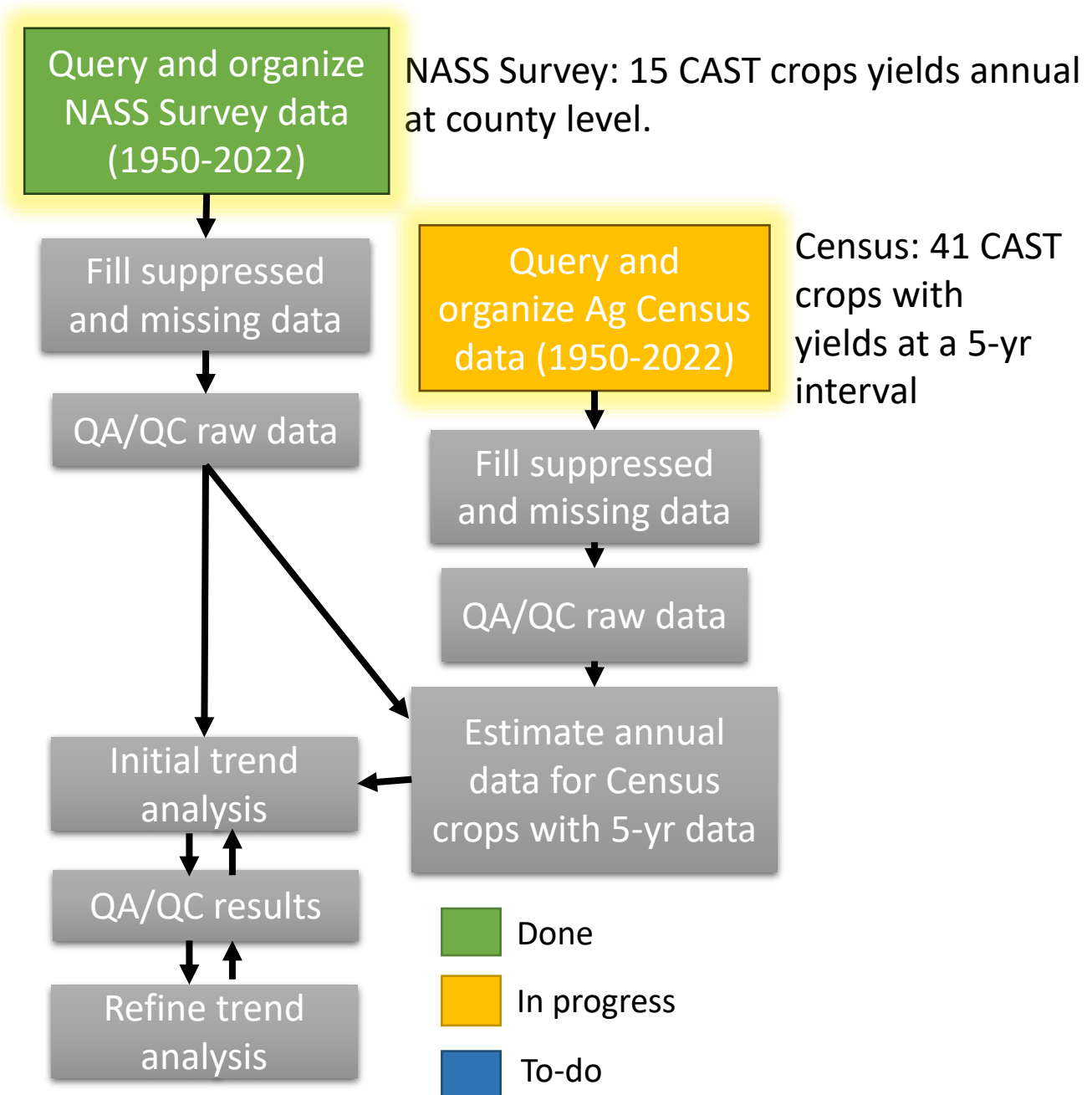
Planned Path for investigation

Suppressed and missing yield data estimated as the mean of counties within the CBP Growth Region.
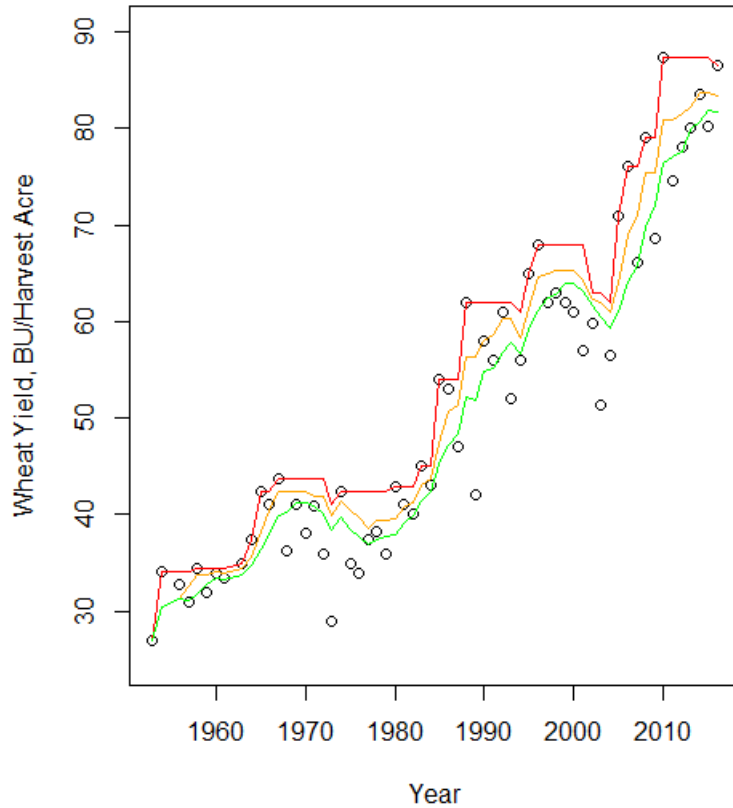
Planned Path for investigation

State:42 County:71

Legend:
- Max yield expectation (red)
- Weather independent yield expectation (orange)
- Mean yield (green)

Wheat Yield, BU/Harvest Acre vs Year

Flowchart:

Query and organize NASS Survey data (1950-2022) → Fill suppressed and missing data → QA/QC raw data

NASS Survey: 15 CAST crops yields annual at county level.

Query and organize Ag Census data (1950-2022) → Fill suppressed and missing data → QA/QC raw data

Census: 41 CAST crops with yields at a 5-yr interval

Estimate annual data for Census crops with 5-yr data → Initial trend analysis

Initial trend analysis → QA/QC results → Refine trend analysis

Legend:
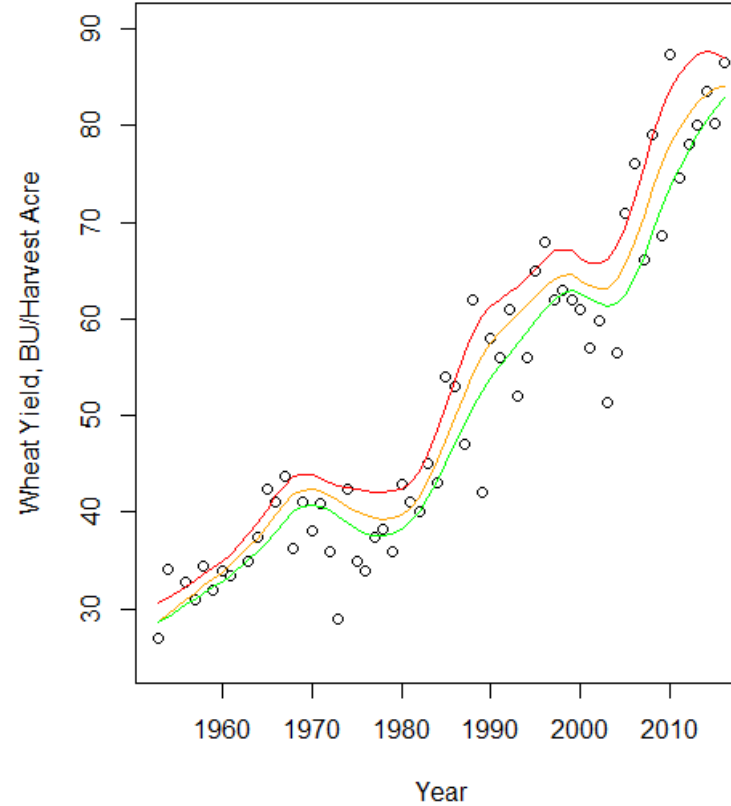- Done (green)
- In progress (orange)
- To-do (blue)

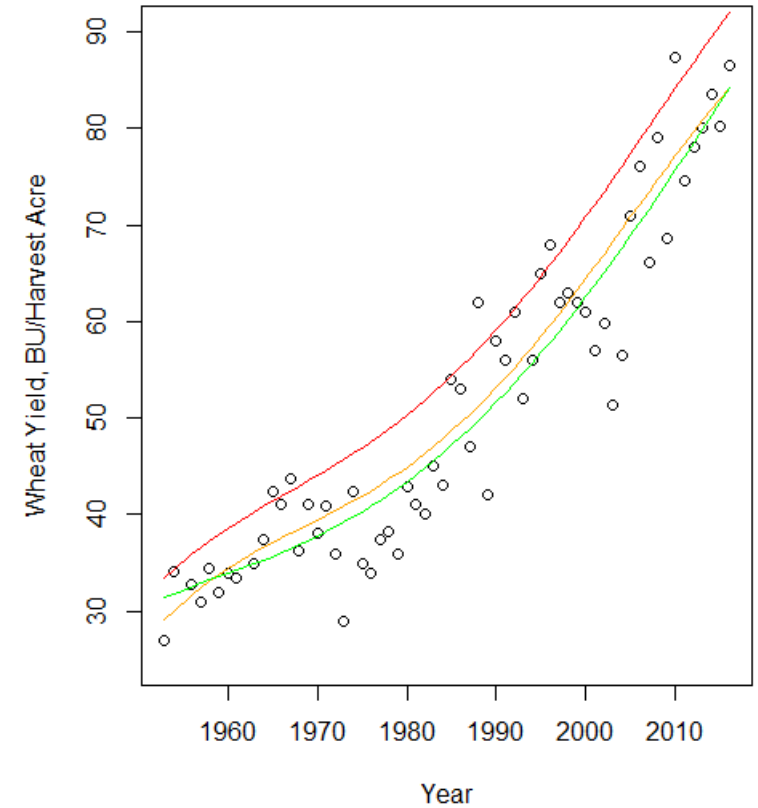# Example trend analyses of NASS survey yields (15 crops)
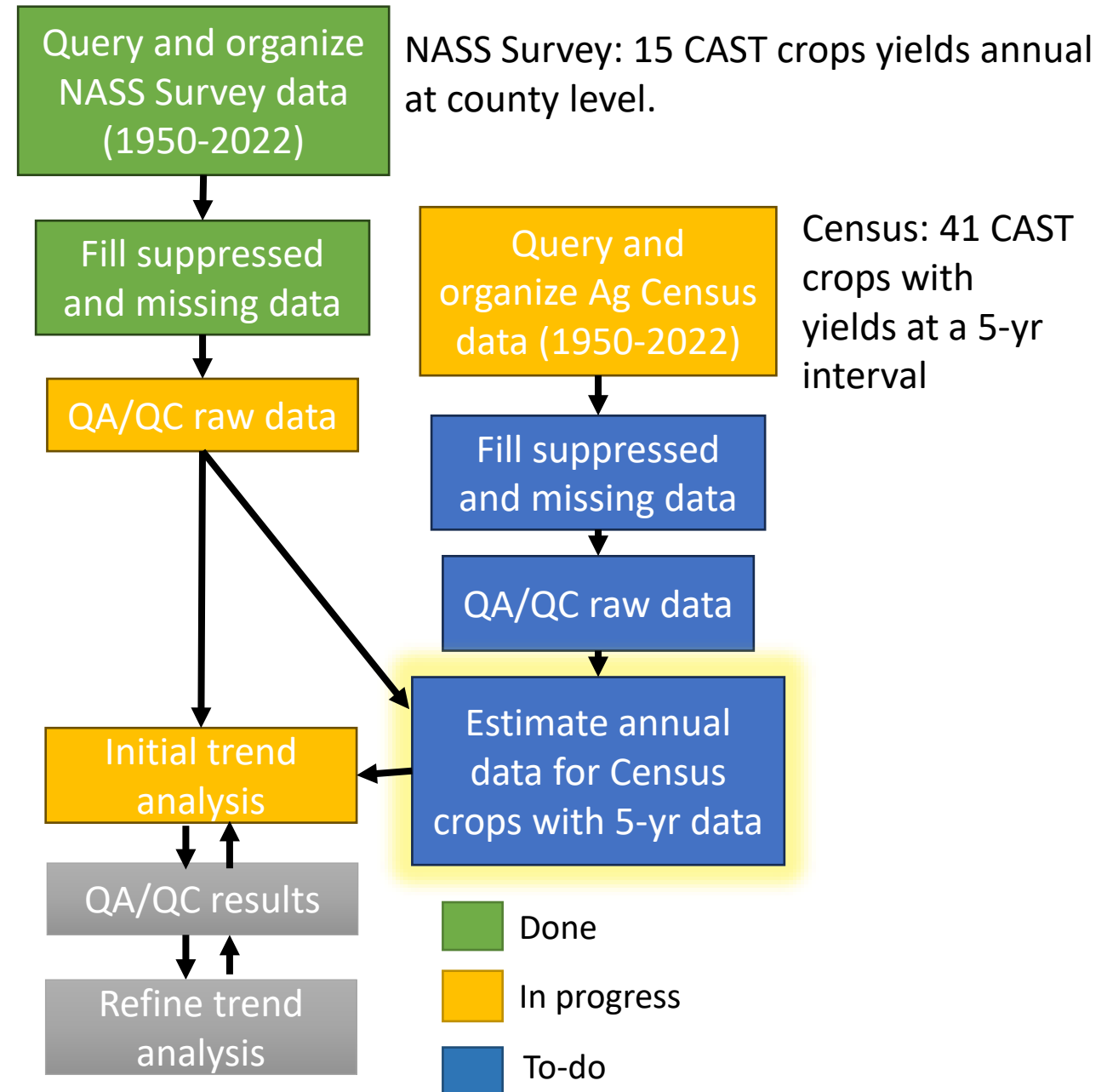

Moving window
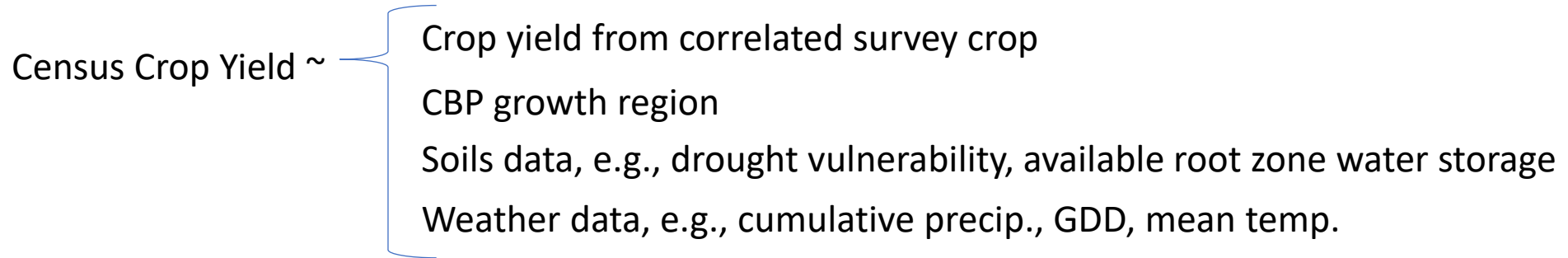
Moving window smoothing

Regression, weighted residuals

— Max yield expectation (5-year max)

— Weather independent yield expectation
(Average of best 3 of past 5 years

— 5-yr mean yield

Planned Path for investigation

We propose to estimate annual crop yields for the 5-year census data set using correlation to the annual survey crops, regional variables, soils data, and weather data.

Query and organize NASS Survey data (1950-2022)

NASS Survey: 15 CAST crops yields annual at county level.

Fill suppressed and missing data

Query and organize Ag Census data (1950-2022)

Census: 41 CAST crops with yields at a 5-yr interval

QA/QC raw data

Fill suppressed and missing data

QA/QC raw data

Initial trend analysis

Estimate annual data for Census crops with 5-yr data

QA/QC results

Refine trend analysis

Done

In progress

To-do

Estimating annual crop yields for NASS census crops

Census Crop Yield ~
- Crop yield from correlated survey crop
- CBP growth region
- Soils data, e.g., drought vulnerability, available root zone water storage
- Weather data, e.g., cumulative precip., GDD, mean temp.

Algorithms can be used to identify the best predictors of yield for each crop. Jiang et. al., (2020) used A Maximum Relevance — Minimum Redundancy algorithm to identify the 10 best predictors of county corn yield in Iowa from an initial set of 28 potential predictors.

Jiang Z, Liu C, Ganapathysubramanian B, Hayes DJ, Sarkar S. Predicting county-scale maize yields with publicly available data. Sci Rep. 2020 Sep 11;10(1):14957. doi: 10.1038/s41598-020-71898-8. PMID: 32917920; PMCID: PMC7486922.

Planned Path for investigation

We will perform trend analyses on the estimated annual Census crop yields and refine Survey crop yield trend analysis.

We will refine trend analyses to incorporate group feedback and provide yield expectations estimates that are consistent in time, across crops, and counties.
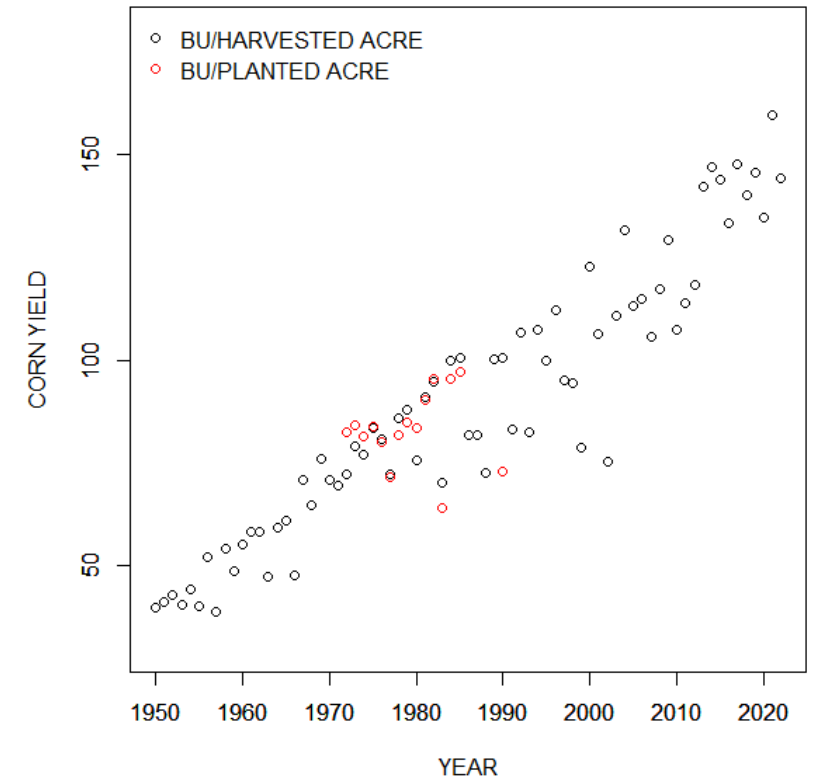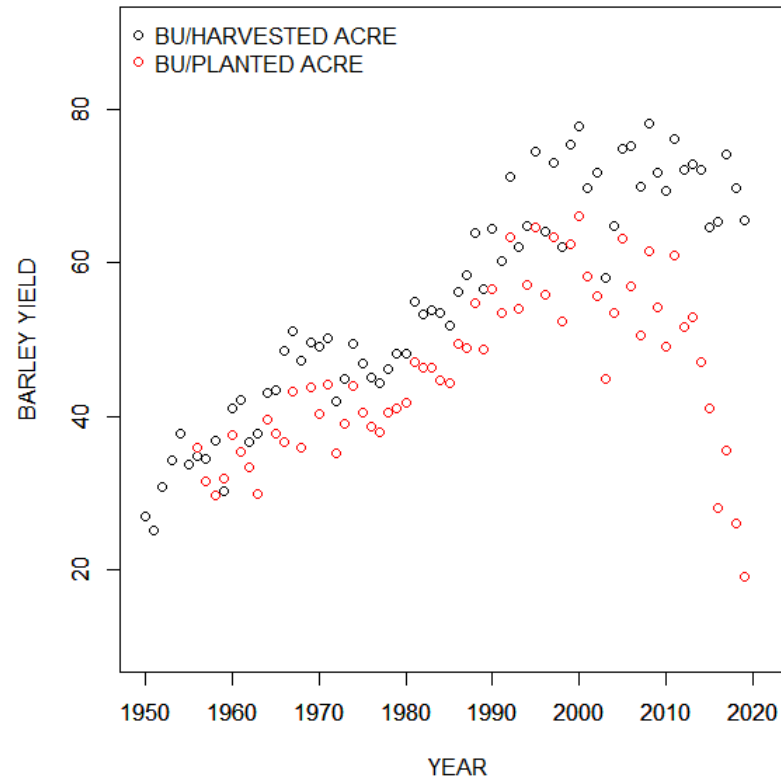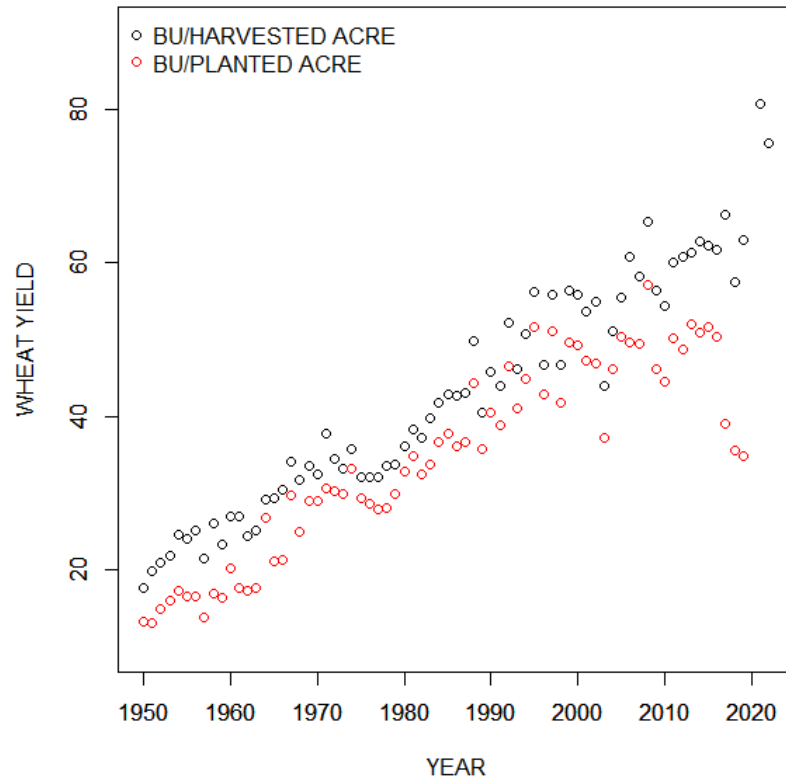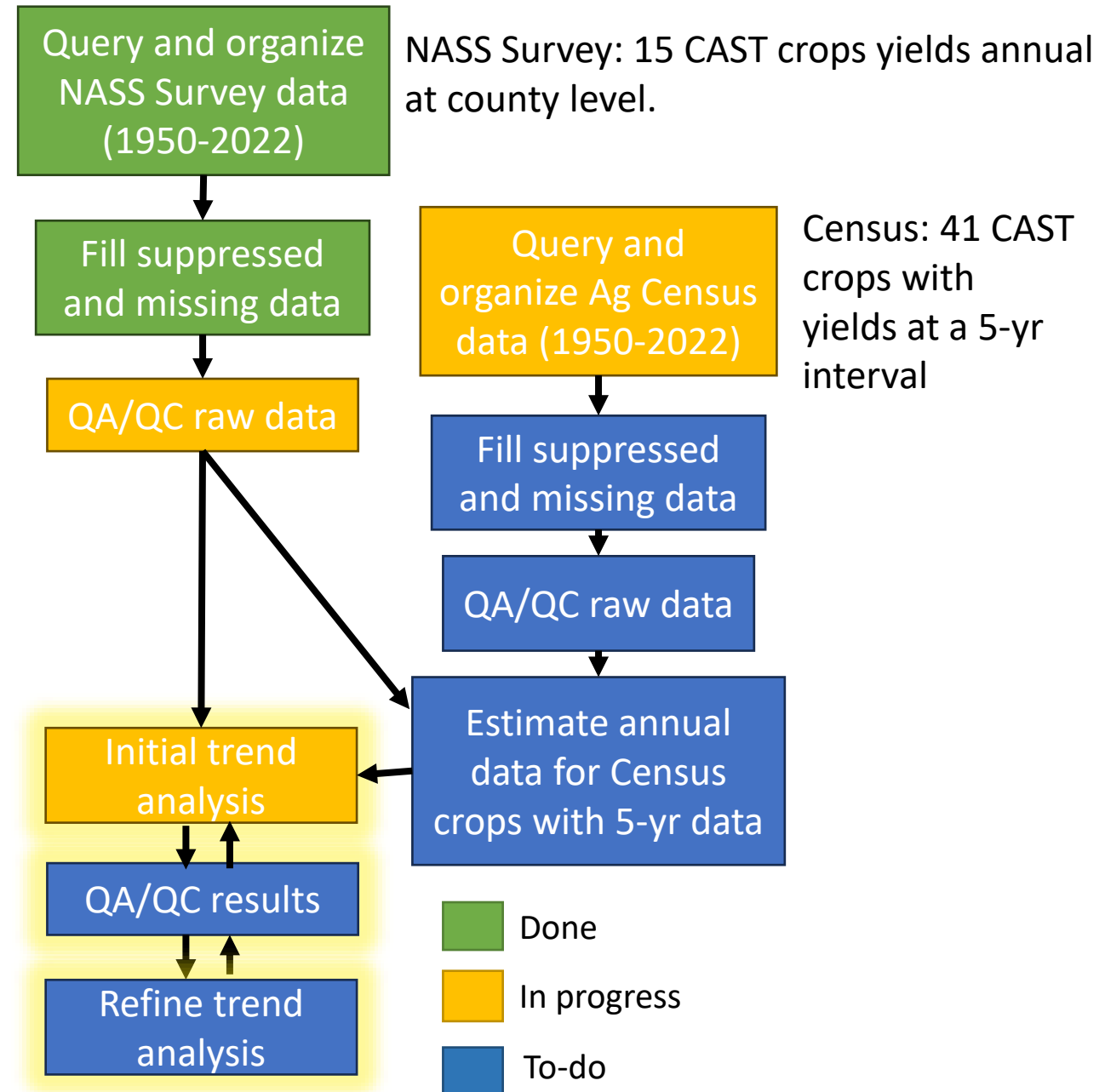
Feedback:

- What is the best way to predict real-world farmer expectation?
  - best 3 of 5?
  - Trailing average?
- For the remaining ~60 CAST crops, which do not have reported yields do we want to:
  - 1) Use yields from similar crops?
  - 2) Use reported yields from state-level data or literature?
- How should we use planted acres and harvested acres?

Planted vs harvested area yield calculations

Yields shown are averaged across all CBW counties

Planted acres are only available for a subset of crops, but these appear to be crops where there is a significant discrepancy between planted and harvested acres.

Planted vs harvested area yield calculations

When estimating total fertilizer application, (Yield * N/yield * acres) do we:

- Multiply yield by the planted acres because all planted acres receive the full amount of fertilizer?
- Multiply yield by the harvested acres because only the harvested acres received the full amount of fertilizer?
- Something in between?

When estimating total crop removal (Yield * N/yield * acres) do we:

- Multiply yield by the planted acres because all planted acres took up the nitrogen and were removed?
- Multiply yield by the harvested acres because only the harvested acres took up the nitrogen and were removed?
- Something in between?

Questions?