Cropping System Stability in the Face of Climate Variability

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K-STATE Research and Extension

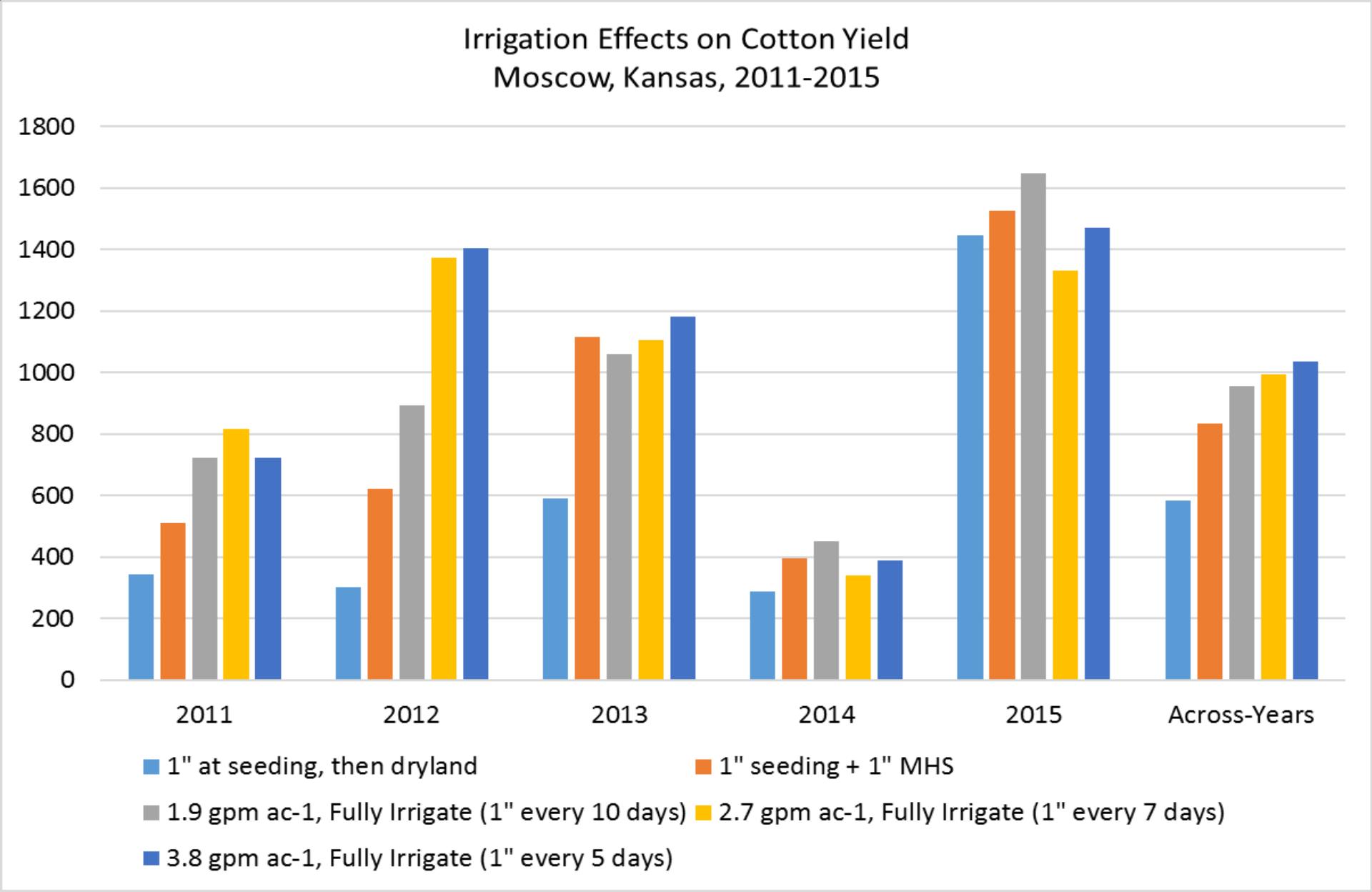
Knowledge for Life

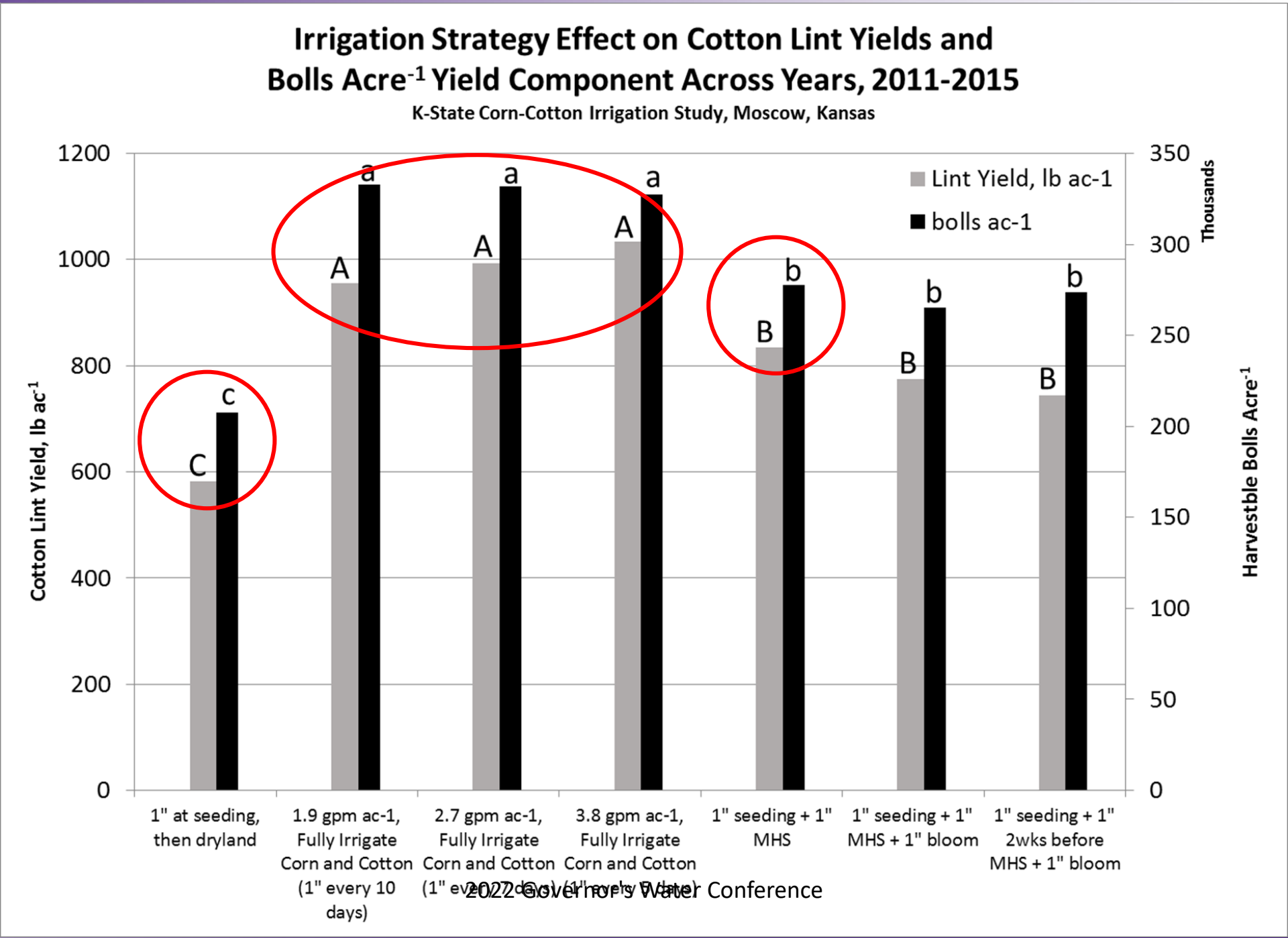
Some ideas.

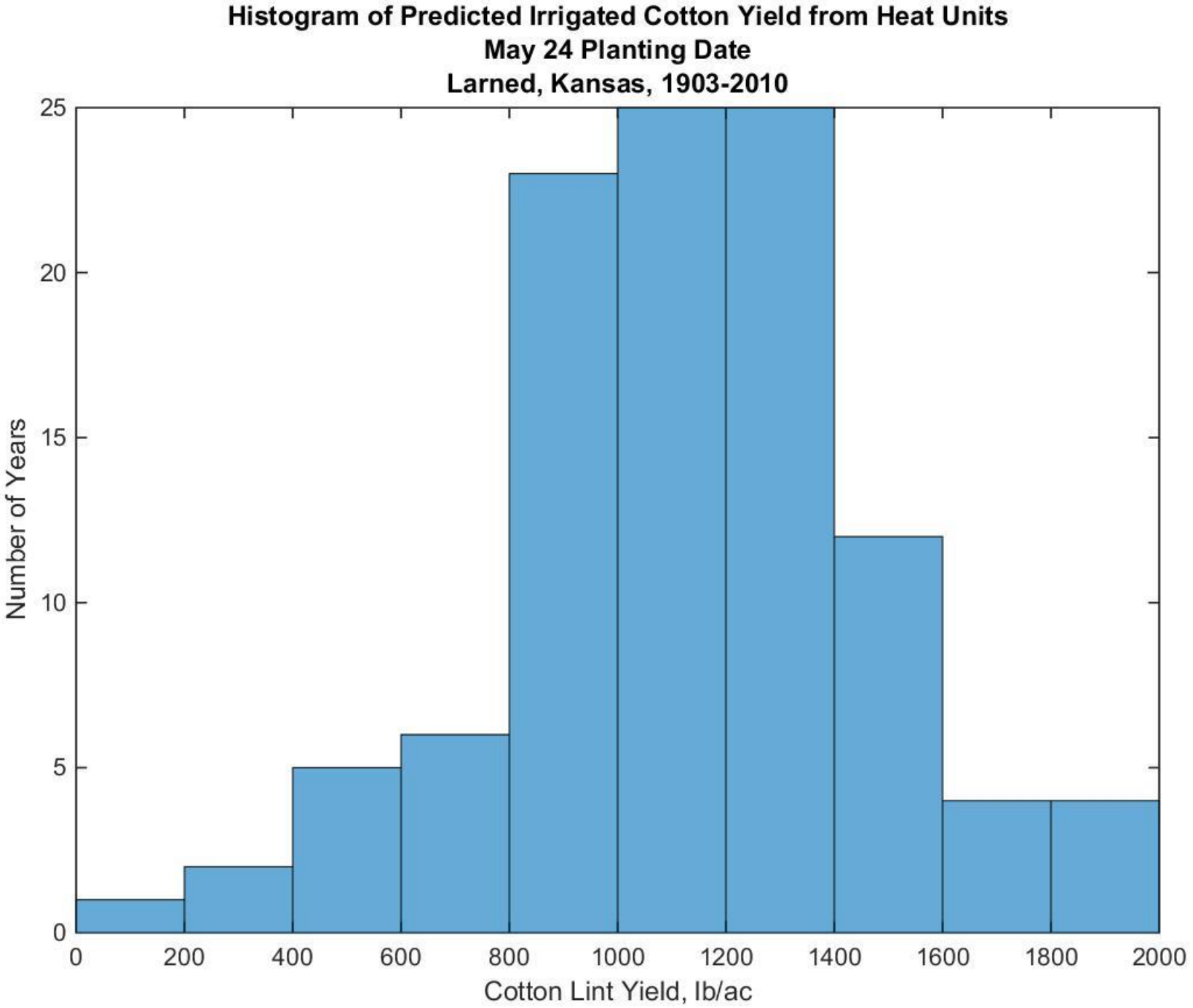
- Genetic / Breeding Improvements
- New Crops
- Adapting management of existing crops
  - Stability of cropping system options
  - Matching Genetics x Management to an environment
  - Exploiting Genetics x Management Stability across environments
- Is the answer something other than annual grain crops?

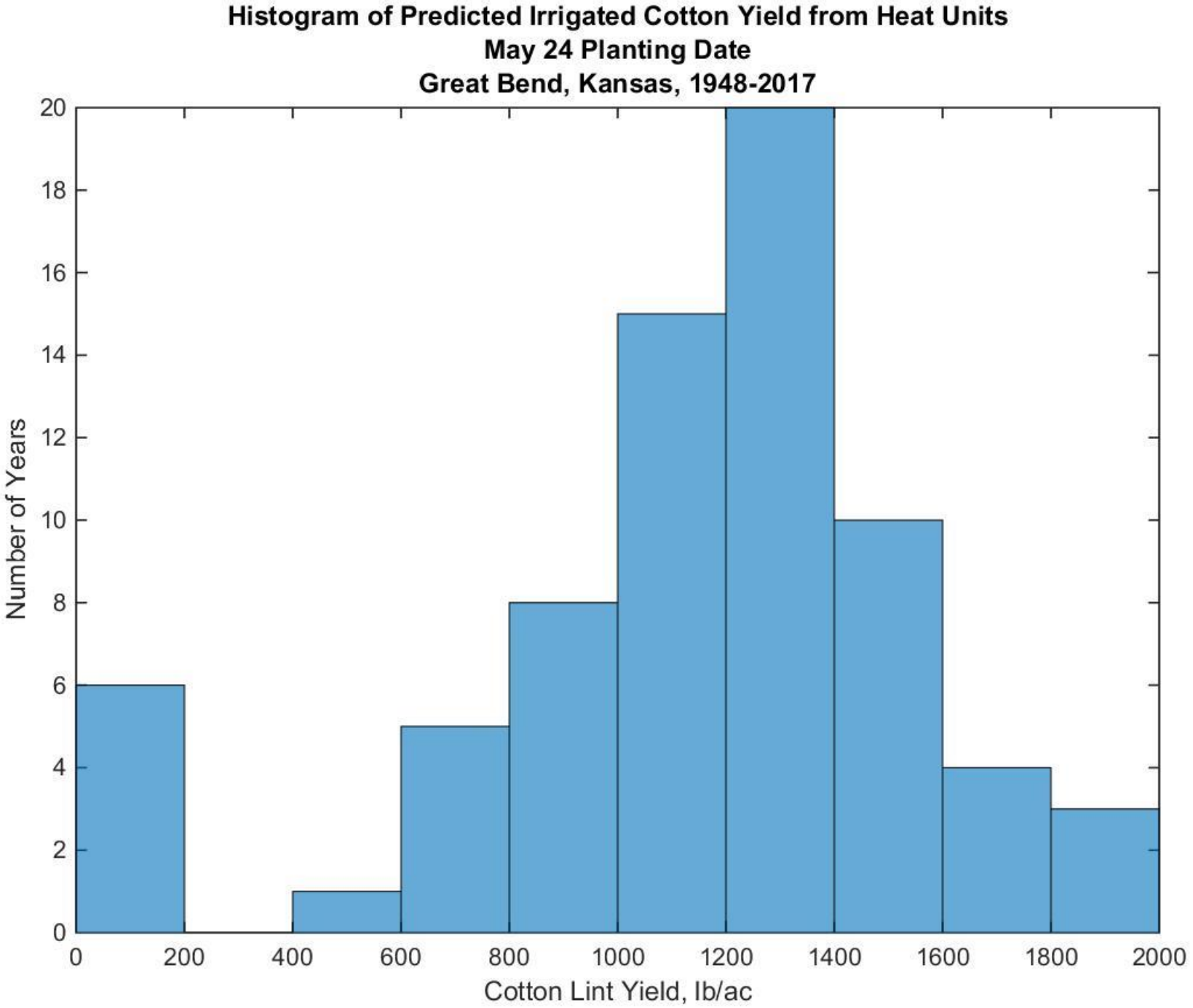
New Crops

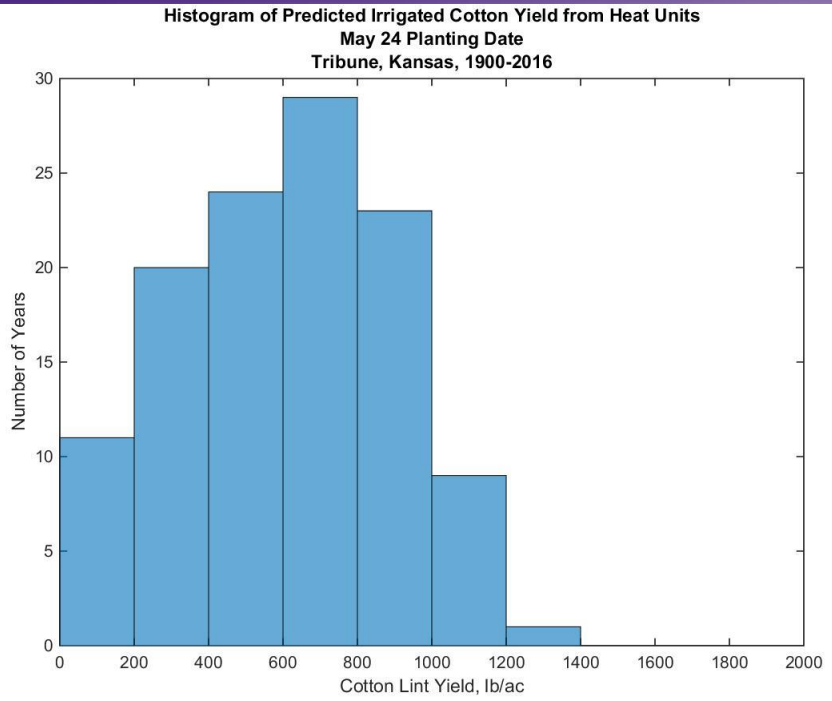
- Conditions (environment, management genetics) have changed, allowing us to grow it in Kansas
- Conditions have changed somewhere else that makes “here” a better alternative
- Of course, economics rules over everything above

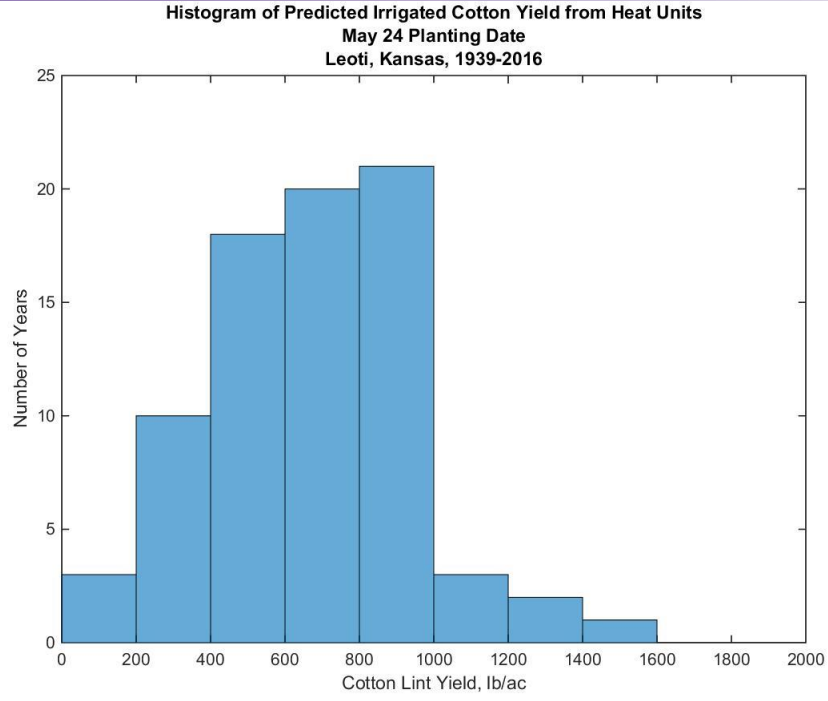

Irrigation Effects on Cotton Yield
Moscow, Kansas, 2011-2015
1800
1600
1400
1200
1000
800
600
400
200
0
2011
2012
2013
2014
2015
Across-Years
1" at seeding, then dryland
1" seeding + 1" MHS
1.9 gpm ac-1, Fully Irrigate (1" every 10 days)
2.7 gpm ac-1, Fully Irrigate (1" every 7 days)
3.8 gpm ac-1, Fully Irrigate (1" every 5 days)

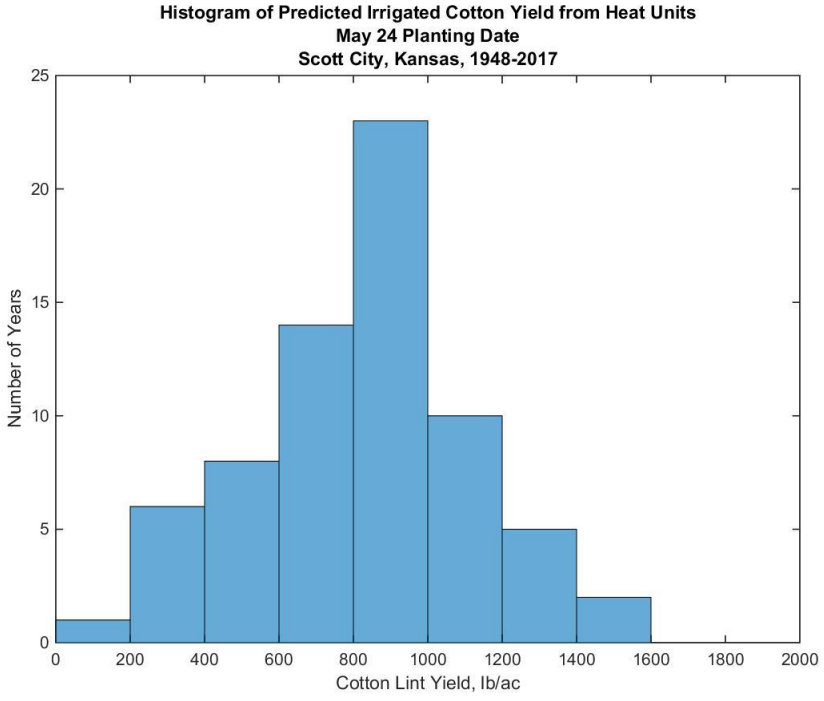

Irrigation Strategy Effect on Cotton Lint Yields and Bolls Acre-1 Yield Component Across Years, 2011-2015
K-State Corn-Cotton Irrigation Study, Moscow, Kansas
Cotton Lint Yield, lb ac-1
Harvestble Bolls Acre-1
Thousands
Lint Yield, lb ac-1
bolls ac-1
1200
1000
800
600
400
200
0
350
300
250
200
150
100
50
0
C
c
A
a
A
a
A
a
B
b
B
b
B
b
1" at seeding, then dryland
1.9 gpm ac-1, Fully Irrigate Corn and Cotton (1" every 10 days)
2.7 gpm ac-1, Fully Irrigate Corn and Cotton (1" every 7 days)
3.8 gpm ac-1, Fully Irrigate Corn and Cotton (1" every 5 days)
1" seeding + 1" MHS
1" seeding + 1" MHS + 1" bloom
1" seeding + 1" 2wks before MHS + 1" bloom

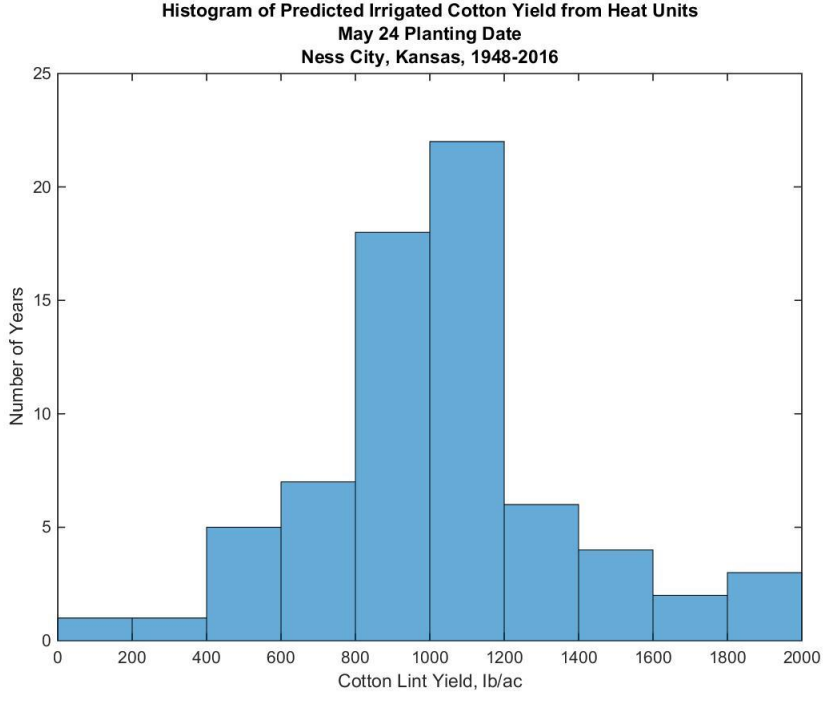

Histogram of Predicted Irrigated Cotton Yield from Heat Units
May 24 Planting Date
Larned, Kansas, 1903-2010
Number of Years
Cotton Lint Yield, lb/ac
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000


Histogram of Predicted Irrigated Cotton Yield from Heat Units
May 24 Planting Date
Great Bend, Kansas, 1948-2017
Number of Years
Cotton Lint Yield, lb/ac
0
2
4
6
8
10
12
14
16
18
20
0
200
400
600
800
1000
1200
1400
1600
1800
2000


Histogram of Predicted Irrigated Cotton Yield from Heat Units
May 24 Planting Date
Tribune, Kansas, 1900-2016
Number of Years
Cotton Lint Yield, lb/ac
0
5
10
15
20
25
30
0
200
400
600
800
1000
1200
1400
1600
1800
2000


Histogram of Predicted Irrigated Cotton Yield from Heat Units
May 24 Planting Date
Leoti, Kansas, 1939-2016
Number of Years
Cotton Lint Yield, lb/ac
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000


Histogram of Predicted Irrigated Cotton Yield from Heat Units
May 24 Planting Date
Scott City, Kansas, 1948-2017
Number of Years
Cotton Lint Yield, lb/ac
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000


Histogram of Predicted Irrigated Cotton Yield from Heat Units
May 24 Planting Date
Ness City, Kansas, 1948-2016
Number of Years
Cotton Lint Yield, lb/ac
0
5
10
15
20
25
0
200
400
600
800
1000
1200
1400
1600
1800
2000

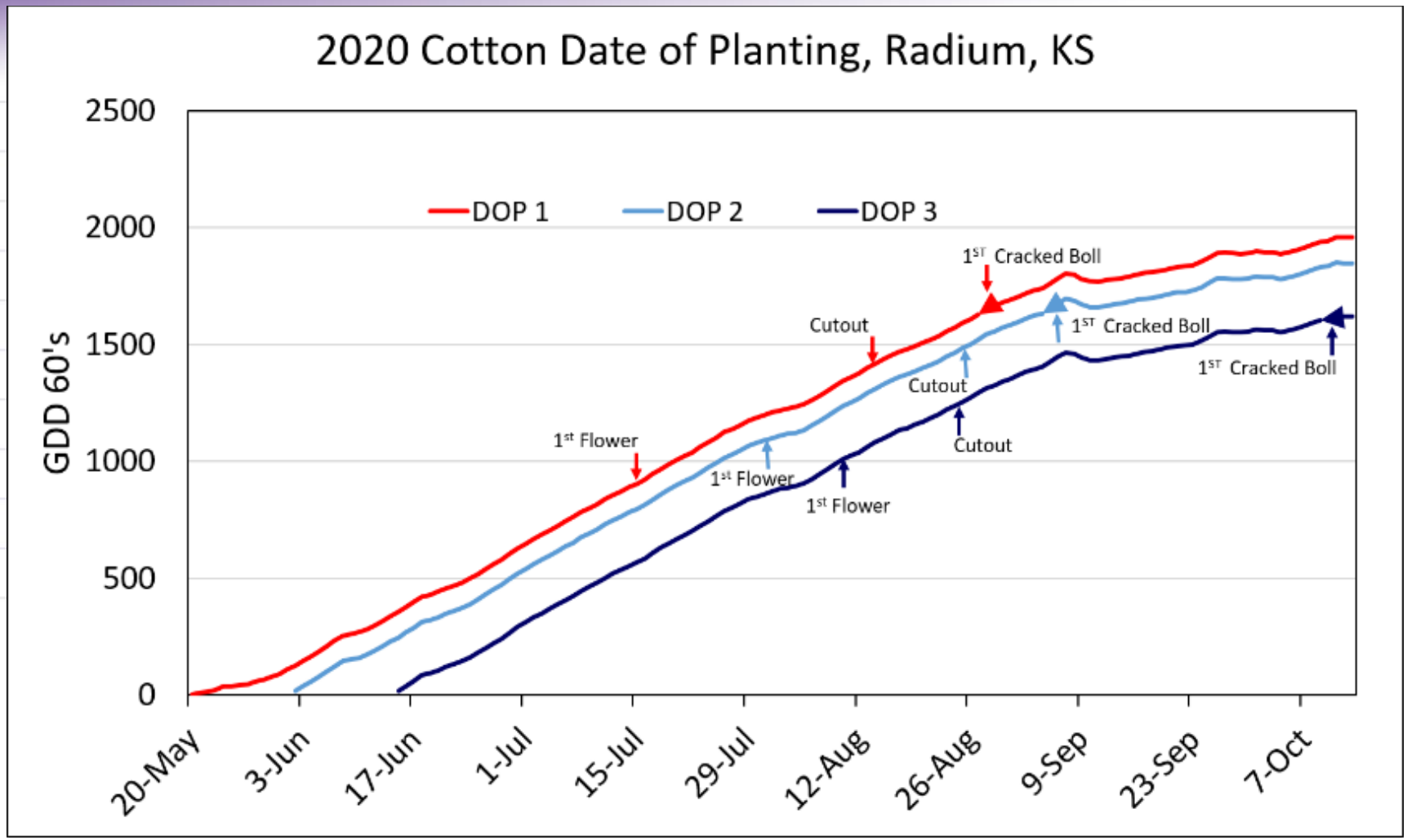


Figure 1. Heat Unit accumulation and stages of cotton development over the course of the 2020 growing season for cotton planted at three different planting dates near Radium, KS. **38.120794, -98.895808**

What's different here?

- With respect to Irrigation
  - Irrigated cotton is likely the only crop in Kansas where water is not the yield limiting factor
  - Management decisions revolve around matching inputs to our yield limiting factor (GDU's)
- With respect to heat unit / yield relationships
  - Lower night time temperatures, how much does that change things? Is GDD base 60 correct?

Work continues…

Southwest Research-Extension Center, Garden City

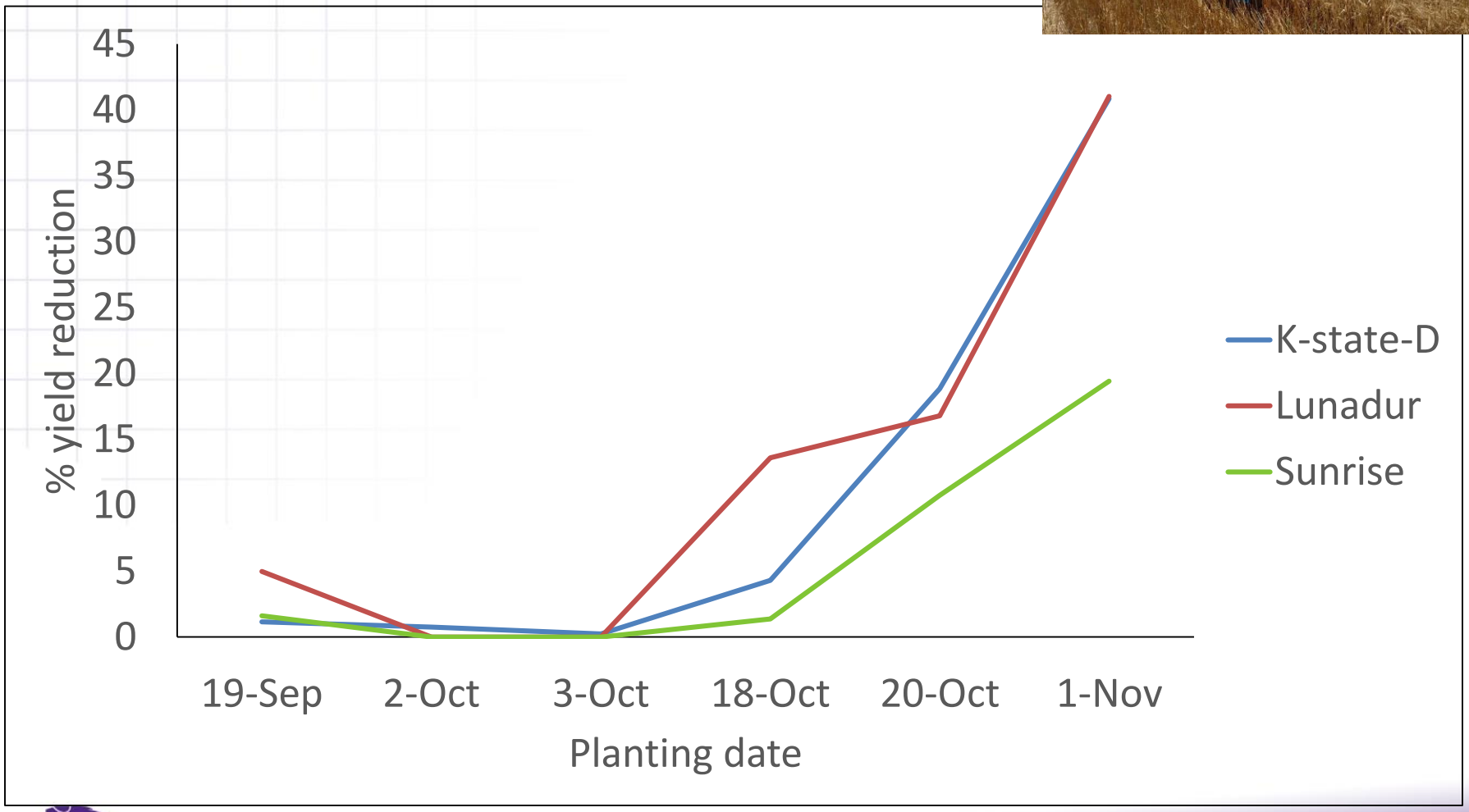
Cotton

Corn

Winter Durum Wheat

- High gluten content, good for pasta
- Higher price per bushel compared to conventional
- Fewer tillers per plant but bigger head size
- Potentially more drought tolerant compared to hard red winter wheat
- Potential to be grown in western Kansas
- Traditional growing regions having challenges

New crops, always a learning curve….



Crops moving to Kansas?

- Cotton
- Durum Wheat
- Increase in millet acres?
- Horticultural Crops?
- Others?

Crops that need some work yet…

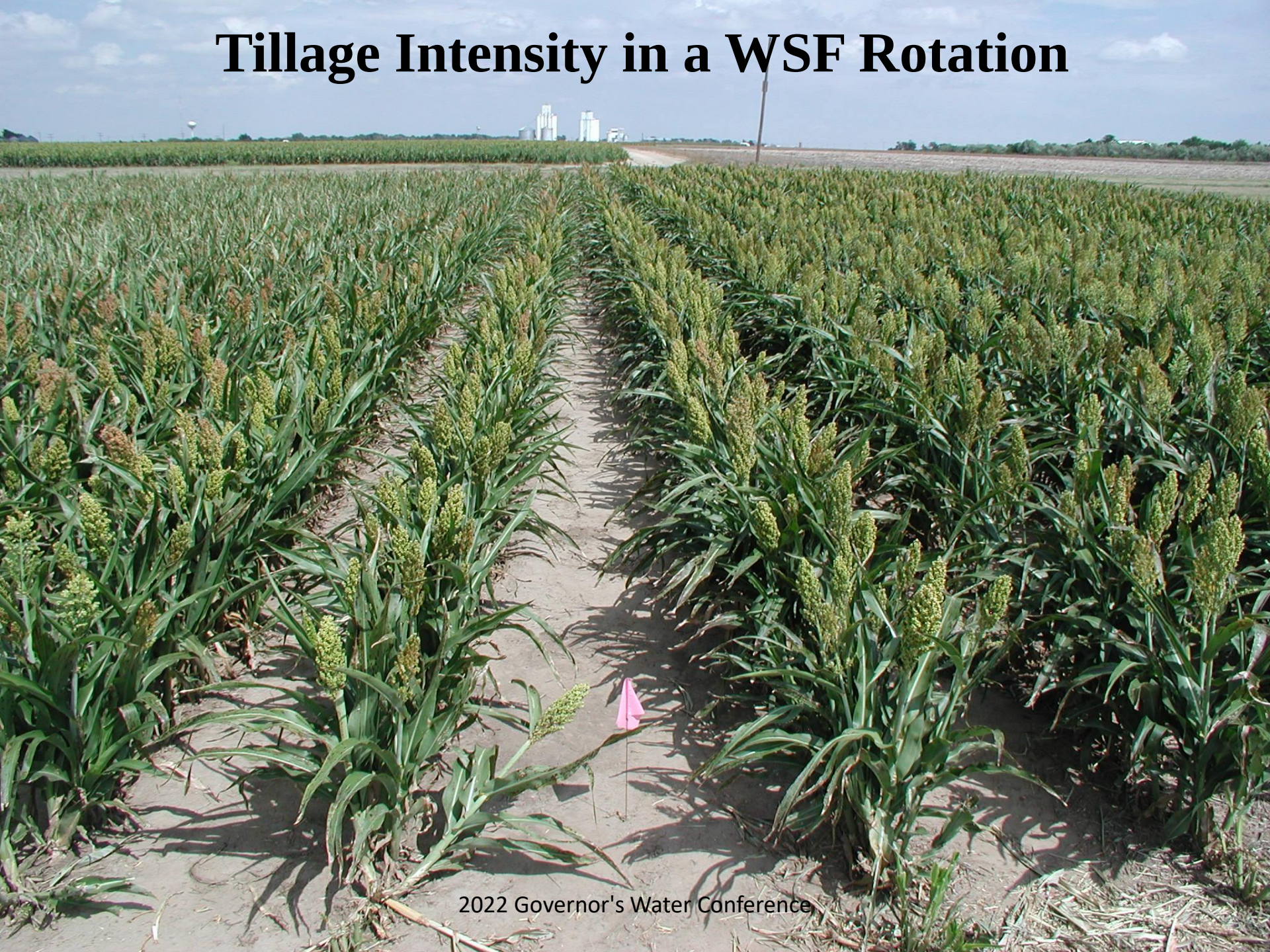
- Canola / Camelina

- Field Peas (winter and spring)

- Perennials?

Stability and Cropping Systems Management

Tillage Intensity in a WSF Rotation



2022 Governor's Water Conference

Original study: compare 3 tillage systems

- ***Conventional***
  - Tilled as needed to control weeds
  - 4-5 times/year with blade plow or field cultivator
- ***Reduced tillage***
  - No-till from wheat harvest through sorghum planting
  - Regular tillage from sorghum harvest through wheat planting
- ***No till***
  - Exclusive use of herbicide for weed control
- Compared using a W-S-F rotation in a study at Tribune from 2001 through present

Yield Stability

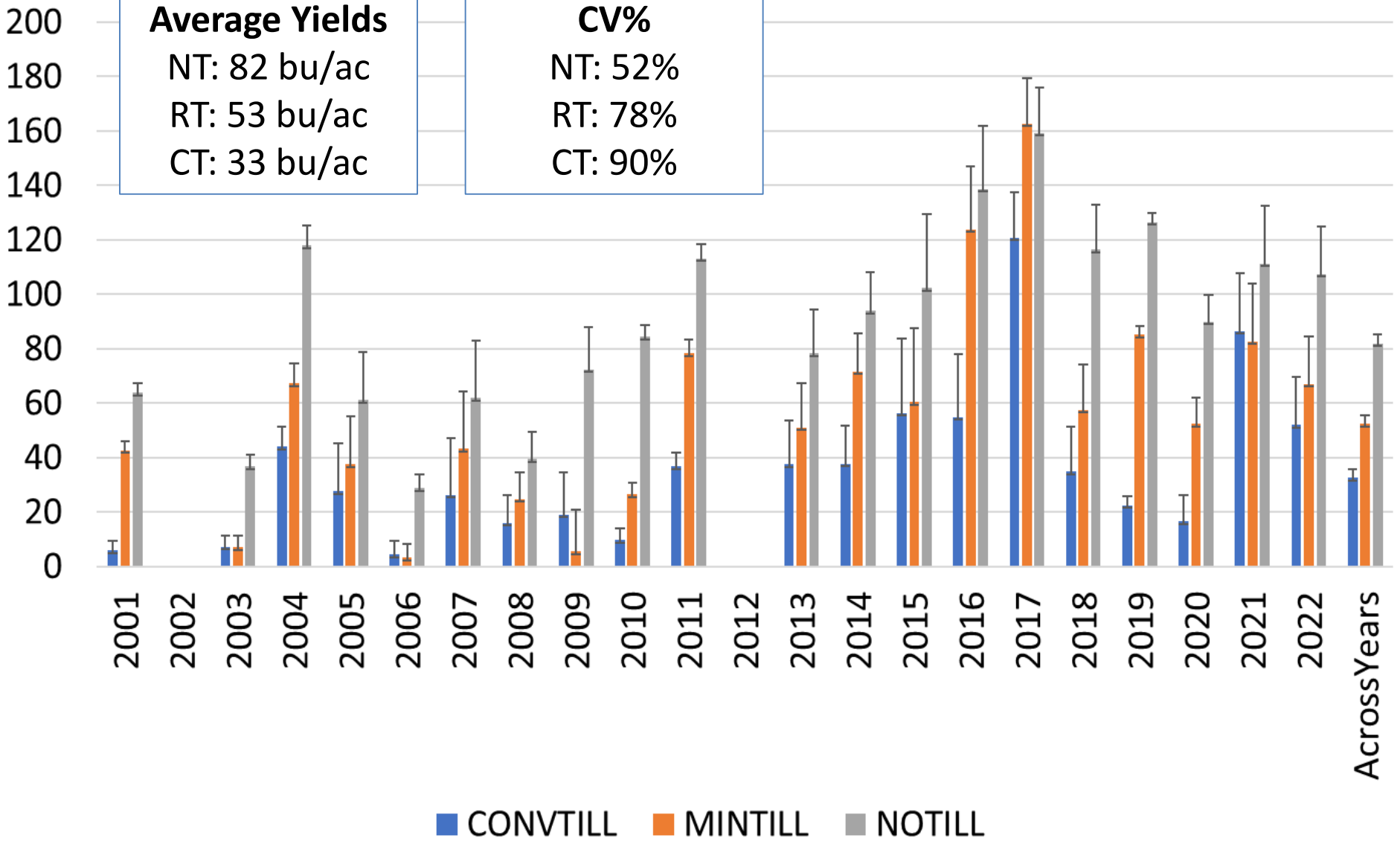
- In Western Kansas, which crop do you think has more stable years over time, sorghum or wheat?

- Do you think tillage system affects yield stability?

Grain Sorghum Yield
K-State Tribune, KS Long-Term Tillage Study
2001-2022

K·STATE Research and Extension

Average Yields	CV%
NT: 82 bu/ac	NT: 52%
RT: 53 bu/ac	RT: 78%
CT: 33 bu/ac	CT: 90%

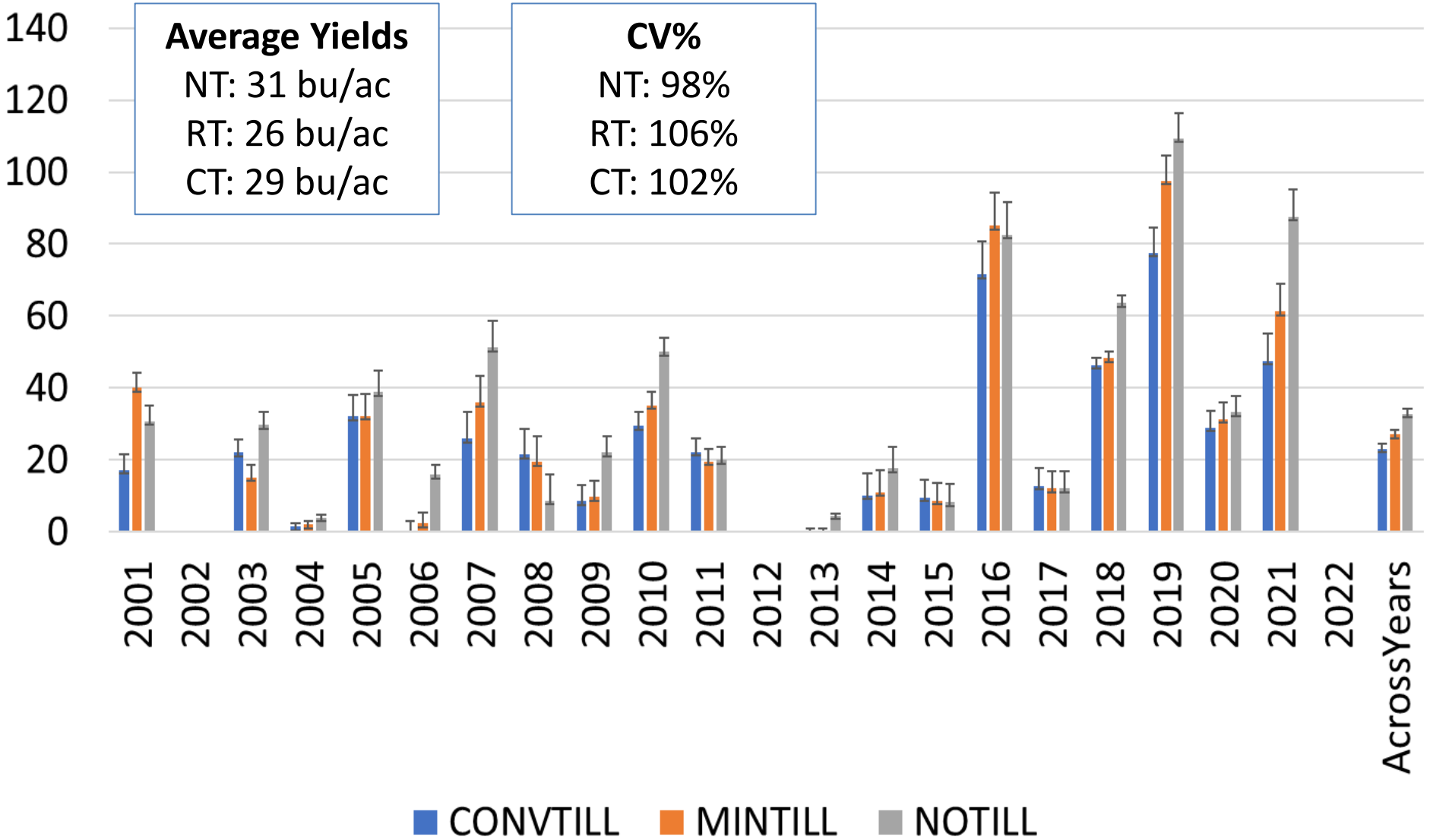


Wheat Grain Yield
K-State Tribune, KS Long-Term Tillage Study
2001-2022

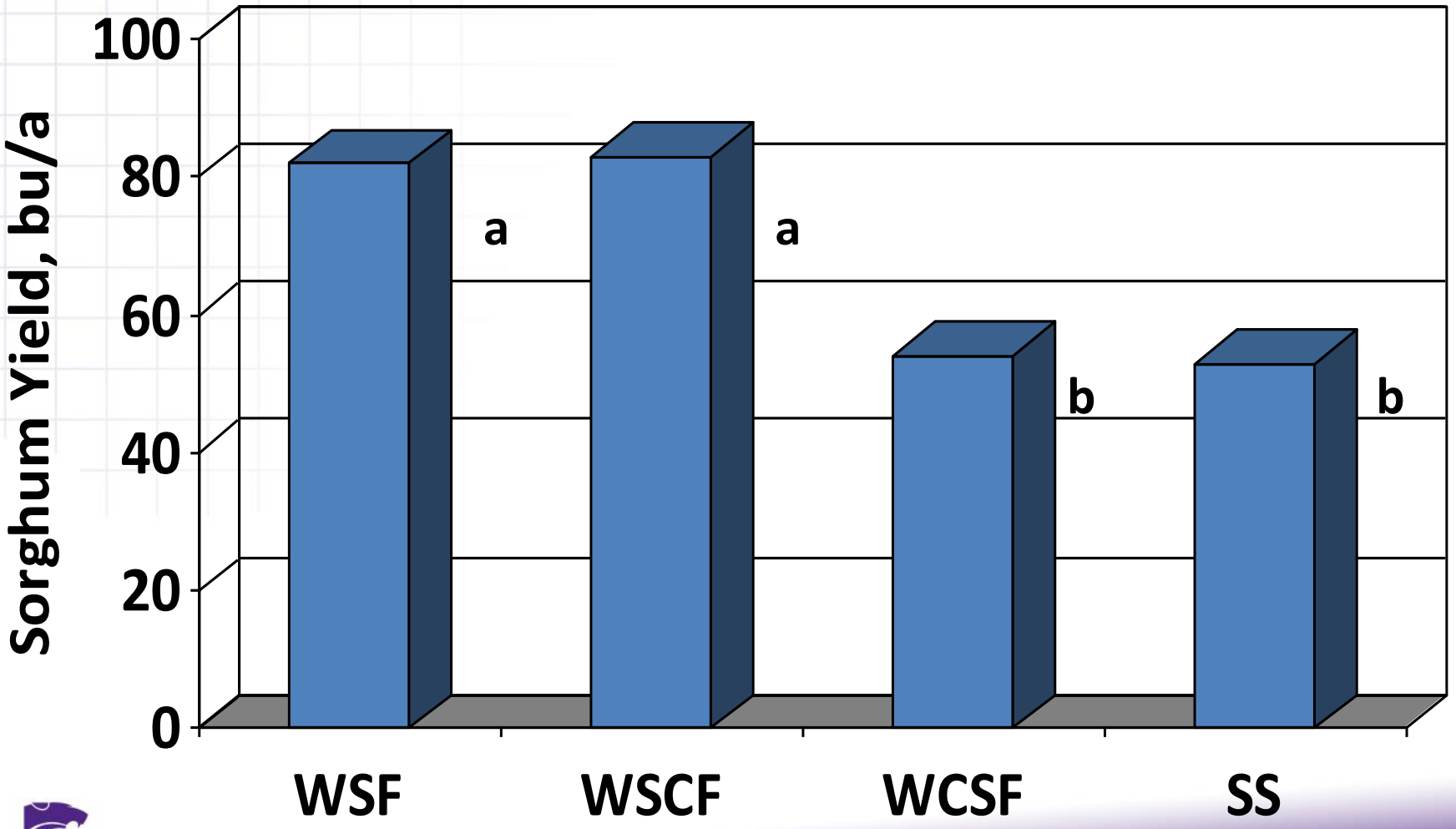
K·STATE Research and Extension

Average Yields
NT: 31 bu/ac
RT: 26 bu/ac
CT: 29 bu/ac

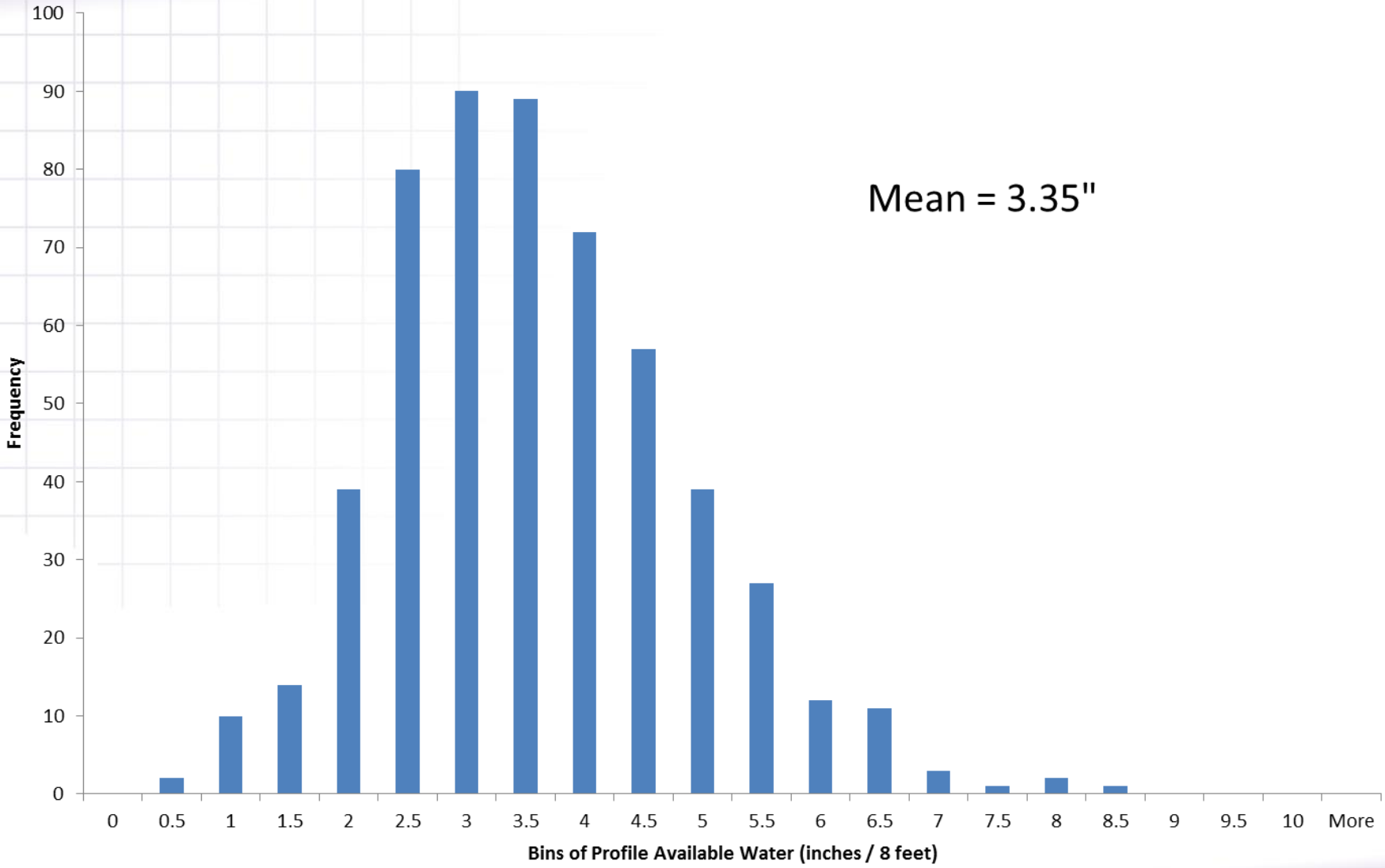
CV%
NT: 98%
RT: 106%
CT: 102%



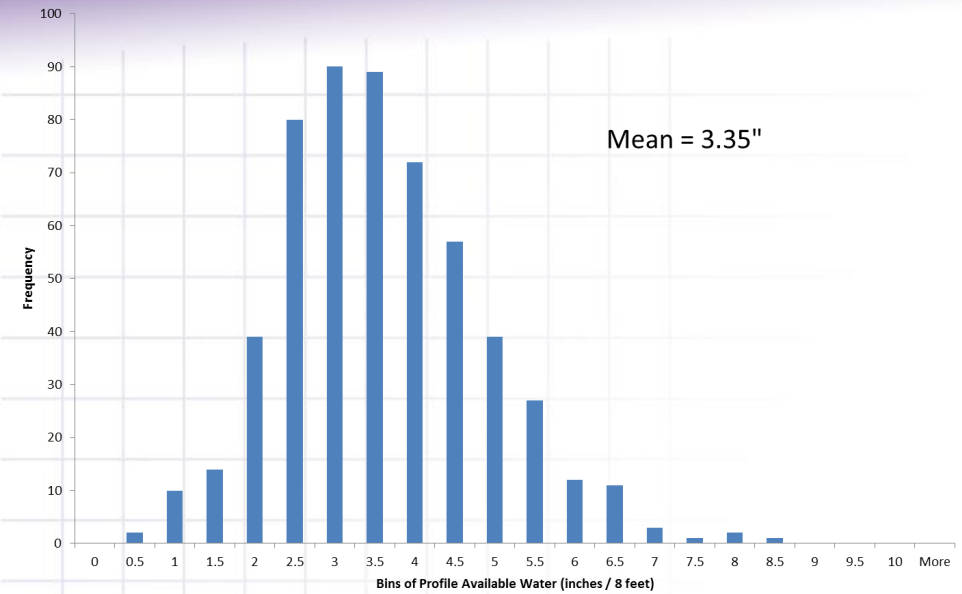
Average Sorghum Yields, 2008-2018



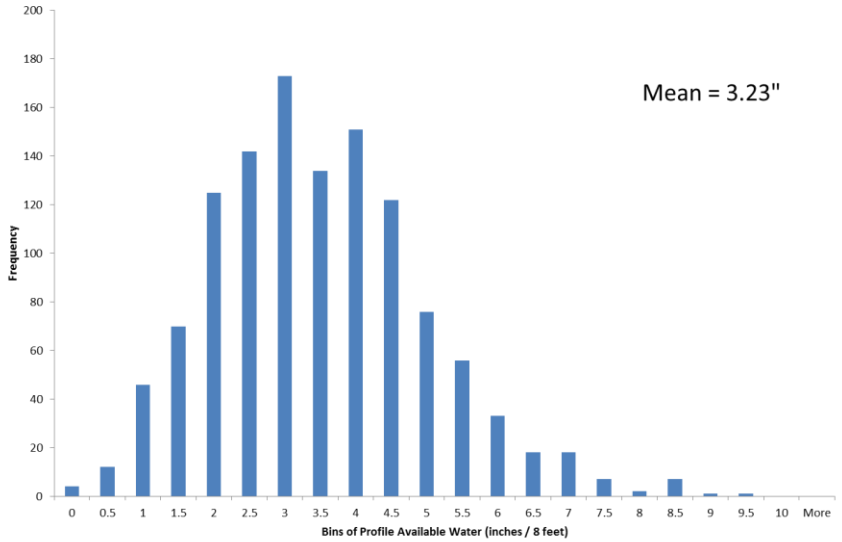
Profile Available Water at Sorghum Harvest
SWREC-Tribune, 1994-2014



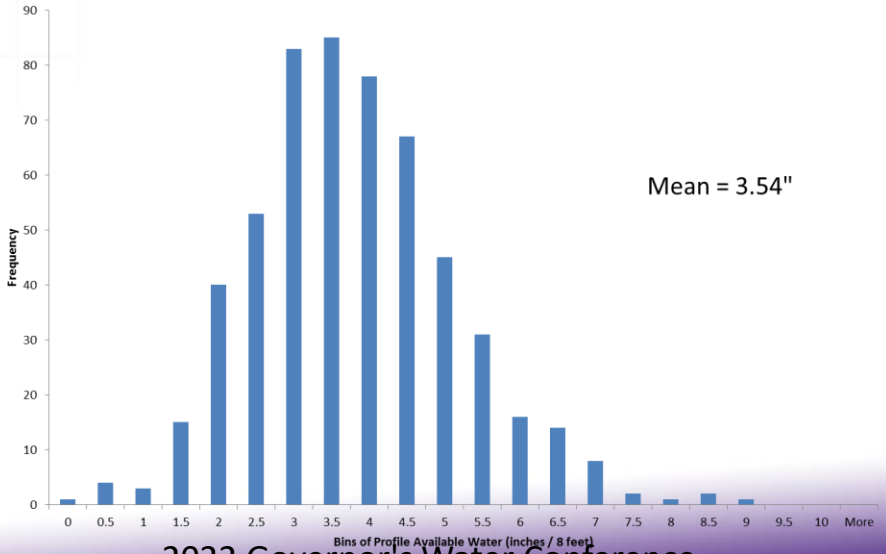
Profile Available Water at Sorghum Harvest
SWREC-Tribune, 1994-2014

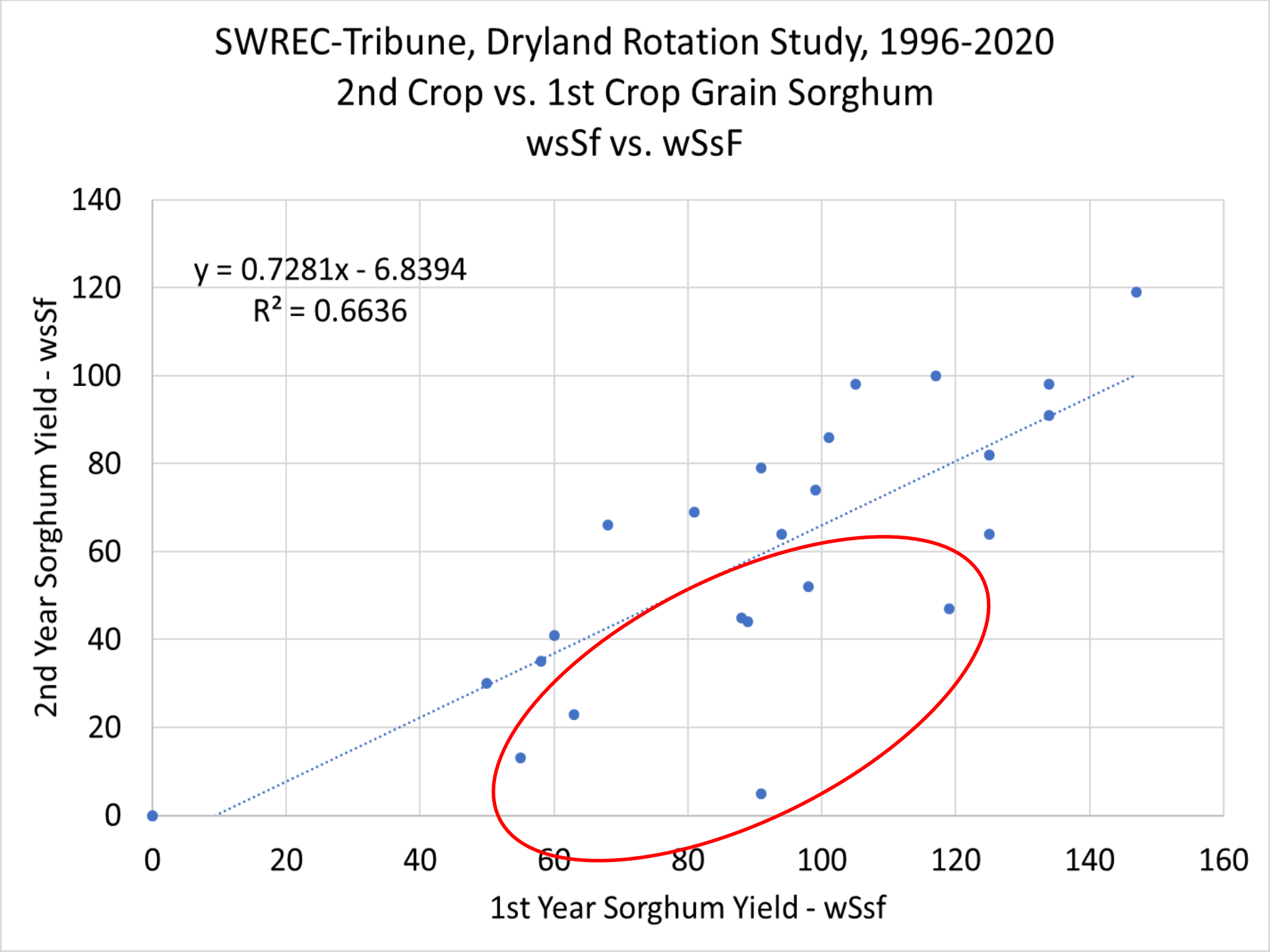


Profile Available Water at Wheat Harvest
SWREC-Tribune, 1994-2014

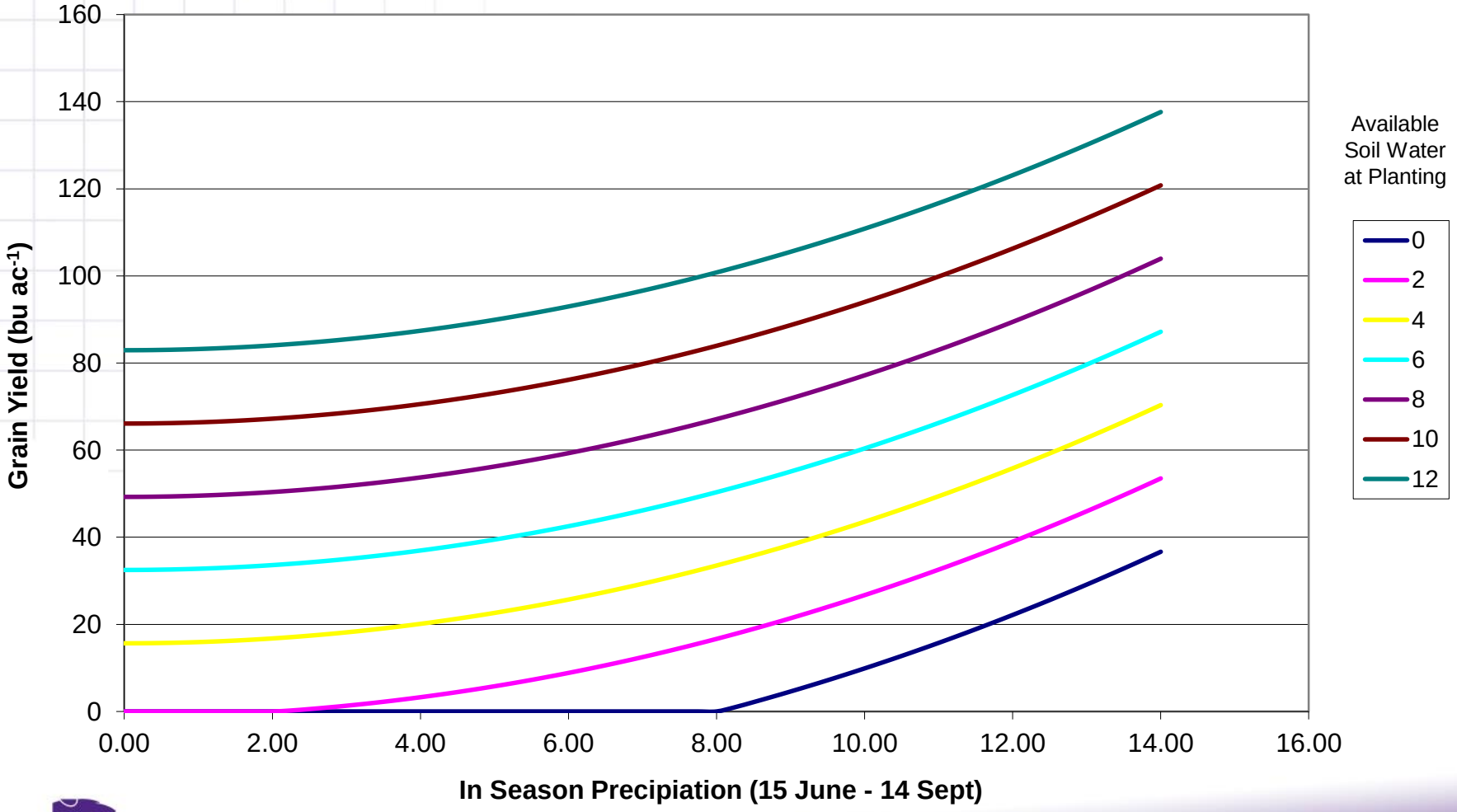


Profile Available Water at Corn Harvest
SWREC-Tribune, 1994-2014




SWREC-Tribune, Dryland Rotation Study, 1996-2020
2nd Crop vs. 1st Crop Grain Sorghum
wsSf vs. wSsF
y = 0.7281x - 6.8394
R² = 0.6636
2nd Year Sorghum Yield - wsSf
1st Year Sorghum Yield - wSsf
0
20
40
60
80
100
120
140
160

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



Adapted from Stone and Schlegel

Flex-Fallow Concept

At time of planting spring crop measure soil moisture profile with Paul Brown Probe

Plant if >12" of soil moisture & Precipitation Outlook is neutral or favorable

Otherwise implement fallow

Trying to reduce losses and take advantage of wet years

Shifting Land Cost – Alternative Crops/Intensified Rotations

Years	Rotation	Phase	Start	End	Days	Time Share	Time Cost	Precip	Precip Share	Precip Cost
3	W-S-F							57.46		
		Wheat	9/11	6/25	653	60%	$ 89.45	31.92	56%	$ 83.32
		Sorghum	6/26	9/10	442	40%	$ 60.55	25.54	44%	$ 66.68
4	W-S-S-F							76.61		
		Wheat	9/11	6/25	653	45%	$ 89.45	31.92	42%	$ 83.32
		Sorghum	6/26	9/10	442	30%	$ 60.55	25.54	33%	$ 66.68
		CC Sorg	9/11	9/10	366	25%	$ 50.14	19.15	25%	$ 50.00

Net Returns Grid for 2nd Crop Sorghum

Includes land charges

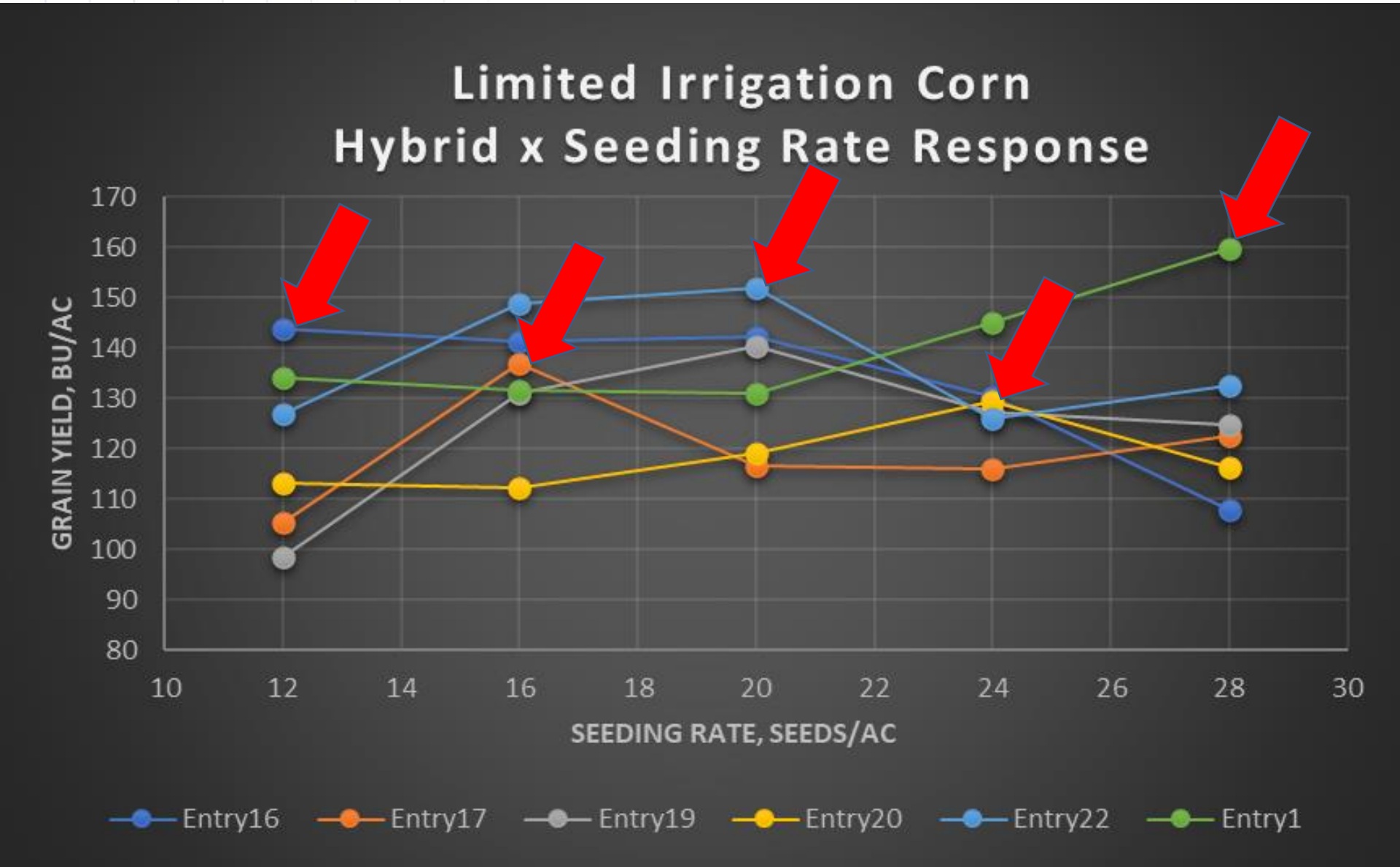
		1st Crop Sorghum Yield												
		50	55	60	65	70	75	80	85	90	95	100	105	110
Sorghum Price	$ 2.50	(69.96)	(60.86)	(51.76)	(42.66)	(33.56)	(24.46)	(15.36)	(6.25)	2.85	11.95	21.05	30.15	39.25
	$ 2.75	(60.86)	(50.85)	(40.84)	(30.83)	(20.82)	(10.81)	(0.79)	9.22	19.23	29.24	39.25	49.26	59.27
	$ 3.00	(51.76)	(40.84)	(29.92)	(19.00)	(8.08)	2.85	13.77	24.69	35.61	46.53	57.45	68.38	79.30
	$ 3.25	(42.66)	(30.83)	(19.00)	(7.17)	4.67	16.50	28.33	40.16	51.99	63.82	75.66	87.49	99.32
	$ 3.50	(33.56)	(20.82)	(8.08)	4.67	17.41	30.15	42.89	55.63	68.38	81.12	93.86	106.60	119.34
	$ 3.75	(24.46)	(10.81)	2.85	16.50	30.15	43.80	57.45	71.11	84.76	98.41	112.06	125.71	139.37
	$ 4.00	(15.36)	(0.79)	13.77	28.33	42.89	57.45	72.02	86.58	101.14	115.70	130.26	144.83	159.39
	$ 4.25	(6.25)	9.22	24.69	40.16	55.63	71.11	86.58	102.05	117.52	132.99	148.47	163.94	179.41
	$ 4.50	2.85	19.23	35.61	51.99	68.38	84.76	101.14	117.52	133.90	150.29	166.67	183.05	199.43
	$ 4.75	11.95	29.24	46.53	63.82	81.12	98.41	115.70	132.99	150.29	167.58	184.87	202.16	219.46
	$ 5.00	21.05	39.25	57.45	75.66	93.86	112.06	130.26	148.47	166.67	184.87	203.07	221.28	239.48
	$ 5.25	30.15	49.26	68.38	87.49	106.60	125.71	144.83	163.94	183.05	202.16	221.28	240.39	259.50
	$ 5.50	39.25	59.27	79.30	99.32	119.34	139.37	159.39	179.41	199.43	219.46	239.48	259.50	279.52
	$ 5.75	48.35	69.29	90.22	111.15	132.08	153.02	173.95	194.88	215.82	236.75	257.68	278.61	299.55
	$ 6.00	57.45	79.30	101.14	122.98	144.83	166.67	188.51	210.35	232.20	254.04	275.88	297.73	319.57

Role of GxExM in Cropping System Stability

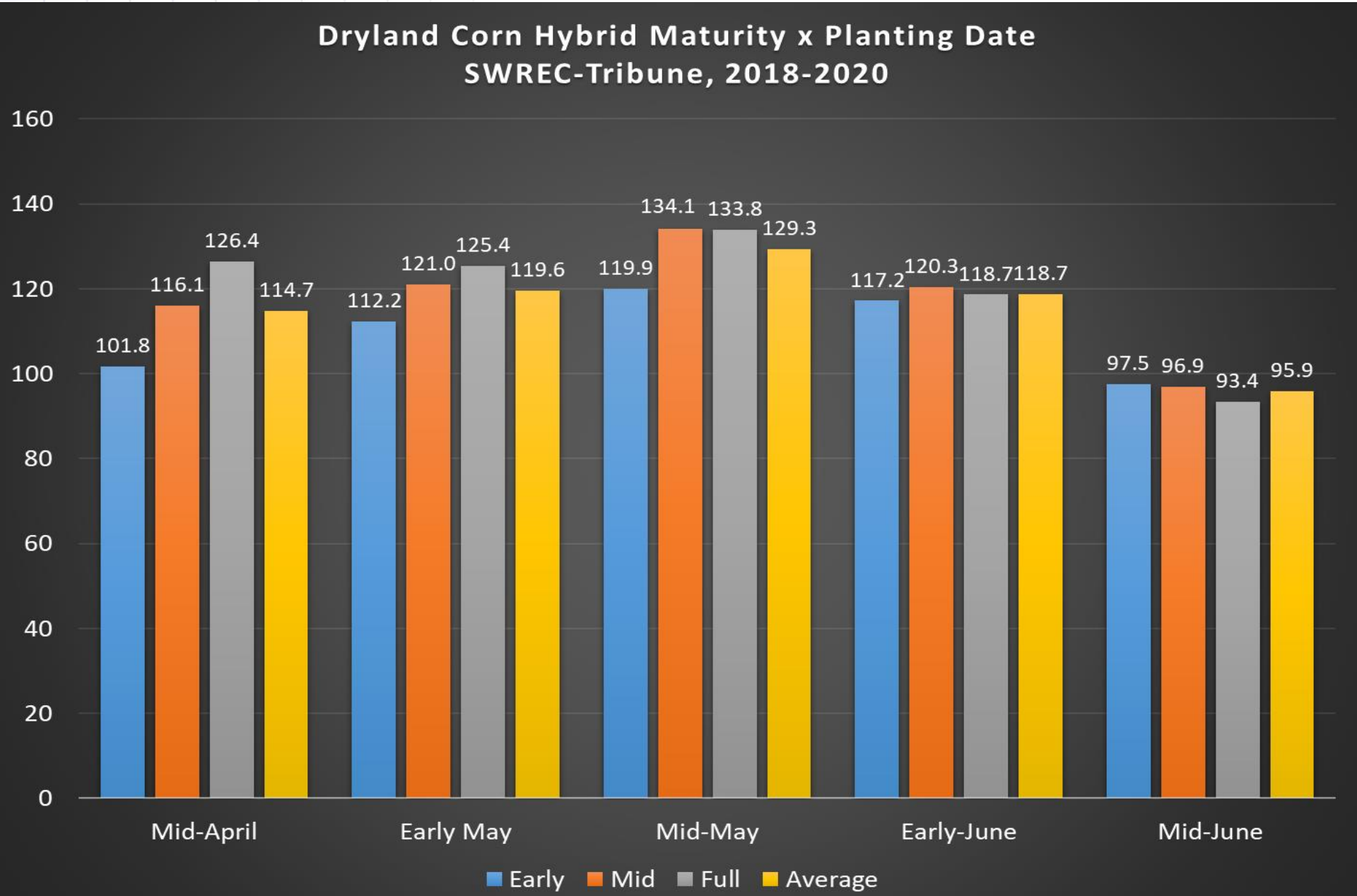
- Matching Genetics x Management to an environment

- Exploiting Genetics x Management Stability across environments

Matching Genetics x Management to Environment



Exploiting G x M Stability Across Environments



June 12 Planting Date - Across Locations

Hybrid		June 12th Planting Date											
Relative Maturity	Black Layer GDU	St. Francis	Sharon Springs	Tribune	Leoti	Scott City	Ness City	Oberlin	Atwood	Goodland	Brewster	Colby	Hoxie
118	2815	5.7%	13.0%	1.9%	6.4%	24.6%	50.7%	12.4%	3.8%	2.9%	5.8%	10.5%	17.9%
113	2768	9.5%	17.4%	4.8%	7.7%	27.5%	59.4%	16.2%	6.4%	2.9%	5.8%	11.4%	24.4%
110	2670	15.2%	37.7%	12.4%	21.8%	47.8%	72.5%	24.8%	10.3%	4.3%	10.1%	17.1%	46.2%
108	2604	22.9%	49.3%	24.8%	38.5%	65.2%	87.0%	38.1%	15.4%	11.6%	11.6%	21.0%	59.0%
105	2520	41.0%	79.7%	37.1%	48.7%	78.3%	92.8%	53.3%	32.1%	18.8%	18.8%	40.0%	74.4%
103	2463	58.1%	88.4%	48.6%	66.7%	85.5%	94.2%	63.8%	52.6%	30.4%	36.2%	50.5%	82.1%
96	2357	74.3%	94.2%	75.2%	84.6%	95.7%	98.6%	78.1%	66.7%	56.5%	69.6%	72.4%	89.7%
91	2250	84.8%	100.0%	86.7%	93.6%	98.6%	100.0%	87.6%	83.3%	85.5%	85.5%	85.7%	96.2%
Average GDU		2482	2628	2475	2537	2670	2794	2533	2442	2403	2425	2470	2640
Maximum GDU		3009	3085	2977	3059	3113	3321	3230	2941	2876	2924	2944	3060
Minimum GDU		1979	2294	1942	2136	2182	2262	1819	1994	2096	1993	1841	2166

www.northwest.ksu.edu/agronomy

GDU's to Emergence - Tribune

Planting Date	GDU's to Emergence		
	Max	Min	Average
4/19	285	231	270
5/3	231	169	204
5/17	226	226	226
5/31	188	165	172
6/14	406	207	260

Most guides will tell you 90 to 120 or 100 to 120 GDU

Is the answer something other than annual grain crops?

Forage Crops

- Once the plant has emerged you have succeeded!
- No critical growth stages for yield
- Dual purpose options
- Quality?
- How much do we really need?

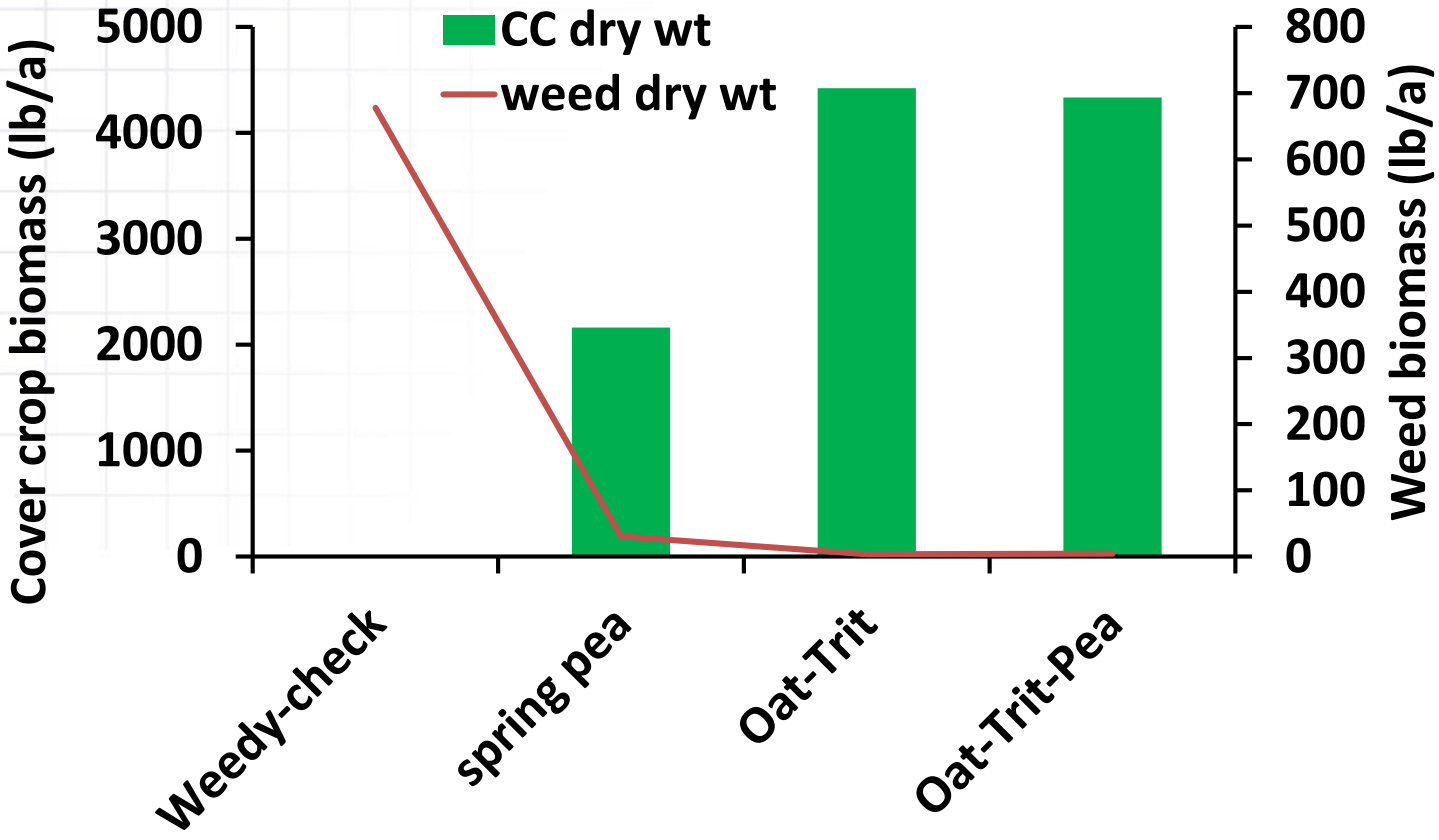
KSFGC
Kansas Forage and Grassland Council

The Kansas Forage Industry is Significant

Kansas Crops - 2019		
Crop	Acres	Value $1,000's)
Corn	5,232,355	$2,962,442
Soybeans	5,120,305	$1,565,214
Wheat	7,003,948	$1,368,900
Forages	18,309,779	$1,235,848
Grain Sorghum	2,430,570	$668,304

Source: USDA

Weed suppression by cover crops (2016-2017)



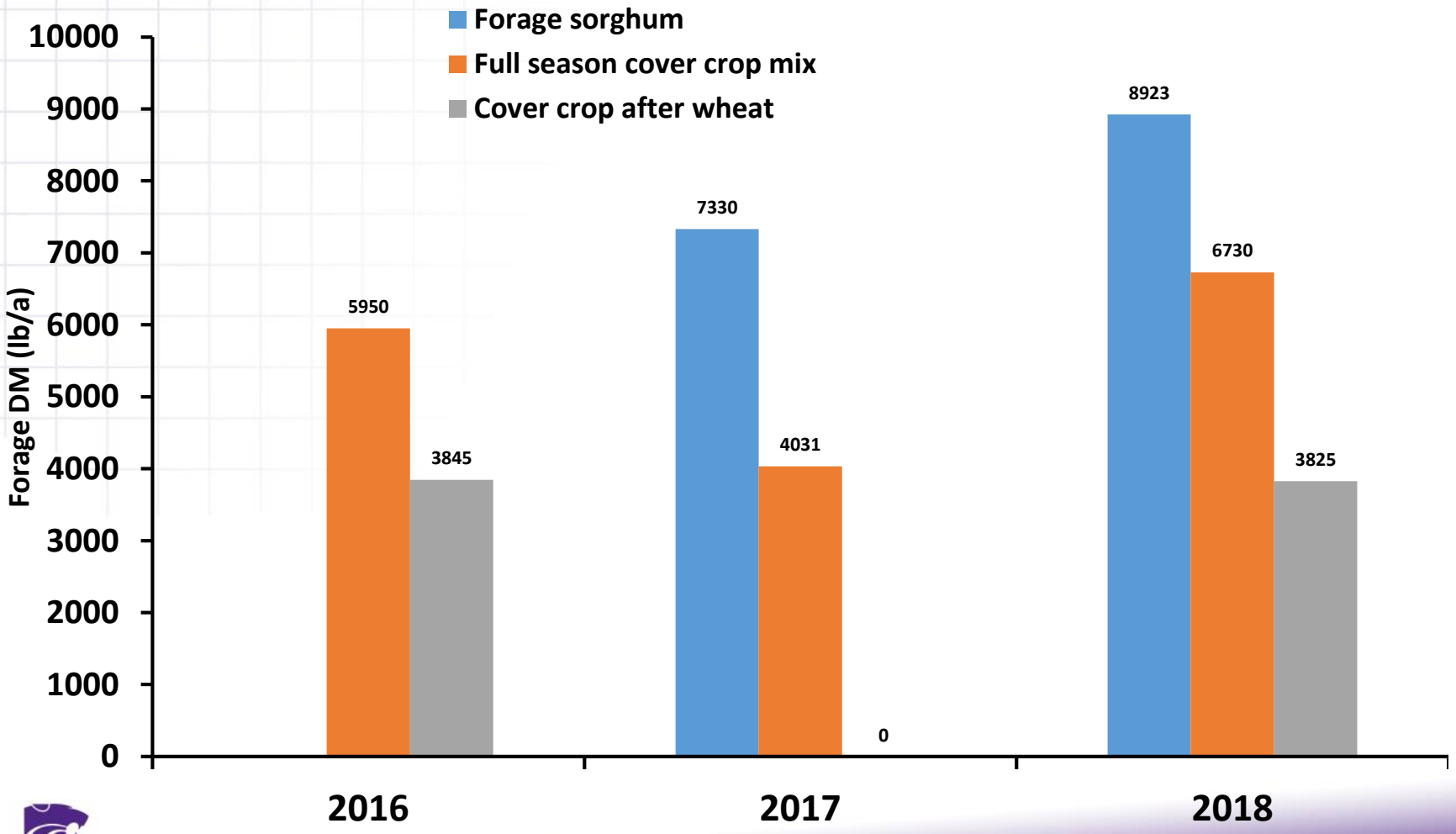
Summer cover crop on producer field at Hays

06/28/2019

07/25/2019

Sunn hemp, Sunflower; millet; Sudangrass, radish

Summer cover crop forage yield



Flex-Fallow Concept

At time of planting spring crop measure soil moisture profile with Paul Brown Probe

Plant if >12" of soil moisture & Precipitation Outlook is neutral or favorable

Otherwise implement fallow

Trying to reduce losses and take advantage of wet years

Questions?

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Twitter @LucasAHaag

Southwest Research-Extension Center – Tribune
Est. 1911

Irrigation Project

Est. 1961

K-STATE
Research and Extension