# Cropping System Intensity, Fallow Efficiency and Evaluating Fallow Alternatives

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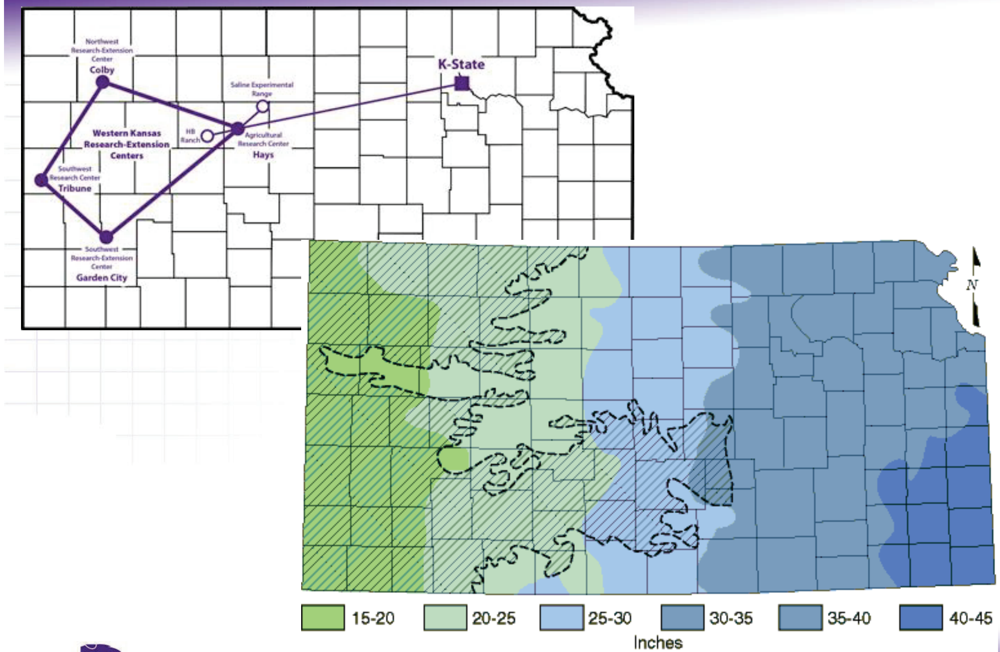


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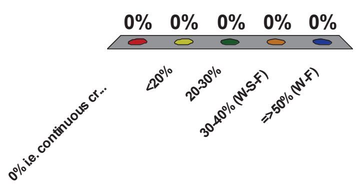
## Under "normal" conditions, what percentage of your dryland acres are in fallow

A. 0% i.e. continuous cropping
B. <20%
C. 20-30%
D. 30-40% (W-S-F)
E. =>50% (W-F)

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## How much can I afford to spend on NT fallow?

*Grain price sensitivity*

| Sorghum Price | Wheat Price: $ 4.00 | $ 4.50 | $ 5.00 | $ 5.50 | $ 6.00 | $ 6.50 | $ 7.00 | $ 7.50 | $ 8.00 | $ 8.50 | $ 9.00 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $ 3.00 | $ 139 | $ 141 | $ 144 | $ 147 | $ 150 | $ 153 | $ 156 | $ 159 | $ 161 | $ 164 | $ 167 |
| $ 3.50 | $ 154 | $ 157 | $ 160 | $ 162 | $ 165 | $ 168 | $ 171 | $ 174 | $ 177 | $ 180 | $ 183 |
| $ 4.00 | $ 169 | $ 172 | $ 175 | $ 178 | $ 181 | $ 183 | $ 186 | $ 189 | $ 192 | $ 195 | $ 198 |
| $ 4.50 | $ 184 | $ 187 | $ 190 | $ 193 | $ 196 | $ 199 | $ 202 | $ 204 | $ 207 | $ 210 | $ 213 |
| $ 5.00 | $ 200 | $ 203 | $ 205 | $ 208 | $ 211 | $ 214 | $ 217 | $ 220 | $ 223 | $ 225 | $ 228 |
| $ 5.50 | $ 215 | $ 218 | $ 221 | $ 224 | $ 226 | $ 229 | $ 232 | $ 235 | $ 238 | $ 241 | $ 244 |
| $ 6.00 | $ 230 | $ 233 | $ 236 | $ 239 | $ 242 | $ 245 | $ 247 | $ 250 | $ 253 | $ 256 | $ 259 |
| $ 6.50 | $ 246 | $ 248 | $ 251 | $ 254 | $ 257 | $ 260 | $ 263 | $ 266 | $ 268 | $ 271 | $ 274 |
| $ 7.00 | $ 261 | $ 264 | $ 267 | $ 269 | $ 272 | $ 275 | $ 278 | $ 281 | $ 284 | $ 287 | $ 289 |
| $ 7.50 | $ 276 | $ 279 | $ 282 | $ 285 | $ 288 | $ 290 | $ 293 | $ 296 | $ 299 | $ 302 | $ 305 |
| $ 8.00 | $ 291 | $ 294 | $ 297 | $ 300 | $ 303 | $ 306 | $ 309 | $ 311 | $ 314 | $ 317 | $ 320 |
| $ 8.50 | $ 307 | $ 310 | $ 312 | $ 315 | $ 318 | $ 321 | $ 324 | $ 327 | $ 330 | $ 332 | $ 335 |

$4/bu wheat to $8 wheat only changes allowable fallow cost by $22/ac

$3.50/bu sorghum to $7 sorghum changes allowable fallow cost by $107/ac

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# NT returns over RT at varying yield reduction levels

Evaluated at 2024 NC Cash at Cornerstone Terminal, Colby on 1/16/2024
$6.26 wheat, $4.82 sorghum

| NT/RT Assumption | | No-Till Fallow Cost | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| bu/bu | | $ 50 | $ 60 | $ 70 | $ 80 | $ 90 | $ 100 | $ 110 | $ 120 | $ 130 | $ 140 | $ 150 | $ 160 | $ 170 | $ 180 | $ 190 |
| 83/83 | 0% | 33 | 23 | 13 | 3 | -7 | -17 | -27 | -37 | -47 | -57 | -67 | -77 | -87 | -97 | -107 |
| 83/80 | 10% | 44 | 34 | 24 | 14 | 4 | -6 | -16 | -26 | -36 | -46 | -56 | -66 | -76 | -86 | -96 |
| 83/77 | 20% | 54 | 44 | 34 | 24 | 14 | 4 | -6 | -16 | -26 | -36 | -46 | -56 | -66 | -76 | -86 |
| 83/74 | 30% | 65 | 55 | 45 | 35 | 25 | 15 | 5 | -5 | -15 | -25 | -35 | -45 | -55 | -65 | -75 |
| 83/71 | 40% | 76 | 66 | 56 | 46 | 36 | 26 | 16 | 6 | -4 | -14 | -24 | -34 | -44 | -54 | -64 |
| 83/68 | 50% | 87 | 77 | 67 | 57 | 47 | 37 | 27 | 17 | 7 | -3 | -13 | -23 | -33 | -43 | -53 |
| 83/64 | 60% | 98 | 88 | 78 | 68 | 58 | 48 | 38 | 28 | 18 | 8 | -2 | -12 | -22 | -32 | -42 |
| 83/61 | 70% | 109 | 99 | 89 | 79 | 69 | 59 | 49 | 39 | 29 | 19 | 9 | -1 | -11 | -21 | -31 |
| 83/58 | 80% | 119 | 109 | 99 | 89 | 79 | 69 | 59 | 49 | 39 | 29 | 19 | 9 | -1 | -11 | -21 |
| 83/55 | 90% | 130 | 120 | 110 | 100 | 90 | 80 | 70 | 60 | 50 | 40 | 30 | 20 | 10 | 0 | -10 |
| 83/52 | 100% | 141 | 131 | 121 | 111 | 101 | 91 | 81 | 71 | 61 | 51 | 41 | 31 | 21 | 11 | 1 |



# How did we get here?

- Fallow not originally part of cropping systems in the Great Plains
- Implementation of fallow stabilized crop yields in a wheat mono-culture vs. continuous cropping
- Mineralization of plant nutrients
- Opportunity to control weeds



# PUE – Precipitation Use Efficiency

- The key to improved productivity and $$$ in your pocket
- How much grain did we raise with the precipitation we received in the entire cropping system?

***(lbs of grain per inch of precipitation)***

- Two ways to improve PUE
  - Grow a crop in place of fallow (W-F to W-S-F)
  - Improve fallow efficiency (No-Till, more residue)



# Evaluation of Fallow Efficiency (Precipitation Storage Efficiency, PSE)

$$\text{Fallow Accumulation} = \Delta\text{ASW}$$

$$\text{Fallow Efficiency} = \frac{\Delta\text{ASW}}{\text{Fallow Precipitation}}$$

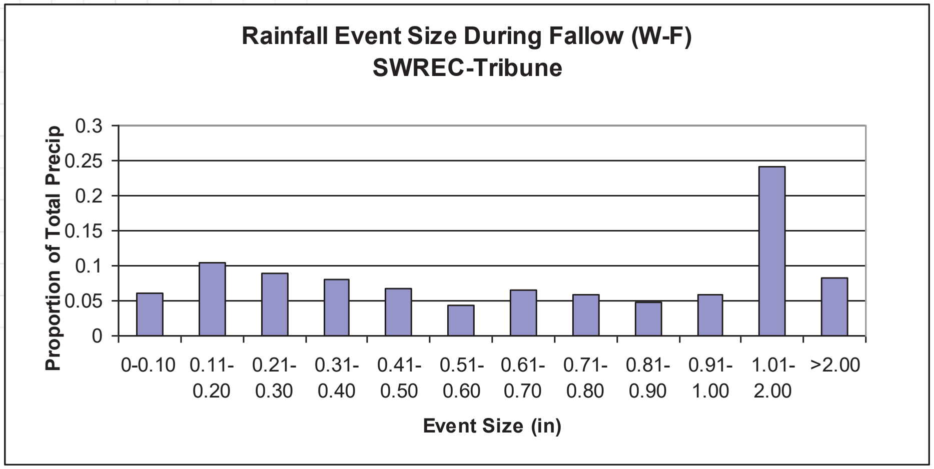
$$\text{Fallow Efficiency} = \frac{\text{Ending Soil Water} - \text{Beginning Soil Water}}{\text{Fallow Precipitation}}$$

# Factors to Fallow Efficiency

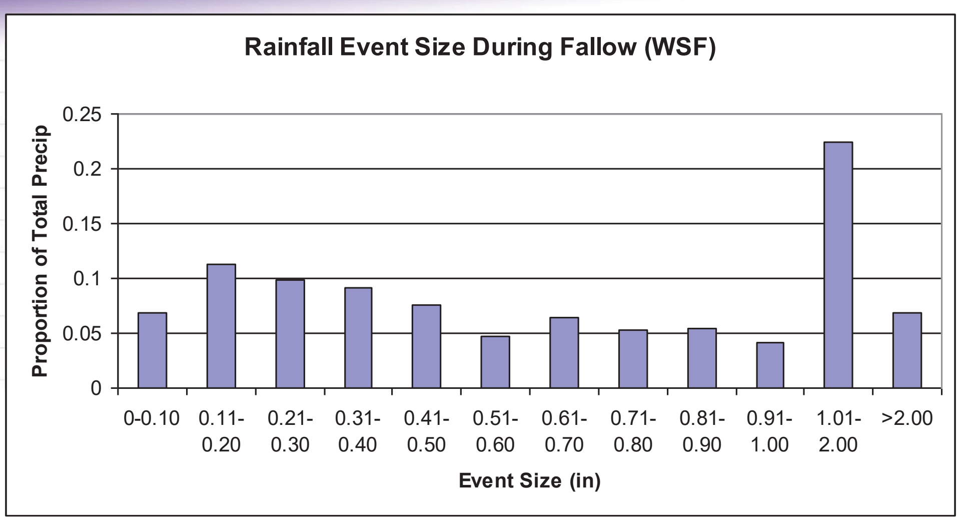
Water is leaving the system in one of two ways

- ***Weed Control***
- **Evaporative Losses**
  - Size of precipitation events
  - Surface residue
  - Tillage





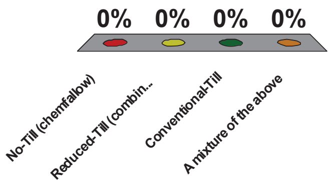


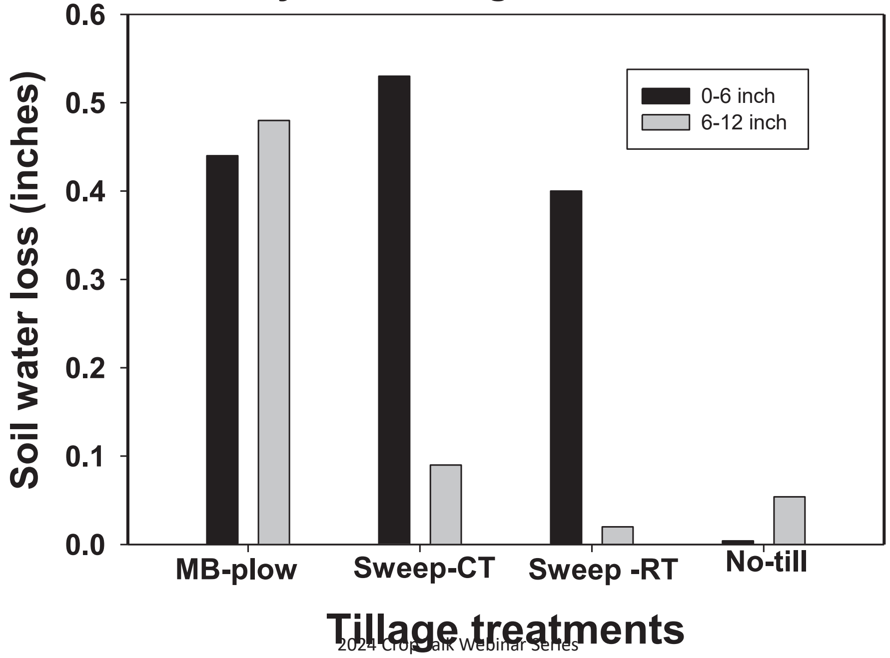



# My fallow acres are:

A. No-Till (chemfallow)
B. Reduced-Till (combination of tillage and chem.)
C. Conventional-Till
D. A mixture of the above

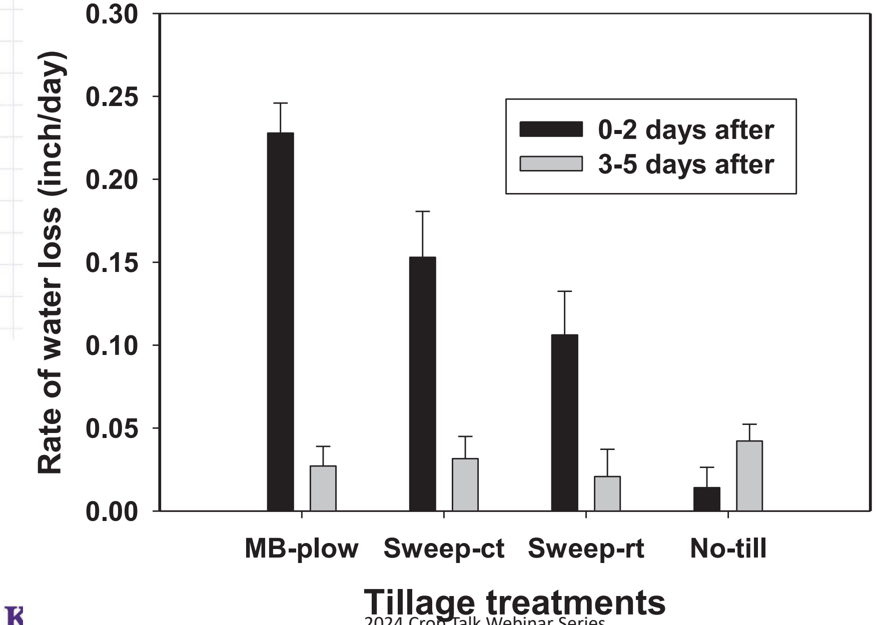


## 2 days after tillage ARS Vigil et al. 2012





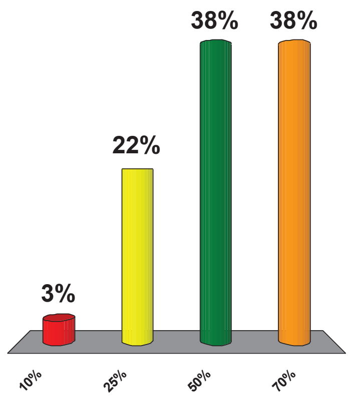

## Rate of water evap. first 2 days, & during the next 3 to 5 days






The use of tillage during summerfallow can reduce water accumulation compared to no-till by as much as:

A. 10%
B. 25%
C. 50%
D. 70%



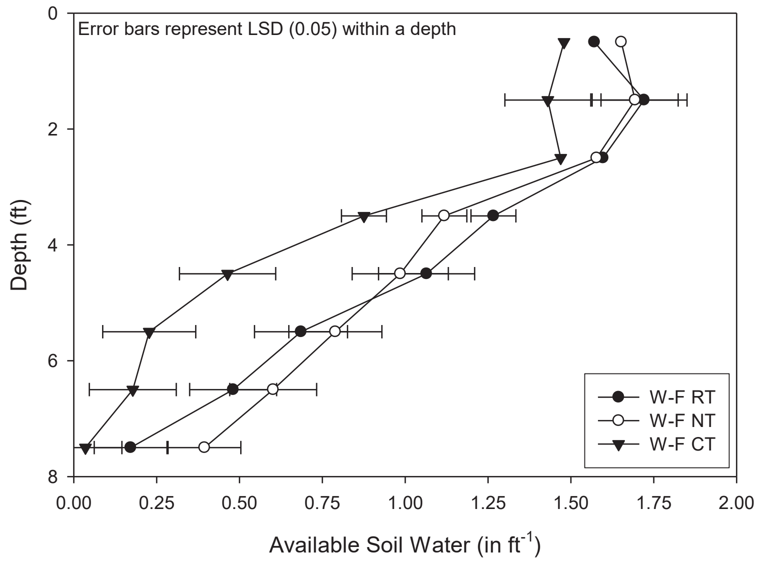



# Effect of Tillage – W-F 1993-1998

| | Fallow | | | |
|---|---|---|---|---|
| Fallow Method | Accumulation | | Efficiency | |
| | cm (in) | | Percent | |
| No-Till | 16.0 (6.30) | a | 23.8 | a |
| Reducted Till | 14.0 (5.51) | b | 20.9 | a |
| Conventional Till | 8.2 (3.23) | c | 12.1 | b |
| | ANOVA P>F | | | |
| Source of Variation | | | | |
| Fallow Method | 0.011 | | 0.0114 | |
| LSD 0.05 | 1.6 1.7 | | 0.07 | |

†Letters within a column represent differences at LSD (0.05)

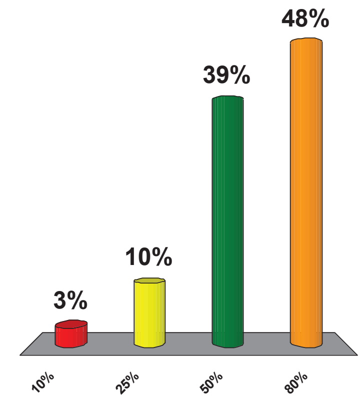
Available Soil Water at Wheat Planting
Tribune, Kansas 1995-1998





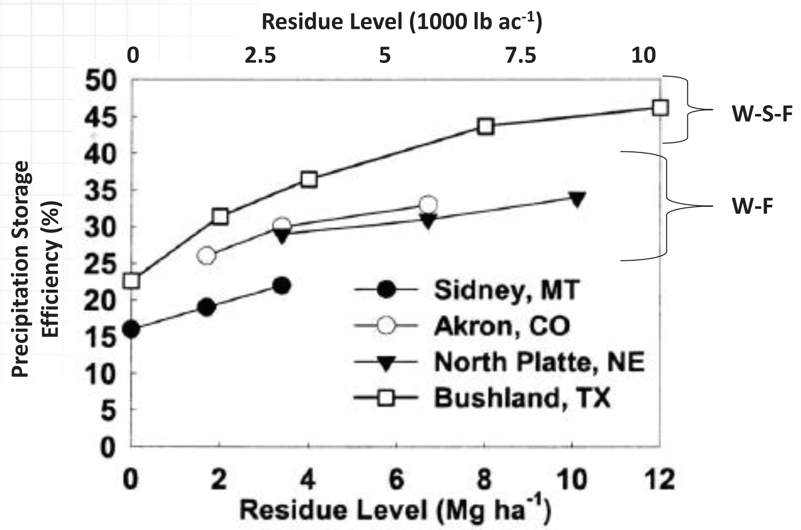

# The level of surface residue can effect fallow efficiency by as much as?

A. 10%
B. 25%
C. 50%
D. 80%





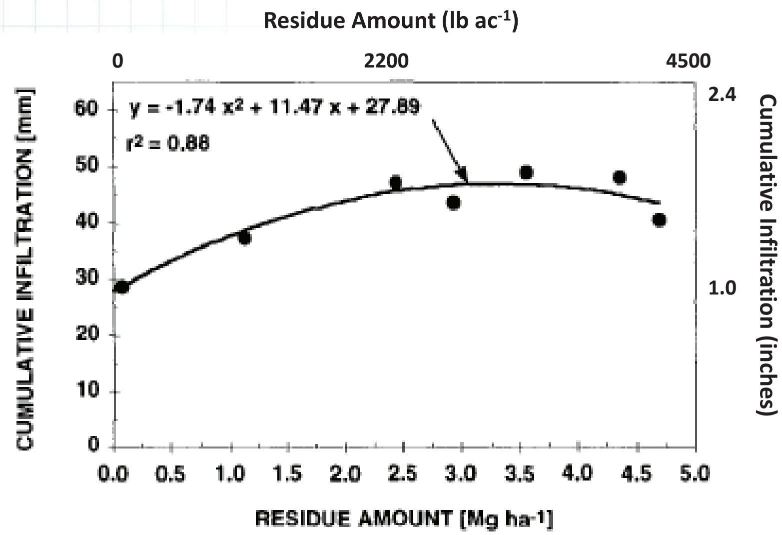

# Residue Effects PSE




Adapted from Nielsen et al., 2005.



# Residue Effects Infiltration




Adapted from Baumhardt and Lascano, 1996.

# Crop Choice Effect on Surface Residues and Fallow Efficiency 1998-2008

| Fallow Method | Fallow Accumulation | | Fallow Efficiency | |
|---|---|---|---|---|
| | cm (in) | | Percent | |
| W-S-F | 8.3 (3.25) | a | 20.1 | a |
| W-SF-F | 5.3 (2.08) | b | 12.5 | b |
| ANOVA P>F | | | | |
| Source of Variation | | | | |
| Fallow Method | 0.0452 | | 0.0346 | |
| LSD 0.05 | 1.6 (1.14) | | 6.94 | |

†Letters within a column represent differences at LSD (0.05)



# Effect of Crop Choice in Stacked Rotations on Fallow Efficiency 2001-2006

| Fallow Method | Fallow Accumulation | | Fallow Efficiency | |
|---|---|---|---|---|
| | cm (in) | | Percent | |
| W-C-GS-F | 8.3 (3.26) | a | 20.4 | a |
| W-C-SB-F | 5.8 (2.27) | b | 14.1 | b |
| W-C-SF-F | 4.2 (1.64) | c | 10.0 | c |
| ANOVA P>F | | | | |
| Source of Variation | | | | |
| Fallow Method | 0.0002 | | <0.0001 | |
| LSD 0.05 | 1.6 (0.54) | | 2.53 | |

†Letters within a column represent differences at LSD (0.05)



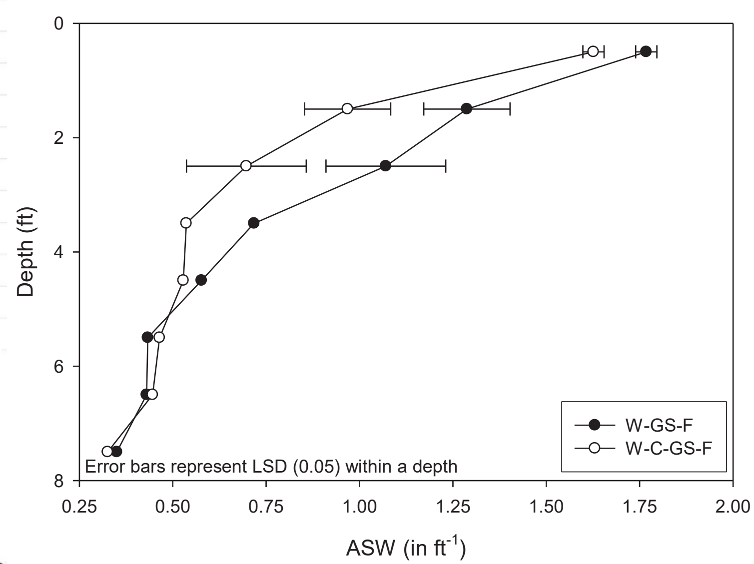
# Effects of Crop Sequence in 3 and 4 year rotations – 2009-2011

| Cropping System | Fallow Accumulation | Fallow Efficiency |
|---|---|---|
| | cm (in) | Percent |
| W-GS-C-F | 8.3 (3.27) | 17.7 |
| W-C-GS-F | 8.0 (3.13) | 17.5 |
| W-S-F | 7.8 (3.07) | 17.6 |
| W-C-F | 6.6 (2.61) | 14.9 |
| ANOVA P>F | | |
| Source of Variation | | |
| Fallow Method | 0.6941 | 0.8018 |
| LSD 0.05 | - - | - |

†Letters within a column represent differences at LSD (0.05)



Available Soil Water at Sorghum Planting
Tribune, Kansas 1999-2008



# Effects of Weed Control and Fallow Efficiency with Time (W-C-F)

Wheat Harvest to Row Crop Planting

| Post Harvest Weed Control | Previous Harvest to August Fallow | | August Fallow to October Fallow | | October Fallow to Row-Crop Planting | | Previous Harvest to Row-Crop Planting | |
|---|---|---|---|---|---|---|---|---|
| | Accumulation | Efficiency | Accumulation | Efficiency | Accumulation | Efficiency | Accumulation | Efficiency |
| | cm (in) | Percent | cm (in) | Percent | cm (in) | Percent | cm (in) | Percent |
| July | 2.3 (0.91) a† | 25.2 | 1.2 (0.49) a | 19.4 | 5.7 (2.23) | 41.3 | 8.8 (3.47) a | 30.1 |
| August | 1.3 (0.53) b | 14.7 | 1.0 (0.41) a | 16.3 | 5.2 (2.03) | 37.6 | 7.9 (3.09) b | 26.9 |
| Spring | 1.3 (0.53) b | 14.6 | -1.5 -(0.60) b | -24.0 | 5.0 (1.95) | 36.2 | 4.8 (1.89) c | 16.4 |
| | | | ANOVA P>F | | | | | |
| Source of Variation | | | | | | | | |
| Weed Control | 0.0012 | - | <0.0001 | - | 0.1282 | - | <0.0001 | - |
| LSD 0.05 | 0.6 (0.23) | - | 0.6 (0.22) | - | - - | - | 0.8 0.30 | - |

†Letters within a column represent differences at LSD (0.05)



# Effects of Weed Control Timing During Fallow on Efficiency and Profile Water (W-C-F)

Wheat Harvest to Row Crop Planting

Table x. Effect of post wheat harvest weed control timing on profoile available water. SWREC-Tribune 2001-2006

| Post Harvest Weed Control | Plant Available Soil Water at Sampling: August Fallow | October Fallow | Corn Planting | July In-Season | Corn Harvest |
|---|---|---|---|---|---|
| | --------------- cm (in) --------------- | | | | |
| July | 10.4 (4.1) a† | 10.8 (4.2) a | 15.9 (6.3) a | 13.8 (5.4) a | 8.6 (3.4) |
| August | 9.3 (3.7) b | 9.1 (3.6) b | 14.8 (5.8) a | 13.2 (5.2) ab | 8.4 (3.3) |
| Spring | 9.5 (3.7) b | 7.0 (2.8) c | 12.0 (4.7) b | 12.0 (4.7) b | 8.4 (3.3) |
| | | ANOVA P>F | | | |
| Source | | | | | |
| Weed Control | 0.0823 | <.0001 | <.0001 | 0.0518 | 0.7593 |
| LSD 0.10 | 0.8 (0.3) | 1.0 (0.4) | 1.0 (0.4) | 1.2 (0.5) | - |
| LSD 0.05 | 0.9 (0.4) | 1.2 (0.5) | 1.1 (0.5) | 1.5 (0.6) | - |
| LSD 0.01 | 1.3 (0.5) | 1.6 (0.6) | 1.5 (0.6) | 2.0 (0.8) | - |

†Letters within a column represent differences at LSD (0.05)

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# Efficiency from Row-Crop Harvest to Wheat Seeding

SWREC-Tribune 2001-2007

| Time Period | Efficiency |
|---|---|
| | Percent |
| Row-Crop Harvest to July Fallow | 28.8 |
| July Fallow to Wheat Planting | -4.6 |
| Row-Crop Harvet to Wheat Planting | 21.2 |

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# Fallow efficiency during winter in standing wheat stubble

Table 1. Reported values for overwinter precipitation storage efficiency (PSE) in wheat stubble throughout the central Great Plains.

| Location | Wheat residue | Years | PSE % | Reference |
|---|---|---|---|---|
| Colby, KS | Undisturbed | 25 | 78.5 | Kuska and Mathews, 1956 |
| | Undisturbed | 4 | 77.0 | |
| North Platte, NE | Undisturbed | 4 | 98.9 | Smika and Whitfield, 1966 |
| | Incorporated | | -15.4 | |
| Akron, CO | Undisturbed | 11 | 80 | Smika et al., 1986 |
| | Stubble-mulch | | 57 | |

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# Where do we go from here?

- We know that there is being water left on the table
  - i.e. Row crop to wheat 20% x 15.5” = 12.4”
- We know that reducing soil water at planting will negatively impact subsequent crop yields
- Can we strike a balance?



# Crazier Things Have Happened
# Weeds grown as residue….

W-F Delayed minimum tillage study. SWREC-Tribune, Kansas 1996-2001

| | Previous Harvest to Fall | | Fall to Spring | | Spring to Seeding | | Previous H[...] Seedi[...] |
|---|---|---|---|---|---|---|---|
| Fallow Method | Accumulation | Efficiency | Accumulation | Efficiency | Accumulation | Efficiency | Accumulation |
| | cm (in) | % | cm (in) | % | cm (in) | % | cm (in) |
| No-Till | 8.0 (3.16) a† | 27.6 a | 3.0 (1.17) a | 30.0 a | 6.3 (2.47) b | 19.1 ab | 19.5 (7.66) a |
| Conservation Sweep Tillage | 4.9 (1.94) b | 14.5 b | 1.1 (0.43) b | -0.6 b | 4.4 (1.73) c | 13.4 b | 11.6 (4.58) c |
| Delayed Minimum Tillage | 1.0 (0.40) c | -8.2 c | 4.3 (1.70) a | 45.5 a | 8.0 (3.15) a | 25.0 a | 15.1 (5.93) b |
| | | | ANOVA P>F | | | | |
| Source of Variation | | | | | | | |
| Fallow Method | <0.0001 | <0.0001 | <0.0001 | 0.0003 | 0.0002 | 0.0012 | <0.0001 |
| LSD 0.05 | 1.6 (0.64) | 9.5 | 1.4 (0.54) | 21.9 | 1.6 (0.64) | 6.0 | 1.7 (0.67) |

†Letters within a column represent differences at LSD (0.05)

***It worked because the hit to soil water was early on, there was time to recover before seeding the next crop***



# Things we have looked at in recent years

- Safflower
- Field Pea
- Spring Wheat
- Cowpeas / Black-Eyed Peas
- Forages
- Camelina



# Winter and Spring Pea in Kansas

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# Pea Development Basics

- Indeterminate, cool season crop
- Growth Temperatures
  - Optimum 17°C / 63°F
  - Minimum 10°C / 50°F
    - RUE reduced at <12°C / 54°F and PSII at < 15°C / 59°F
  - Maximum 23°C / 73°F
  - Damaging 28-32°C / 82-90°F
  - Damage to Pollen and Ovule 36°C / 95°F



# Winter vs. Spring Types

- We're not talking about vernalization
- Winter types tend to be more photoperiod sensitive
- Lower temperatures begin the cold acclimation process
  - Accumulation of solutes, changes in membrane lipid composition
  - Higher proportion of biomass accumulation to below-ground



# Winter vs. Spring Types - Flowering

- The *Hr* gene blocks floral initiation when the days are short (13.5 hours, April 25 @ Colby)
- Recessive *If* gene results in plants that flower as early as the 8th node
- If you combine *Hr* with If you get a plant that should flower after last freeze, but hopefully early enough to beat the heat



# Pea Seed and Germination

- Seed Size
  - Spring Pea 1600-2500 Seeds/Lb
  - Winter Pea 2200-3500 Seeds/Lb
- Seed doubles in volume in first 2 days of germination
- Requires 3x the moisture for germination compared to small grains
  - Management Note: Plant at least ½" into moisture


**Fig. 7, left.** Mineralization of N in fallow following fall-sown peas and winter wheat on four farms in Washington in early May. **Fig. 8, above.** Seed quality characteristics of new food quality winter peas (PS113000287W and PS11300289W) compared with spring peas Hampton and Carousel, winter pea Windham, and Austrian winter pea Common.



**Fig. 9.** Branching habit of spring pea (*left*) vs. winter pea (*right*). Photos by H. Nelson.



# Locations

- 2010 Pilot Study
  - NWREC-Colby
  - SWREC-Tribune
- 2011-2012 Additions
  - SWREC-Garden City
  - USDA-ARS Bushland



# Field Peas

- DS Admiral Yellow Field Pea
- Planted mid March @ 150-180 lbs $ac^{-1}$
- Four Treatments
  - Terminated 15 May and left as cover crop
  - Terminated 1 June and left as cover crop
  - Allowed to fully mature and left as cover crop
  - Harvested for grain early July
- 2011 Winter wheat failed at Tribune and emerged late at Colby (end of February / early March)
- 2012 Winter wheat was harvested at the Kansas locations

## Water Use by Field Peas vs. No-Till Fallow SWREC-Tribune

| | Water Use to Date (Inches) | | |
|---|---|---|---|
| | 15-May Termination | 1-Jun Termination | 1-Jul Harvest |
| Peas | 2.18 | 5.42 | 9.30 |
| Fallow | 1.81 | 3.94 | 5.92 |
| Fallow Efficiency | 23.3% | 31.1% | 25.9% |

Peas effectively used 3.38" of water



## Colby 2010 - Fallow Alternative Impacts on Available Soil Water at Wheat Planting

Table 2. Available soil water at wheat planting as affected by fallow method. NWREC-Colby 2010

| Fallow Method | Available Soil Water at Wheat Planting | | |
|---|---|---|---|
| | cm (in) | | |
| NT Fallow | 30.6 | (12.05) | a |
| Peas - Green Fallow | 27.1 | (10.66) | b |
| Safflower | 18.8 | (7.42) | c |
| ANOVA P>F | | | |
| Source of Variation | | | |
| Fallow Method | 0.001 | | |
| LSD 0.10 | 3.2 | (1.26) | |

†Letters within a column represent differences at LSD (0.10)



## Tribune 2010 - Fallow Alternative Impacts on Available Soil Water at Wheat Planting

Table 1. Available soil water at wheat planting as affected by fallow method. SWREC-Tribune 2010 Preliminary Data

| Fallow Method | Available Soil Water at Wheat Planting | | |
|---|---|---|---|
| | cm (in) | | |
| NT Fallow | 20.4 | (8.02) | a |
| Peas Terminated 6/1 | 13.9 | (5.47) | ab |
| Peas Harvested for Grain | 13.9 | (5.47) | ab |
| Peas Terminated 5/18 | 13.1 | (5.16) | abc |
| Peas - Green Fallow | 12.2 | (4.79) | bc |
| Safflower | 6.4 | (2.50) | c |
| ANOVA P>F | | | |
| Source of Variation | | | |
| Fallow Method | 0.0951 | | |
| LSD 0.10 | 7.3 | (2.87) | |

†Letters within a column represent differences at LSD (0.10)



## Tribune 2011 – Fallow Alternative Impacts on Available Soil Water at Wheat Planting

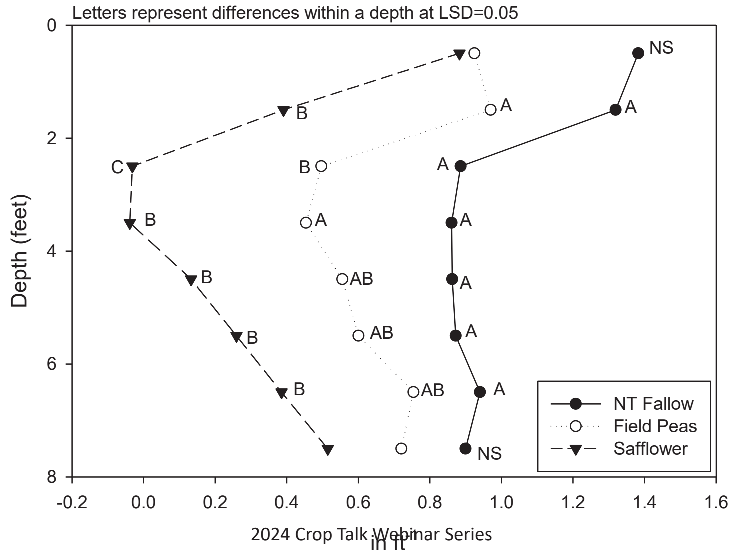
Table 3. Available soil water at wheat planting as affected by fallow method. SWREC-Tribune 2011 Preliminary Data

| Fallow Method | Available Soil Water at Wheat Planting | | |
|---|---|---|---|
| | cm (in) | | |
| Peas Terminated 5/18 | 17.1 | (6.72) | a |
| NT Fallow | 16.7 | (6.58) | a |
| Peas Terminated 6/1 | 14.4 | (5.68) | ab |
| Peas Harvested for Grain | 11.5 | (4.53) | b |
| Peas - Green Fallow | 10.2 | (4.02) | b |
| Safflower | 4.2 | (1.67) | c |
| ANOVA P>F | | | |
| Source of Variation | | | |
| Fallow Method | 0.0008 | | |
| LSD 0.10 | 4.2 | (1.67) | |

†Letters within a column represent differences at LSD (0.10)

Fallow Alternative Study
SWREC-Tribune 2010
Available Soil Water at Wheat Planting

***PRELIMINARY DATA***






# 2012 Colby Wheat Grain Yields

Table x. Subsequent wheat grain yields as affected by fallow method.
NWREC-Colby 2012 Preliminary Data

| Fallow Method | Wheat Grain Yield | |
|---|---|---|
| | kg/ha (bu/ac) | |
| Peas Terminated 5/18 | (56.59) | a |
| NT Fallow | (51.22) | ab |
| Peas Terminated 6/1 | (49.19) | ab |
| Peas Harvested for Grain | (44.50) | bc |
| Peas - Green Fallow | (40.51) | c |
| Safflower | (38.44) | c |

| Source of Variation | ANOVA P>F |
|---|---|
| Fallow Method | 0.0099 |
| LSD 0.10 | (7.96) |

†Letters within a column represent differences at LSD (0.10)



# 2012 Garden City Wheat Grain Yields

Table x. Subsequent wheat grain yields as affected by fallow method.
SWREC-Garden City 2012 Preliminary Data

| Fallow Method | Wheat Grain Yield | |
|---|---|---|
| | kg/ha (bu/ac) | |
| NT Fallow | (30.16) | a |
| Peas Terminated 5/18 | (20.23) | b |
| Peas Terminated 6/1 | (17.57) | bc |
| Peas - Green Fallow | (16.93) | bc |
| Midas Peas for Grain | (14.29) | bc |
| Admiral Peas for Grain | (13.06) | c |
| Safflower | (4.14) | d |

| Source of Variation | ANOVA P>F |
|---|---|
| Fallow Method | 0.0003 |
| LSD 0.10 | (6.47) |

†Letters within a column represent differences at LSD (0.10)



# 2012 Tribune Wheat Grain Yields

Table x. Subsequent wheat grain yields as affected by fallow method.
SWREC-Tribune 2012 Preliminary Data

| Fallow Method | Wheat Grain Yield | |
|---|---|---|
| | kg/ha (bu/ac) | |
| NT Fallow | (6.61) | a |
| Peas Terminated 6/1 | (6.22) | a |
| Peas - Green Fallow | (5.84) | a |
| Midas Peas for Grain | (5.51) | a |
| Peas Terminated 5/18 | (5.29) | a |
| Safflower | (0.73) | b |

| Source of Variation | ANOVA P>F |
|---|---|
| Fallow Method | 0.0092 |
| LSD 0.10 | (3.62) |

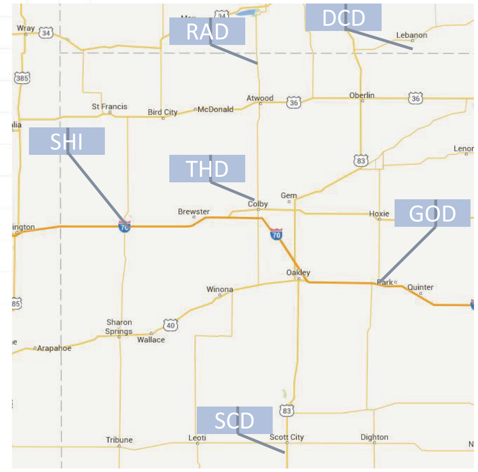
†Letters within a column represent differences at LSD (0.10)

# K-State Field Pea Research

Lucas Haag, Ph.D.
Assistant Professor / Northwest Area Agronomist
Northwest Research-Extension Center, Colby, Kansas



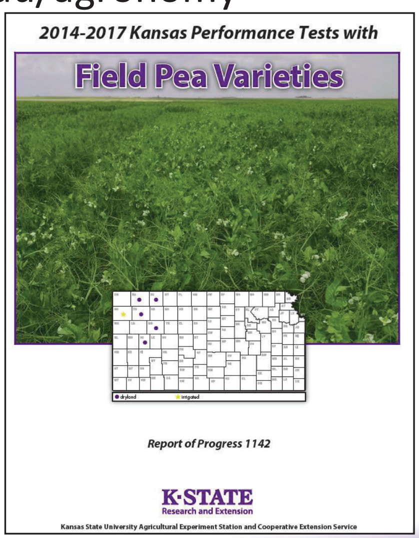
# Field Pea VPT Locations






# Trial Results and Field Pea Production Info

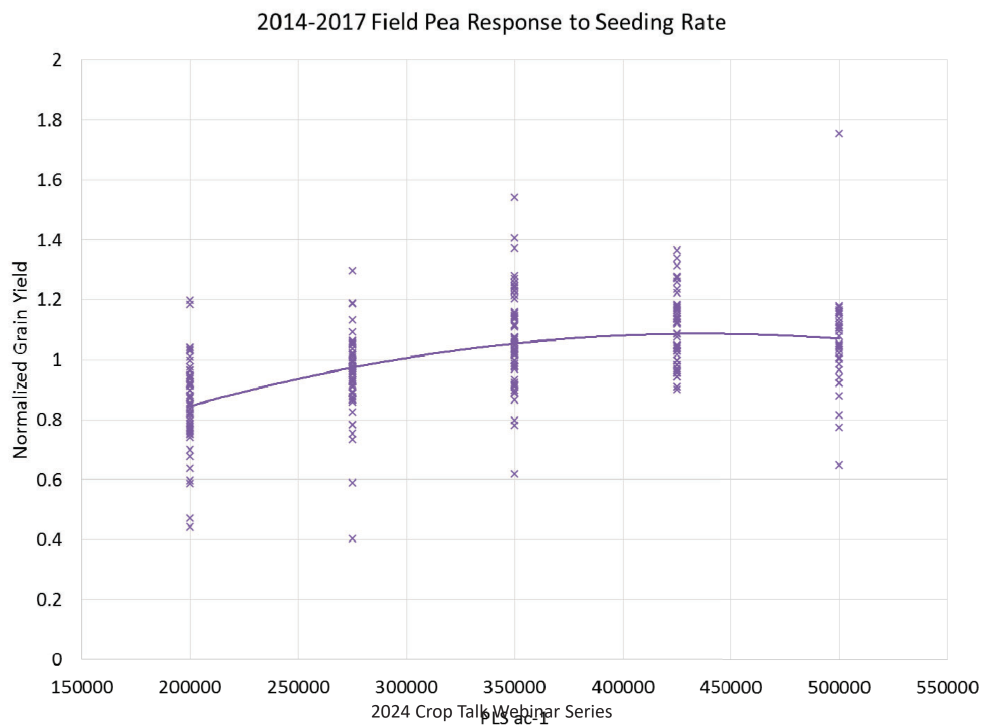
- www.northwest.ksu.edu/agronomy






# Top yield group across site-years

| Location | 2014<br>Top Group Average Yield | 2015<br>Top Group Average Yield | 2016<br>Top Group Average Yield | 2017<br>Top Group Average Yield | 2018<br>Top Group Average Yield | 2019<br>Top Group Average Yield | Top Group Across Years |
|---|---|---|---|---|---|---|---|
| Rawlins | 49.2 | 40.9 | 31.4 | 29.7 | 39.5 | 19.9 | 35.1 |
| Thomas | 28.2 | 30.6 | 33.8 | 39.3 | 26.5 | 48.7 | 34.5 |
| Decatur | - | 47.5 | 31.7 | - | 34.9 | 36.1 | 37.6 |
| Gove | - | - | 27.9 | 29.6 | 23.1 | 52.3 | 33.2 |
| Scott | 4.6 | - | - | - | - | - | 4.6 |
| Sherman IRR | - | 55.2 | - | - | - | - | 55.2 |
| Rooks | - | - | - | - | - | 31.1 | 31.1 |
| Republic | - | - | - | - | - | 12.9 | 12.9 |






# Seeding Rate Summary

- K-State data would suggest our optimal seeding rate is likely higher than the 350,000 PLS/acre that we initially recommended to producers
- Current KSU recommendation is 365,000 PLS/acre



# Seeding Rate Summary

Some of my thoughts on this from a crop physiologist perspective:

- Why might we need higher seeding rates than the Northern Plains?
  - As peas are moved south our conversion of yield components into actual grain yield is more limited
    - Fewer flowers converted into pods
    - Fewer seeds per pod
  - Therefore it possibly takes more plants/acre to maximize yield potential



# Seed Quality

- Warm Germination is all that is required for seed to be certified
- Is that really enough information?
- What about farm saved seed?
- Proper handling is essential
  - Cold temps, overly dry seed, contact with steel
- Keep a sample back of what you plant

# Seed Quality - Testing

- Having warm germ, cold germ, and accelerated aging test ran provides you more information
- Once you start with a lab, stick with it
- Talk to your lab, while test procedures are standardized, philosophies and interpretation are not
- Other potential tests of interest
  - Disease Assay
  - Conductivity
    (detects mechanical damage in seed coat)



# Fungicide Seed Treatments

- Seed Treatments
  - Untreated
  - Obvious (BASF)
  - VibranceMaxx (Syngenta)
  - Apron Maxx RTA (Syngenta)
- Seeded at 350,000 PLS
- Three locations

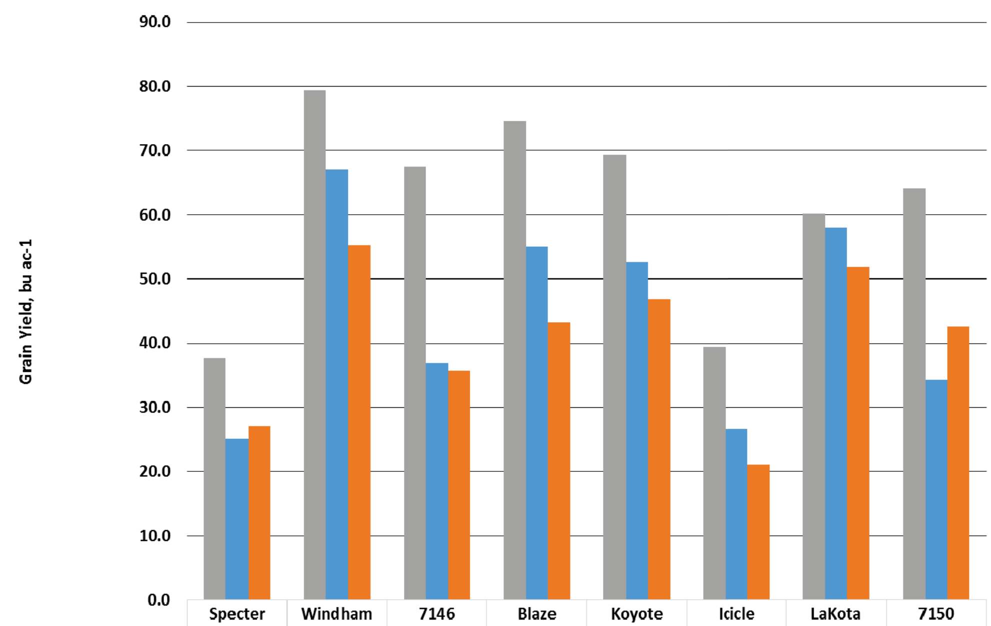


# 2017 Yield Results

| | Rawlins | Gove | Thomas | |
|---|---|---|---|---|
| | | -- bu/ac -- | | |
| Untreated | 28.4 | 19.9 | 26.2 | b |
| Obvious | 28.5 | 19.6 | 28.4 | a |
| VibranceMaxx | 31.0 | 19.0 | 29.4 | a |
| Apron Maxx RTA | . | . | 28.2 | ab |
| | ANOVA | | | |
| P>F | 0.5945 | 0.8694 | 0.049 | |
| LSD | NS | NS | 2.18 | |



Winter Pea Variety x Seeding Rate - Colby 2018




| | Specter | Windham | 7146 | Blaze | Koyote | Icicle | LaKota | 7150 |
|---|---|---|---|---|---|---|---|---|
| DOP1 - 10/18/2017 | 37.7 | 79.4 | 67.5 | 74.6 | 69.3 | 39.4 | 60.1 | 64.2 |
| DOP2 - 10/30/2017 | 25.1 | 67.0 | 36.9 | 55.0 | 52.6 | 26.6 | 57.9 | 34.2 |
| DOP3 - 11/15/2017 | 27.1 | 55.3 | 35.7 | 43.2 | 46.9 | 21.1 | 51.9 | 42.7 |

# 2019 Winter Pea VPT at Colby

| VARNUM | Entrant | Entry | Class | YieldLb | YieldBu | |
|---|---|---|---|---|---|---|
| WP1804 | ProGene | Blaze | Yellow | 5278 | 88.0 | a |
| WP1803 | ProGene | 7146 | Yellow | 5169 | 86.1 | ab |
| WP1908 | ProGene | PRO_144-7211 | Yellow | 5092 | 84.9 | abc |
| WP1805 | ProGene | Koyote | Yellow | 4922 | 82.0 | abcd |
| WP1802 | USDA-ARS | Windham | Yellow | 4707 | 78.4 | abcde |
| WP1808 | ProGene | 7150 | Green | 4654 | 77.6 | abcde |
| WP1907 | NS Seed | Mraz | Yellow | 4522 | 75.4 | bcde |
| WP1902 | USDA | PS11300289W | Yellow | 4376 | 72.9 | bcde |
| WP1906 | ProGene | Keystone | Green | 4369 | 72.8 | bcde |
| WP1807 | USDA-ARS | LaKota | Green | 4341 | 72.4 | bcde |
| WP1905 | USDA-ARS | PS1430NZ003W | Green | 4300 | 71.7 | cde |
| WP1901 | USDA-ARS | PS11300240W | Green | 4279 | 71.3 | de |
| WP1903 | USDA-ARS | PS12300049W | Green | 3993 | 66.6 | ef |
| WP1904 | USDA-ARS | PS12300058W | Yellow | 3134 | 52.2 | f |
| | P>F | | | | 0.0039 | |
| | LSD (0.05) | | | 810 | 13.5 | |

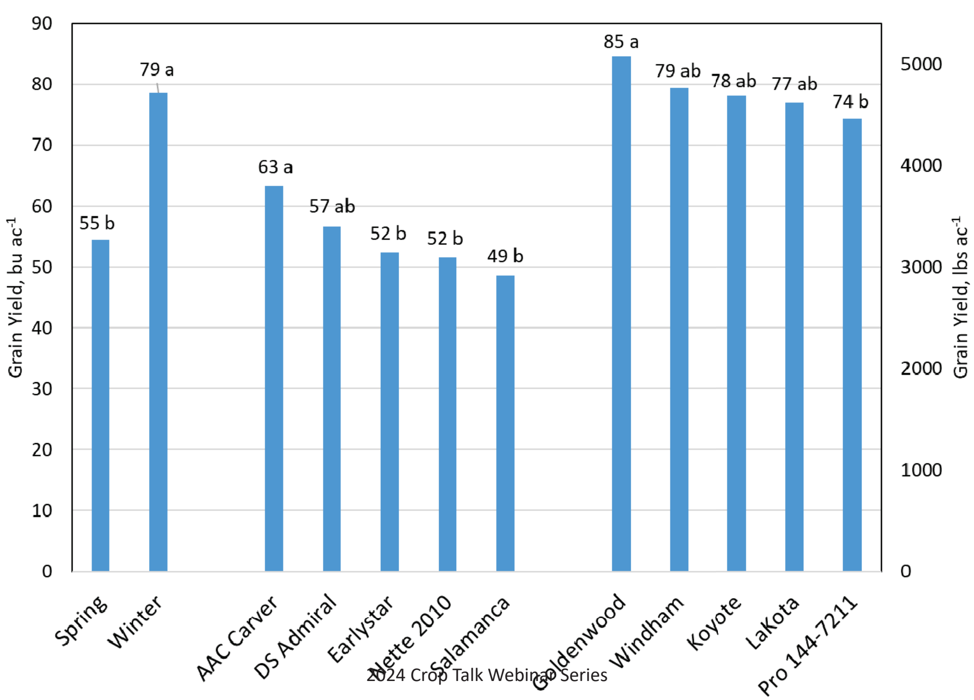


## 2021 K-State Winter Pea Variety Performance Test

| Variety | RAD | THD | Average |
|---|---|---|---|
| Payback | 35.8 | 40.0 | 37.9 |
| Koyote | 36.2 | 38.7 | 37.5 |
| Blaze | 32.8 | 41.0 | 36.9 |
| MS-20W3 | 31.7 | 42.1 | 36.9 |
| PRO_184-7148 | 33.5 | 40.1 | 36.8 |
| MS-20W2 | 27.5 | 39.3 | 33.4 |
| PRO_164-7117 | 27.3 | 38.5 | 32.9 |
| PRO_144-7211 | 31.5 | 34.1 | 32.8 |
| Goldenwood | 28.2 | 36.5 | 32.3 |
| Windham | 28.2 | 33.8 | 31.0 |
| PRO_154-7225 | 27.1 | 33.6 | 30.3 |
| PS1430NZ010W | 24.8 | 34.1 | 29.5 |
| PS1430NZ003W | 29.5 | 28.8 | 29.1 |
| LaKota | . | 27.3 | 27.3 |
| MS-20W1 | 22.2 | 32.0 | 27.1 |
| PRO_152-7121 | 24.6 | 25.6 | 25.1 |
| Vail | 24.0 | 21.3 | 22.6 |
| Specter | 23.6 | 19.6 | 21.6 |
| PRO_184-7145 | 21.2 | 14.9 | 18.1 |
| Keystone | 15.9 | 17.0 | 16.4 |
| | <0.0001 | <0.0001 | |
| | 5.48 | 9.25 | |

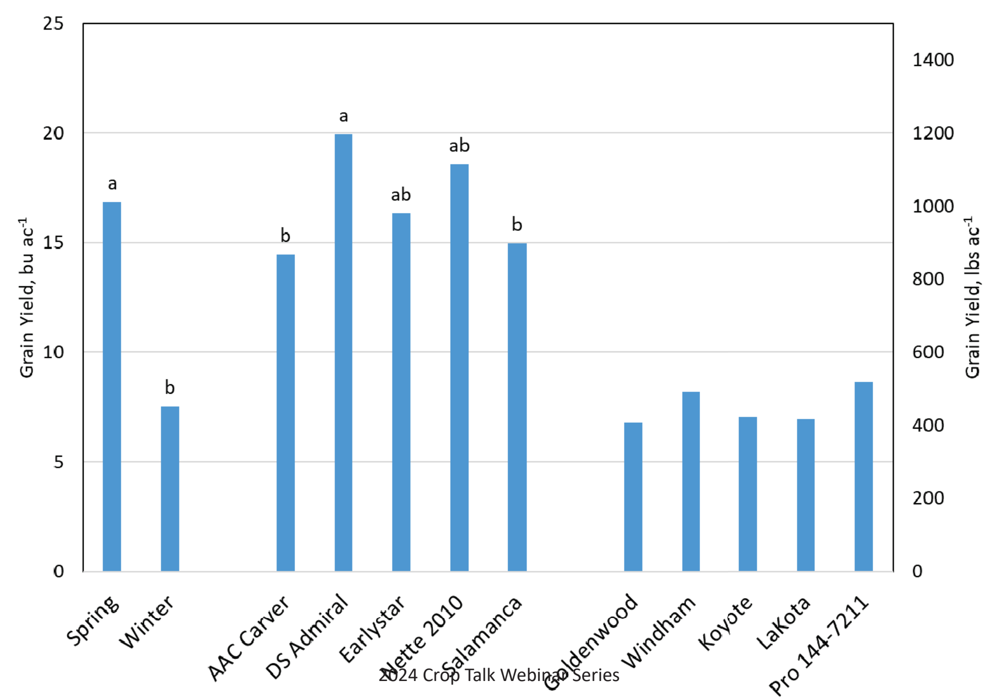


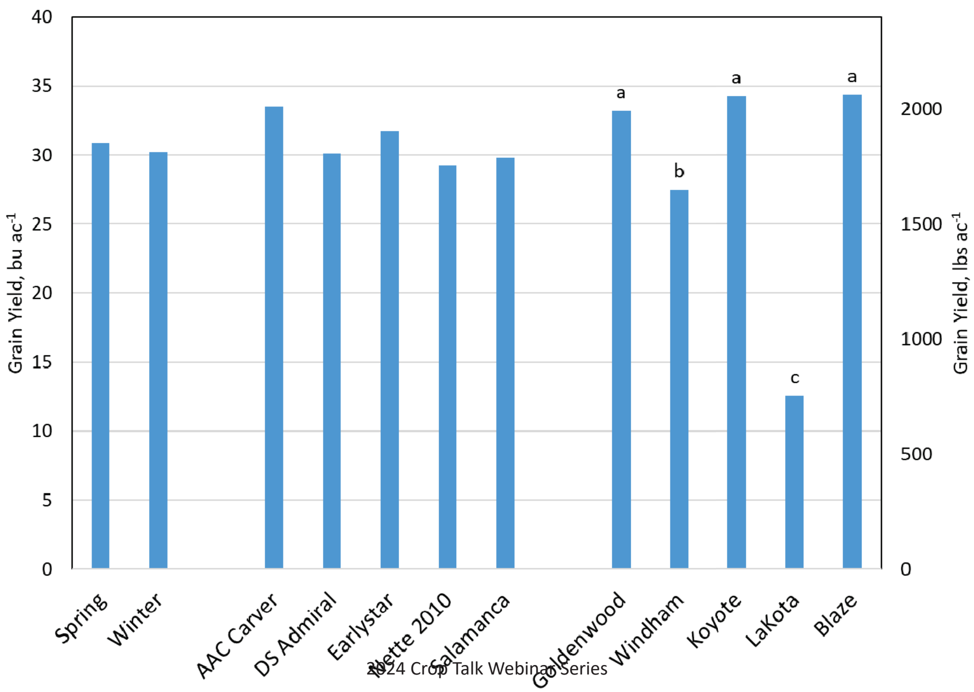
2019 USDA-PCHI Pulses in Rotation - Colby Pea Yields





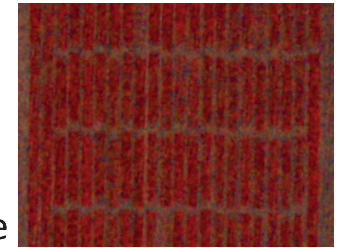

2020 USDA-PCHI Pulses in Rotation - Colby Pea Yields








- Winter pea variety x date of planting
- Phenotyping 300+ lines of spring field pea for heat stress tolerance
  - Use planting date to generate stress levels
  - USDA PSP Collection, Australian lines, commercial varieties
  - Use of sUAVs: Thermal, RGB, NDVI
- Continue variety testing and management trials





# Questions?

Spring Field Peas at the Colby Branch Experiment Station, 1915

Contact Info:
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www.northwest.ksu.edu/agronomy
Twitter @LucasAHaag



# Spring Wheat in Northwest Kansas

# Spring Wheat

- 1915-1950: Averaged less than ½ of WW
- 2001-2005: Averaged 49% of WW (28-56%)
- 2019: Averaged 43% of WW (36-55%)

Colby, Kansas Spring Wheat and Winter Wheat, 2001-2005

| Year | Winter Wheat Mean of Top LSD Group | Spring Wheat Mean |
|---|---|---|
| | -- Grain Yield, bu ac$^{-1}$ -- | |
| 2001 | 82.1 | 46.0 |
| 2002 | 43.2 | 12.1 |
| 2003 | 78.7 | 42.4 |
| 2004 | 60.1 | 30.3 |
| 2005 | 78.2 | 37.5 |
| Average | 68.5 | 33.7 |

R. Aiken, 2008. unpublished data.



**Cornerstone Ag Cash Bids**

| Notes | Basis Month | Basis | Cash Price | Futures Price |
|---|---|---|---|---|
| **Corn** | | | | |
| IN-STORE BID | May 2024 | -5 | $4.35 | 440-2 |
| 2024 NEW CROP BID | December 2024 | -25 | $4.47 | 471-4 |
| **Hard Red Winter Wheat** | | | | |
| IN-STORE BID | May 2024 | -70 | $5.23 | 593-2 |
| NEW CROP 2024 | July 2024 | -50 | $5.32 | 581-6 |
| **Milo** | | | | |
| IN-STORE BID | May 2024 | 0 | $4.40 | 440-2 |
| 2024 NEW CROP BID | December 2024 | -45 | $4.27 | 471-4 |
| **Soybeans** | | | | |
| IN-STORE BID | May 2024 | -125 | $10.57 | 1182-2 |
| 2024 NEW CROP BID | November 2024 | -115 | $10.60 | 1175-0 |
| **Spring Wheat** | | | | |
| IN-STORE BID | May 2024 | -65 | $6.00 | 664-4 |

**$0.77/bu**

**Plus the difference in fallow cost**

**3/11/2024 Closing Prices**



# Spring Wheat

- So why would you do this?
  - Fallow alternative
  - Potential marketing opportunities for spring wheat
- Unknowns
  - Any economic return will be contingent on growing satisfactory quality, can we consistently do that in our environment?
- Be Aware
  - Different market class than HRWW, cannot be blended. However, white is a different story



Table x. Spring Wheat, Colby, Kansas 2019.

| Variety | Grain yield | | | Moisture | Test Weight | | Kernel weight | | Plant Height | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mg ha$^{-1}$ | (bu ac$^{-1}$) | | | | | mg | | in | |
| LCS_Cannon | 3.51 | (56) | a | 11.8 | 59.8 | a | 30.7 | abcd | 28.8 | bcd |
| WB7589 | 2.99 | (48) | b | 10.8 | 54.4 | g | 31.7 | ab | 26.0 | cd |
| WB9590 | 2.98 | (47) | b | 11.2 | 55.0 | fg | 30.7 | abc | 27.3 | bcd |
| WB9479 | 2.90 | (46) | bc | 11.0 | 56.3 | def | 30.2 | bcde | 26.8 | cd |
| LCS_Trigger | 2.89 | (46) | bc | 11.1 | 56.6 | cdef | 28.8 | efg | 28.8 | bcd |
| WB7202CLP | 2.80 | (45) | bcd | 11.4 | 55.5 | defg | 28.8 | ef | 28.3 | bcd |
| MS_Barracuda | 2.75 | (44) | bcde | 11.3 | 57.0 | bcde | 30.7 | abcd | 29.3 | abcd |
| MS_Chevelle | 2.71 | (43) | cde | 10.9 | 56.1 | defg | 28.1 | fgh | 30.5 | ab |
| SY_Valda | 2.71 | (43) | cde | 11.4 | 58.4 | ab | 29.9 | cde | 26.8 | cd |
| LCS_Rebel | 2.66 | (42) | cde | 10.9 | 57.2 | bcd | 26.9 | h | 32.5 | a |
| WB97179 | 2.62 | (42) | def | 11.3 | 55.2 | efg | 28.5 | efgh | 26.5 | cd |
| SY_Rustler | 2.59 | (41) | def | 11.4 | 58.5 | ab | 32.0 | a | 29.2 | abc |
| MS_Camaro | 2.52 | (40) | efg | 11.5 | 58.0 | bc | 29.7 | cde | 25.5 | d |
| WB7328 | 2.38 | (38) | fg | 11.1 | 55.6 | defg | 31.0 | abc | 27.3 | bcd |
| MS_Stingray | 2.37 | (38) | g | 11.9 | 55.9 | defg | 29.1 | def | 32.5 | a |
| WB9668 | 2.30 | (37) | g | 11.3 | 55.3 | efg | 27.3 | gh | 26.8 | cd |
| LSD = 0.05 | | | | | | | | | | |
| Variety | 0.24 | (3.7) | | 0.0 | 1.7 | | 1.6 | | 3.8 | |
| | ANOVA P>F | | | | | | | | | |
| Effect | | | | | | | | | | |
| Variety | <0.0001 | | | 0.7816 | <0.0001 | | <0.0001 | | 0.0058 | |

† Letters within a column and an effect represent differences at LSD (0.05) unless noted otherwise

Planted 4/23/2019 at 1.3M seeds/ac
Harvested 7/31/2019, yields reported at 13.5% moisture

2020 Thomas County, Kansas Dryland Spring Wheat Variety Performance Test

| Company | Variety | Grain Yield | Moisture | Test Weight | Protein | Heading Date | | Seeds/Lb |
|---|---|---|---|---|---|---|---|---|
| | | bu/ac | % | bu/ac | % | DOY | | |
| WestBred | WB9590 | **24.3** a | 12.1 | 54.0 abcd | 17.94 | 6/3 | defg | 21551 efgh |
| Meridian Seeds | MS Ranchero | **23.6** ab | 13.1 | 52.9 cd | 17.64 | 5/31 | h | 23366 abcd |
| Limagrain | LCS Cannon | **23.6** ab | 12.2 | 55.9 ab | 17.51 | 6/1 | gh | 24445 ab |
| Meridian Seeds | MS Chevelle | **23.5** ab | 12.2 | 56.6 a | 16.59 | 6/3 | de | 22541 cdefg |
| WestBred | WB9606 | **22.9** ab | 12.2 | 54.6 abc | 16.93 | 6/4 | cd | 23033 abcde |
| Meridian Seeds | MS Barracuda | **22.6** ab | 12.2 | 54.9 abc | 17.71 | 6/2 | efgh | 21006 gh |
| WestBred | WB7202CL | **22.5** ab | 12.0 | 51.7 d | 17.47 | 6/1 | fgh | 24846 a |
| Syngenta AgriPro | SY Ingmar | **22.4** ab | 12.8 | 55.8 ab | 18.43 | 6/8 | a | 23389 abcd |
| WestBred | WB7696 | **21.9** abc | 12.0 | 53.3 bcd | 17.94 | 6/2 | efgh | 23120 abcde |
| WestBred | WB9719 | **21.7** abc | 11.9 | 53.1 cd | 17.68 | 6/5 | bc | 20499 h |
| WestBred | WB9479 | **21.6** abc | 12.3 | 53.6 bcd | 18.00 | 6/3 | de | 21321 fgh |
| Meridian Seeds | MS Camaro | **21.2** abc | 12.1 | 56.1 ab | 17.66 | 6/4 | cd | 22089 cdefgh |
| Limagrain | LCS Trigger | **21.0** abc | 12.0 | 55.2 abc | 17.75 | 6/5 | bc | 22016 cdefgh |
| Limagrain | LCS Rebel | 20.6 bc | 12.4 | 56.4 a | 19.00 | 6/3 | defg | 21809 defgh |
| Syngenta AgriPro | SY Rustler | 19.0 c | 12.2 | 53.2 abcd | 17.36 | 6/3 | def | 23653 abc |
| Syngenta AgriPro | SY Valda | 18.8 c | 13.4 | 52.2 cd | 17.87 | 6/6 | ab | 22774 bcdef |
| | P>F | **0.0404** | 0.0839 | **0.0165** | 0.1350 | **<0.0001** | | **0.0002** |
| | LSD (0.05) | 3.2 | NS | 2.8 | NS | 1.5727 | | 1737 |

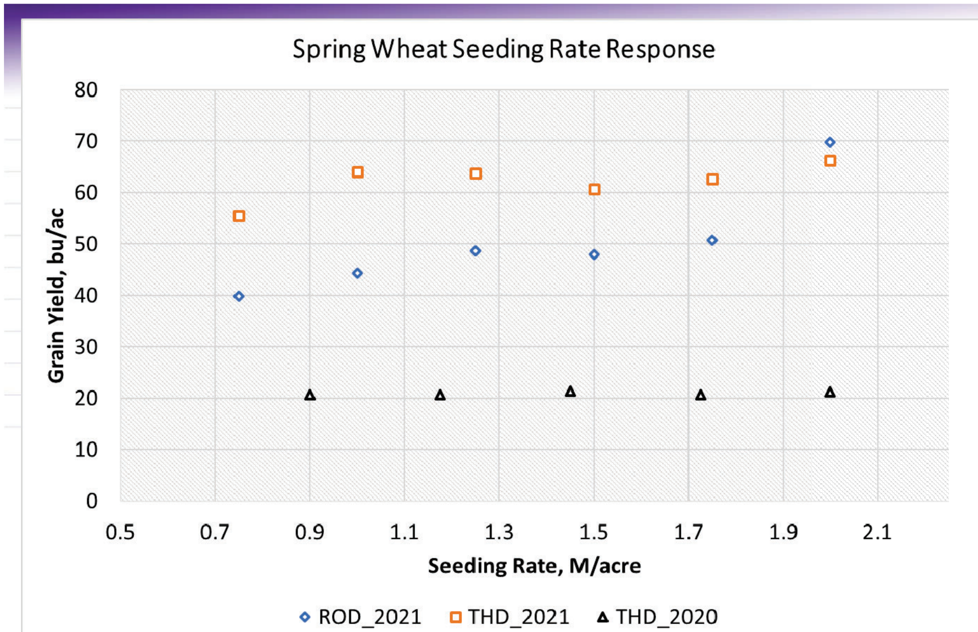
Bold yields represent the top yield group at LSD (0.05)
Spring wheat was seeded into fresh (2019 crop) dryland corn stalks
Seeded 3/12/2020 on 10" row spacing at 1.5M live seed/acre
130 lb/ac N applied as UAN topdress prior to joint
Different letters represent statistical differences at LSD=0.05



K-State Dryland Spring Wheat Variety Trial Summary, 2019-2022

| Variety | Thomas Dryland 2019 | Thomas Dryland 2020 | Thomas Dryland 2021 | Rooks Dryland 2021 | Rooks Dryland 2022 | 2-Site-Year Average | 3-Site-Year Average | 4-Site-Year Average | 5-Site-Year Average |
|---|---|---|---|---|---|---|---|---|---|
| | Grain Yield, bu ac$^{-1}$ | | | | | | | | |
| LCS Cannon | 55.9 | 23.6 | 53.8 | 50.7 | 21.0 | . | . | . | 46.0 |
| WB9590 | 47.4 | 24.3 | 54.9 | 44.8 | 20.0 | . | . | . | 42.9 |
| LCS Trigger | 46.0 | 21.0 | 52.4 | 52.0 | 13.6 | . | . | . | 42.9 |
| WB9719 | 41.7 | 21.7 | 54.0 | 41.0 | 14.5 | . | . | . | 39.6 |
| LCS Rebel | 42.4 | 20.6 | 49.4 | 40.6 | . | . | . | 38.3 | . |
| WB9606 | . | 22.9 | 49.6 | 48.2 | 11.1 | . | . | 32.9 | . |
| ND VitPro | . | . | 47.0 | 38.0 | 14.5 | . | 33.2 | . | . |
| ND Prohberg | . | . | 42.6 | 36.0 | 14.0 | . | 30.9 | . | . |
| WB7202CLP | 44.6 | 22.5 | . | . | 24.3 | . | 30.5 | . | . |
| WB9707 | . | . | 49.4 | 42.2 | | 45.8 | . | . | . |
| WB9479 | 46.1 | 21.6 | . | . | | 33.9 | . | . | . |
| MS Chevelle | 43.1 | 23.5 | . | . | | 33.3 | . | . | . |
| MS Barracuda | 43.8 | 22.6 | . | . | | 33.2 | . | . | . |
| SY Valda | 43.1 | 18.8 | . | . | | 31.0 | . | . | . |
| MS Camaro | 40.1 | 21.2 | . | . | | 30.6 | . | . | . |
| SY Rustler | 41.3 | 19.0 | . | . | | 30.2 | . | . | . |
| AP Murdock | . | . | 44.5 | . | | . | . | . | . |
| AP509-2 | . | . | 46.4 | . | | . | . | . | . |
| MS Ranchero | . | . | . | . | | . | . | . | . |
| MS Stingray | 37.7 | . | . | . | | . | . | . | . |
| SY Ingmar | . | 22.4 | . | . | | . | . | . | . |
| WB7328 | 38.0 | . | . | . | | . | . | . | . |
| WB7589 | 47.7 | . | . | . | | . | . | . | . |
| WB7696 | . | 21.9 | . | . | | . | . | . | . |
| WB9668 | 36.7 | . | . | . | | . | . | . | . |
| LCS Hammer AX | | | | | 15.2 | . | . | | . |
| LCS Heron | | | | | 12.6 | . | . | | . |
| LCS Dual | | | | | 11.1 | . | . | | . |
| LCS Buster | | | | | 6.7 | . | . | | . |
| Site Average | 43.5 | 21.8 | 49.5 | 43.7 | 14.9 | | | | |
| P>F | <0.0001 | 0.0404 | 0.0013 | 0.0016 | <0.0001 | | | | |
| LSD (0.05) | 3.7 | 3.2 | 5.8 | 7.6 | 2.9 | | | | |



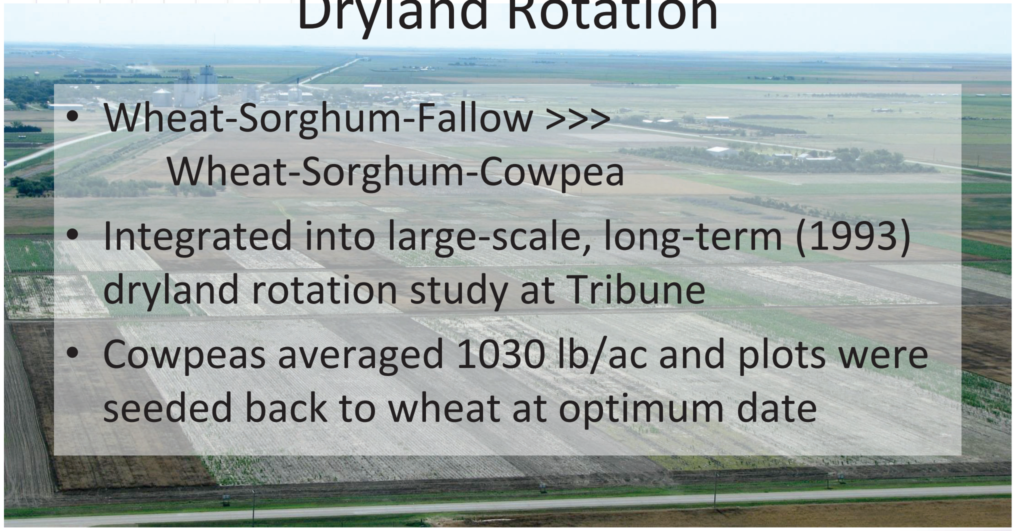





# Cowpeas

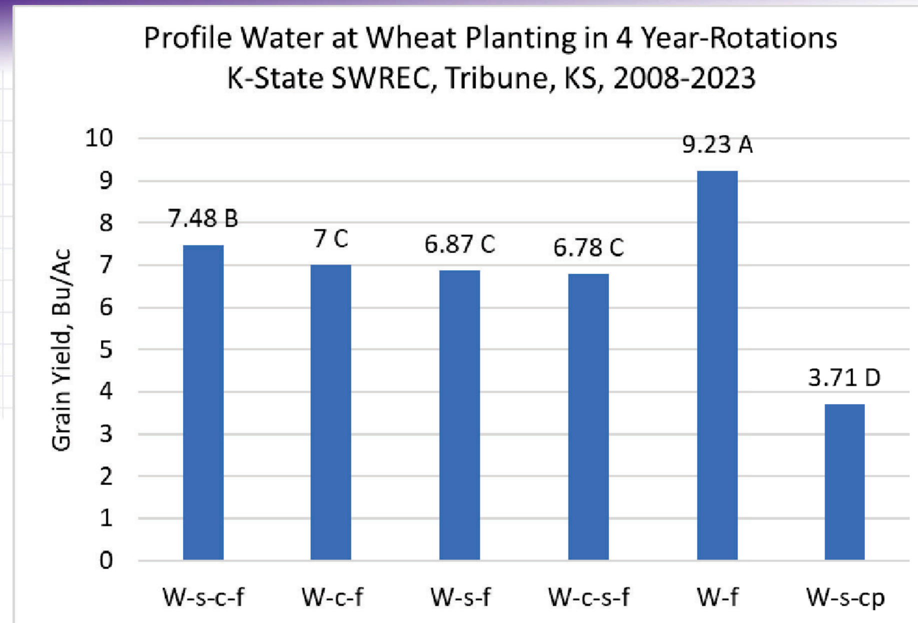
- Heat and drought tolerant
- Relatively low water use
- Short duration crop
  - Somewhat unintentionally we have seen cowpeas succeed in NWKS at late planting dates

# Cowpea Evaluation in a Dryland Rotation

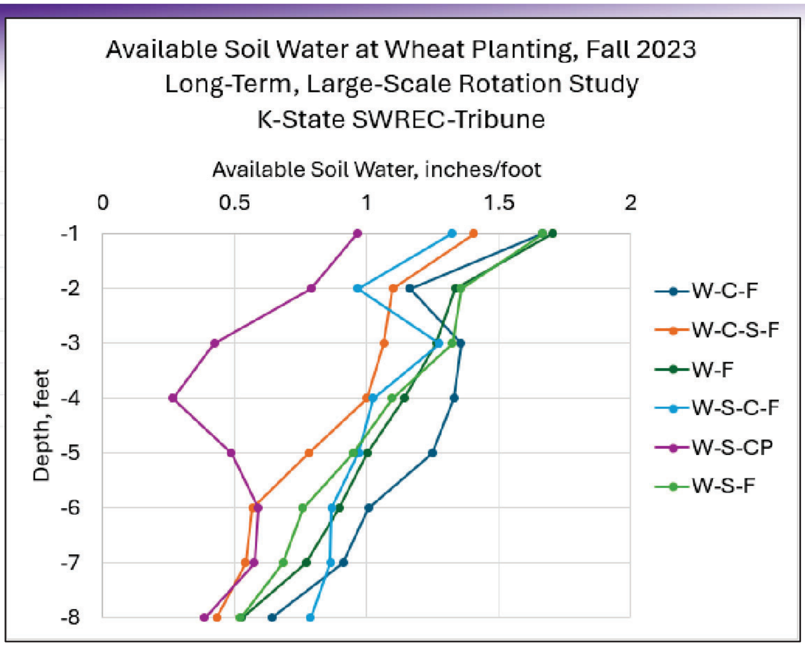


- Wheat-Sorghum-Fallow >>> Wheat-Sorghum-Cowpea
- Integrated into large-scale, long-term (1993) dryland rotation study at Tribune
- Cowpeas averaged 1030 lb/ac and plots were seeded back to wheat at optimum date

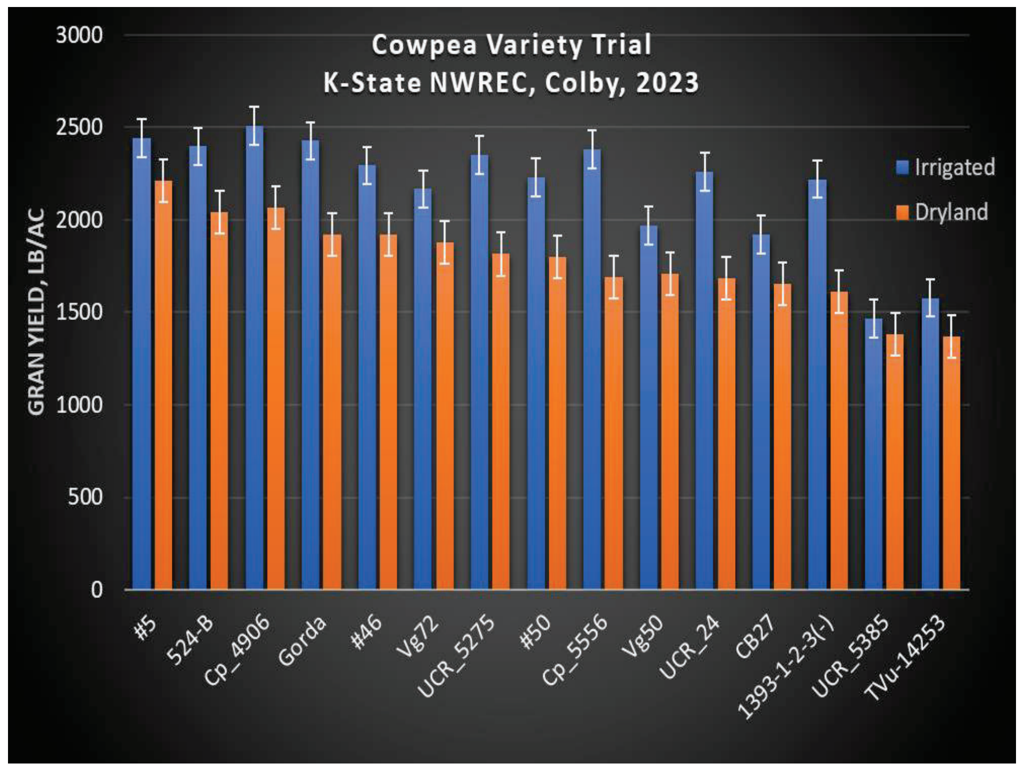


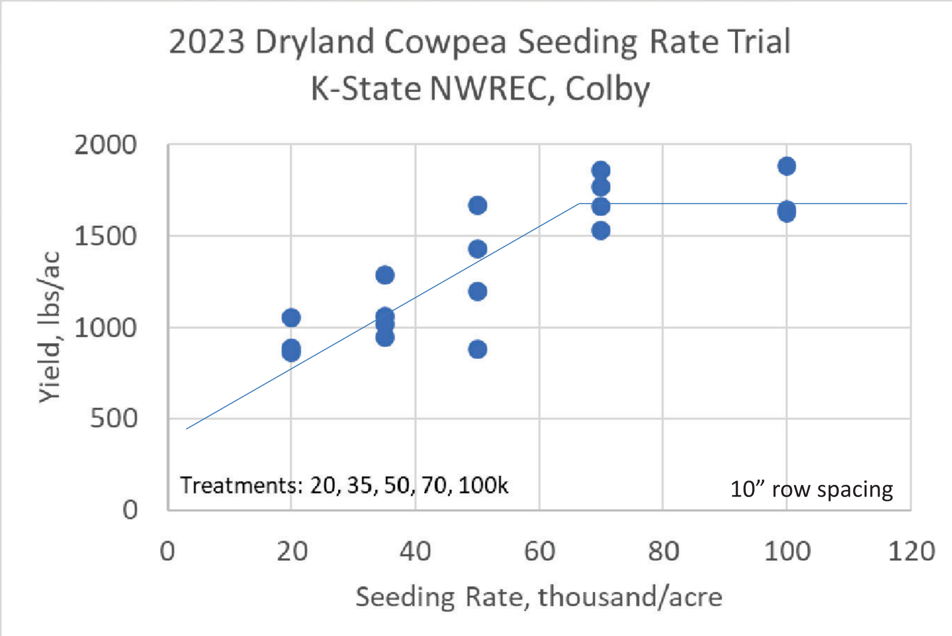




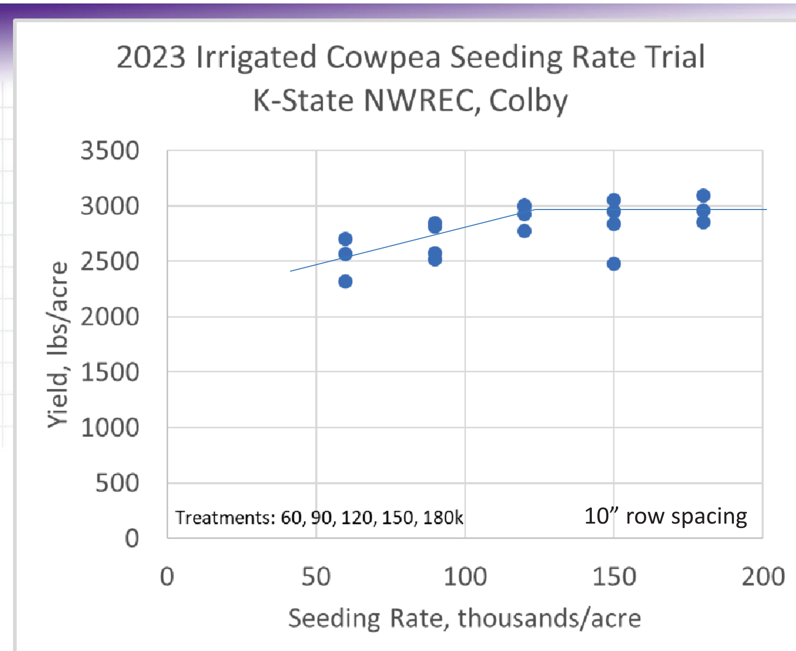












# Inoculant and Nitrogen

- 2023 Colby
  - Irrigated: 0, 30, 60, 90, 150 lb/ac, with and without inoculant
  - Dryland: 0, 25, 50, 75, 100 lb/ac, with and without inoculant
  - Observed no differences in yield or any other measured parameter



# Cowpea Evaluation - 2023

- 30 lines form MAGIC collection
  - (8 parents, 22 lines)
  - Thanks to Lam Huynh
- 126 lines from UCR Minicore
  - Thanks to Tim Close

- 15 varieties, breeding lines, misc.
  - Thanks to Sally Jones Diamond, CSU and María Muñoz Amatriaín, Universidad de León
- 171 Total
- Grown under dryland and irrigated, very limited notes, mostly seed increase
- 2024 – More active effort, two locations

# Camelina

- Oilseed crop in the brassica family
- Grown as early as 600 BC in the Rhine valley
- Important oil crop in Europe pre WWII
- Winter and Spring types Exist
- Short Season Crop: 70-100 days
- Industrial (biodiesel and jet fuel) and human markets (high omega 3 fatty acid content)



# Camelina - Management

- Planting Date: Winter: 9/5 - 10/5
  Spring: 2/15 – 4/1

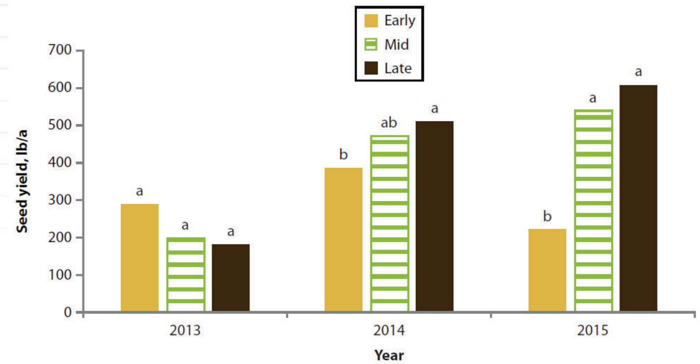



Figure 2. Camelina yield at early, mid, and late seeding dates in year 2013, 2014, and 2015, Agricultural Research Center–Hays; comparison is among planting dates within year. Within years, means followed by the same letter(s) are not significantly different at P>0.05.



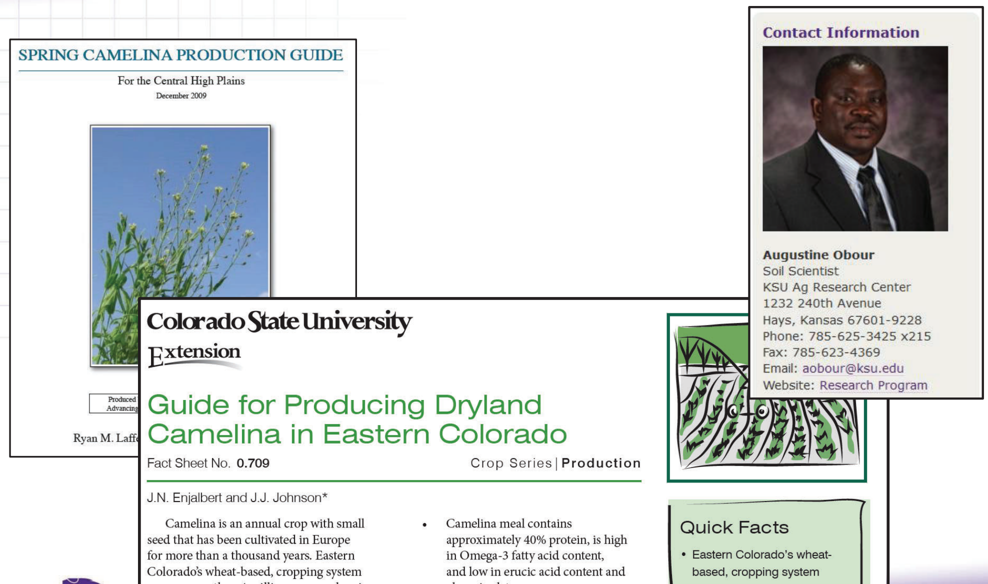
# Camelina - Summary

**Camelina Production Basics:**

- ✓ Good quality seed
- ✓ Firm seedbed
- ✓ Clean field sanitation
- ✓ 1 lb N ≈ 25 lbs seed production
- ✓ or 35-40 lbs N for 1000lb yield*
  *provided good moisture and low weed pressure
- ✓ Seeding rate ≈ 3 to 5 lb/a
- ✓ Row spacing: 8” or less
- ✓ Planting date: Mid-March to mid-April (≈ 35 to 40°F soil temp)
- ✓ **Timely harvest**



# Camelina - Resources



# Winter Canola Variety Trials

Northwest Research-Extension Center, Colby, KS

| 2015/16 Great Plains Trial Results | | | |
|---|---|---|---|
| Variety | 50% bloom (d) | Yield (bu/a) | Yield (rank) |
| KS4658 | 127 | 55.6 | 1 |
| Riley | 119 | 52.7 | 4 |
| Safran | 126 | 50.4 | 7 |
| KS4719** | 129 | 48.8 | 12 |
| Wichita | 124 | 38.6 | 35 |
| Sumner | 121 | 31.8 | 36 |
| Mean | 124 | 45.6 | |
| LSD (0.05) | 3 | 11.8 | |

**Proposed for increase in 2019/20.



# Spring Oilseed Variety Trials

Northwest Research-Extension Center, Colby, KS
(lb/acre)

| | Year | | | |
|---|---|---|---|---|
| Variety | 2003 | 2004 | 2005 | 2006 |
| Hyola 401 (check) | 978 | 868 | 1,204 | 91 |
| High Yield B. napus | 1,294 | 908 | 1,204 | 325 |
| Low Yield B. napus | 431 | 137 | 183 | 28 |
| Camelina | 1,370 | 289 | 1,034 | 93 |
| B. juncea | 1,171 | 417 | 607 | --- |

- Limited by available water, stand establishment, and heat at reproductive stage



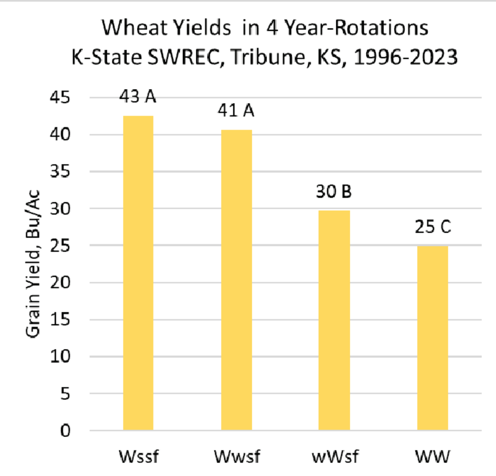
# *Shifting Gears… Intensified Rotations*

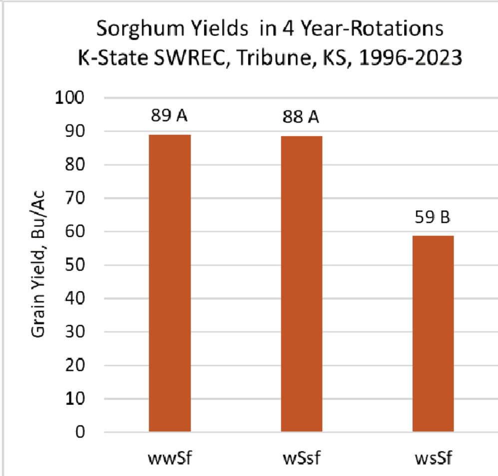


# Four Year Rotations (1996-present)

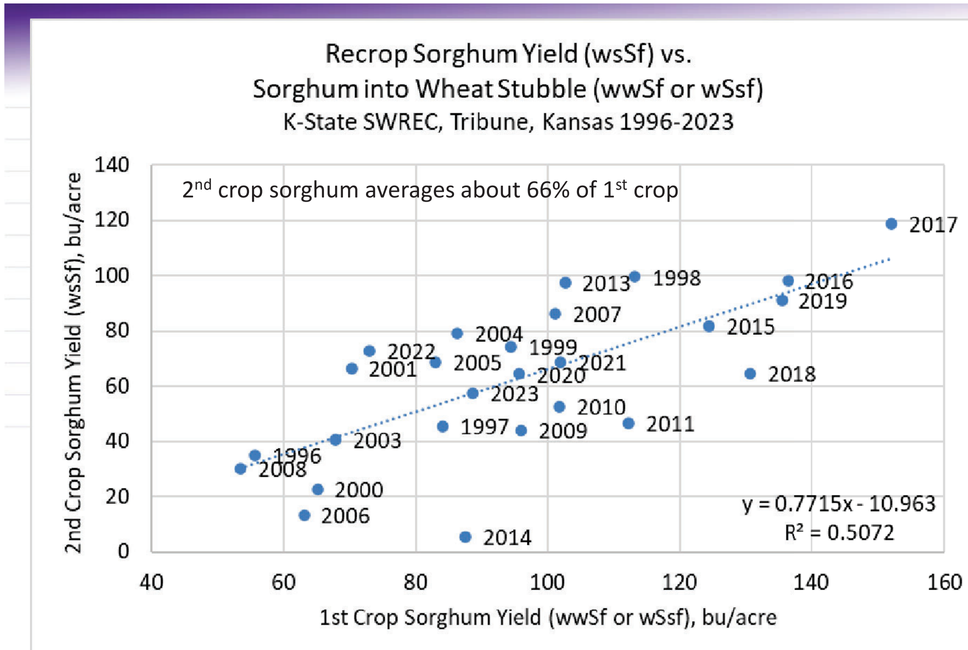
- Wheat-Wheat-Sorghum-Fallow
- Wheat-Sorghum-Sorghum-Fallow
- Continuous Wheat
- All Continuous No-Till

# Average Yields, 1996-present



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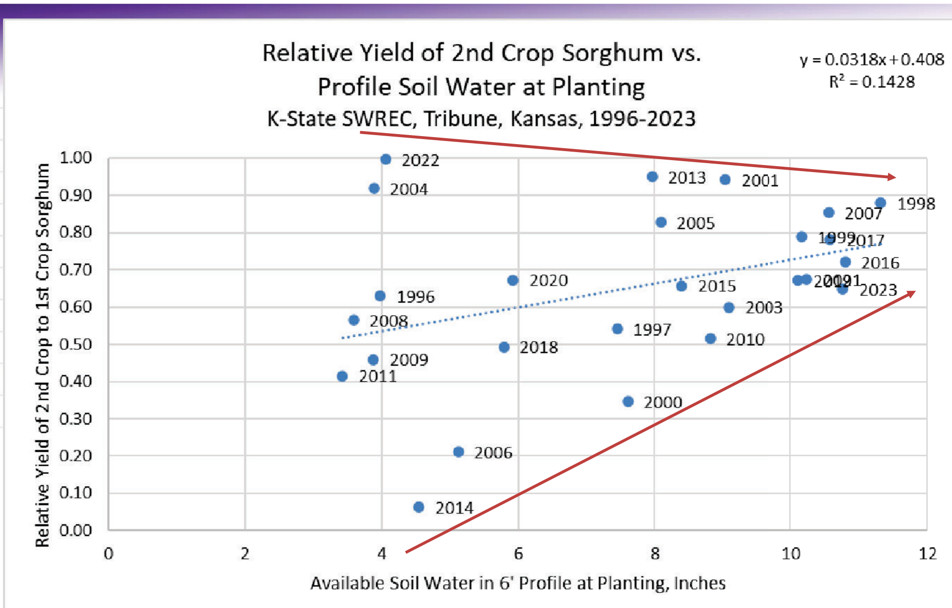


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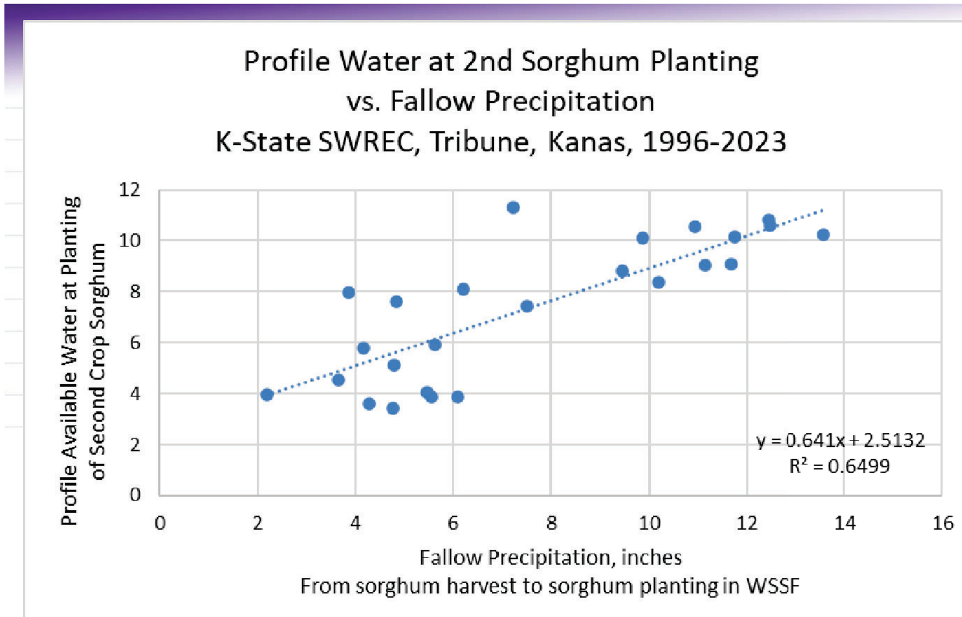


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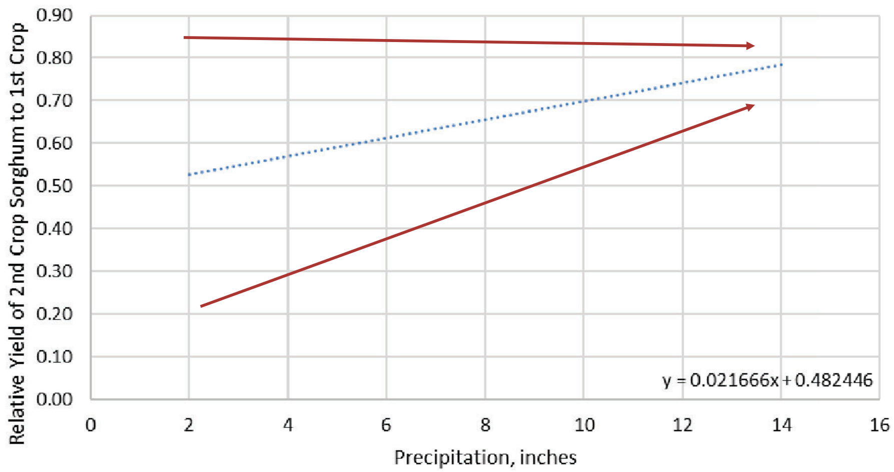
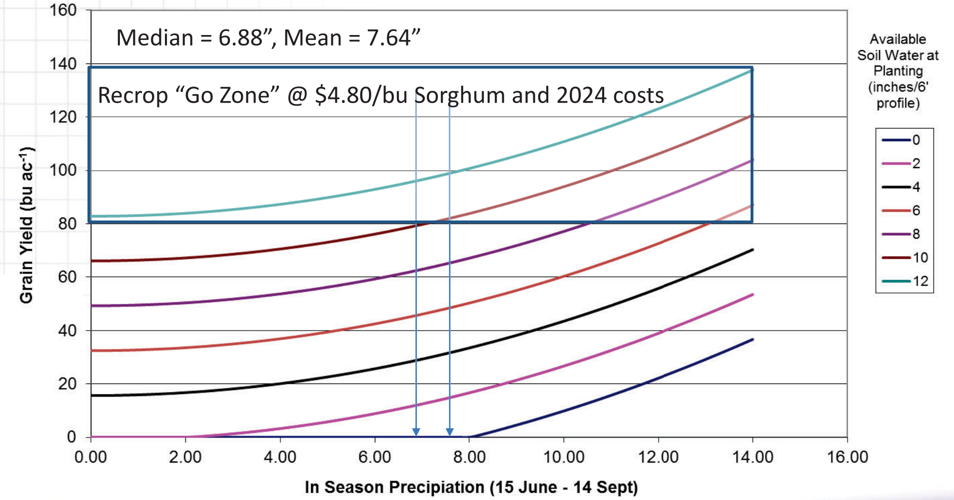
Relative Yield of 2nd Crop Sorghum vs. Fallow Precip
(from 1st sorghum harvest to 2nd sorghum planting)






**Grain Sorghum Yield associated with Water Supply Components**
**SWREC-Tribune 1973-2003**

Adapted by L. Haag from Stone and Schlegel, 2006. Agron. J. 98:1359-1366

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# Long-Term, Large-Scale, Dryland Rotation Study

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# Current Rotations

- Wheat-Fallow (RT)
- Wheat-Corn-Fallow
- Wheat-Sorghum-Fallow
- Wheat-Corn-Sorghum-Fallow
- Wheat-Sorghum-Corn-Fallow
- Continuous Sorghum
- Wheat-Sorghum-Cowpea

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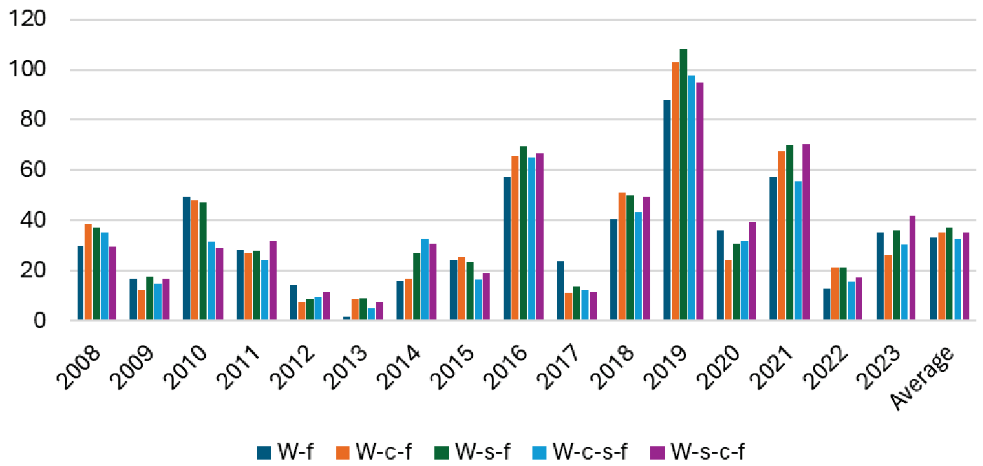
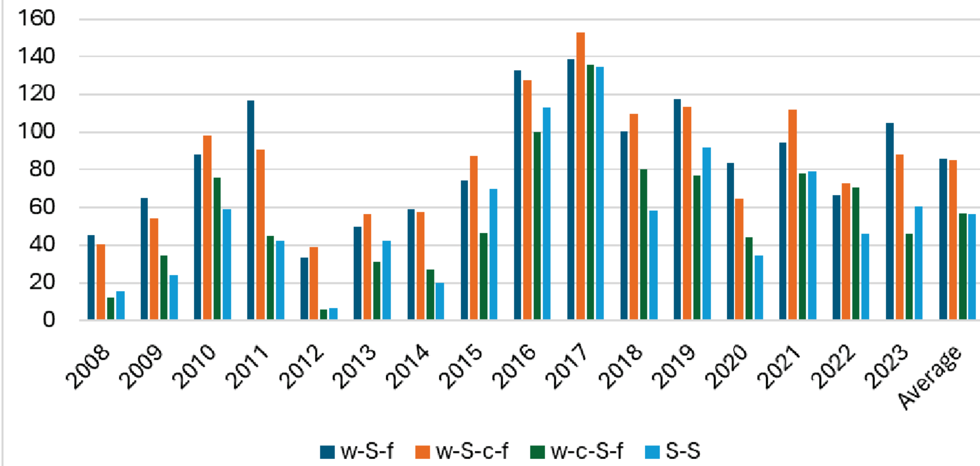
## Long-Term, Large-Scale Dryland Rotation Study
## Wheat Grain Yields by Rotation
## K-State SWREC-Tribune, 2008-present



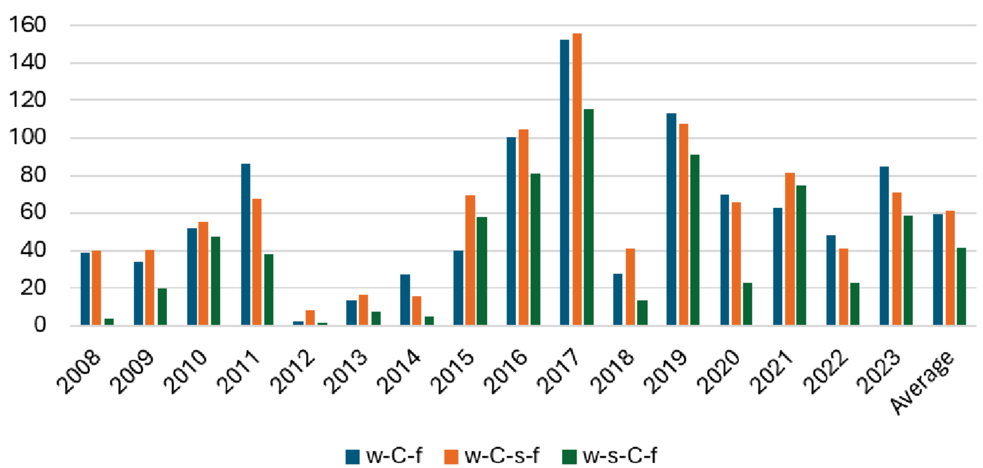



## Long-Term, Large-Scale Dryland Ration Study
## Sorghum Grain Yields by Rotation
## K-State SWREC-Tribune, 2008-present



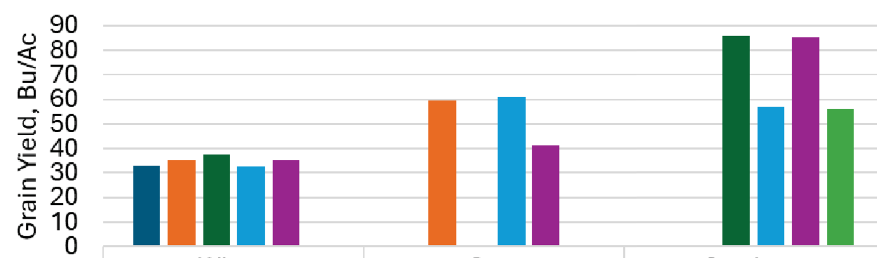



## Long-Term, Large-Scale Dryland Rotatoin Study
## Corn Grain Yields by Rotation
## K-State SWREC-Tribune, 2008-present






## Long-Term, Large-Scale Dryland Rotation Study
## K-State SWREC, Tribune, KS, 2008-present




| | Wheat | Corn | Sorghum |
|---|---|---|---|
| W-F | 33.2 | | |
| W-C-F | 35.2 | 59.6 | |
| W-S-F | 37.5 | | 85.6 |
| W-C-S-F | 32.8 | 61.2 | 56.9 |
| W-S-C-F | 35.1 | 41.3 | 85.2 |
| S-S | | | 56.1 |

W-F W-C-F W-S-F W-C-S-F W-S-C-F S-S

# Concluding Thoughts

- What is my profile water situation?
- What is my surface residue condition?
- Make decisions that will improve precipitation use efficiency
  - Good fallow management
    - No-till, residue, and weed control
  - System Intensification
    - Can we intensity with cash, forage, or green fallow (cover) crops
    - But efforts need to keep in mind “do no harm”
      - hits on subsequent crops reduce surface residues, etc.