VARIETY x MANAGEMENT:

20 to 50 varieties

3 to 4 reps

Standard
- Yield goal of 60 bu/A
- N fertilizer:
  - Soil NO₃-N = ~2 lbs N/bu/A
  - Applied Feekes 3
    (late February)

Intensive
- same as standard plus:
  + 40 lb N/A at Feekes 5
    (mid-March)
  + Jointing fungicide
  + Flag leaf/heading fungicide

NITROGEN APPLIED

![Graph showing nitrogen applied]

diff = 40 lb N/A

A

B

NITROGEN APPLIED

![Graph showing total N available]

diff = 40 lb N/A

A

B
2014-15
Chickasha, OK

2015-16
Chickasha, OK

Photo courtesy of Brian Arnall, OSU Soil Fertility Extension Specialist
2015-16 Ellsworth, KS - NDVI

Image courtesy of Ray Asebedo, K-State Precision Ag

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K-STATE

VISUAL DIFFERENCES

Standard Management  Intensive Management  Standard Management

Photos: Amanda de Oliveira (former student)

DIFFERENCES IN GREEN COVERAGE

Ellsworth, 2016

Susceptible variety with Fungicide  Susceptible variety without Fungicide
Sustainability of crop production

GRAIN YIELD

n = 2,870
Mean = 56.4 bu/a

n = 2,873
Mean = 69.5 bu/a
Sustainability of crop production

GRAIN PROTEIN

YIELD GAIN – VARIETY x ENVIRONMENT

Resistant varieties

Initial soil NO3-N

- > 100 lb N/acre
- < 100 lb N/acre

0.6 bu/acre

2.3 bu/acre

Growing season rainfall (in)

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Source: K-State SEIL
Sustainability of crop production

Crop Budget

Only variable costs considered:
- CT: chisel, disk, cultivation, plus one in-season herbicide (product + spraying)
- NT: one pre- and one post-herbicide (products plus spraying)
- Cost of seed and drilling
- Cost of DAP
- Cost of N fertilizer plus one (SM) or two (IM) passes
- Two fungicide applications on IM (products plus spraying)
- Harvesting, hauling, and labor

Price scenarios:
- Flat price
- 15% protein premium (12% or more)

Variable costs
Profit over variable costs

Profit depending on variety

Profit – protein premium over 12%
Profit – protein premium over 12%

Sustainability of crop production

Environmental impact evaluation

Water:
- Water use efficiency

Nitrogen:
- Export from the field
- Fertilizer N use efficiency (bu/lb N fertilizer)
- Available N use efficiency (bu/lb N available)
- N balance (input – output)
- N leaching
- Yield-scaled N leaching
- N2O emissions
- Yield-scaled N2O emissions
Water use efficiency

Nitrogen use efficiency
Nitrogen leaching

N2O emissions

N2O = 298x CO2 in global warming potential

N2O emissions
Environmental impact evaluation

Global warming potential (CO2 equivalents for):
- Tillage operation diesel + MTR (machinery manuf., transp., and repair)
- Moldboard plow, disk, and cultivation for Conventional Till
- Production and transport of seed used
- Planting operation diesel + MTR
- N fertilizer production and transport
- N application diesel + MTR
- P2O5 fertilizer production and transport
- Herbicide production and transport
- Herbicide application diesel + MTR
- Fungicide production and transport
- Fungicide application diesel + MTR
- Harvest diesel + MTR

Global warming potential

Global warming potential
Global warming potential

Sustainability of wheat production

THE WHEAT WE GROW vs. THE WHEAT WE COULD GROW
Replicating Trial

Gathered data from on-farm survey

Replicated management practices adopted in:
- Lowest 20% yielding fields
- Average yielding fields
- Highest 20% yielding fields
- Highest 5% yielding fields

Wheat Varieties

Central Kansas: trials after soybeans (6 and 8 in 2021 and 2022)
Western Kansas: trials after fallow (4 and 6 in 2021 and 2022)

<table>
<thead>
<tr>
<th>Practice</th>
<th>Central Kansas (Sub-Humid)</th>
<th>Western Kansas (Semi-Arid)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Average</td>
</tr>
<tr>
<td>Seed rate (seed/acre)</td>
<td>35</td>
<td>40</td>
</tr>
<tr>
<td>Nitrogen (lbs N/acre)</td>
<td>40</td>
<td>80</td>
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<tr>
<td>Sulfur (lbs S/acre)</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Phosphorus (lbs P/acre)</td>
<td>-</td>
<td>20</td>
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<tr>
<td>Micronutrients</td>
<td>-</td>
<td>-</td>
</tr>
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Central Kansas Grain Yield

Western Kansas Grain Yield

Central Kansas Protein

Letters indicate significant differences at <0.05 level.
Western Kansas Protein

<table>
<thead>
<tr>
<th>Management</th>
<th>Mean Protein (%)</th>
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<tbody>
<tr>
<td>Low</td>
<td>11.8c</td>
</tr>
<tr>
<td>Average</td>
<td>12.2b</td>
</tr>
<tr>
<td>High</td>
<td>12.6a</td>
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<tr>
<td>Top</td>
<td>12.9a*</td>
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</table>

Letters indicate significant differences at <0.05 level
*Significant at <0.10 level

BREAD YIELD

<table>
<thead>
<tr>
<th>Management</th>
<th>Bread Yield (Mg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>1.35 ± 0.05</td>
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<tr>
<td>Average</td>
<td>1.56 ± 0.10</td>
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<tr>
<td>High</td>
<td>1.78 ± 0.15</td>
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<td>Top</td>
<td>1.90 ± 0.20</td>
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ANCOVA

<table>
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<tr>
<th>Factor</th>
<th>Pr (&gt;F)</th>
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<tbody>
<tr>
<td>Management</td>
<td>&lt;0.0001</td>
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<tr>
<td>Variety</td>
<td>0.722</td>
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</table>

Residue returned to soil
Central, KS

<table>
<thead>
<tr>
<th>Management</th>
<th>Lbs residue / acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>4305 c</td>
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<tr>
<td>Average</td>
<td>5647 b</td>
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<tr>
<td>High</td>
<td>6249 a</td>
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<td>Top</td>
<td>6444 a</td>
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ANOVA

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<tr>
<td>Variety</td>
<td>0.722</td>
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<tr>
<td>MxV</td>
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</table>
Residue returned to soil
Western, KS

<table>
<thead>
<tr>
<th>Management Level</th>
<th>Lbs residue / acre</th>
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<tbody>
<tr>
<td>Low</td>
<td>6608 b</td>
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<tr>
<td>Average</td>
<td>6880 b</td>
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<tr>
<td>High</td>
<td>6967 ab</td>
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<td>7506 a</td>
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ANOVA

<table>
<thead>
<tr>
<th>Source</th>
<th>Pr(&gt;F)</th>
<th>Management</th>
<th>Variety</th>
<th>Residue Lbs</th>
<th>MxV</th>
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<tbody>
<tr>
<td>Management</td>
<td>0.0013</td>
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<td>0.0028</td>
<td>0.1845</td>
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GLOBAL WARMING POTENTIAL

From cradle to farm gate:

GLOBAL WARMING POTENTIAL

From cradle to farm grave (consumer's):

GLOBAL WARMING POTENTIAL
**TAKE HOME**

- Increased yield and protein:
  - It is possible! Though, dilution still occurs within management...
  - Increased bread yield
  - Decreased the magnitude of increases in GWP
- Importance of E, V, and M depended on attribute evaluated
- Wheat as a Carbon sink: potential for global warming mitigation
- Huge opportunities to increase export (20% more grain at 30% more protein yield) and domestic bread yield (30% greater) with minor increases in yield-scaled global warming potential
- Efforts to improve agricultural input efficiencies could further reduce impacts, but improvements at other phases of the bread product system are also necessary as Ag represents <25% of total GWP

**Questions?**

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KSU Wheat