



Combining 4R Nutrient Management and Ecological Intensification to Advance Corn Production

Jeffrey Vetsch and Dr. Jeffrey Coulter,
University of Minnesota

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Research Questions

- What yield levels are possible?
- How far are current yields from these levels?
- Is standard fertilizer management capable of attaining yields at levels close to yield potential?



Agricultural Intensification

- As farmers intensify their ag systems to increase production (yield). They need to balance profitability and environmental effects of management.



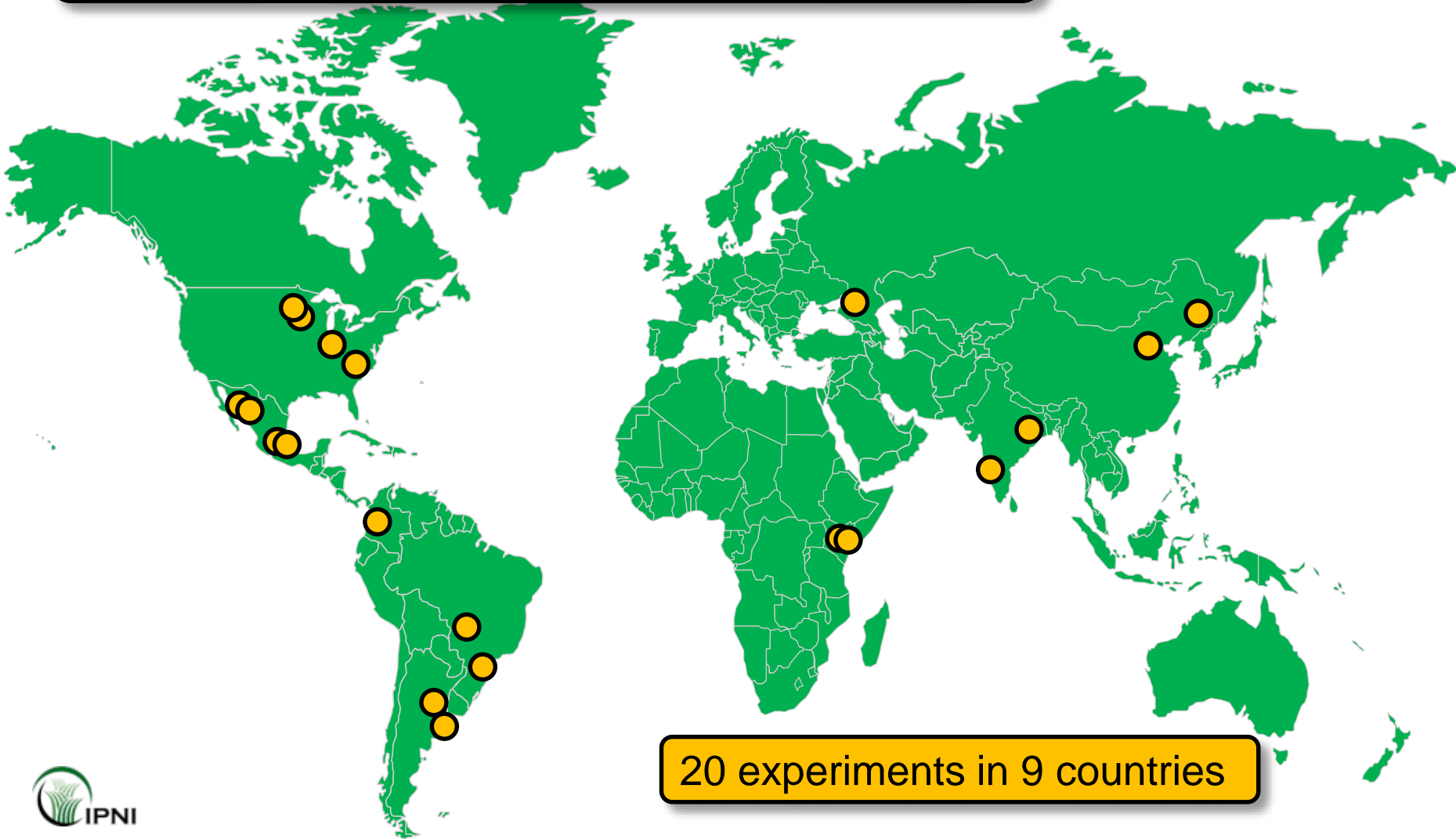
Sustainability Questions

- Does intensifying management to increase yield affect profitability?
- Are there impacts to the soil resource?
- What are the environmental (water or air) effects?

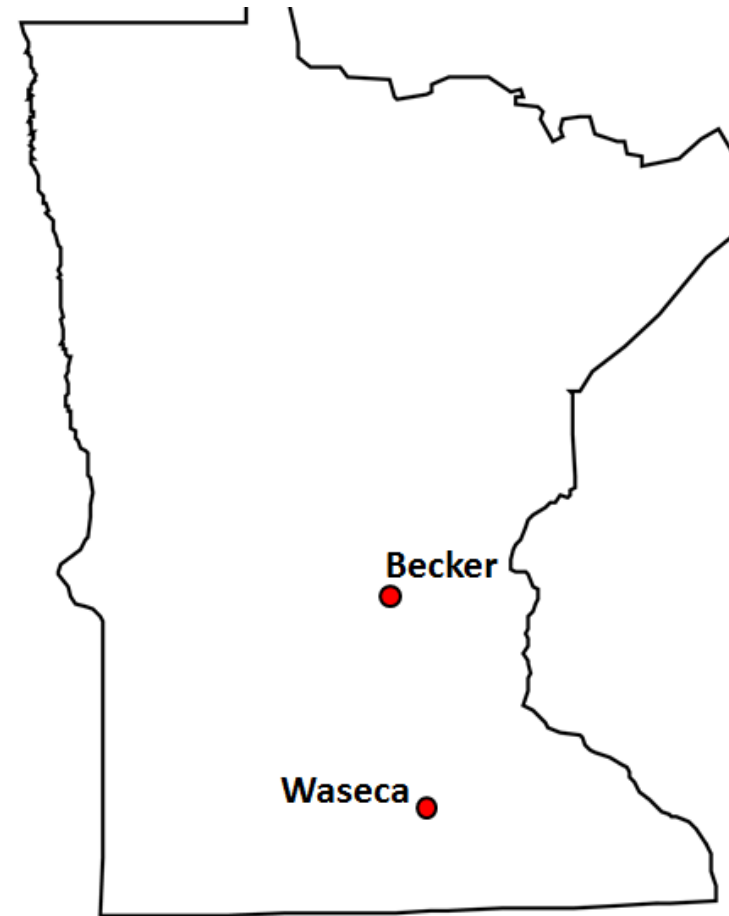


Global network of experiments

Compare normal vs. intensive agronomics with
standard vs. advanced fertilizer management



- **Waseca (2013 – present)**
 - Nicollet clay loam
 - 4.3% SOM, 6.2 pH
 - Patterned tile drainage
 - Continuous corn
 - Same plots every year
- **Becker (2014 – present)**
 - Irrigated
 - Hubbard-Mosford loamy sand
 - 1.6% SOM, 6.6 pH
 - Continuous corn
 - New site in 2018



■ Continuous corn

- Requires top management for high yields
- Greater risk of nutrient losses

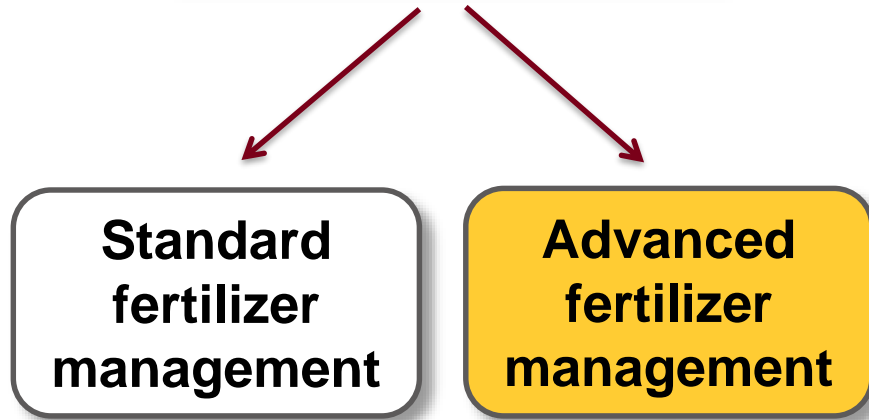
■ Irrigated sands

- High yield potential
- Greater risk of crop nutrient deficiency
- Greater risk of nutrient losses



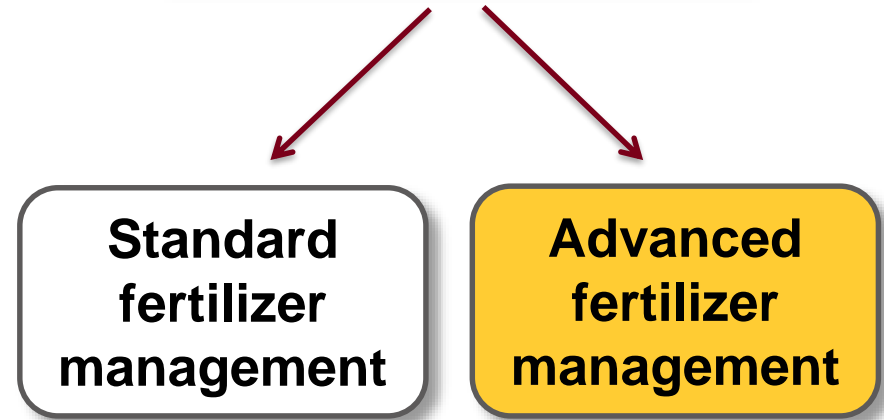
Typical farmer practice

Normal agronomics



Ecological intensification

Intensive agronomics



- **Standard fertilizer management was Univ. of Minnesota guidelines for N, P, K and S.**
- **‘Systems’ treatments developed & updated:**
 - AFREC, crop advisors, industry agronomists, farmers

Agronomic treatments – Waseca

| | Normal | Intensive |
|----------------------------|--------|-----------|
| Corn stover harvested (%) | 0 | 40 |
| Hybrid maturity (CRM) | 101 | 105 |
| Planting rate (seeds/acre) | 36,000 | 41,000 |
| Fungicide at tasseling | No | Yes |



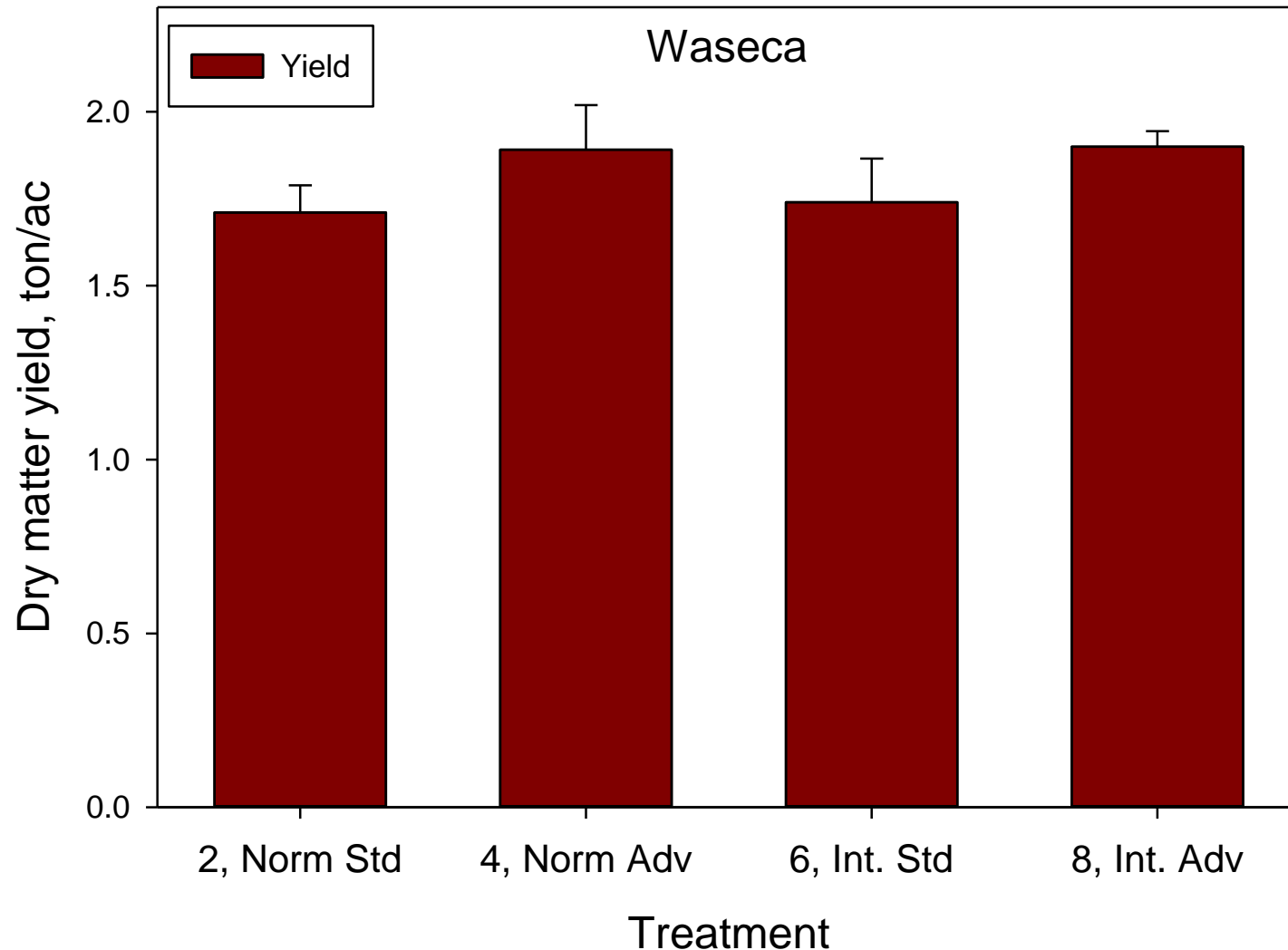
Fertilizer treatments – Waseca

| | Standard | Advanced |
|-------------------------------------|---------------------------|---|
| S | 20 lb SO ₄ /ac | 20 lb SO ₄ /ac |
| P | U of M guidelines | 50% grain removal |
| K | U of M guidelines | 100% grain removal |
| 10-34-0 in furrow | 4 gal/ac | 4 gal/ac |
| Surface-banded starter (2" x 0") | --- | 7 gal/ac 28-0-0 + 2 gal/ac 12-0-0-26 |
| Pre-plant N (urea) | 175 lb N/ac | 111 lb N/ac |
| V6 N (28-0-0, injected) | --- | 40 lb N/ac |
| V14 N (28-0-0, Y-DROPS) | --- | 40 lb N/ac |
| Total N | 180 lb N/ac | 220 lb N/ac |

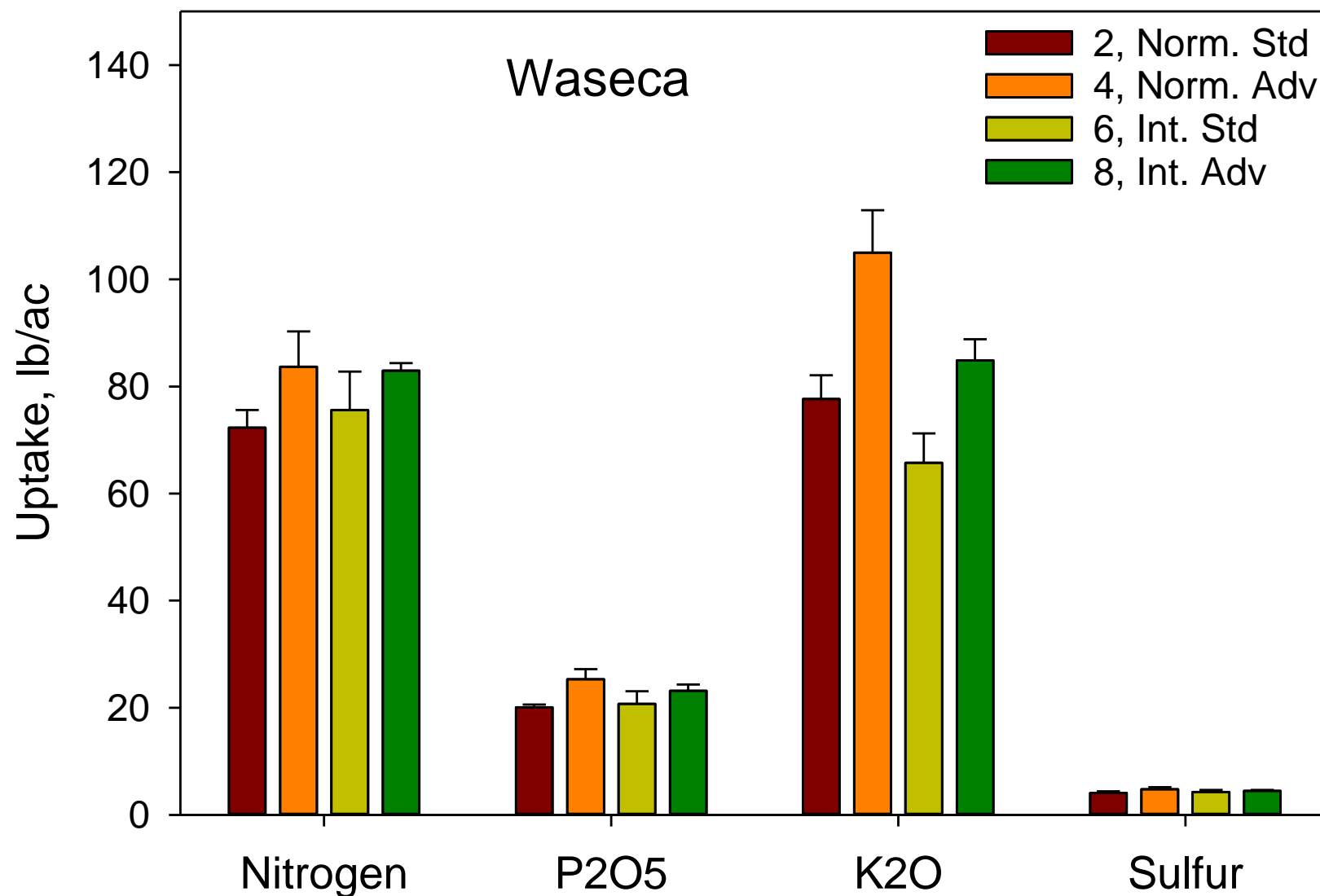
Fertilizer treatment changes 2018 – Waseca

| | Standard | Advanced |
|-------------------------------------|---------------------------|---|
| S | 20 lb SO ₄ /ac | 20 lb SO ₄ /ac |
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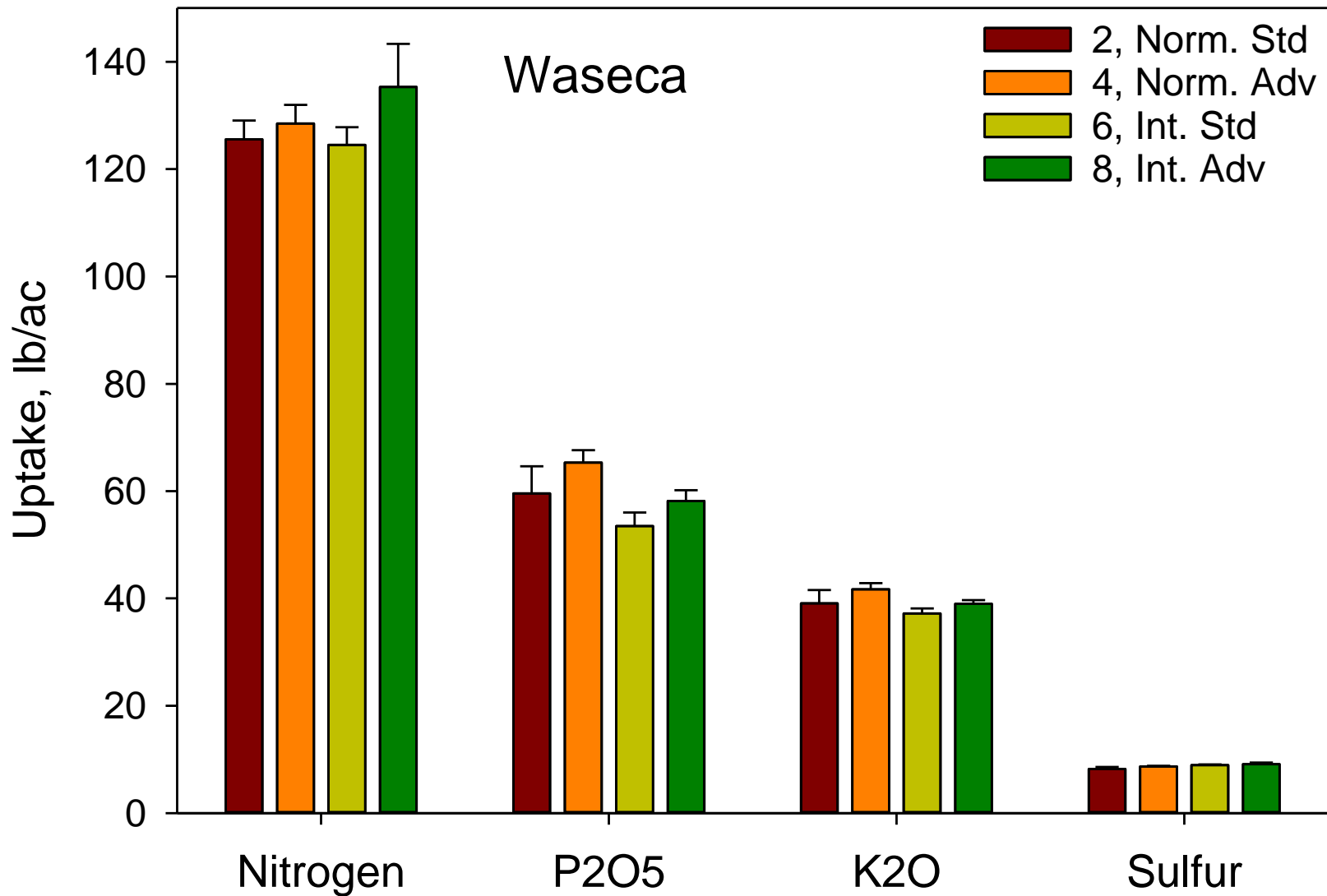
Treatment effects on dry matter yield at V10 Waseca 2018



Treatment effects on nutrient uptake at V10



Treatment effects on grain nutrient removal



- Yield gap = 16 to 64 bu/ac (average = 35 bu/ac)
- Greatest yield = advanced fertilizer mgt. + intensive agronomics
- Moderate yield = advanced fertilizer mgt. or intensive agronomics

Waseca

| Agronomic management | Normal | Normal | Intensive | Intensive |
|-----------------------|---------------------------------|----------|-----------|-----------|
| Fertilizer management | Standard | Advanced | Standard | Advanced |
| ----- year ----- | ----- grain yield (bu/ac) ----- | | | |
| 2013 | 193 c | 215 b | 210 b | 233 a |
| 2014 | 92 c | 121 b | 124 b | 156 a |
| 2015 | 203 c | 220 b | 234 a | 242 a |
| 2016 | 214 c | 220 b | 233 a | 239 a |
| 2017 | 209 c | 230 b | 228 b | 238 a |
| 2018 | 213 b | 224 a | 218 b | 229 a |
| 6-year average | 187 c | 205 b | 208 b | 223 a |

- Net return increased with intensive agronomics in 2 of 6 years

Waseca

| Agronomic management | Normal | Normal | Intensive | Intensive |
|-----------------------|--|----------|-----------|-----------|
| Fertilizer management | Standard | Advanced | Standard | Advanced |
| Added inputs (\$/ac) | --- | 77 & 54 | 18 & 33 | 95 & 87 |
| ----- year ----- | -- change in net return after drying + inputs (\$/ac) -- | | | |
| 2013 | --- | -8 | -3 | -8 |
| 2014 | --- | 6 | 64 | 80 |
| 2015 | --- | -22 | 45 | -4 |
| 2016 | --- | -56 | 6 | -49 |
| 2017 | --- | -14 | -6 | -43 |
| 2018 | --- | -27 | -54 | -68 |
| 6-year average | --- | -19 | 10 | -13 |

Agronomic treatments – Becker (irrigated)

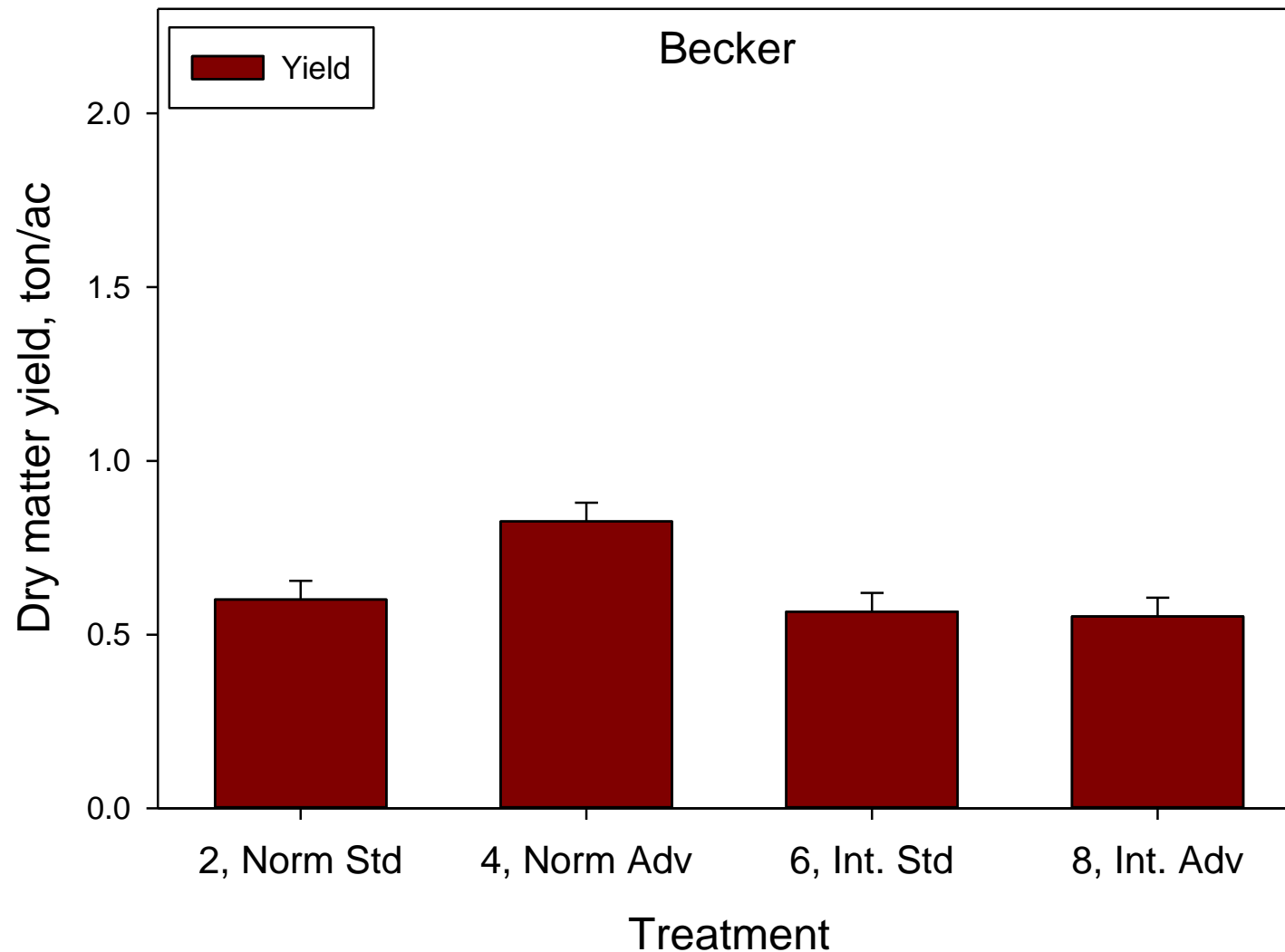
| | Normal | Intensive |
|----------------------------|--------|-----------|
| Hybrid maturity (CRM) | 96 | 103 |
| Planting rate (seeds/acre) | 36,000 | 41,000 |



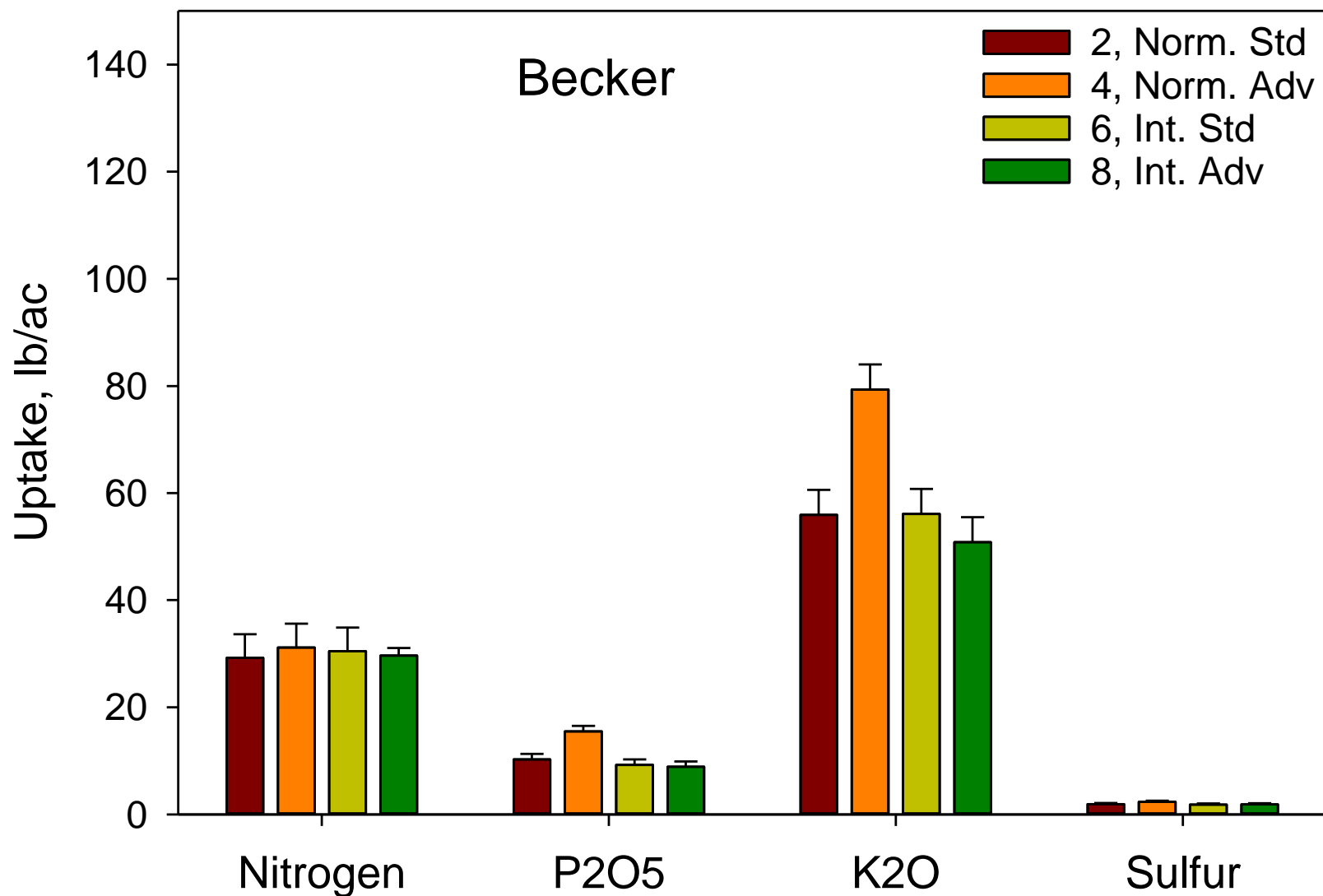
Fertilizer treatments – Becker (irrigated)

| | Standard | Advanced |
|-------------------|---------------------------|---------------------------|
| S | 25 lb SO ₄ /ac | 25 lb SO ₄ /ac |
| P | U of M guidelines | 50% grain removal |
| K | U of M guidelines | 100% grain removal |
| 10-34-0 in furrow | 4 gal/ac | 4 gal/ac |
| V2 N (urea) | 40 lb N/ac | 40 lb N/ac |
| V6 N (urea) | 185 lb N/ac | 70 lb N/ac |
| V12 N (urea) | --- | 70 lb N/ac |
| VT N (urea) | --- | 45 lb N/ac |
| Total N | 230 lb N/ac | 230 lb N/ac |

Treatment effects on dry matter yield at V10 Becker 2018



Treatment effects on nutrient uptake at V10



- Yield gap = 38 to 59 bu/ac (average = 46 bu/ac)
- Greatest yield = advanced fertilizer mgt. + intensive agronomics
- Moderate yield = advanced fertilizer mgt. or intensive agronomics

Becker (irrigated)

| Agronomic management | Normal | Normal | Intensive | Intensive |
|-----------------------|---------------------------------|----------|-----------|-----------|
| Fertilizer management | Standard | Advanced | Standard | Advanced |
| ----- year ----- | ----- grain yield (bu/ac) ----- | | | |
| 2014 | 159 c | 192 ab | 180 b | 205 a |
| 2015 | 163 d | 183 c | 197 b | 222 a |
| 2016 | 190 c | 189 c | 209 b | 229 a |
| 2017 | 169 c | 192 b | 171 c | 224 a |
| 2018 | 169 c | 207 a | 190 b | 190 b |
| 5-year average | 178 c | 200 b | 201 b | 217 a |

- Greatest net return with advanced fertilizer mgt. in 3 of 5 years & advanced fertilizer mgt. + intensive agronomics in 2 of 5 years
- Net return increased with advanced fertilizer mgt. or intensive agronomics in 4 of 5 years

Becker (irrigated)

| Agronomic management | Normal | Normal | Intensive | Intensive |
|-----------------------|--|----------|-----------|-----------|
| Added inputs (\$/ac) | --- | 52 & 38 | 18 | 70 & 56 |
| Fertilizer management | Standard | Advanced | Standard | Advanced |
| ----- year ----- | -- change in net return after drying + inputs (\$/ac) -- | | | |
| 2014 | --- | 44 | 28 | 36 |
| 2015 | --- | 16 | 84 | 101 |
| 2016 | --- | -54 | 31 | 42 |
| 2017 | --- | 12 | -6 | -17 |
| 2018 | --- | 73 | 19 | -17 |
| 5-year average | --- | 19 | 31 | 29 |

Summary

- **Experiments established with 10-year horizon**
 - Plan to continue for 2 to 4 more years
 - Weather & crop response are dynamic over time
 - Treatment effects on soil nutrient levels expected
 - Found a significant yield gap among treatments
 - >40 bu/ac in some years
 - Current yield levels are less than potential
 - Profitability a concern



Acknowledgement

- The authors thank the Minnesota Agricultural Fertilizer Research and Education Council (AFREC) and the Fluid Fertilizer Foundation for funding,
 - Scott Murrell and IPNI for expertise
 - Ward Lab for in-kind support of FFF
 - Corteva Pioneer agronomists for input and in-kind support.
 - Monsanto (DeKalb) for in-kind support



Contact info

Jeffrey Vetsch
Researcher and Soil Scientist
Southern Research and Outreach Center
jvetsch@umn.edu
Follow on Twitter @ jvetsch2

Dr. Jeffrey Coulter
Professor and Extension Corn Agronomist
Dept. Of Agronomy and Plant Genetics
jeffcoulter@umn.edu



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