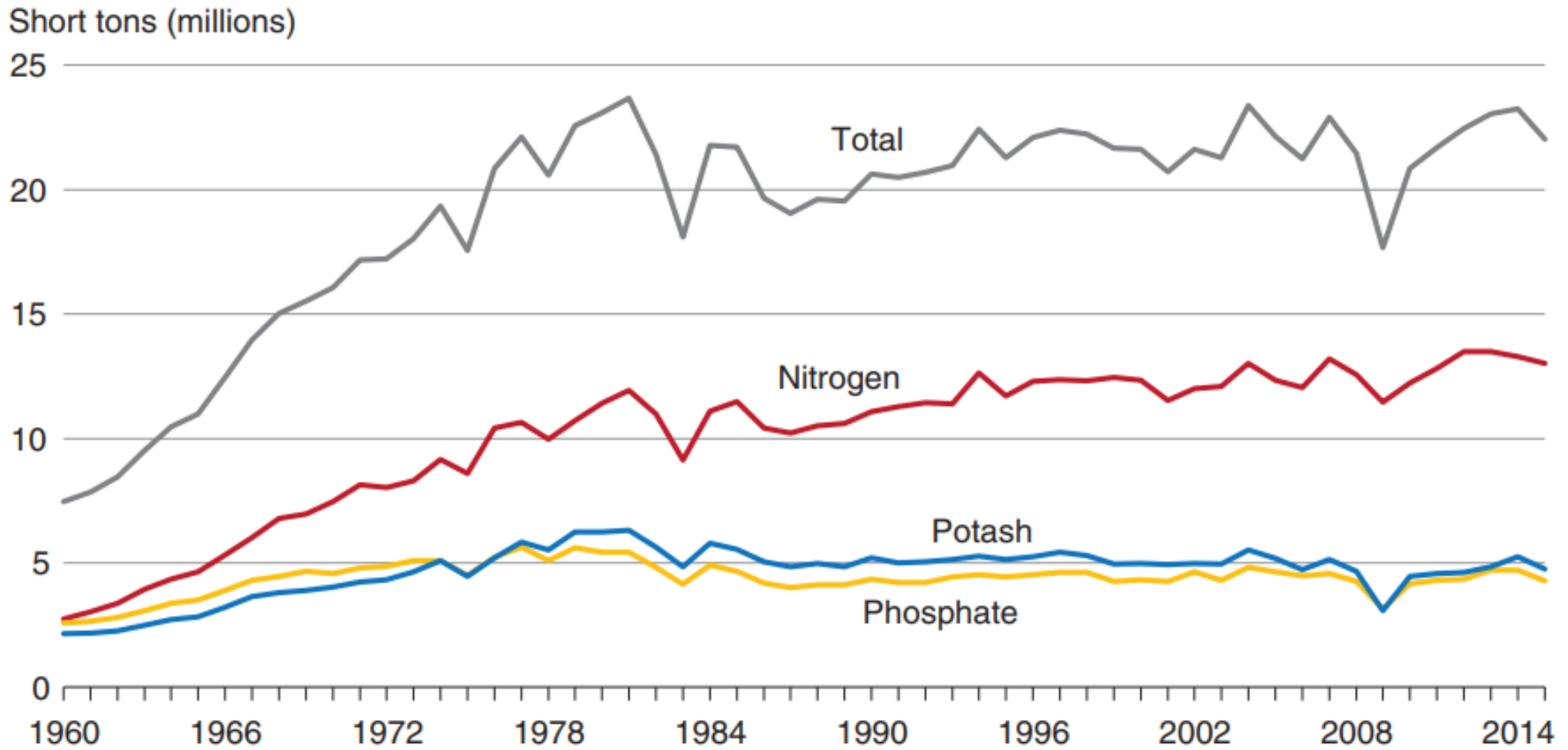




Comparison of Private and Public Lab Fertilizer Recommendations

MEGAN BAKER, MATT YOST, JODY GALE, EARL CREECH, GRANT CARDON, STEVEN PRICE, KALEN TAYLOR, CODY ZESIGER, RANDALL VIOLETT, REAGAN WYTSALUCY, REGANNE BRIGGS, MARK NELSON, AND MIKE PACE

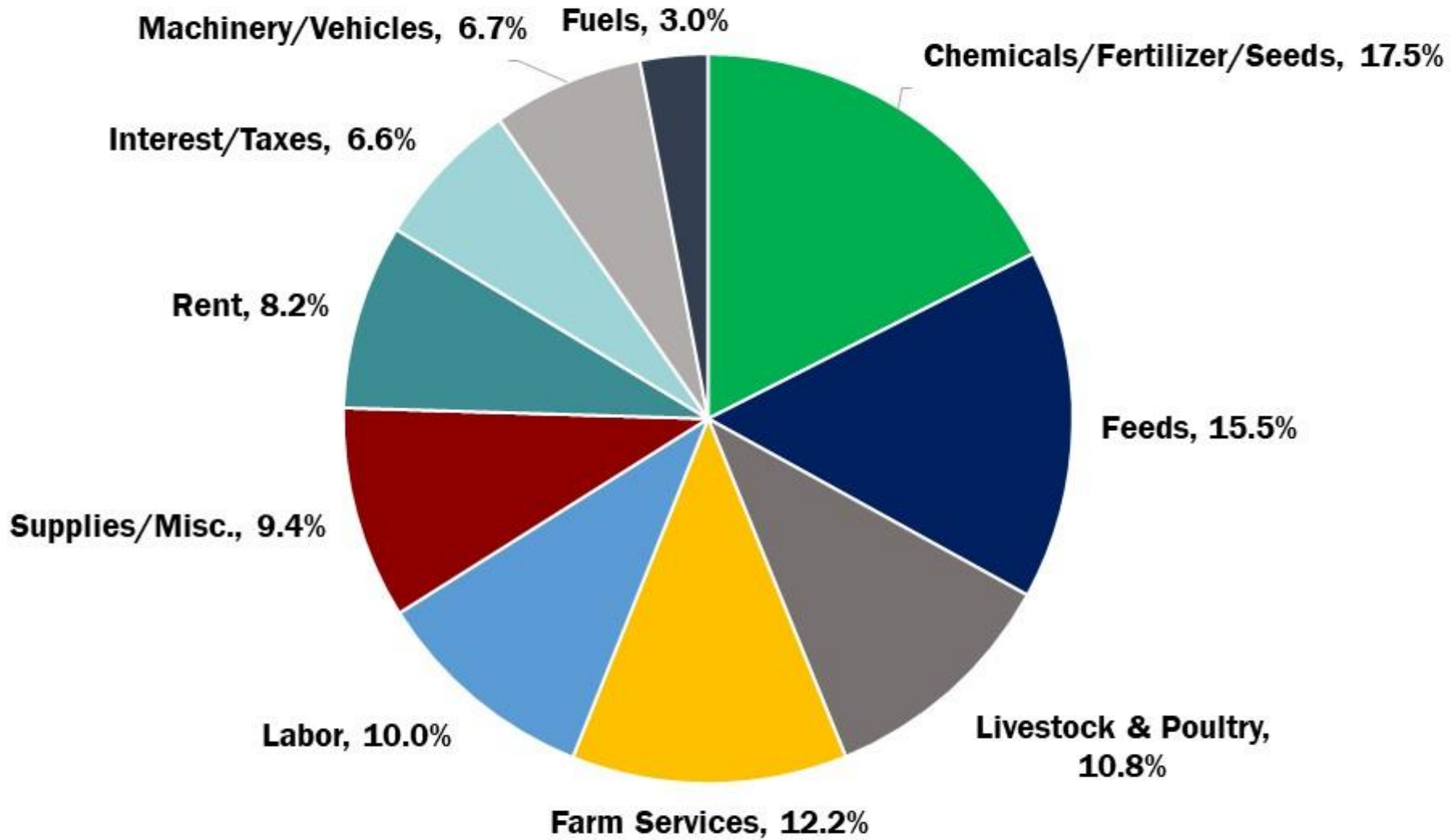
Total nutrient use increased dramatically until 1981



Note: 1 short ton equals 2,000 pounds.

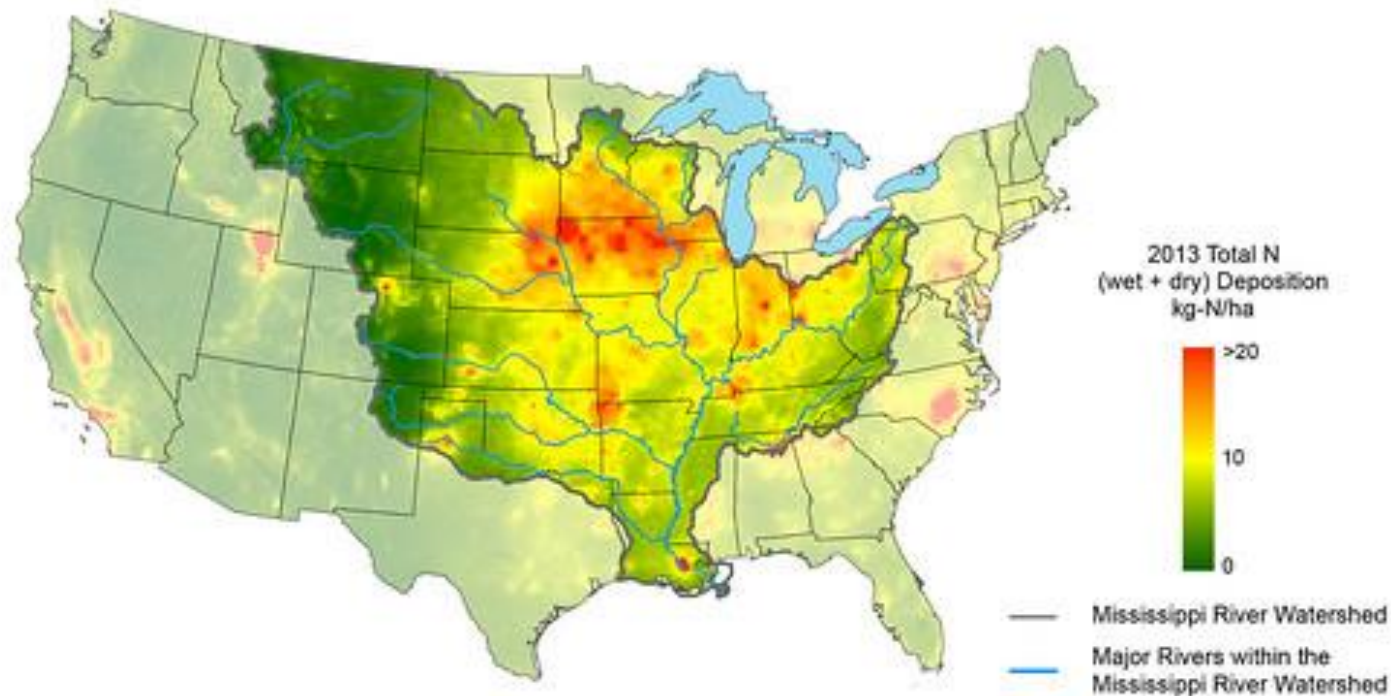
Source: USDA, Economic Research Service using data from the Tennessee Valley Authority, Association of American Plant Food Control officials (2018).

Share of Total On-Farm Production Expenditures



Eutrophication

- Elevated levels of nitrogen and phosphorus in water stimulate the growth of algae and aquatic plants, which reduces the dissolved oxygen content of the water
- Eutrophication can lead to hypoxia (“dead zones”), where fish and aquatic species are eventually suffocated due to a lack of oxygen



4R Nutrient Stewardship Principles



RIGHT SOURCE

Matches fertilizer type to crop needs.



RIGHT RATE

Matches amount of fertilizer type crop needs.



RIGHT TIME

Makes nutrients available when crops needs them.



RIGHT PLACE

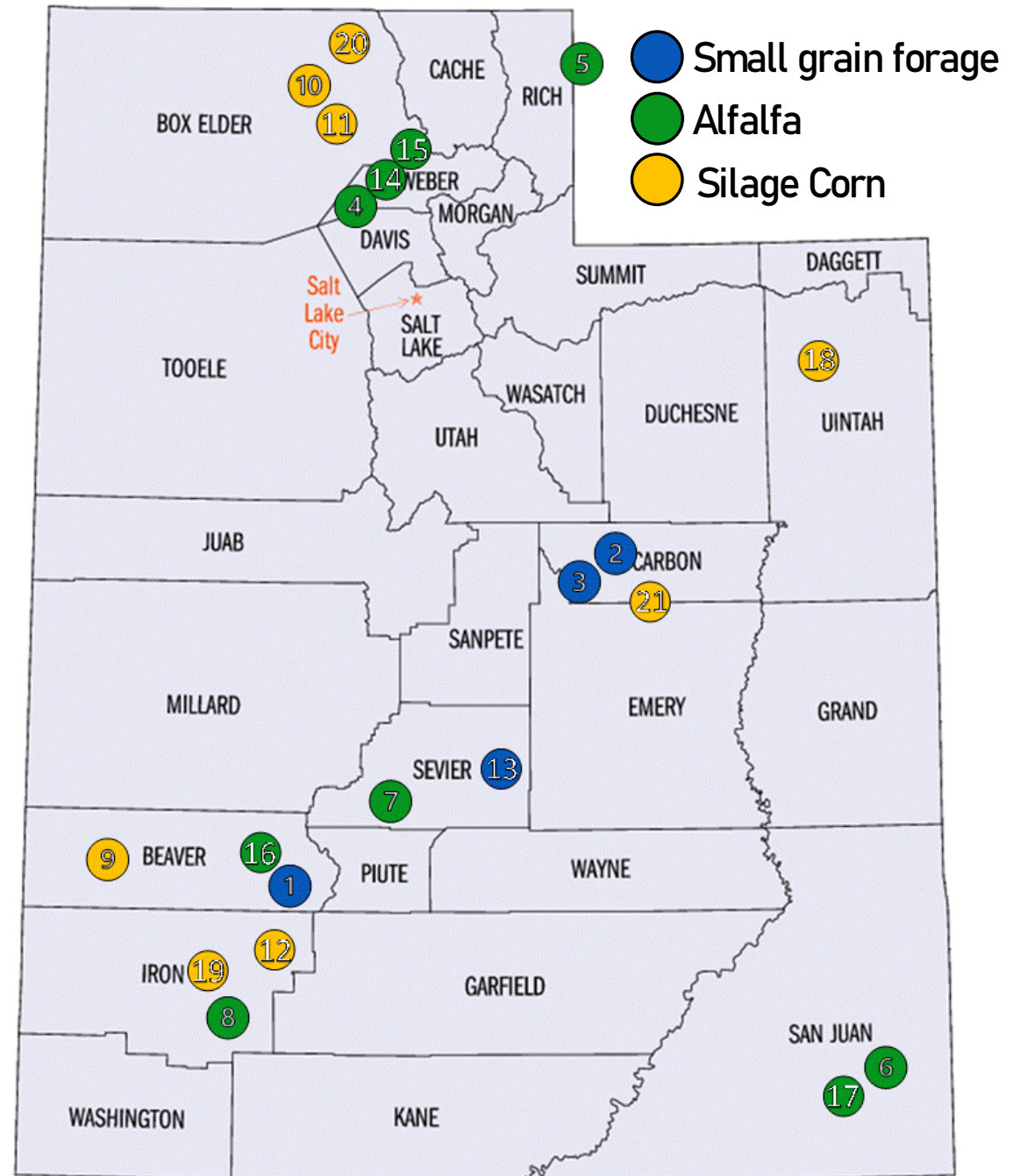
Keep nutrients where crops can use them.

Fertilizer Recommendation Sources

- Fertilizer Dealers
- Crop Advisors
- Soil Testing
Laboratories
- University Extension
Services

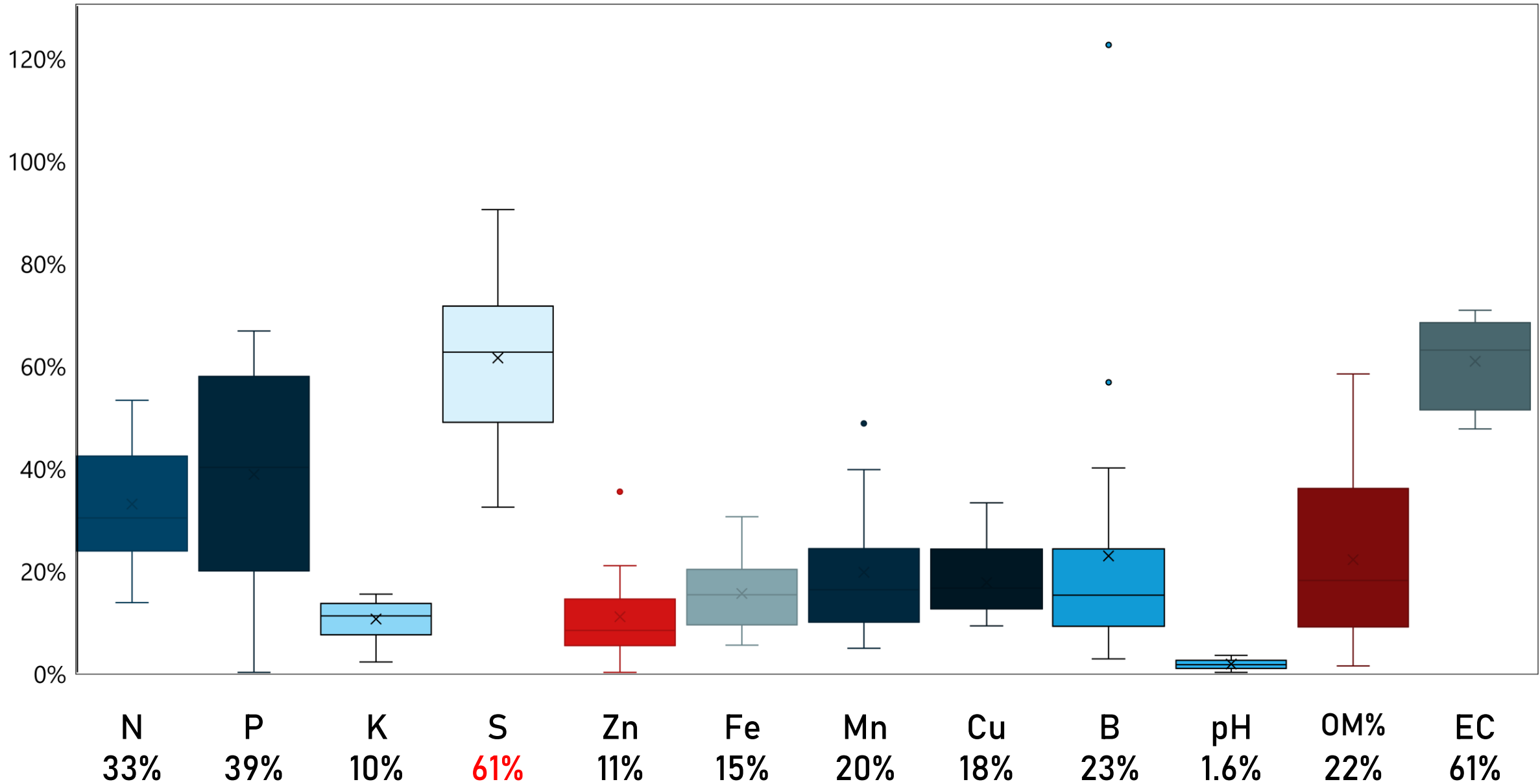


21 Locations
where soil
samples
were
collected
and sent to
various soil
testing
laboratories

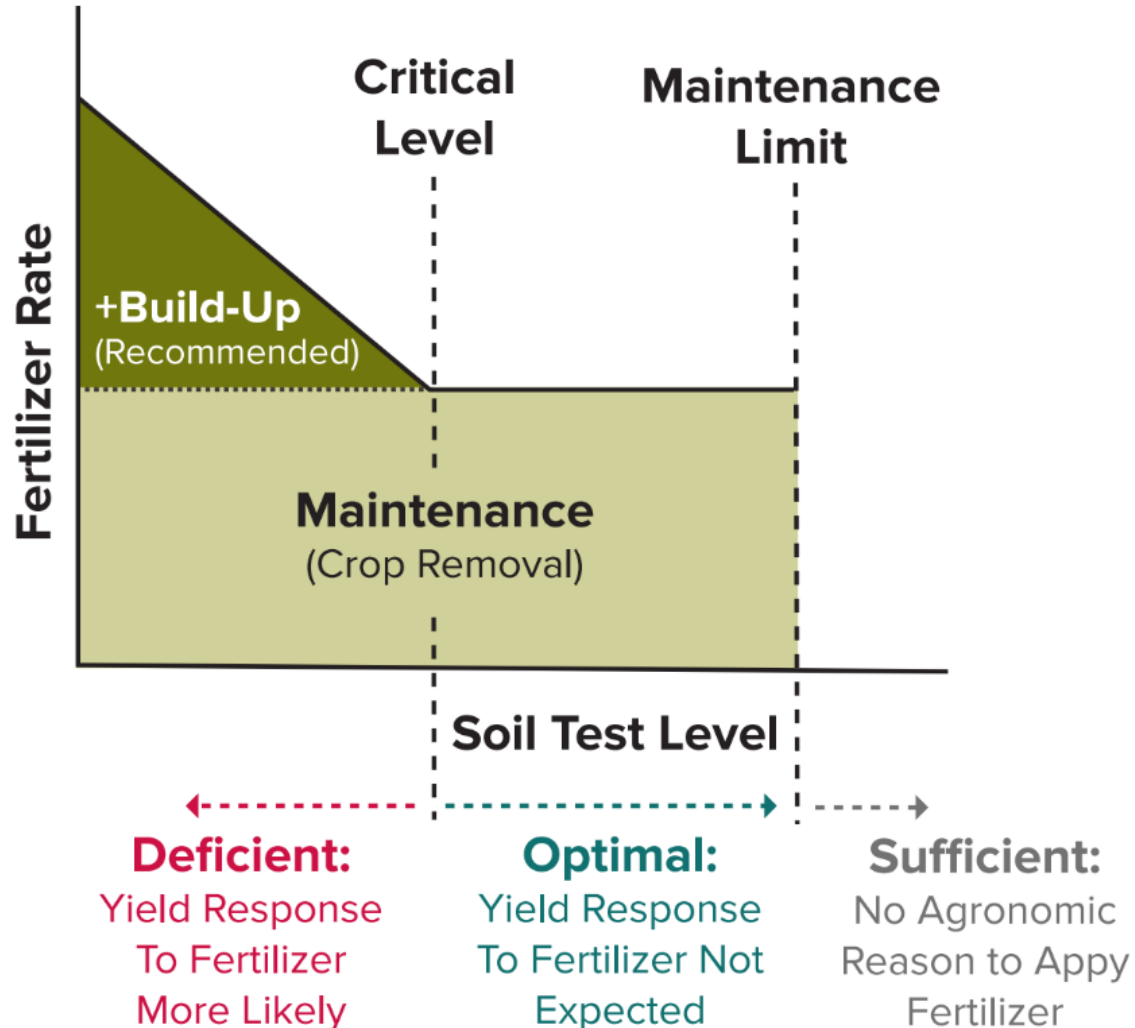


CV of Soil Test Nutrient Concentrations

Percent Variation in Soil Test Values Among Labs

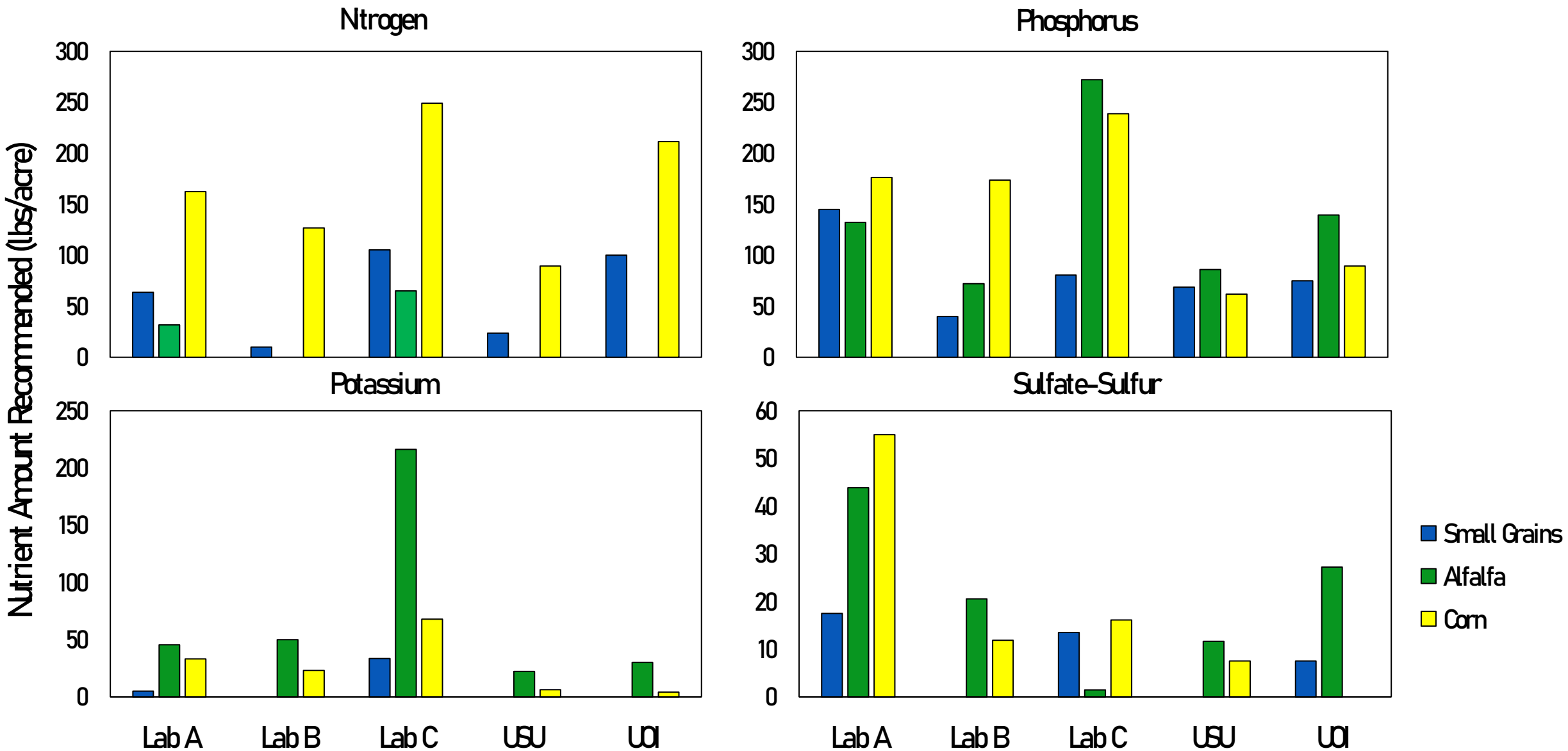


Fertilizer Recommendation Philosophies



- **Sufficiency-** Ensure plant has nutrients needed to grow for that season, with fertilizer supplementing.
- **Maintenance-** Replaces nutrients in soil taken up by crop.
- **Build-Up-** Builds concentration of nutrients within soil to the point that they will not be limiting.

Variation in Recommended Fertilizer Rates



Fertilizer Recommendation Costs

| Difference between Highest and Lowest Treatment Costs (\$/acre) | | | | |
|---|--------|------------|-------------|-------------|
| Crop | Farm # | 2021 | 2022 | 2023 |
| Small Grains | 1 | 392 | 279 | |
| | 2 | 236 | 605 | |
| | 3 | 214 | 700 | 766 |
| | 13 | 438 | | |
| Alfalfa | 4 | 819 | 1196 | 1051 |
| | 5 | 244 | | |
| | 6 | 460 | 852 | |
| | 7 | 675 | 859 | 843 |
| | 8 | 554 | 1110 | 985 |
| | 14 | 770 | | |
| | 15 | 325 | | |
| | 16 | 252 | | |
| Corn | 17 | 393 | | |
| | 9 | 412 | 351 | |
| | 10 | 622 | 1240 | 1279 |
| | 11 | 743 | 1613 | 999 |
| | 12 | 477 | 505 | |
| | 18 | 506 | | |
| | 19 | 555 | | |
| 20 | 489 | | | |
| | 21 | 349 | | |

Impacts of Cost Differences

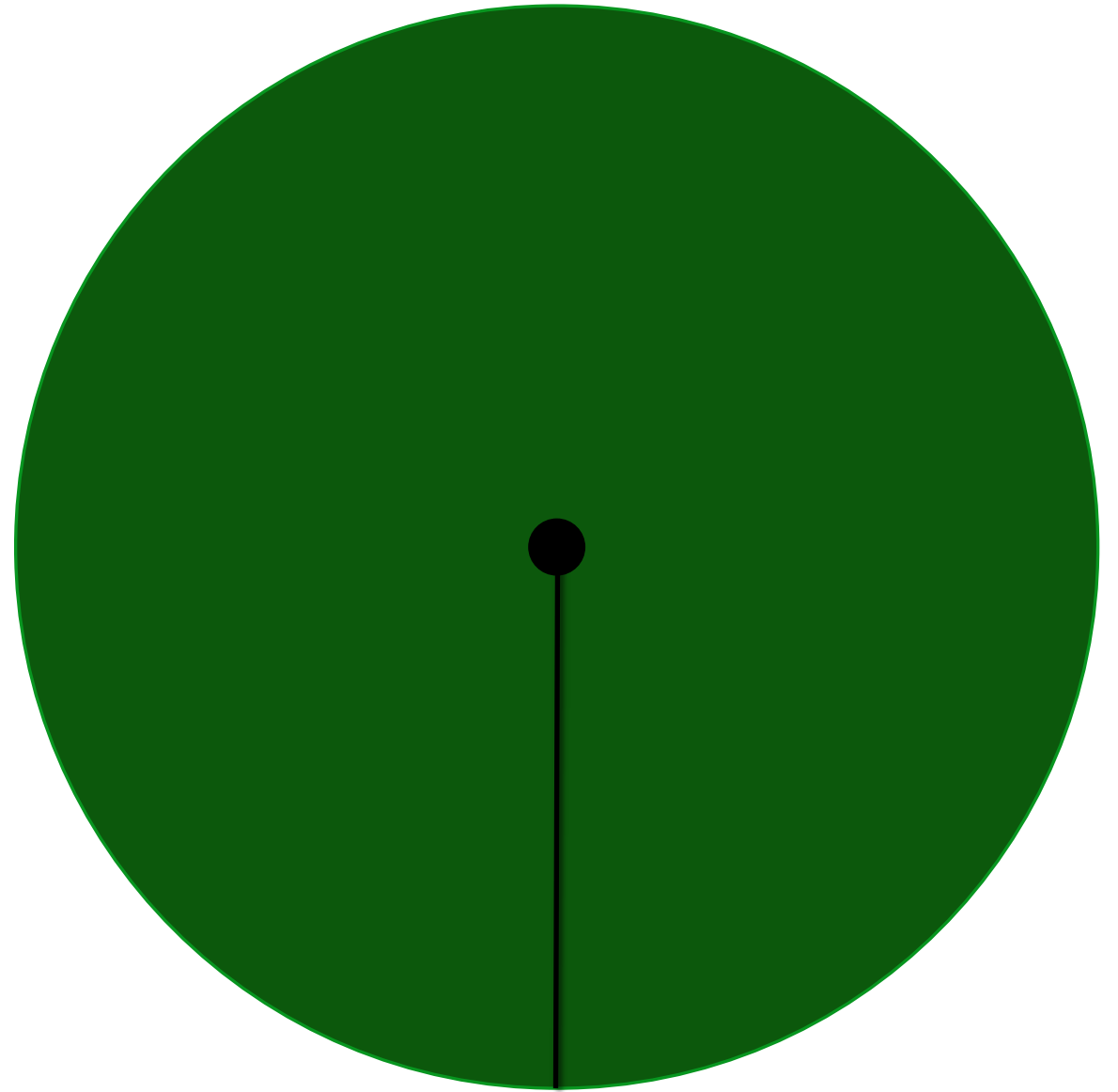
Average center pivot size - 126 acres

Average fertilizer cost difference between highest and lowest treatments

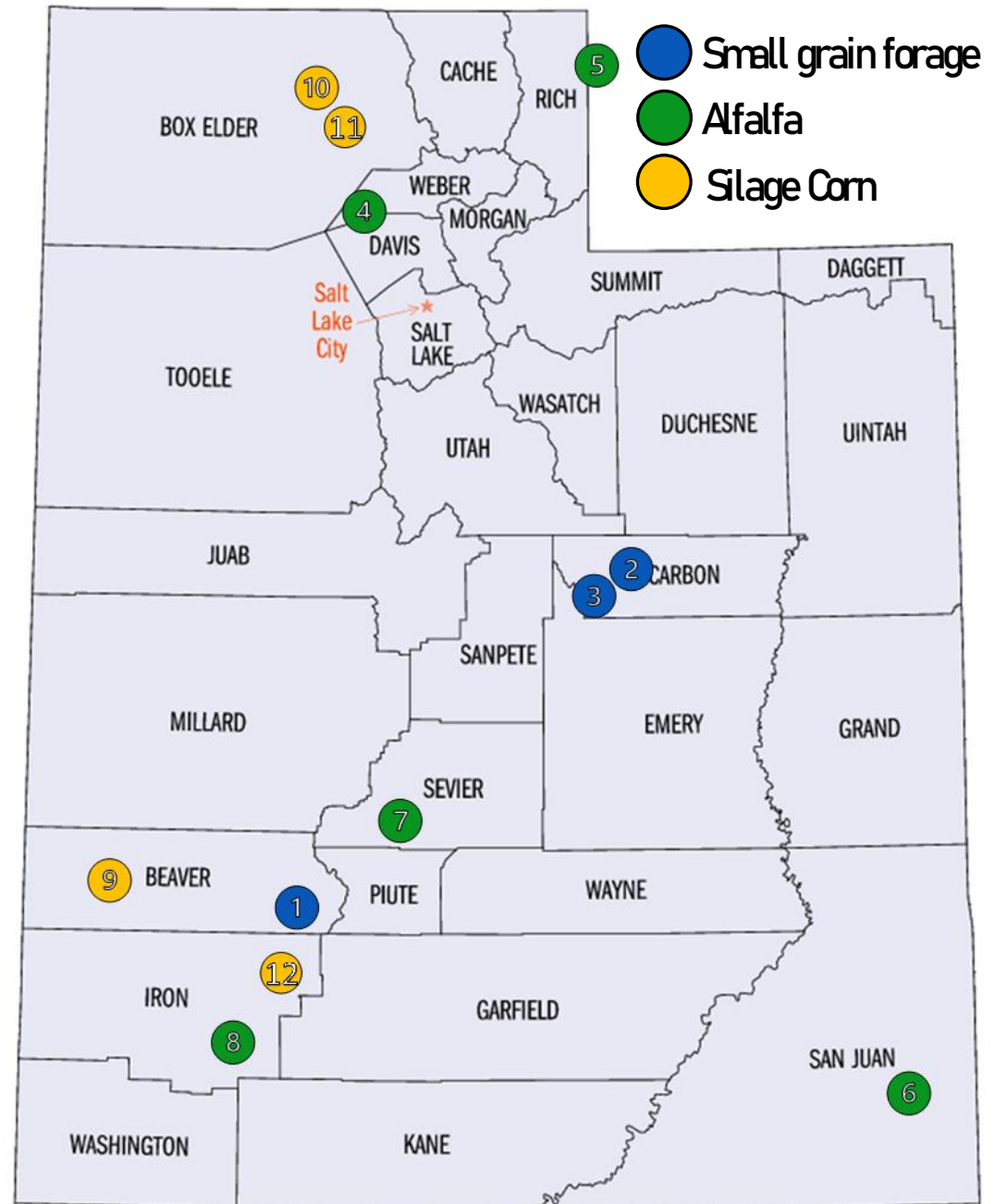
2021: \$59,598

2022: \$106,596

2023: \$124,362



Sites
where
yield and
forage
quality
data were
collected

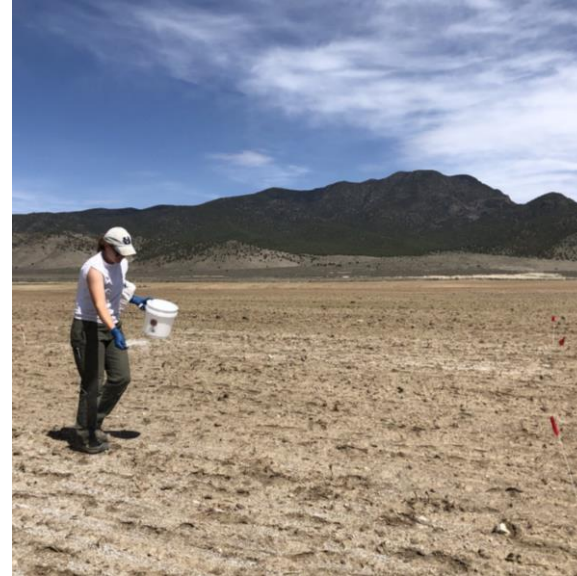


Methods

Fertilizer broadcast applied by hand in the spring

Plot dimensions varied by crop and site (50-185 ft²)

Treatments re-sampled each spring and sent to their respective labs to be analyzed



Fertilizers Used

| Nutrient | Source | Analysis |
|----------------|------------------------|----------|
| N | Ammonium Nitrate | 34% |
| P | Triple Super Phosphate | 45% |
| K | Potash | 60% |
| Sulfate-sulfur | 2021 Gypsum | 64% |
| S | Elemental Sulfur | 90% |
| Zn | Zinc Sulfate | 36% |
| Mn | Manganese | 8% |
| B | Boron | 14% |
| Cu | Copper Sulfate | 25% |
| Sulfate-sulfur | 22-23 Gypsum | 97% |

Liquid Micronutrients 2022-2023

| | | |
|----|---------------|-----|
| Zn | Chelated Zinc | 9% |
| Mn | Manganese | 5% |
| B | Boron | 10% |
| Cu | Copper | 8% |

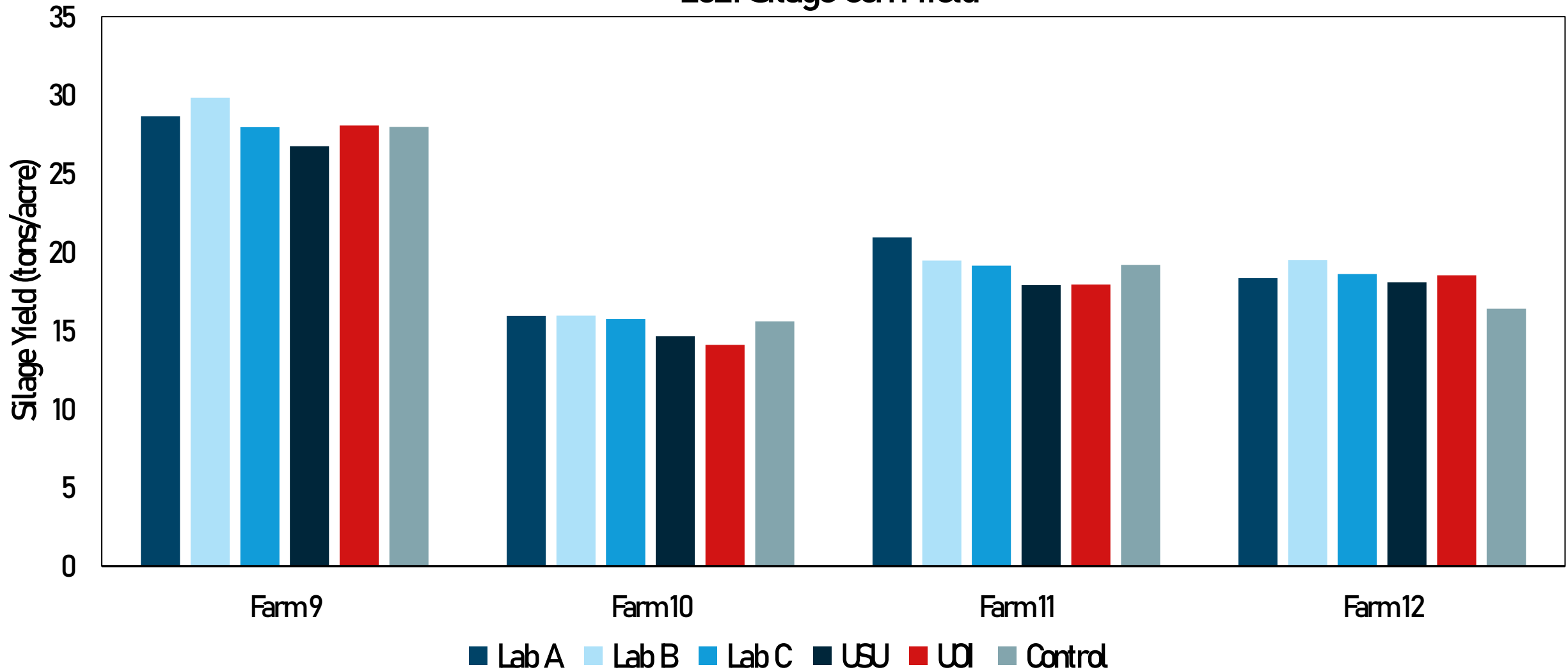




Harvests

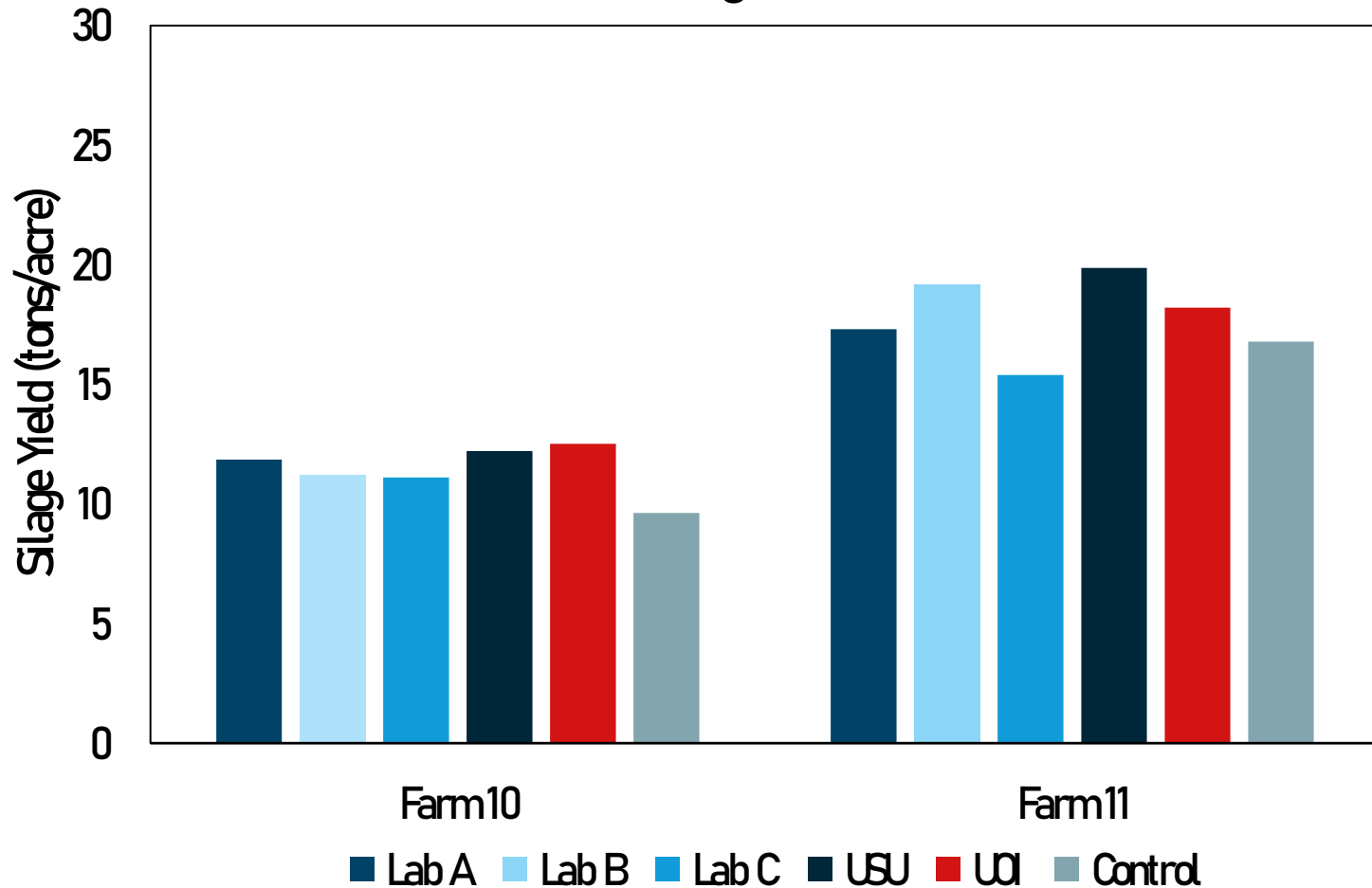
Silage Corn

2021 Silage Corn Yield



Silage Corn

2022 Silage Corn Yield

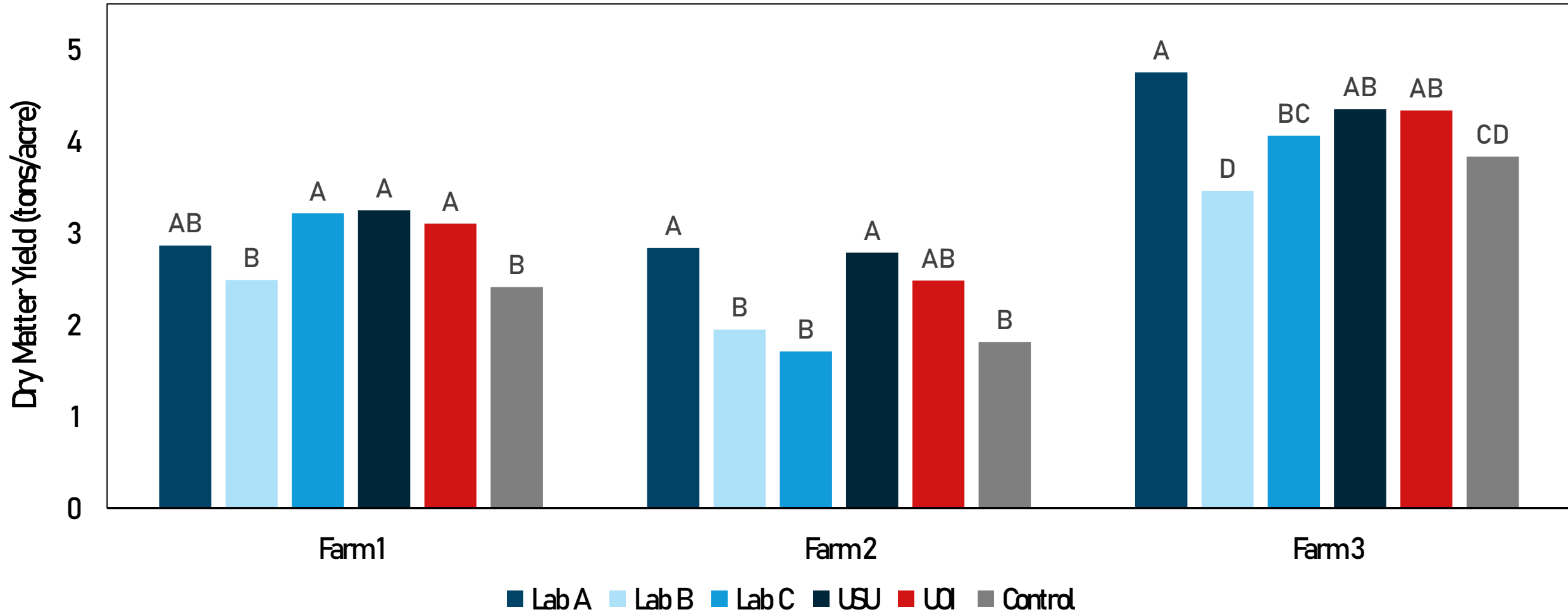


Quality Factors being Examined:

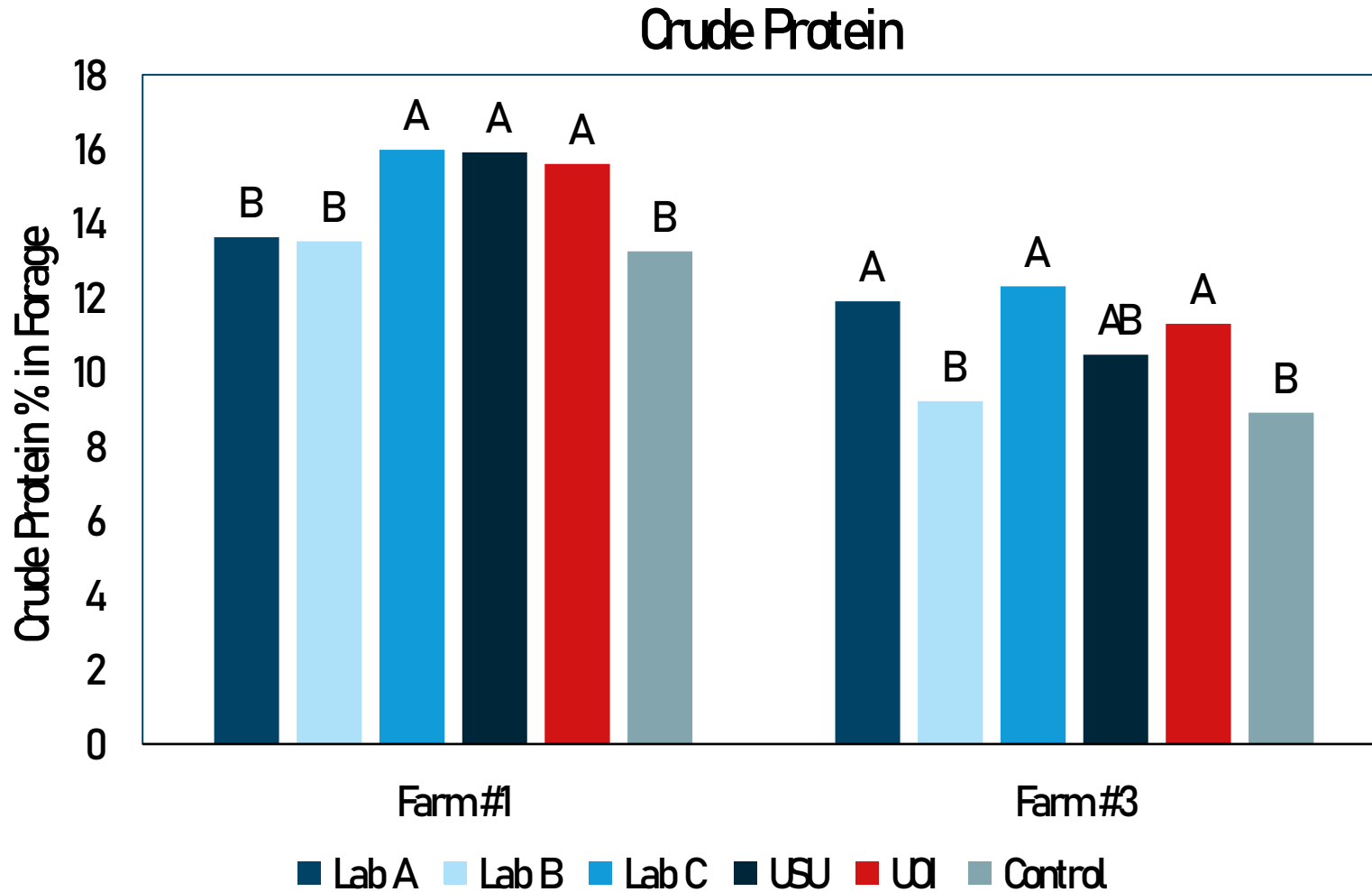
- Crude Protein (CP)
- Acid Detergent Fiber (ADF)
- Neutral Detergent Fiber (NDF)
- Total Digestible Nutrients (TDN)
- Starch

Small Grains

Small Grain Forage Yield Across Years



Small Grains – Farm 3

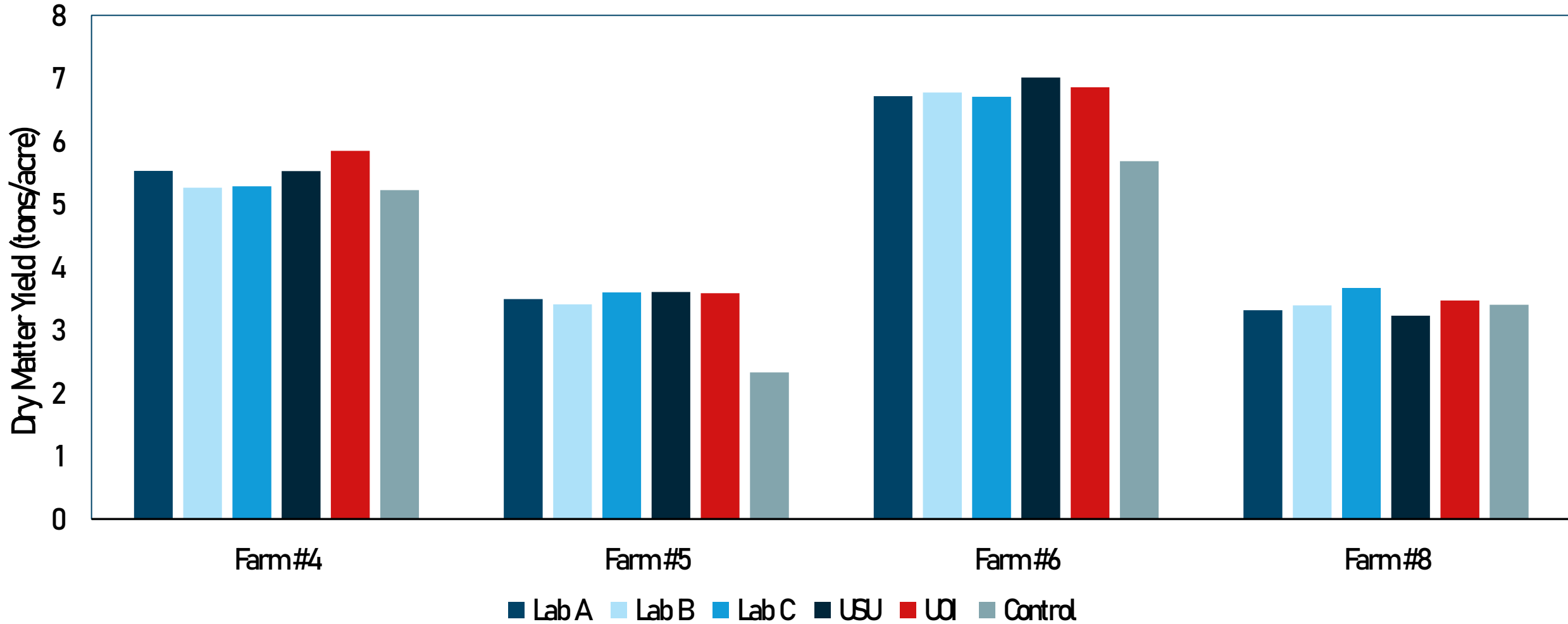


Quality Factors being Examined:

- CP
- ADF
- NDF
- TDN
- Relative Feed Value (RFV)
- Relative Forage Quality (RFQ)

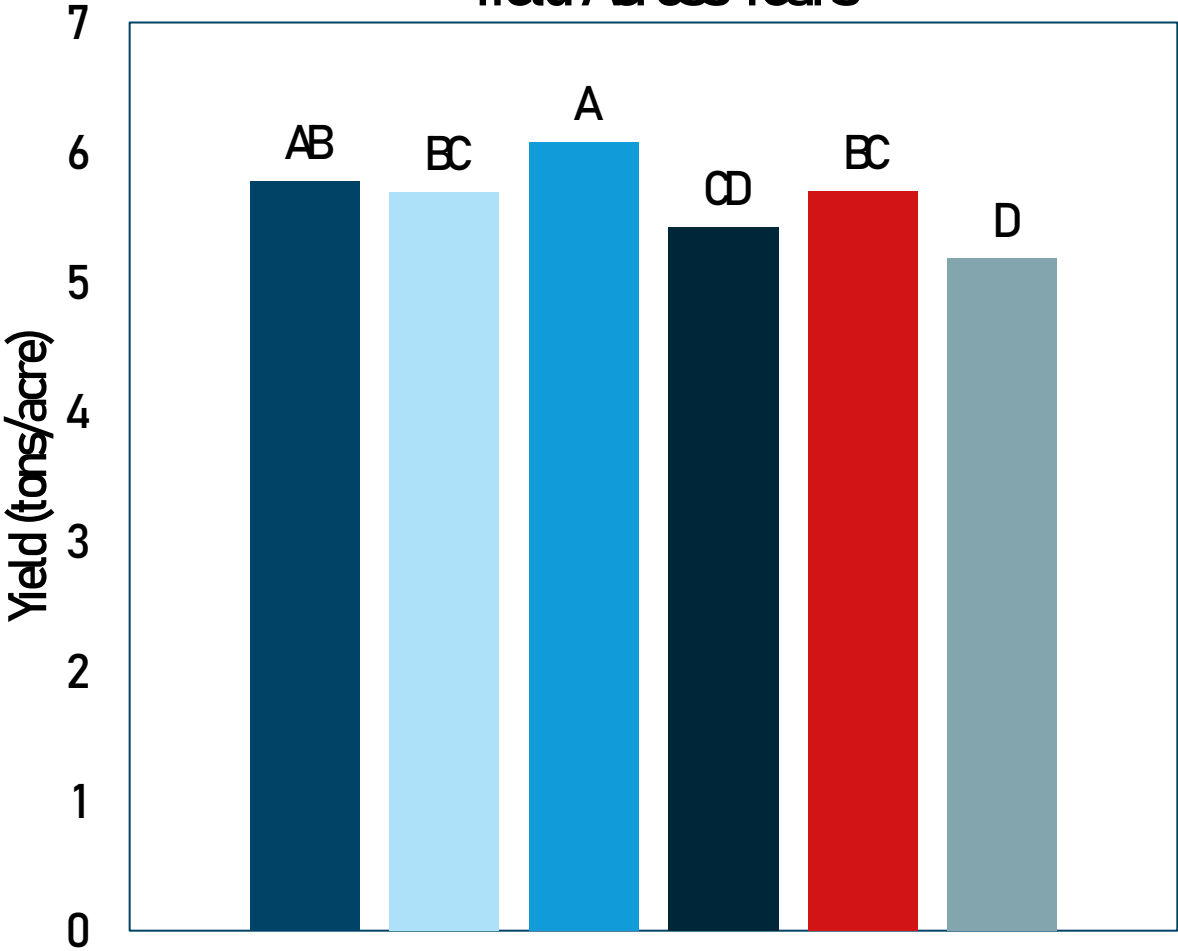
Alfalfa

Alfalfa Yield Across Years

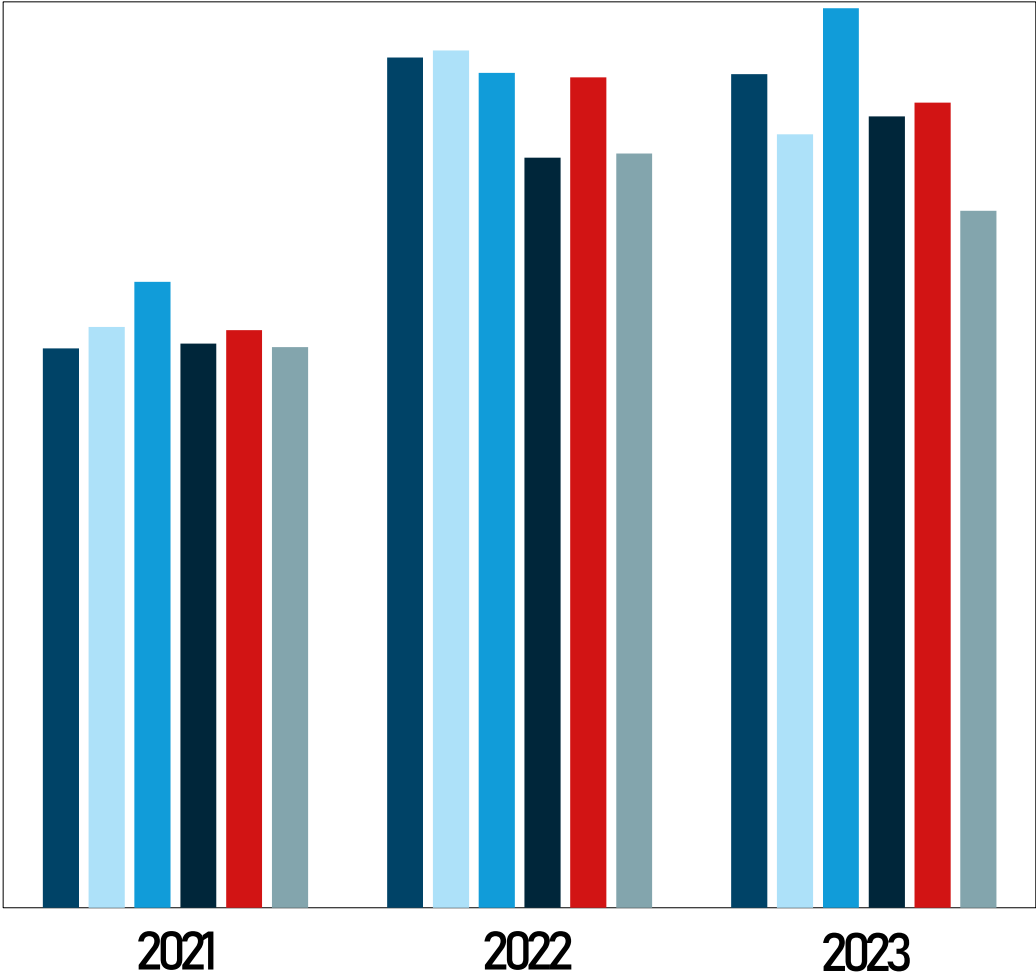


Alfalfa – Farm 7

Yield Across Years



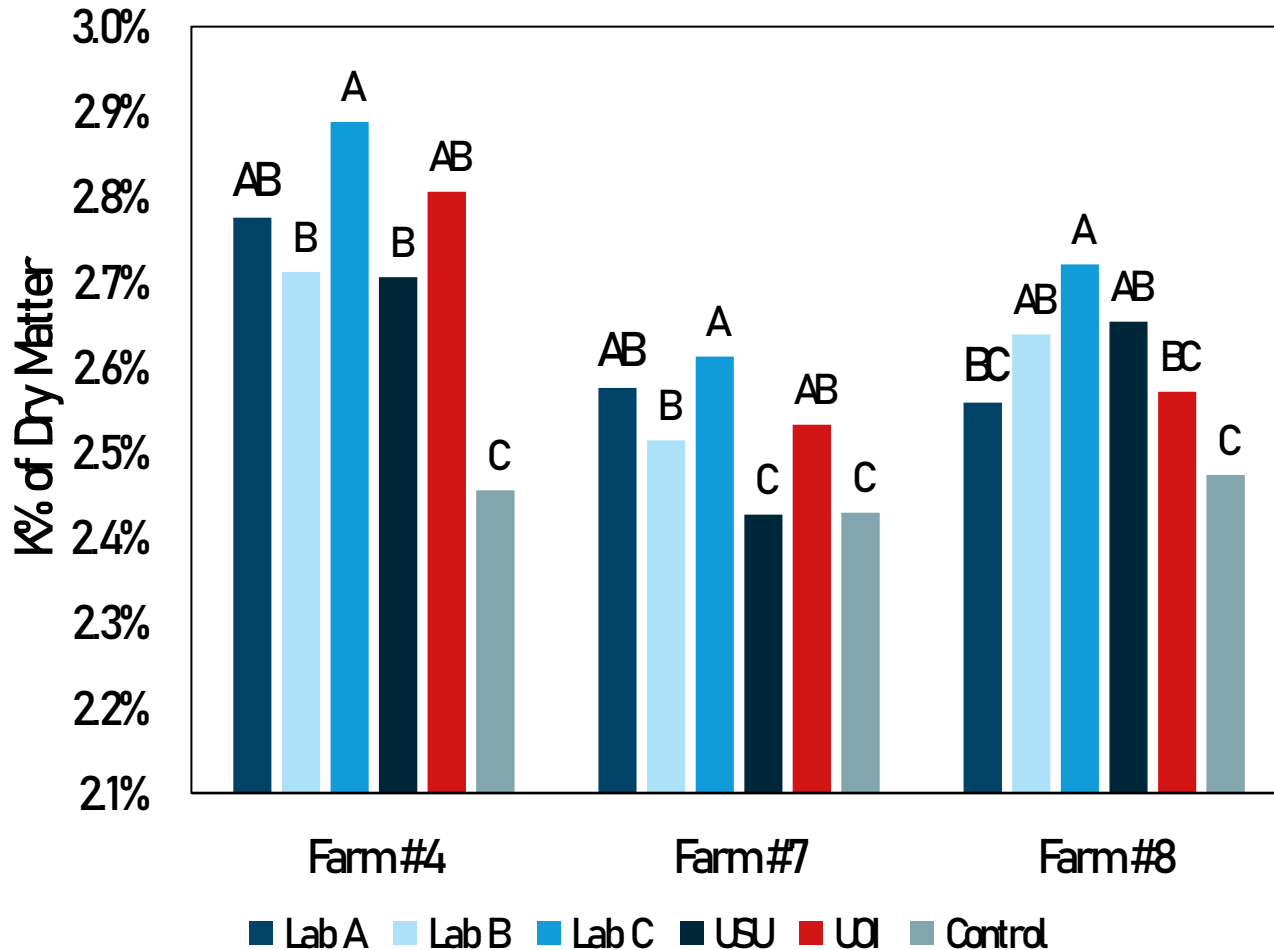
Yield Each Year



- Lab A
- Lab B
- Lab C
- USU
- UOI
- Control

Alfalfa – Forage Quality

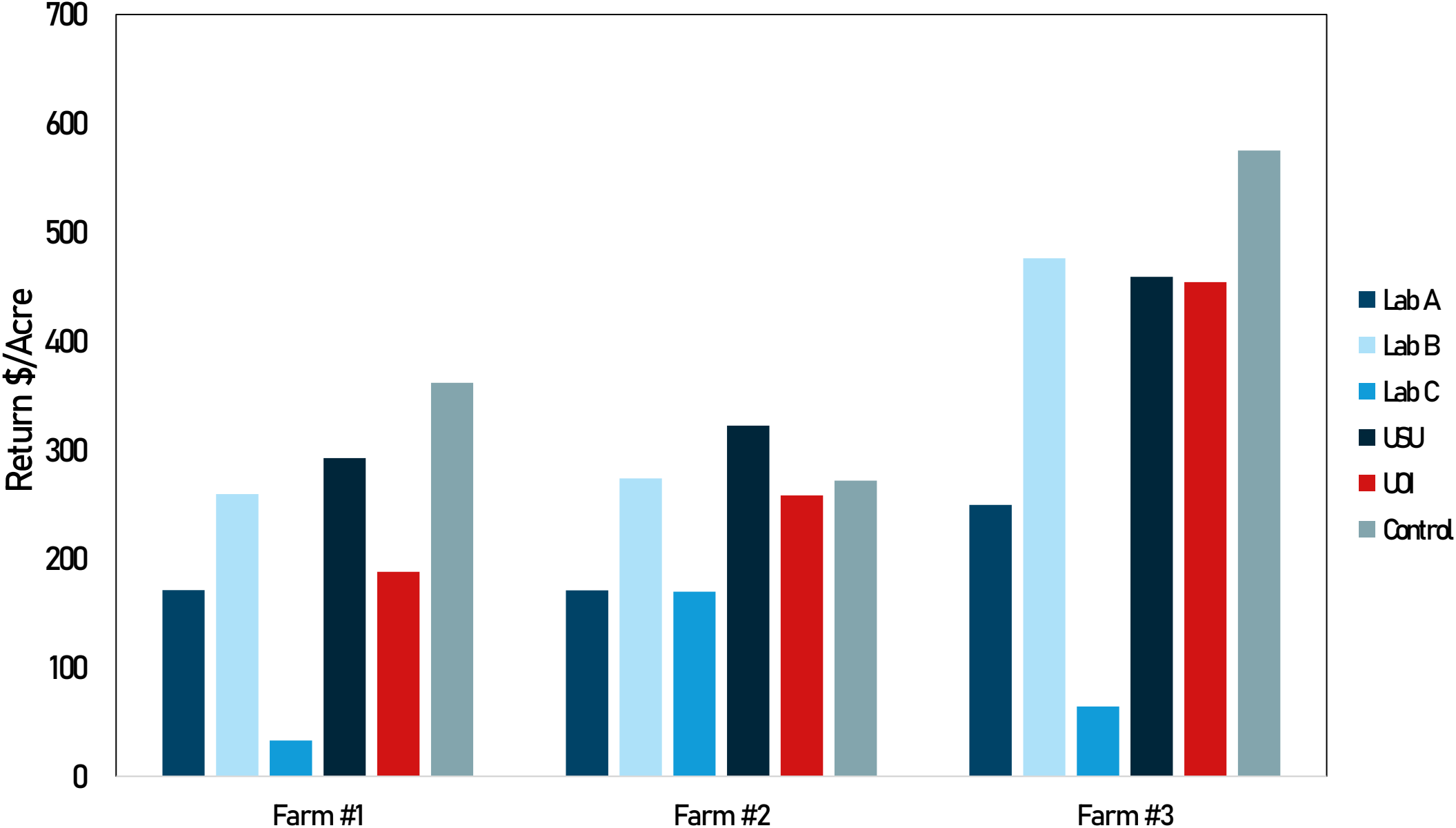
Alfalfa Potassium Content



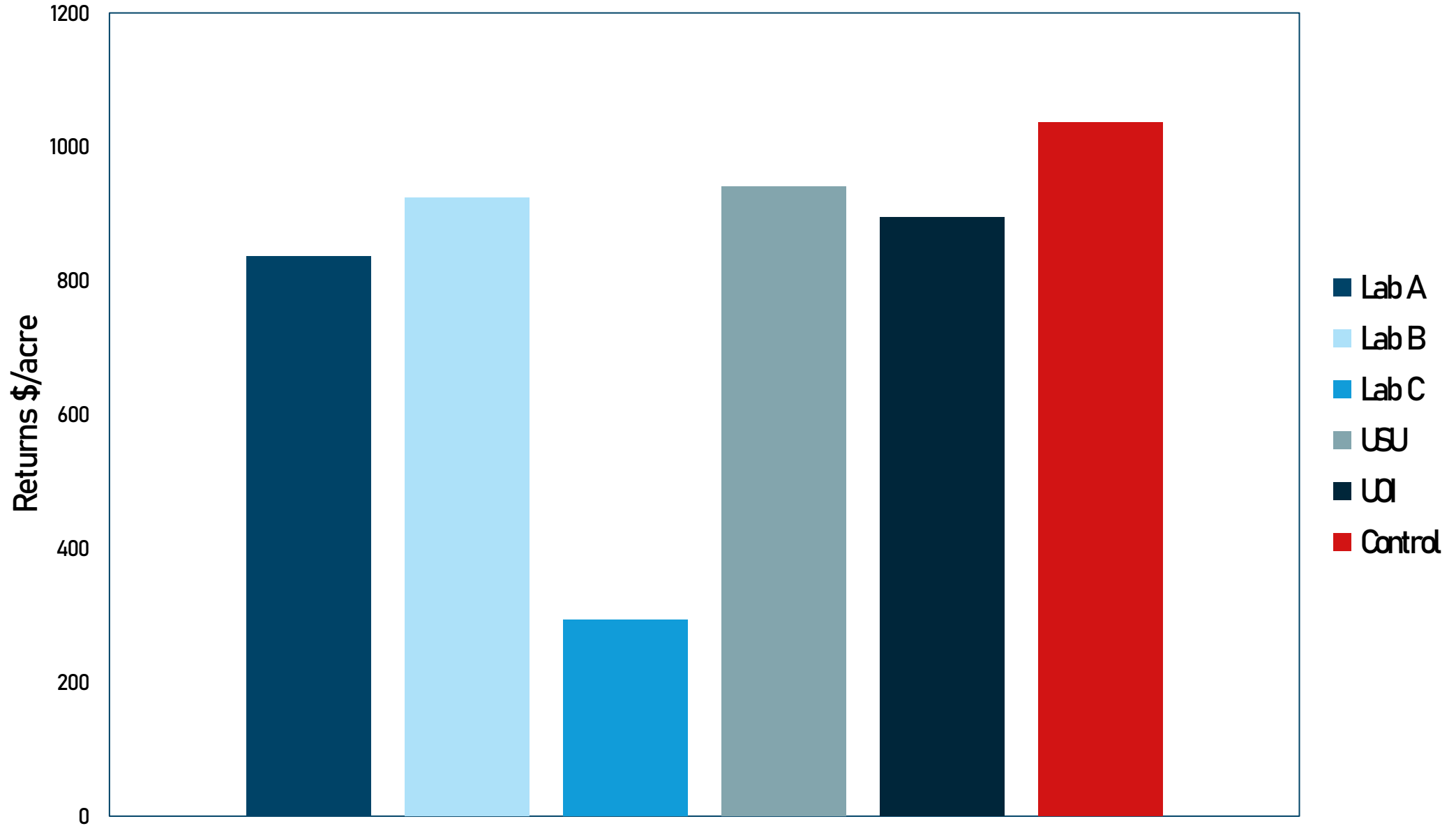
Quality Factors being Examined:

- CP
- ADF
- NDF
- TDN
- RFV
- RFQ
- Phosphorus % (P)
- Potassium % (K)
- In vitro dry matter digestibility 48hr (INVDMD48)
- Neutral detergent fiber digestibility 48hr (NDFD48)

Economic Returns For Small Grains



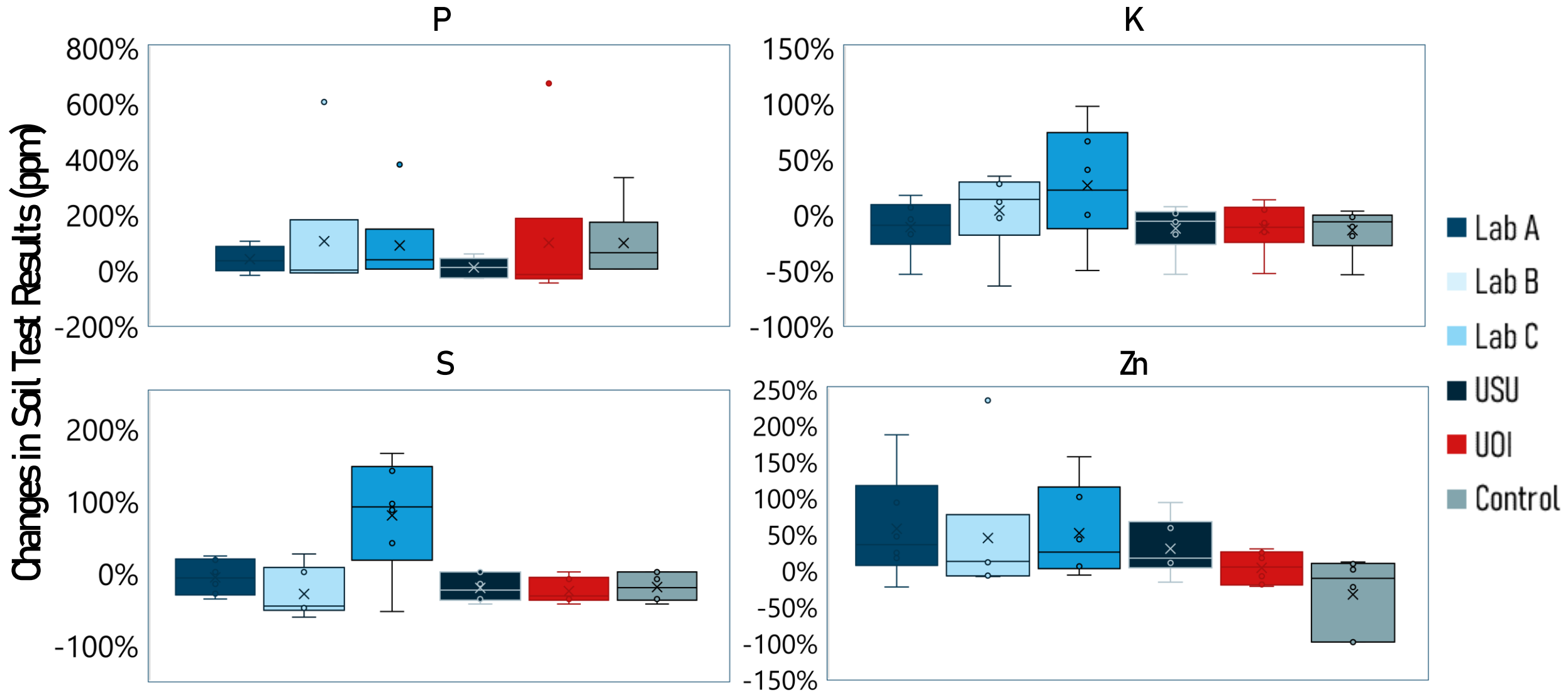
Farm #7 Economic Returns





Changes in Soil Test Results

Changes in Soil Test Results 2021-2023 for Six Sites



Soil Test Change Classifications

| | |
|---|---|
| <p data-bbox="715 219 970 287">Category 1</p> <p data-bbox="537 448 1156 572">STV Δ: Increase Fertilizer Recommended: Yes</p> | <p data-bbox="1574 219 1844 287">Category 2</p> <p data-bbox="1409 434 2010 558">STV Δ: Not Applicable Fertilizer Recommended: No</p> |
| <p data-bbox="715 742 986 809">Category 3</p> <p data-bbox="537 956 1156 1080">STV Δ: No Change Fertilizer Recommended: Yes</p> | <p data-bbox="1574 742 1844 809">Category 4</p> <p data-bbox="1409 956 2023 1080">STV Δ: Decrease Fertilizer Recommended: Yes</p> |

Farms where
fertilizer increased
soil nutrient
concentrations

Phosphorus

33–82%

Potassium

9–67%

Sulfate–Sulfur

0–55%

Zinc

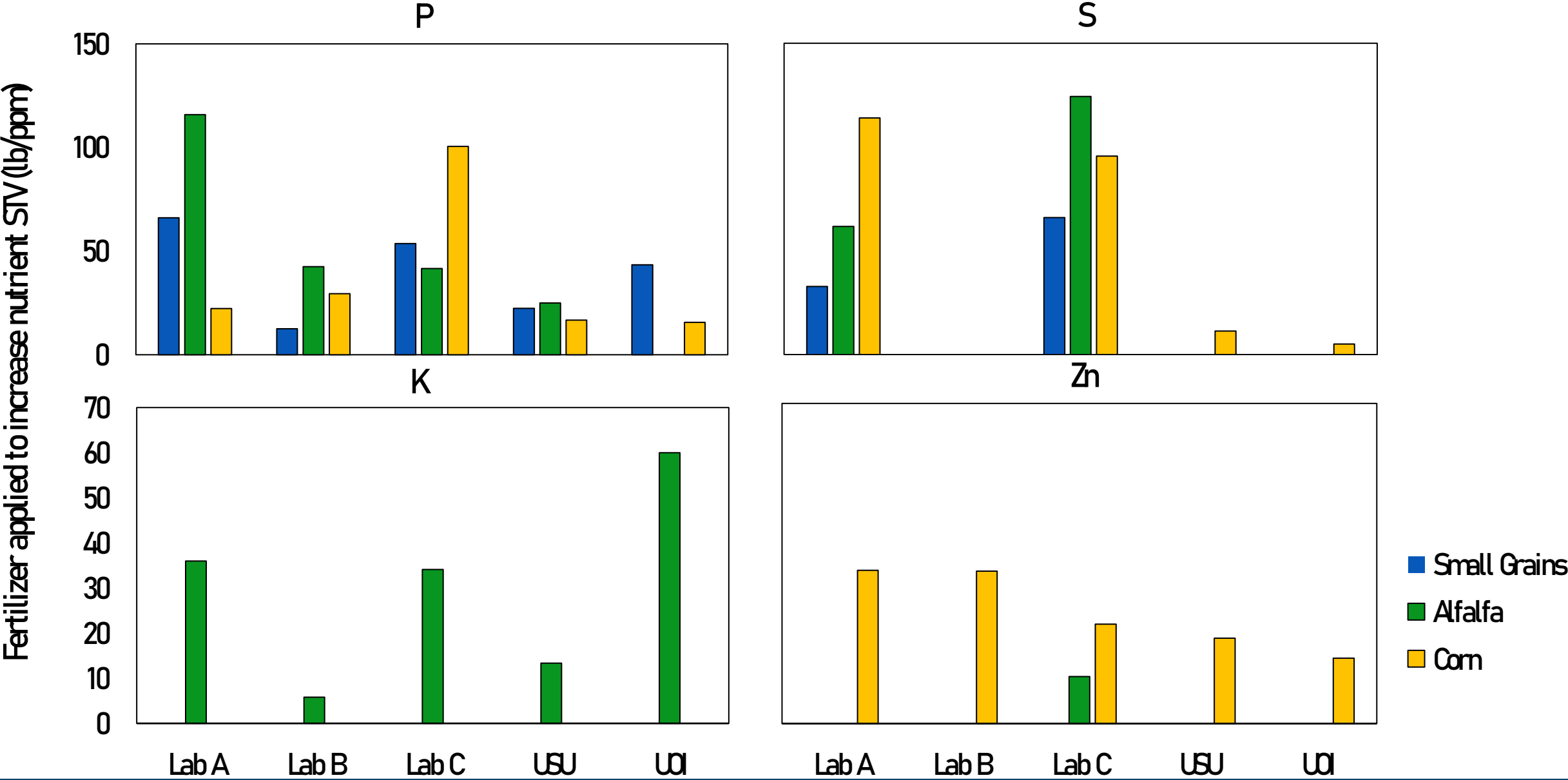
9–83%

| | | Soil Test Change Categories | | | | | | | |
|----------|-----------|-----------------------------|-----|-----|-----|-------------------------|-----|-----|-----|
| Nutrient | Treatment | After 1 Year (11 sites) | | | | After 2 Years (6 sites) | | | |
| | | 1 | 2 | 3 | 4 | 1 | 2 | 3 | 4 |
| P | Lab A | 82% | 0% | 9% | 9% | 67% | 0% | 0% | 33% |
| | Lab B | 73% | 9% | 9% | 9% | 67% | 0% | 33% | 0% |
| | Lab C | 55% | 18% | 9% | 18% | 67% | 0% | 0% | 33% |
| | USU | 55% | 0% | 18% | 27% | 33% | 0% | 17% | 50% |
| | UOI | 55% | 0% | 18% | 27% | 83% | 0% | 0% | 17% |
| K | Lab A | 9% | 55% | 0% | 36% | 17% | 33% | 0% | 50% |
| | Lab B | 9% | 64% | 0% | 27% | 50% | 33% | 0% | 17% |
| | Lab C | 18% | 45% | 0% | 36% | 67% | 0% | 0% | 33% |
| | USU | 9% | 82% | 0% | 9% | 17% | 50% | 0% | 33% |
| | UOI | 9% | 73% | 0% | 18% | 17% | 50% | 0% | 33% |
| S | Lab A | 55% | 0% | 9% | 36% | 33% | 0% | 17% | 50% |
| | Lab B | 0% | 36% | 9% | 55% | 17% | 0% | 17% | 67% |
| | Lab C | 36% | 64% | 0% | 0% | 33% | 33% | 0% | 17% |
| | USU | 18% | 45% | 27% | 9% | 0% | 33% | 17% | 50% |
| | UOI | 9% | 55% | 18% | 18% | 0% | 33% | 17% | 50% |
| Zn | Lab A | 27% | 45% | 0% | 27% | 67% | 33% | 0% | 0% |
| | Lab B | 18% | 64% | 0% | 18% | 50% | 50% | 0% | 0% |
| | Lab C | 55% | 36% | 0% | 9% | 83% | 0% | 0% | 17% |
| | USU | 27% | 64% | 0% | 9% | 33% | 67% | 0% | 0% |
| | UOI | 9% | 82% | 0% | 9% | 17% | 83% | 0% | 0% |

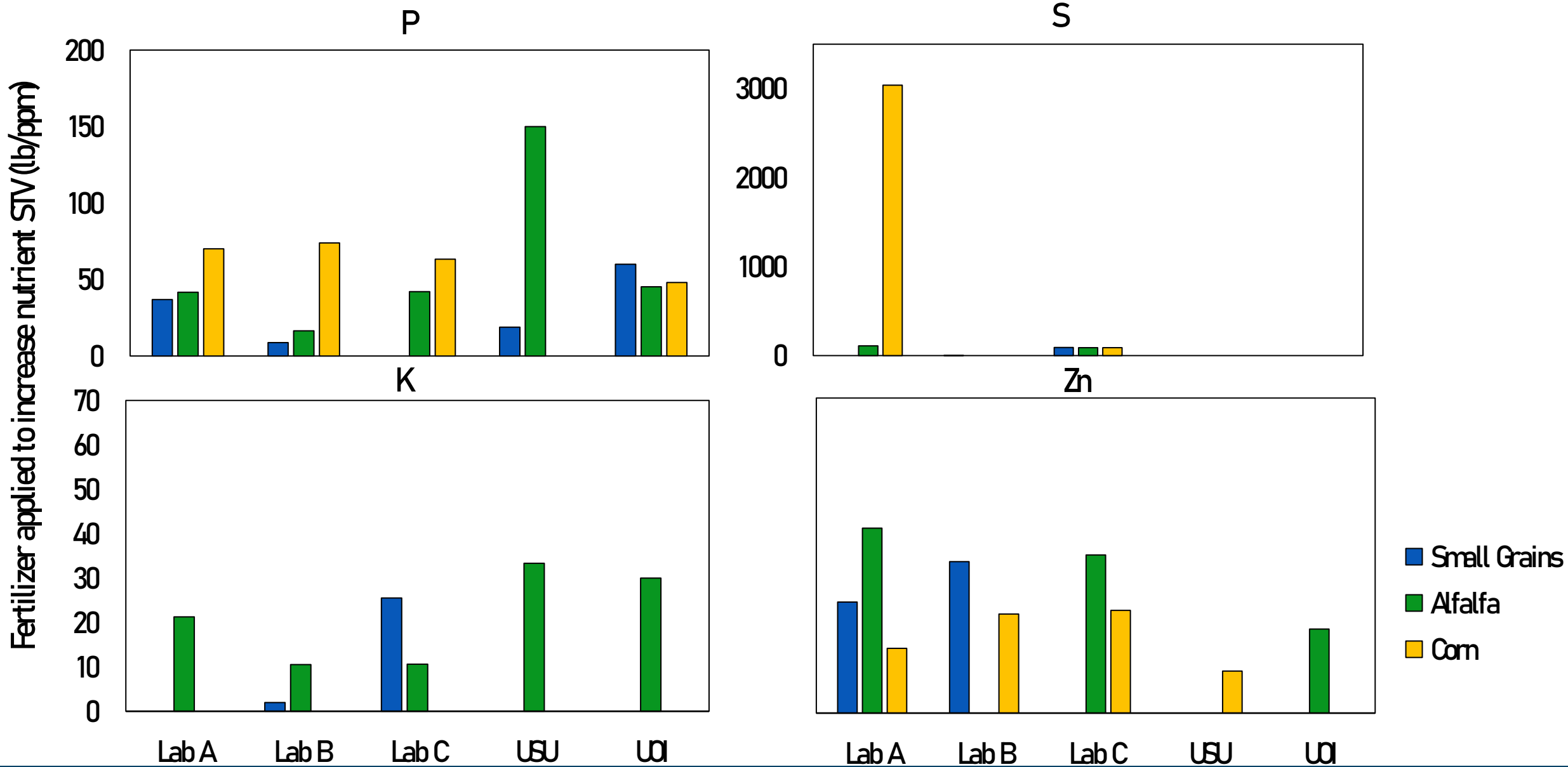
Fertilizer Required to Soil Nutrient Concentration

$$\frac{\text{Fertilizer Rate Applied}}{\Delta \text{Soil Nutrient Concentration}} = \text{Fertilizer Needed to Increase Nutrient Level (lb/ppm)}$$

Fertilizer Required to Increase Soil Nutrient Concentration 2021-2022



Fertilizer Required to Increase Soil Nutrient Concentration 2021-2023





Conclusions

- Reported soil test results and resulting fertilizer recommendations can vary greatly depending on the soil testing laboratory or recommendation source being used
- These differences in fertilizer recommendations can result in drastically different costs, but rarely had an impact on crop yields or forage quality
- These results do not indicate fertilizers are unnecessary, but that recommendations vary depending on the source and that there is room for improvement
- Differing analysis methods can impact soil test results for some nutrients, but the largest driver of differences in fertilizer recommendations is the fertilization philosophy being used
- The sufficiency approach is often the most economically feasible, but the build and/or maintain methods can be used to increase soil nutrient concentrations



Questions?