Cover Your Acres

Winter Conference

January 15 & 16, 2019

Gateway Civic Center
Oberlin, KS

K-STATE
Research and Extension

2019 Proceedings, Vol. 16

ADDENDUM

2019 Cover Your Acres Proceedings – Electronic Format

Remediation of Eroded High pH Hill-Top Soils with Manure

Due to the federal government shutdown at the time of the conference, Merle Vigil, the scientist who led the study, was under direct order to not attend. His proceedings paper is published in this book. In place of this talk Lucas Haag delivered a presentation on Dryland Tillage and Crop Rotation Studies at Tribune.

Long-Term Dryland Tillage and Crop Rotation Studies at Tribune, Kansas

This presentation was made in place of "Remediation of Eroded High pH Hill-Top Soils with Manure" The presentation was delivered by Lucas Haag, K-State Northwest Research-Extension Center. The slides presented in this talk can be found at the end of this electronic version of the proceedings

Dryland Corn Hybrids, Seeding Rates, and Planting Dates

The slides presented in this talk can be found at the end of this electronic version of the proceedings

Table of Contents

To provide a positive experience for presenters and attendees, please silence your wireless device.

Session Summaries

A Fresh Look at High Plains Irrigated Soybean Management: Recent field-scale trials in Southwest Nebraska has evaluated seeding rates, row spacing, and in-season nitrogen applications. Information from these trials will be shared along with considerations for management.

Adjuvants and Their Effects on Herbicides and Tank Mixes: Many products are on the market. This session will focus on placement of those products to maximize herbicide and tank-mix efficacy.

Current Financial Status of NW Kansas Farms: Using data from northwest Kansas farms, we take a look at opportunities for profitability and where producers should be alert for possible concerns.

Dryland Corn Hybrids, Seeding Rates and Planting Dates: Research in northwest Kansas has evaluated over 30 hybrids for optimal seeding rate and differences in ear flex. Additionally, hybrid maturity x planting date combinations have been evaluated in another study. This session will discuss the results and their implications for dryland corn management.

Getting Peak Performance From Paraquat-Rates, Adjuvants, Droplets and More: Paraquat is a valuable tool in management of resistant weeds such as Kochia and Palmer Amaranth. This session will look at how environment, application methods, and various other factors play a role in the efficacy of Paraquat.

Land Values and Rental Rates-Where are we going?: There are a lot of moving pieces in the land market and the many factors that drive rental rates. We'll take a look at the most recent data and discuss potential future direction and what it might mean to your business.

Managing Insect Resistance in Corn: This session will address the current resistance situation and discuss the various management options to control resistant insect populations and minimize the development of additional resistance.

Palmer Amaranth Management: A discussion of what makes Palmer Amaranth different than many of the weed species we face, the latest performance results from western Kansas herbicide trials, and recommendations for developing an overall weed control strategy.

Remediation of Eroded High pH Hill-top Soils with Manure: A long-term study in eastern Colorado, started in 2006 to evaluate using beef manure at various rates, timings of application, and incorporation methods. Results and management recommendations will be shared.

Top 3 Mistakes in Northwest Kansas Wheat Production: We'll step through the growing season and discuss the most common production problems observed in the field and consider the management practices that can improve yields and profitability in wheat production.

Producer Panel Discussion: A producer panel will discuss various alternative crop options in the region. Crops discussed may include winter canola, dry edible beans, field peas, barley, and triticale.

Proceedings from prior years of the Cover Your Acres
Winter Conference can be found online:
www.northwest.ksu.edu/coveryouracres

Presenters

Randall Currie- Dr. Currie was born in Plainville and raised in Stockton, KS. Randall worked as a youth on local small grains farm and hog operation. Randall graduated from KSU in 1980 with a BS in Agronomy. He worked in central Kansas as a crop consultant scout and crop production chemical and fertilizer sales man from 1980 to 1985. He graduated with a Master's Degree in Weed Science from Oklahoma State University in 1983 and a PhD from Texas A&M in Herbicide Physiology in 1990. He has worked for the last 28 years as a research scientist for Kansas State at Garden City, KS. His primary focus has been on management of herbicide resistance and weed control in irrigated corn, sorghum and fallow. During this period, he has conducted over 250 trials with over 2000 herbicide combinations for weed control in these crops.

Jeanne Falk Jones- Jeanne Falk Jones is a multi-county agronomy specialist with K-State Research and Extension. She is the product of two century farm families and grew up as the 5th generation on the Falk family farm in northeast Kansas near Atchison. Jeanne is a graduate of Kansas State University with a B.S. degree in Agronomy and M.S. degree in Agronomy (weed physiology). Her programming focus is on wheat production, herbicide resistant weeds, and other crop production challenges in northwest Kansas. Jeanne is active in her family's farm near Atchison. She and her husband Adam, ranch in Cheyenne County and own Crooked Creek Angus.

Lucas Haag- Lucas Haag was raised on a diversified dryland farming and ranching operation near Lebanon, Nebraska along the Kansas/Nebraska line. He received his B.S. in Agricultural Technology Management in 2005 and a M.S. in Agronomy (crop ecophysiology) in 2008 from K-State. Lucas completed his Ph.D. in Agronomy in 2013. He is an associate professor of agronomy and Northwest Area Agronomist stationed at the Northwest Research-Extension Center in Colby, Kansas. He has extension agronomy responsibilities for 29 counties in northwest and north-central Kansas. He conducts research and extension activities in a variety of areas but specializes in precision ag and dryland cropping systems. Lucas remains actively tied to production ag as a partner with his brothers in Haag Land and Cattle Co.

Marshall Hay- Marshall Hay is a PhD candidate in the Department of Agronomy at Kansas State University under the direction of Dr. Dallas E. Peterson. Marshall's dissertation is on integrated pigweed management in dryland soybean and grain sorghum with additional research on improving Paraquat efficacy on pigweed and grasses with droplet size, tank mixes, and adjuvants. Marshall's interest in agronomy and weed science stems from his family's farm and crop protection retail business in Iowa. After completing his B.S. at Iowa State University, he moved to K-State for his M.S. which upon completion transitioned into his doctoral work. During his spare time, Marshall enjoys helping on the farm and restoring antique tractors.

Jordan Steele- Jordan Steele is an Extension Agricultural Economist with Kansas Farm Management Association, NW assisting members with accurate record keeping and financial analysis. Jordan grew up on a Wyoming cattle ranch then attended the University of Wyoming to obtain a Bachelor's Degree in Agricultural Business in 2010 and a Master's Degree in Agricultural Economics in 2012. Steele enjoys working with NW Kansas farm families to develop and maintain profitable agribusinesses.

Presenters

Strahinja Stepanovic- Strahinja Stepanovic was born in Serbia in 1987. Upon his graduation with B.S. degree in Agronomy (2010) he came to Nebraska to study flaming as a weed control method in organic cropping systems. In 2013, he graduated with M.S. degree from University of Nebraska-Lincoln and started his Ph.D. research in evaluating water conservation practices for corn and soybean production under limited-irrigation. In 2014, he started working as Extension Educator in southwest Nebraska and built his program around on-farm research, irrigation water management, and pulse crops industry development in NE.

Mykel Taylor– Mykel Taylor is a native of Montana with extensive experience in production agriculture. Mykel earned her B.S. in Agricultural Business Management from Montana State University in 2000. She went on to complete a M.S. in Applied Economics at Montana State and a Ph.D. in Economics at North Carolina State University. Mykel joined Kansas State University in 2011 as assistant professor of agricultural economics with a major appointment in extension. Her areas of focus include agricultural leases and land values, grain marketing, farm policy, and many other areas of farm management. She earned her Ph.D., Economics in 2008.

Merle Vigil– Dr. Vigil, a Colorado native, earned a B.S. in Crop Science in 1980 and an M.S. in Agronomy from Colorado State University in 1983. He earned his Ph.D. in soil science at Kansas State University in 1989. Dr. Vigil's interests reside in the development of sustainable dryland cropping systems for the Central Great Plains region with a focus on maximizing precipitation use efficiency and fertilizer use efficiency. Dr. Vigil has authored or co-authored 180 research and technical publications and is a Fellow of the American Society of Agronomy and a Fellow in the Soil Science Society of America. He has worked as a soil scientist for the last 27 years at the USDA-ARS Central Great Plains Research Station in Akron, Colorado. He has served as research leader since 2001 and is now also serving in that capacity for the Soil Management and Sugar Beet Research Unit in Ft. Collins, Colorado.

Rich Zollinger- Rich Zollinger is a Professor Emeritus, Department of Plant Sciences, at North Dakota State University, Fargo, ND. Rich was raised on a family farming operation with livestock and crop production farms in Utah, Idaho, Montana, and an 18,000-acre farm in the Peace River Region of British Columbia, Canada. He earned his Ph.D. in Weed Science from Michigan State University in 1988; and his M.S. and B.S. degrees from Utah State University in 1985 and 1983, respectively. Zollinger retired from NDSU at the end of 2017 after 28 years of service as state Extension Weed Specialist. Dr. Zollinger conducted weed control and herbicide research primarily in corn, soybean, dry edible beans, and sunflower. His weed science project conducted over 70 field trials each year in these areas in addition to extensive greenhouse work. His main research interest was in adjuvants and formulations.

Sarah Zukoff- Dr. Sarah N. Zukoff is a field crop entomologist who has a dual role in research and extension. She specializes in integrated pest management of key pests of corn, sorghum, wheat, alfalfa and cotton. Her extension efforts focus on providing farmers with sustainable, environmentally sound insect and mite pest management strategies to provide the highest yielding crops possible to feed an ever growing population. Her current research includes characterizing resistance levels among corn feeding pests to Bt toxins and insecticides as well as quantifying the effect of Bt toxin cross pollination on resistance development among major lepidopteran pests of corn.

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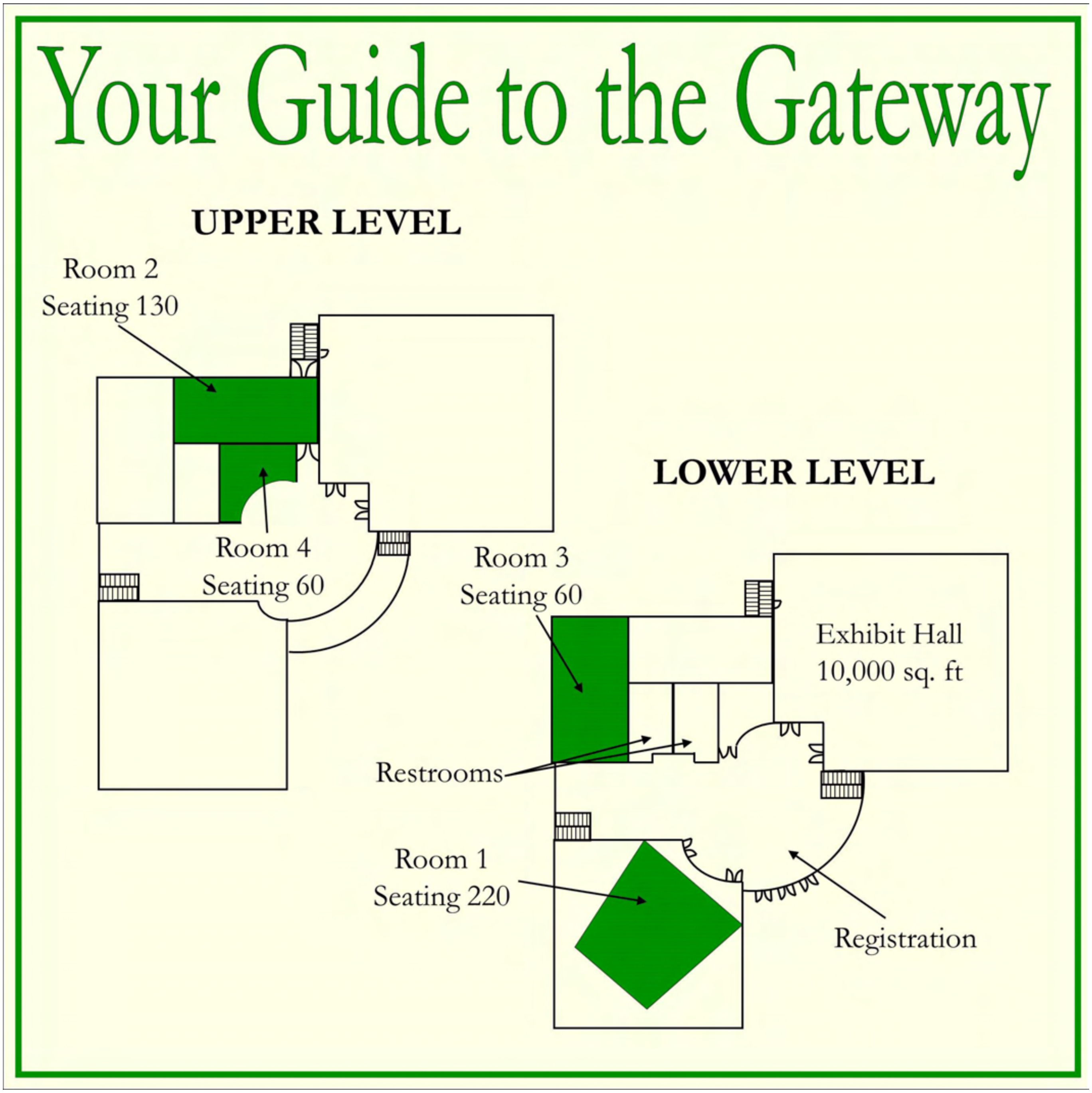

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Seeding Practices and Nitrogen Management for Western Nebraska Soybean: What Matters and Why

Strahinja Stepanovic

Continuous corn is the most common irrigated crop sequence in southwest Nebraska. Although rotating to other crops, such as soybeans, can mitigate some production issues of continuous corn and often boost the next year's corn yield, larger adoption of soybean has not readily occurred in this area. According to USDA Farm Service Agency planted acreage data, on average southwest Nebraska farmers plant irrigated soybean every fifth year.

The culture of farming in southwest Nebraska evolves around corn, which often prevents growers from raising soybeans under more ideal conditions. For example, priority is often given to planting corn first, soybeans are planted strip-till in 30-inch rows, and seeding rates of 160,000 seeds/ac are common. In addition, late season chemigation with nitrogen (N) is widespread without a full understanding of when and where it's warranted (Stepanovic et al., 2018a)

The objective of this study was to investigate the impact of planting date, row spacing, seeding rates, and N management on yield and yield components of irrigated soybean in southwest Nebraska. *Cover photo: Irrigated soybean in Perkins County, NE (2019).*

Characteristics of the Two Research Sites

The study was conducted at two locations in Perkins County (the Kemling and Stumpf farms) in 2018. The predominant soil type at the Kemling Farm was Rosebud loam; at the Stumpf farm it was Kuma silt loam. At the Kemling Farm, the whole field was disked prior to planting; at the Stumpf farm, soybeans were seeded no-till. At both locations the previous crop was corn. Besides study treatments, soybeans were grown following UNL agronomic and irrigation recommendations.

The 2018 seasonal precipitation (May-Oct) was 6.5 inches higher than the 30-year average, especially early in the season (*Figure 1*), leading to issues with crusting and soybean germination. In addition, two hail events occurred at both sites. The first hail event occurred May 25, causing stand reduction in early planted soybeans. The second hail event occurred in mid-August, causing 20% hail injury at the Stumpf Farm and 5% at the Kemling Farm.

Data We Collected

The study evaluated four practices, each at two different levels, for a total of 16 treatments:

- Planting dates (May 1 vs June 5)
- Row spacing (15 inch vs 30 inch rows)
- Seeding rates (90,000 vs 140,000 live seeds/ac)
- N management – two fertility differed between the sites:
    - Stumpf Farm – control vs chemigation 50 lbs of N/ac @ R5 (beginning seed)
    - Kemling Farm – control vs pre-plant compost @ 5 tons/ac

Each treatment was replicated four times and each replication was divided into blocks by N management (fertility regime). Seeding practices (planting date, row spacing, and seeding rates) were randomized within each fertility N management block. The study treatments were planted into strips 40 ft by 180 ft. The middle 30 ft of each strip was harvested for yield using a John Deere 6000 series combine.

In addition, harvest population (plants/ac) was counted in each strip right before the harvest and five plant subsamples were taken to evaluate yield components, including nodes/plant, branches/plant, pods/plant, seeds/pod, and seed weight.

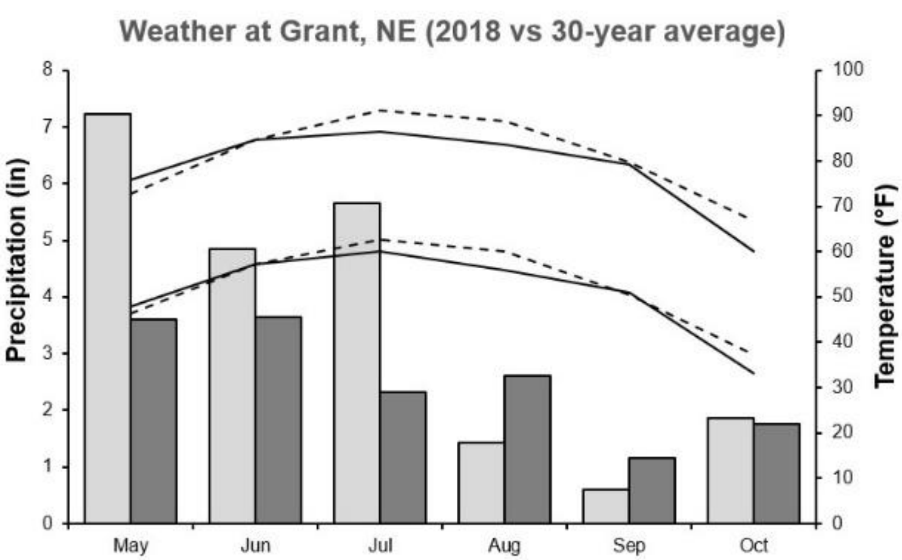


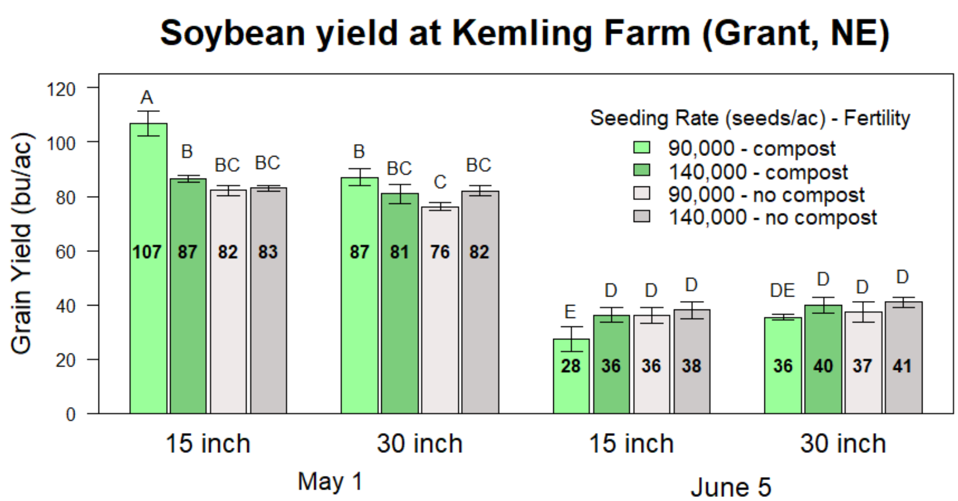
Figure 1. Weather conditions including total monthly precipitation and maximum and minimum temperatures at Grant, NE (2018 vs 30-year average)

Grain Yield Results

Overall, grain yield was lower at the Stumpf Farm compared to the Kemling Farm, mostly due to greater impact of soil compaction and hail injury. A cool wet spring in combination with direct seeding (no-till) of soybean at the Stumpf farm caused issues with sidewall compaction, soil crusting, and early season growth and development. Disked soil at the Kemling Farm dried out quicker, creating better seeding conditions, less sidewall compaction, and consequently fewer issues with crusting and early season plant growth (Jasa, 2010).

At both locations the best soybean yields were observed at the early planting date (May 1) and in narrower row spacing (15 inches), while higher seeding rates did not have any measurable yield increase regardless of location and practices used

At the Kemling Farm, early planted soybeans benefited from pre-plant application of compost at 5 ton/ac, yielding as much as 107 bu/ac. This trend, however, was not observed at late planting dates as yields dropped to 28-41 bu/ac. At the Stumpf Farm, chemigation of 50 lbs of N/ac at R5 (beginning seed) did not result in a yield increase.



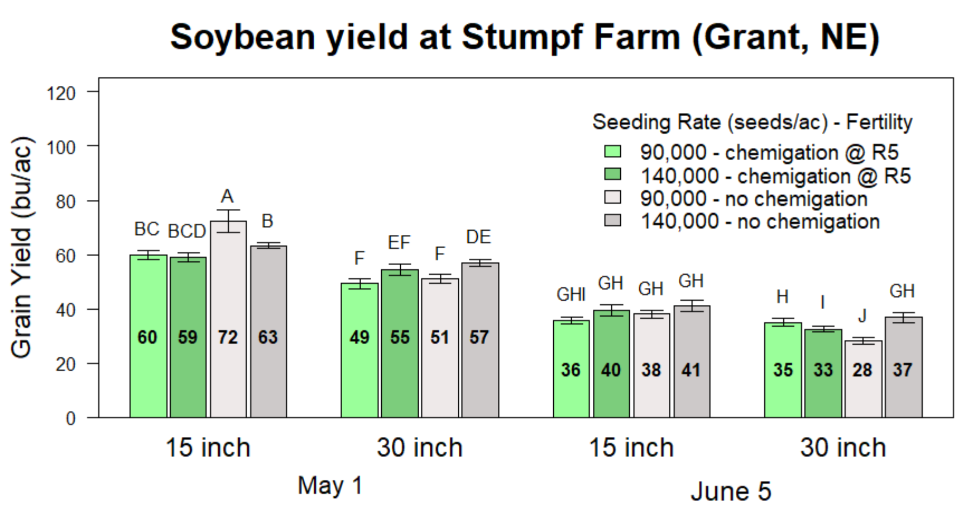


Figure 2. Impact of planting date (May 1 vs June 5), row spacing (15 inch vs 30 inch), seeding rates (90,000 vs 140,000 live seeds/ac) and fertility regimes at Kemling Farm and Stumpf Farm during 2018 growing season in Grant, NE.

What are Soybean Yield Components and Why do They Matter?

Grain yield is comprised of several components that, when analyzed separately, can allow us to better understand their individual contribution to overall grain yield. Despite differences in grain yield, the relationship between grain yield and yield components was similar at the two sites. *Table 1* summarizes correlation coefficients averaged across sites. The sign of correlation coefficient (r) indicates the nature of the relationship (either positive or negative) while the magnitude of coefficient (ranging from 0 to 1) represents the strength of the linear relationship.

Correlation between grain yield and plants/ac, seeds/pod, and seed weight was not significant (*Table 1*), suggesting that:

1. changes of plant population had no impact on grain yield, and
2. differences observed in grain yield had no impact on seeds/pod and/or seed weight.

On the other hand, significant positive correlation was observed between grain yield and nodes/plant (r=0.58), branches/plant (r=0.50) and pods/plant (r=0.42) suggesting that the best seeding and N management practices are those that facilitate node, branch, and pod development.

Table 1. Correlation (r) between soybean grain yield, planting date, plants/ac (at harvest), branches/plant, nodes/plant, pods/plant, seeds/pod, seed weight (1000 seeds) in field experiments at Kemling Farm and Stumpf Farm in Perkins County, NE (2018)

Terms	Grain yield (bu/ac)	Planting date	Plants/ acre	Nodes/ plant	Branches/ plant	Pods/p lant	Seeds/ pod
Planting date	-0.83*						
Plants/acre	-0.01	0.32*					
Nodes/plant	0.58*	-0.58*	-0.28*				
Branches/plant	0.50*	-0.52*	-0.30*	0.41*			
Pods/plant	0.42*	-0.62*	-0.62*	0.54*	0.61*		
Seeds/pod	-0.14	0.21	0.07	0.04	0.00	-0.30*	
Seed weight	0.19	-0.10	0.02	0.09	0.28	0.14	0.14

* Correlation coefficient significant at 5% level. The sign of coefficient indicates the nature of relationship (either positive + or negative -) while the magnitude of coefficient (ranging from 0 to 1) represents the strength of the linear relationship.

Why Planting Date Matters

Previous UNL research on soybean in eastern Nebraska has demonstrated that for each day that soybean planting is delayed after May 1, yield penalties of 0.25-0.63 bu/ac can occur, depending on the year. (Elmore et al., 2014; Specht et al., 2012.) In our one-year study in southwest Nebraska, we found much larger daily yield penalties of 1.40 bu/ac/day at the Kemling Farm and 0.64 bu/ac/day at the Stumpf Farm (*Figure 3*).

Among yield components, nodes/plant, branches/plant and pods/plant were all negatively correlated with planting date (*Table 1*) suggesting that each soybean plant produced less nodes, branches and pods as planting date was delayed (*Figure 3*).

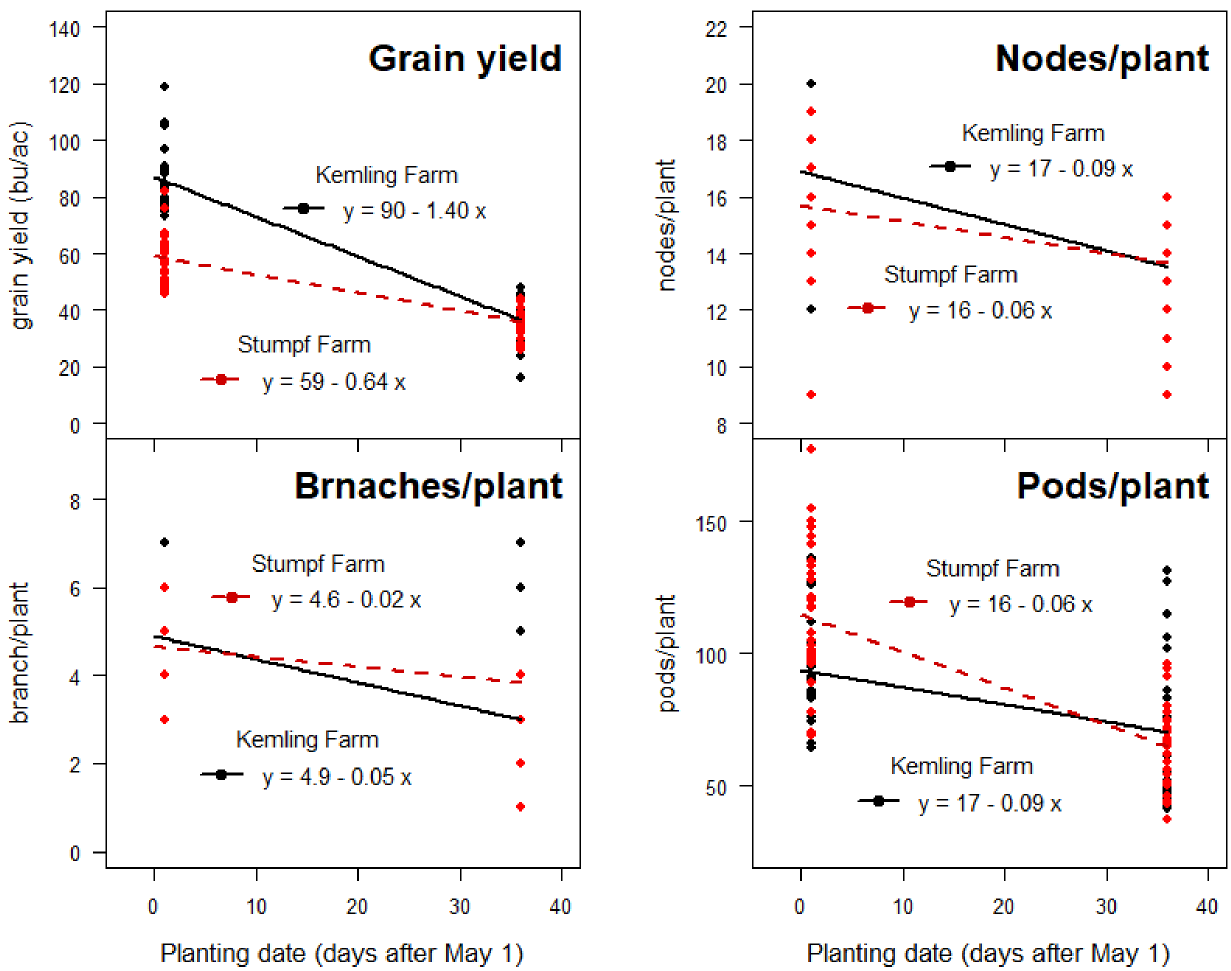


Figure 3. Effects of planting date on soybean yield at Kemling Farm and Stumpf Farm in a study conducted near Grant, NE in 2018

Why Row Spacing Matters

Overall, soybeans yielded better when planted in narrower rows. At the Kemling Farm a yield advantage of 8 bu/ac was observed with 15-inch rows at early planting, while there was no yield advantage with narrower rows at late planting date (Figure 4). At the Stumpf Farm, there was a yield advantage of 11 and 6 bu/ac with narrower rows at early and late planting, respectively. This is largely in agreement with our previous on-farm research studies that showed 3-13 bu/ac increases with 15-inch as compared to 30-inch rows (Stepanovic et al., 2018b).

Narrower seeding did not influence soybean node development; however, we did observe enhanced branching and consequently a greater number of pods per plant. The additional pods located on the side branches contributed greatly to the yield increase in narrower rows (data not show).

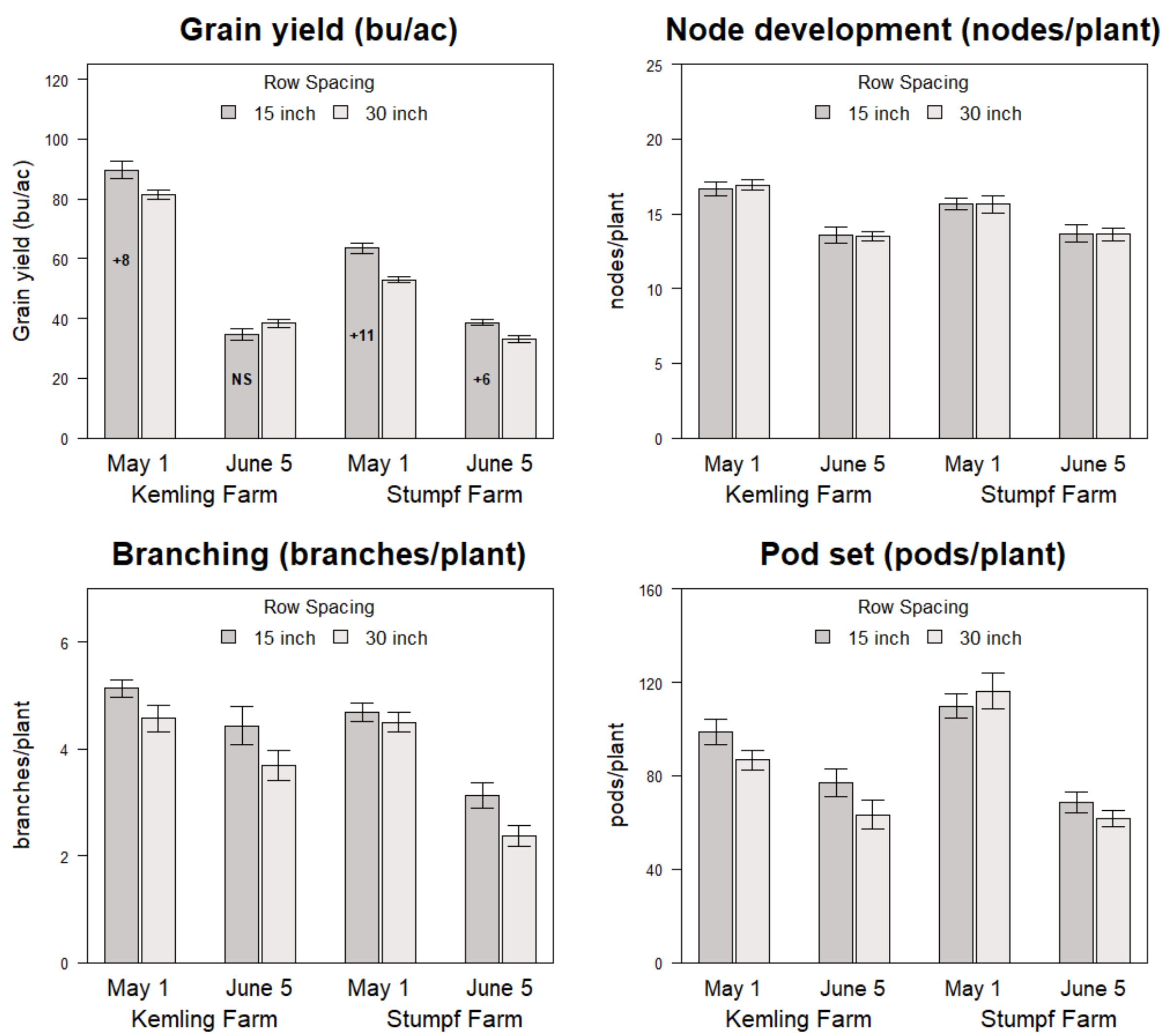


Figure 4. Impact of planting dates (May 1 vs June 5) and row spacing (15 inch vs 30 inch) on grain yield (bu/ac), node development (nodes/plant), branching (branches/plant) and pod set (pods/plant) of soybeans at Kemling Farm and Stumpf Farm during 2018 growing season at Grant, NE.

Why Seeding Rate Matters Less than Other Factors

Soybean yield at both the Kemling and Stumpf farms did not respond to changes in plant populations. Although soybeans were seeded at 90,000 and 140,000 live seeds/ac, actual harvest population (plants/ac) ranged between 30,000 and 120,000 plants/ac at the Kemling Farm and between 20,000 and 110,000 plants/ac at the Stumpf Farm. The stand reduction at both sites was due to early season crusting issues and hail injury.

Lack of soybean yield response to increasing populations may be explained by increased competition among the soybean plants themselves. Increasing plant population causes individual soybean plants to produce fewer branches, pods, and seeds, and consequently less yield (Figure 5).

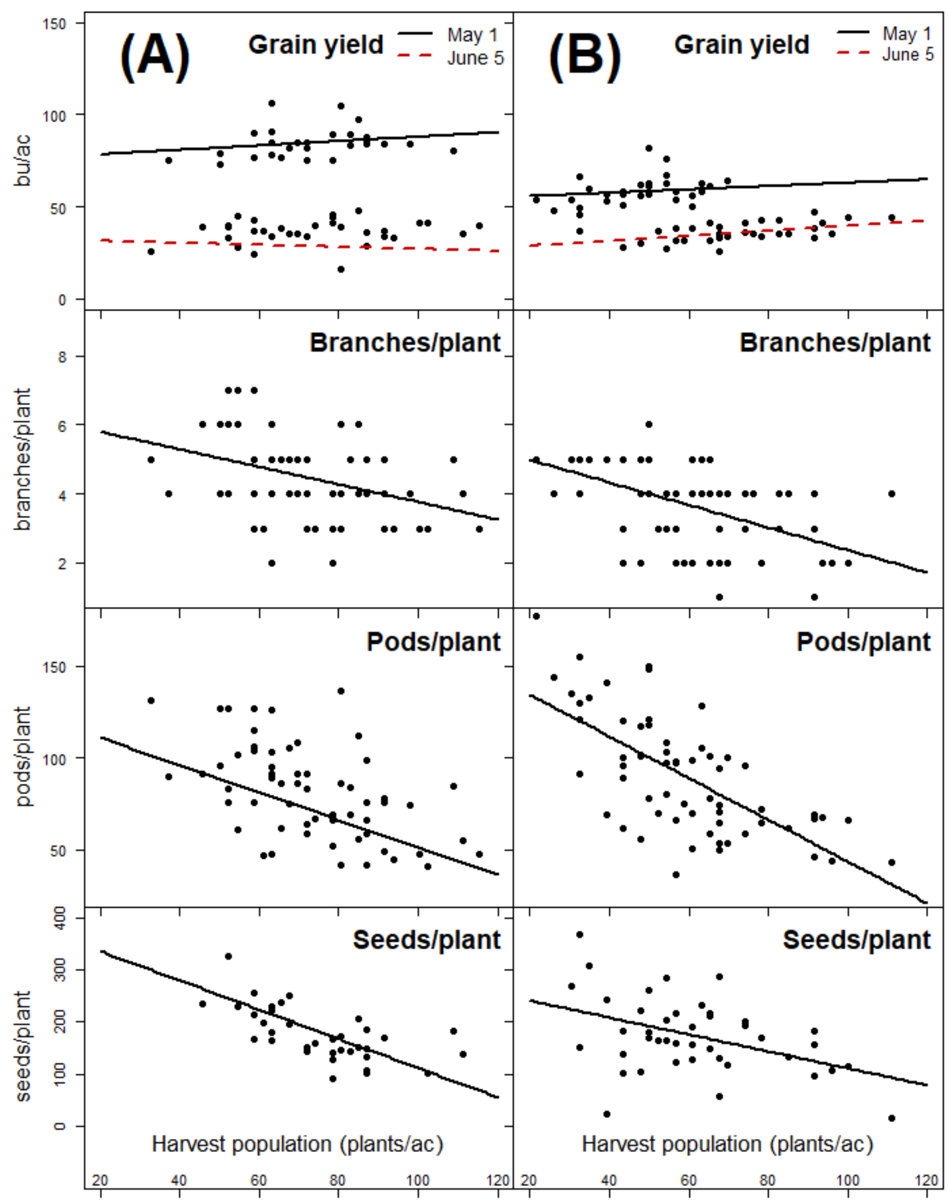


Figure 5. Impact of harvest population (plants/ac) on soybean grain yield (bu/ac) and yield components (nodes/plant, branches/plant, pods/plant, seeds/plant) in field experiments conducted at Kemling Farm and Stumpf Farm during 2018 growing season.

It's All About Being More Profitable

In summary, soybean yield potential is increased when the crop is seeded earlier (0.64-1.40 bu/ac/day) and in narrower rows (up to 11 bu/ac yield advantage). This yield potential was achievable at lower seeding rates and without late season N supplementation.

It is not uncommon in western Nebraska to see soybean seeding delayed until after irrigated corn is planted, and to do it in 30-inch rows and at 160,000 seeds/ac. Assuming that yield penalties for late planting are lower for corn than for soybean, that typically there are fewer soybean acres to plant, and that market prices of soybean ($8.00/bu) are higher than corn ($3.30/bu), we outline potential savings from incorporating the following practices:

- Seeding soybeans 10 days earlier than as traditional and before corn – $48 to $112/ac;
- Seeding soybean in 15-inch rather than 30-inch rows with modest 3 bu/ac yield increase – $24/ac;
- Reducing seeding rates from 160,000 to 120,000 seeds/acre – $15/ac; and
- Eliminating late season chemigation with 50 lbs of N/ac – $20/ac.

The real question is what should we plant first to achieve optimal profitability in southwest Nebraska: corn or soybeans?

The answer is soybeans.

Among these four production factors, early planting is the one factor that soybean growers in the region most often overlook and therefore lose the opportunity to increase their profit margins substantially. Therefore, the real question is what should we plant first in southwest Nebraska: corn or soybeans? The answer is: soybeans.

We can look to Iowa State University research for supporting data (Klein, 2009). Corn planted between April 20 and May 5 achieved 100% yield potential. Depending on year-to-year variability 99% of yield potential could still be achieved with corn planted before May 20. In the three-year study, significant yield reductions occurred only once and that was when corn planting dates were extended to late May or June. In southwest Nebraska research in 2018, we observed daily yield penalties of 0.5-1.0 bu/ac/day for corn planted after May 1 (Stepanovic, 2018; one year data).

We strongly recommend soybean farmers in western Nebraska evaluate their seeding and fertility practices and consider implementing changes that could lead to a more profitable crop.

Acknowledgements

I would like to thank my interns Nemanja Arsenijevic and Zaim Ugljic as well as our part-time technician Justin Richardson for their hard work on this project. We also thank Jim and Troy Kemling who allowed us to do this research on their farm. Lastly, we thank the Nebraska Soybean Board. Without their financial support, this project would not have been possible.

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Spray Adjuvants: The Rest of the Story

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Introduction

Adjuvants and spray water quality influence POST herbicide efficacy. PRE herbicides do not require adjuvants for activity unless weeds have emerged and labels include POST application. Questions about adjuvant selection are common. EPA and other regulatory agencies do not regulate adjuvants allowing no standards for quality or activity. Adjuvants are composed of a wide range of ingredients which may or may not contribute to herbicide phytotoxicity. Results vary when comparing specific adjuvants, even within a class of adjuvants. POST herbicide effectiveness depends on spray droplet retention, deposition, and herbicide absorption by weed foliage.

Spray adjuvants generally consist of surfactants, oils and fertilizers. The most effective adjuvant will vary with each herbicide and the need for an adjuvant will vary with environment, weeds, and herbicide used. Follow adjuvant label directions for optimum herbicide enhancement and adequate crop safety. An adjuvant may increase weed control from one herbicide but not from another. Differences in adjuvant activity are observed on marginally controlled species when comparing adjuvants and determining adjuvant enhancement. Effective adjuvants will enhance herbicides and provide consistent results under adverse conditions. Reducing herbicide rates when using effective adjuvants exempts herbicide manufacturers from liability for nonperformance.

Surfactants (nonionic surfactants = NIS) are used at 0.25 to 1% v/v (1 to 8 pt/100 gal of spray solution) regardless of spray volume. NIS rate depends on the amount of active ingredient in the formulation, plant species and herbicides used. The main function of a NIS is to increase spray retention, but to a lesser degree influence herbicide absorption. When a range of surfactant rates is given, the high rate is for use with low herbicide rates, drought stress and tolerant weeds, or when the surfactant contains less than 90% active ingredient. Surfactants vary widely in chemical composition and in their effect on spray retention, deposition, and herbicide absorption.

Silicone surfactants reduce spray droplet surface tension, which allow the liquid to run into leaf stomata (“stomatal flooding”). This entry route into plants is different from adjuvants that aid in absorption through the leaf cuticle. Rapid entry of spray solution into leaf stomata from use of silicone surfactants may not improve weed control. Silicone surfactants are weed and herbicide specific just like other adjuvants.

Oil adjuvants were used at 2 pt/A and in past years have been recommended at at a reduced rate of 1% v/v (1 gal/100 gal of spray solution). Oil adjuvants rate of 2 pt/A enhances herbicides at all spray volumes. Using oil adjuvants 1% v/v may not provide sufficient oil concentration if using less than ~15 gpa. Oil additives increase droplet retention on leaf foliage and increase herbicide absorption. Oil adjuvants contain petroleum oil (COC) or methylated vegetable/seed oils (MSO) plus an emulsifier for dispersion in water. The term crop oil concentrate (COC) designates a petroleum oil concentrate but is misleading because the oil type in COC is petroleum and not a crop vegetable oil. The emulsifier, the oil class (petroleum, vegetable, etc.), and the specific type of oil in a class all influence effectiveness of an oil adjuvant. Oil adjuvants enhance POST herbicides more than NIS and are effective with all POST herbicides, except Liberty, Cobra, paraquat, and Roundup.

MSO adjuvants enhance most POST herbicides more than NIS and PO adjuvants. MSO adjuvants are more aggressive in dissolving leaf wax and cuticle resulting in faster and greater herbicide absorption. The greater herbicide enhancement from MSO adjuvants may occur more in low humidity/low rainfall environments where weeds develop a thicker cuticle. MSO adjuvants cost significantly more than NIS and PO adjuvants. The added cost of MSO and increased risk of crop injury when used at high temperatures have deterred people from using this class of adjuvants. Using reduced MSO adjuvant rates may enhance weed control while lowering risk of crop injury to an acceptable level.

Some herbicide labels restrict use of oil adjuvants and recommend only NIS alone or combined with nitrogen based fertilizer solutions. Follow label directions for adjuvant selection and if PO or MSO adjuvants may be used.

NDSU research has shown wide difference in adjuvant enhancement of herbicides. However, in many studies, no or small differences occur depending on environmental conditions at application, growing conditions of weeds, rate of herbicide used, and size of weeds. For example, under warm, humid conditions with actively growing weeds, NIS + nitrogen fertilizer may enhance weed control to the same level as oil adjuvants. The following are conditions where MSO type additives may give greater weed control than other adjuvant types:

1. Low humidity, hot weather, lack of rain, and drought-stressed weeds or weeds not actively growing due to stress conditions.
2. Weeds larger than recommended on the label.
3. Herbicides used at reduced rates.
4. Target weeds that are somewhat tolerant to the herbicide.
5. When university data supports reduced herbicide rates. Most herbicides, except Roundup, give greater weed control when used with MSO type adjuvants.

Oil adjuvant applied on a volume or area basis

Labels of many POST herbicides recommend oil adjuvants at 1% v/v. At a spray volume of 15-20 GPA, 1% oil adjuvant (COC/PO) will provide a minimum adjuvant concentration (1% v/v in 17 gpa = 1.4 pt/A). The optimum rate of a PO is 2 pt/A. State surveys show common spray volumes are 10 gpa or lower. PO at 1% v/v in 8.5 gpa = 0.68 pt/A and does not provide sufficient volume oil adjuvant or the area covered. Further, aerial applications containing 1% v/v of oil adjuvant in 3-5 GPA will not provide oil adjuvant volume. For example, Pursuit and Raptor labels require oil adjuvants to be added at 1.25% v/v or 1.25 gal/100 gal water for aerial application at 5 GPA.

Some herbicide labels contain information on adjuvant rates for different spray volumes. To insure sufficient adjuvant concentration, add oil adjuvant at 1% v/v but no less than 1.25 pt/A at all spray volumes. Surfactant at 0.25 to 1% v/v water is sufficient across all water volumes.

High surfactant oil concentrates (HSOC) were developed to enhance lipophilic herbicides without antagonizing glyphosate. HSOC adjuvants contain at least 50% w/w oil plus 25 to 50% w/w surfactant, are PO or MSO based, and are usually applied at ½ the oil adjuvant rate (area basis). Glyphosate must be applied with other herbicides to control glyphosate tolerant weeds and crops and to delay resistant weeds. Glyphosate is highly hydrophilic, is enhanced by NIS and nitrogen fertilizer surfactant type adjuvants, and is antagonized by oil adjuvants. Most POST herbicides mixed with glyphosate to increase weed control (Select, Banvel, Laudis, Flexstar, others) are lipophilic and require oil adjuvants for optimum herbicide enhancement. Surfactants are less effective in enhancing lipophilic herbicides. Oil adjuvants, including PO and MSO adjuvants, may antagonize glyphosate. NDSU research has shown wide variability among PO based HSOC adjuvants (POMOC) with many performing no different than common PO adjuvants. However, MSO based HSOC adjuvants (HSMOC) enhance both glyphosate and the lipophilic herbicide. HSMOC adjuvants when used at optimum rates enhance lipophilic herbicides more than HSPOC, MSO and PO adjuvants.

Some water pH modifiers are used to lower (acidify) spray solution pH because many insecticides and some fungicides degrade under high water pH. Most solutions are not high or low enough in pH for important herbicide breakdown in the spray tank. A theory has long been postulated that acidifying the spray solution results in greater absorption of weak-acid-type herbicides. pH-reducing adjuvants (water conditioners/AMS-replacement) were developed under this belief. However, low pH is not essential to optimize herbicide absorption.

Many herbicides are formulated as various salts, which are absorbed as readily as the acid. Salts in the spray water may antagonize formulated salt herbicides. In theory, acid conditions would convert the herbicide to an acid and overcome salt antagonism. However, herbicides in the acid form are less water soluble than in salt form. An acid herbicide with pH modifiers may precipitate and plug nozzles when solubility is exceeded, such as with high herbicide rates in low water volumes. Antagonism of herbicide efficacy by spray solution salts can be overcome without lowering pH by adding AMS or, for some herbicides, 28% UAN.

Acidic AMS replacement (AAR) adjuvants (see page 130) contain adjuvants including monocarbamide dihydrogensulfate (urea and sulfuric acid) and some adjuvants in this class are similar to NIS + AMS in enhancing glyphosate and other weak-acid herbicides. The sulfuric acid forms sulfate when reacting with water and can prevent herbicide antagonism with salts in water. The conversion of urea to ammonium is slow but the ammonium formed can partially enhance herbicides. AAR adjuvants must be applied at 1% v/v or greater to achieve the same level of herbicide enhancement as AMS.

Basic pH blend adjuvants are blends of nonionic surfactant, fertilizer, and basic pH enhancer and are used at 1% v/v regardless of spray volume. Data indicate basic blend adjuvants at 1% v/v from 5 to 20 GPA will provide adequate adjuvant enhancement for similar weed control.

Basic pH blend adjuvants are surfactant based, increase spray solution pH, and contain nitrogen fertilizer to enhance herbicide activity. They contain a surfactant to aid in spray retention, spray deposition, and herbicide absorption, and a buffer to increase water pH. Basic pH blends adjuvants increase water pH to near pH 9 which increases water solubility of some herbicides and can increase herbicide phytotoxicity. Within the sulfonylurea chemistry the magnitude of solubility from high spray solution pH can increase from 40 fold (Harmony GT) to 3,670 fold (UpBeet). The solubility of herbicides in other chemical families increase with high pH: Achieve (1-Dim), florasulam (2-TPS), Everest (2-SACT), Sharpen (14), and diflufenzopyr (19), Callisto and Laudis (27-triketone), and pyrasulfatole and Impact (27-pyrazolone) (numbers represent herbicide mode of action).

Some herbicides degrade rapidly in high pH spray solution. Cobra (diphenylether), Resource and Valor (N_phenylphthalimide), and Sharpen (pH 9) degrade within a few minutes in high pH water but are stable for several days at low pH. Optimum use of pH adjusting adjuvants requires some knowledge of herbicide chemistry or experience. Research has shown that basic pH blend adjuvants may enhance weed control similar to MSO adjuvants and can be used in situations where oil adjuvants are restricted.

Spray carrier water quality

Minerals, clay, and organic matter in spray carrier water can reduce the effectiveness of herbicides. Clay inactivates paraquat, diquat, and glyphosate. Organic matter inactivates herbicides. Hard water cations or micronutrients such calcium, magnesium, manganese, sodium, and iron reduce efficacy of all weak-acid herbicides. Cations antagonize glyphosate efficacy by binding with glyphosate to form salts (e.g. Glyphosate-Ca) that are not readily absorbed by plants. Antagonistic minerals can inactivate the activity of most POST herbicides, including glyphosate, growth regulators (not esters), ACCase inhibitors, ALS inhibitors, HPPD inhibitors, and Ignite. The antagonism is related to the salt concentration. At low salt levels, loss in weed control may not be noticeable under normal environmental conditions but will occur when weed control is marginal because of drought or partially susceptible weeds. The precise salt concentration in water that causes a visible loss in weed control is difficult to establish because weed control is influenced by other factors.

ND water often contains a combination of sodium, calcium, magnesium, and iron and these cations generally are additive in the antagonism of herbicides. Water in ND, SD, and MT is often high in sodium bicarbonate which does not normally occur in other areas of the U.S. Calcium levels above 150 ppm and sodium bicarbonate levels above 300 ppm in spray water can reduce weed control in all situations. Water with 1600 ppm sodium bicarbonate can occur in ND, but total hardness levels can exceed 2,500 ppm.

Ammonium nitrogen increases effectiveness of most weak-acid herbicides formulated as a salt. Fertilizers should always be used with herbicides unless prohibited by label. Ammonium ions greatly enhance herbicide absorption and phytotoxicity even in the absence of antagonistic salts in the spray carrier. However, enhancement of Roundup and most other POST herbicides from ammonium is most pronounced when spray water contains large quantities of antagonistic cations. Herbicide enhancement by nitrogen compounds appears in most weed species but is most pronounced in species like volunteer corn and species that accumulate antagonistic salts on or in leaf tissue (lambsquarters, velvetleaf, and sunflower).

AMS enhances phytotoxicity and overcomes salt antagonism for weak-acid herbicides formulated as a salt including glyphosate, growth regulators (not esters), ACCase inhibitors, ALS inhibitors, HPPD inhibitors, and Ignite. The antagonism may be overcome by increasing the glyphosate concentration relative to the cation content or by adding AMS and some water conditioners to the spray solution. Effective water conditioners include EDTA, citric acid, AMS, and some acidic AMS replacements. Of these, AMS has been the most widely adopted. When added to a spray solution, the ammonium (NH_4^+) ion complexes with the glyphosate molecule and reduces glyphosate interaction with the hard-water cations, and the sulfate (SO_4^{2-}) ion complexes with the hard-water cations (e.g. calcium sulfate), causing the salt to precipitate from solution. This combined effect increases absorption and efficacy. Natural sulfate in water can be disregarded but can reduce antagonism if the sulfate concentration is at least three times the calcium concentration.

Antagonism of Roundup by calcium in a spray solution was overcome by sulfuric but not nitric acid, indicating that the sulfate ion was important, but not the acid hydrogen ion. The importance of the sulfate ion explains the effectiveness of ammonium sulfate, and not 28% UAN, in overcoming calcium antagonism of glyphosate. Other herbicides that become acid at a higher pH than Roundup may realistically benefit from a reduced pH as has been shown for Poast. However, Poast does not require a low pH for efficacy. pH of 4 has overcome sodium antagonism of Poast, but nitrogen fertilizer or AMS also will overcome sodium antagonism of Poast without lowering the pH. The ammonium ion provided by these fertilizers is apparently the important ion.

AMS is recommended at 8.5 to 17 lb/100 gal spray volume (1 to 2%) on most Roundup* labels. However, AMS at 4 lb/100 gal (0.5%) is adequate to overcome most salt antagonism but more than 4 lb/100 gal may be required to fully optimize herbicides. AMS at 0.5% has adequately overcome antagonism of glyphosate from 300 ppm calcium. Use at least 1 lb/A of AMS when spray volume is more than 12 gpa. The amount of AMS needed to overcome antagonistic ions can be determined as follows:

Lbs AMS/100 gal = (0.002 X ppm K) + (0.005 X ppm Na) + (0.009 X ppm Ca) + (0.014 X ppm Mg) + (0.042 X ppm Fe)

This does not account for antagonistic minerals on or in the leaf tissue in species like lambsquarters, sunflower, and velvetleaf which may require additional AMS.

AMS may contain contaminants that may not dissolve resulting in plugged nozzles. Use spray grade AMS to prevent nozzle plugging. Commercial liquid solutions of AMS are available and contain approximately 3.4 lbs of AMS/gallon. For 8.5 lbs of AMS/100 gallons of water add 2.5 gallons of liquid AMS solution.

28% UAN fertilizer is effective in enhancing weed control and overcoming mineral antagonism of most POST herbicides, but not calcium antagonism of Roundup. Sodium bicarbonate antagonism of Poast is overcome by 28% UAN and AMS. AMS or 28% UAN does not preclude the need for an oil adjuvant with lipophilic herbicides. Generally, 4 gal of 28% UAN/100 gal of spray has been adequate. AMS and 28% UAN enhance herbicide control of most weeds even in water without antagonistic salts. Nitrogen fertilizer/surfactant blends may enhance weed control of most herbicides formulated as a salt.

The analysis may report salt levels in ppm or grains. To convert from grains to ppm, multiply by 17 (Example: 10 grains calcium X 17 = 170 ppm calcium). AMS at 2% (17 lb/100 gallons water) will overcome antagonism from the highest calcium and/or sodium concentrations in water. However, AMS at 4 lb/100 gal is adequate for most water sources. Iron is the most antagonistic salt to many herbicides but is not abundant in water.

Water conditioner adjuvants are liquid for user preference, applied at low use rates, may contain no or very little AMS, may lower spray solution, and are advertised to replace AMS, and thus are called AMS replacement adjuvants. Pesticide applicators prefer the convenience of low use rate water conditioners, but performance has been inconsistent. Glyphosate plus commercial water conditioner products that included AMS at the equivalent rate of 1% w/w can give similar control to 1% w/w (8.5 lbs/100 gal) AMS. Commercial water conditioners that do not provide an equivalent amount of AMS give less control than glyphosate with 1% or 2% w/w AMS and are often no better than glyphosate alone.

Acidic AMS replacement (AAR) adjuvants have been developed for use with glyphosate and other weak acid herbicides. Claims have been made to enhance herbicide activity, and negate the effects of antagonistic salts in spray water and the antagonism from micronutrient solutions added for crop health. Most adjuvants in this class contain monocarbamide dihydrogen sulfate or AMADS (urea plus sulfuric acid) which lowers spray solution pH to 1.4 to 3. The low pH is below the pKa of postemergence herbicides causing most herbicide molecules to be in the acid state which results in fewer molecules binding to positively charged salts.

Some water conditioner adjuvants and acidic AMS replacement adjuvants (AAR) are marketed to modify spray water pH, but low pH is not required for herbicide efficacy. The type of acid or components of buffering agents and the specific herbicide all need to be considered before using pH-modifying agents. Several commercial AAR adjuvants applied with glyphosate in distilled water were tested and ranked as follows: surfactant + AMS > AMS > NIS = AAR. A commercial AAR adjuvant composed primarily of sulfuric acid was much less phytotoxic than most AAR adjuvants which support the concept and use of ammonia to enhance weak acid herbicides. Generally, AAR adjuvants applied with glyphosate in 1000 ppm hard water (Ca and Mg) gave similar weed control as when applied in distilled water supporting the theory of non-binding herbicide molecules when pH is below the pKa of the herbicide. Clearly, commercial adjuvants vary greatly in function, use, and chemical and biological effect.

Low spray volumes (5 to 10 gpa) have been equally or more effective than higher spray volumes for many herbicides. Low spray volume originally was considered important to glyphosate efficacy because it would reduce the ratio of glyphosate and antagonistic cations in the spray solution. However, low spray volumes have enhanced glyphosate efficacy because of higher glyphosate concentration in the spray deposit. Greater efficacy from higher concentrated droplets has been shown with many other herbicides but is logical that the highly concentrated droplets with low volume would be positive for translocated herbicides (NDSU Pile Theory). Contact herbicides (Cobra, Cadet, Ignite, Flexstar/Reflex, paraquat, Sharpen) require higher spray volume for adequate and thorough coverage to enhance control.

Low spray volumes usually imply use of low-volume nozzles that produce small droplets which can increase off-target movement. However, drift-reducing nozzles have been developed that produce large droplets at low volume. In low spray volumes, larger droplets produced by drift-reducing nozzles have been equally effective as small droplets with several translocating herbicides. However, coarse or larger droplets may be less phytotoxic than fine and medium size droplets for most POST herbicides. Limited research is available about efficacy based on droplet size although will become important as regulation requires larger droplet size to mitigate drift from small droplets.

Financial Status of Northwest Kansas Farms

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Economic Overview:

Northwest Kansas farms are trudging through some of the hardest financial times in almost 70 years of KFMA, NW data even while producing record yields over the past few years. Looking back over the past 10-12 years, 2007 was the first peak in accrual net farm income followed by an enormous double peak in 2011. Following those highly profitable times has been five years of meager breakeven years with most operations not generating enough profit to cover family living and debt payments. KFMA, NW economists will be working on the 2018 analysis in the upcoming months but 2018 does not appear to have much change from the recent years.

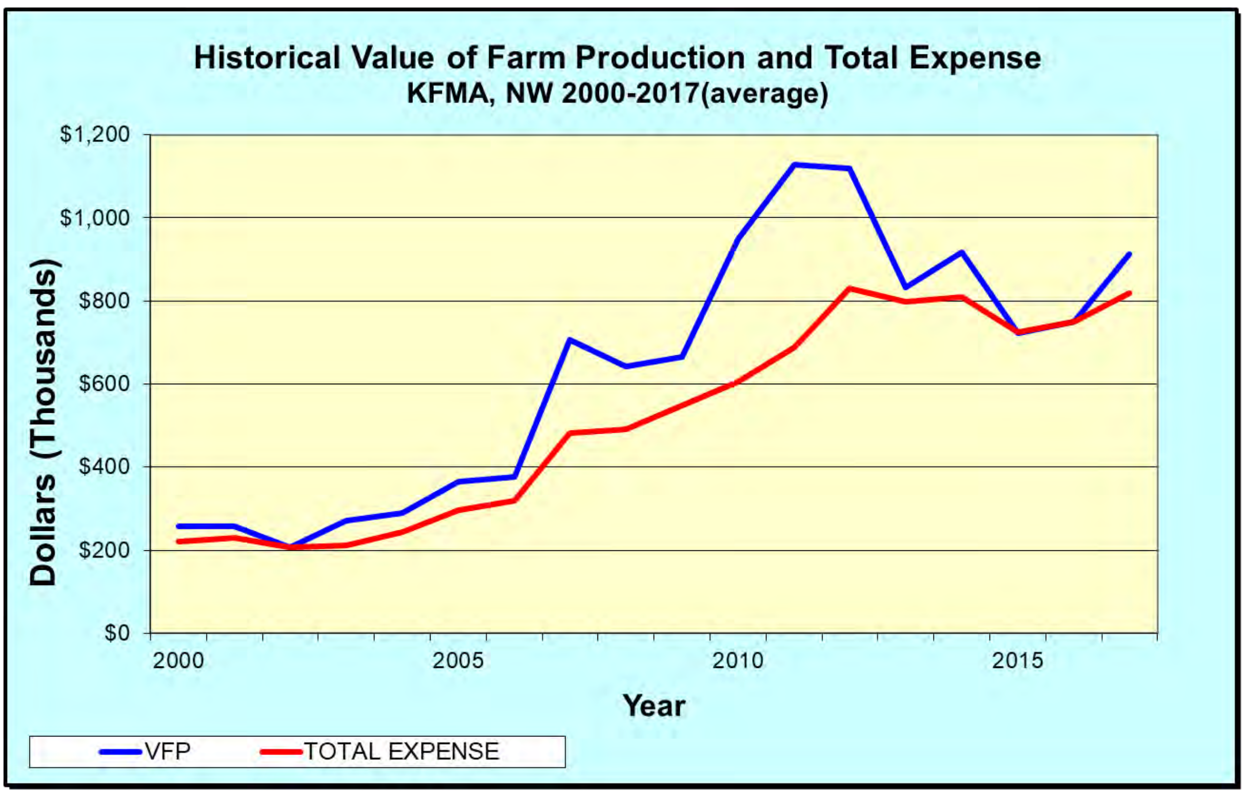

Figure 1

Figure 1 shows Value of Farm Production (VFP) and Total Expense (TE) for KFMA, NW member farms since 2000. Notice the VFP above the TE line showing positive Net Farm Income (NFI) in those years. Many factors in the background led to those highly profitable years including the ethanol mandate providing a high demand for corn then a Corn Belt drought limiting supply. NW Kansas had favorable yields and could take advantage of the high market prices. Even through the drought of 2012, crop insurance APH's were high leading to large crop insurance claims adding to net farm income.

Behind the crop scene, cattle numbers and markets were adding to overall farm profitability. As crop incomes came down in 2013, cattle markets were soaring in 2014 and 2015 extending most farms good years. The Texas drought during this time liquidated breeding livestock creating a cattle-cycle favorable to whoever could keep their herd numbers stocked. One last factor helping farm cash flow was oil leases and royalties sweeping through the area with high crude oil prices.

However basic economics kicked in leading to inflated land, machinery, breeding stock, and input costs. Profit margins tightened up quickly and positive cash flow diminished. Also, family living is still lingering around $100,000 for the average KFMA, NW family and has little room to budget. Figure 2 shows family living and income taxes paid during the same time period as Figure 1's value of farm production. Family living and income taxes are generally lagged from net farm income but increased after the good years and has decreased during the poor years. Unless there is sufficient off farm income to cover family living and income taxes, the farm business must provide all the funds or the family is living on borrowed money.

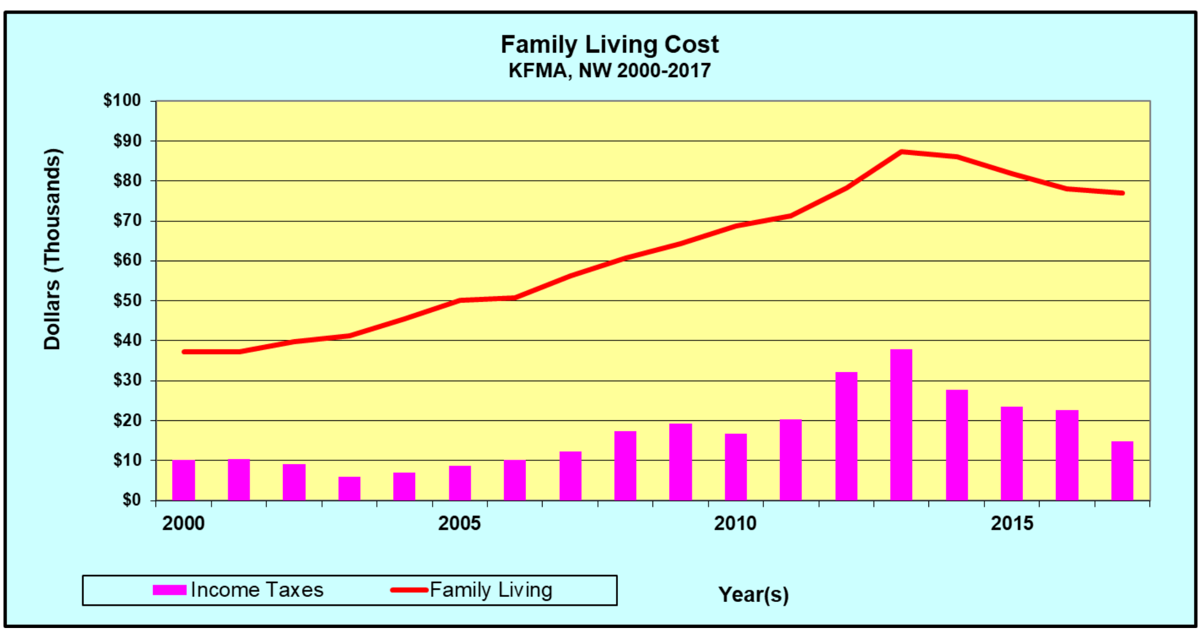

Figure 2

Regardless of past years' performance, there are still many farms with a positive net farm income. Farm size and profit margin are both critical to net farm income; large farms do not necessarily have an advantage over small farms. If the total expense ratio is greater than one (meaning it costs more than one dollar to generate one dollar of revenue), then large farms will lose more money. Farm size does help but only if profit margins are acceptable. Figure 3 shows the relationship between total expense ratio and value of farm production. The larger farms are shown to the right of the graph and the more efficient farms are shown lower on the graph. Three groups are important to note on this graph. First are the group of diamonds around $4,000,000 VFP with total expense ratio of $1.20 showing a net farm LOSS of $800,000 and proving the importance of profit margin with large farms. Second are the two farms at $5,000,000 and $6,000,000 VFP and under $0.75 total expense ratio showing net farm incomes nearing $2,000,000. The third group to consider are all farms under $2,000,000 VFP and under $0.75 total expense ratio; these are family owned farms with enough profitability to provide for a comfortable family living.

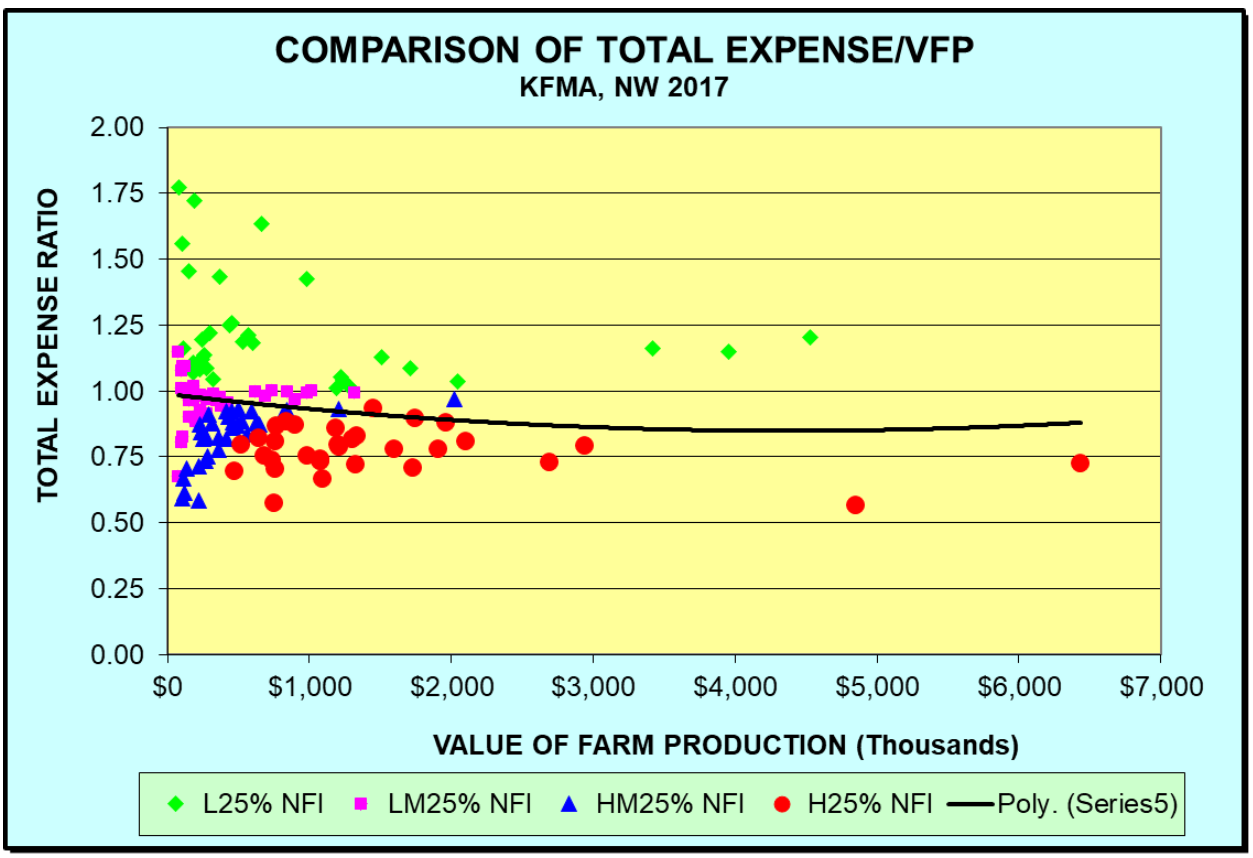

Figure 3

Going forward, important pieces for farm business managers to remember is the difference between the accrual income, cash flow, and tax return numbers. First, farms must be showing positive accrual income which includes grain and livestock inventories, prepaid expenses, and accounts receivable at each year end. Second, cash flow and timing of sales, purchases, and loan payments must be planned and communicated with bankers and other lenders. Last, profitable farms will have income tax liabilities and successful managers will pay them as needed. Although it is not as easy as the good years, the current market situations still have opportunity for farms to find income and profitability, ensure cash flow and liquidity, and improve net worth and solvency.

Income Tax Update:

The new tax law for 2018 has many changes that will affect agricultural businesses, here are some highlights:

- Individual rates decreased to 10, 12, 22, 24, 32, 35, and 37% brackets
- C Corporate rates are 21% flat
- Personal exemptions are eliminated
- Standard deduction is doubled
  - Or itemized deductions (medical, donations, mortgage interest, property taxes)
  - Does not impact deduction of business farm real estate or property taxes!
- Child tax credit doubled and AGI phase-out increased
- Estate exclusion increased to $11.2 million (inflation adjusted until 2025)
- Excess Business Losses over $500,000 carried forward
- Farm Net Operating Losses back 2 years or elect forward, offsets 80% taxable income
- Employer meals 50%, 0% after 2025
- Depreciation
  - Like-kind exchanges not allowed, trade is sale then full value purchase
  - Section 179 still available with limits
  - Bonus 100% until 2022 then phases down
  - 200DB method and 5-year life for some machinery
  - Impacts tax return and self-employment tax
- Section 199A Qualified Business Income Deduction

Cover Your Acres

Winter Conference

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Getting Peak Performance from Paraquat

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Executive Summary

1. **Paraquat is a contact herbicide that requires coverage to ensure maximum efficacy.**
2. **Select spray nozzles that deliver medium to coarse spray droplets for the best efficacy.**
3. **Use an appropriate drift reduction agent that is compatible with your spray nozzle, and be aware of shifts in droplet size with the addition of tank mix partners.**
4. **Use a PSII-inhibiting herbicide whenever possible to synergize paraquat efficacy.**
5. **Apply paraquat with other effective herbicide sites of action and as part of an integrated strategy to reduce the risk of paraquat resistance.**

Introduction to Paraquat

Paraquat was first synthesized in 1882 for use in bench chemistry; however, it was not recognized as an herbicide until 1955 with its commercial launch in 1962. Contrary to the myth, paraquat is not “Agent Orange” or a known carcinogen. Paraquat is a non-selective contact herbicide. When applied in sunny conditions, symptomology usually appears on treated plants within 1-2 hours after application. The Weed Science Society of America (WSSA) recognizes paraquat as a Group 21 herbicide site of action (SOA). After paraquat is absorbed through the cell membrane, it enters the chloroplast and binds to a protein on the photosystem I (PSI) light reaction center. Here it diverts electrons to reduce oxygen. Reduced oxygen destroys cell membranes which appears as the necrotic symptoms on plants. Paraquat has no activity in the dark or on cloudy days because the light reaction centers are not active. Generally, plants can be assessed for control or regrowth within 14 days after an application.

Before paraquat can cause plant death, it must be absorbed through the leaf cuticle and the cell membrane. All herbicides can be classified as either oil or water-loving. Because paraquat is a water-loving molecule, it is usually applied with 0.25% v/v NIS; however, oil-activator adjuvants and ammonium nitrogen sources such as UAN at 2.5% v/v can increase absorption, especially in hot, dry environments when plants can have thick and waxy cuticles. Different results were observed with various adjuvants with a sublethal rate of paraquat at Franklin and Reno Counties (Table 1). Differences are likely due to the significantly warmer temperatures before and after application at Reno County (Figure 1). In most situations, 0.25% v/v NIS is suitable; however, in hot, dry environments, UAN at 2.5% v/v may be beneficial.

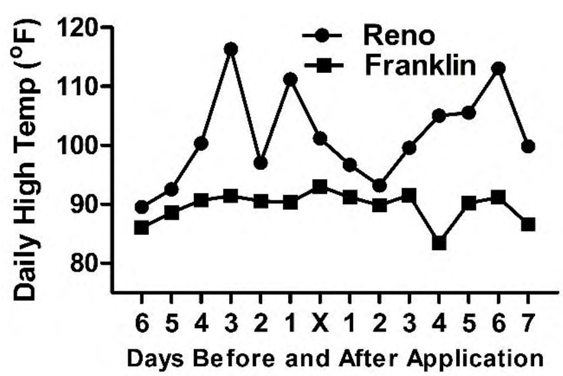


Figure 1. *Daily high temperature before and after herbicide application for paraquat adjuvant trials. X denotes the day of application.*

Treatment	Adj. Rate	Franklin County	Reno County
		Control (%)	
paraquat	-	46 a-c	43 c
para + NIS	0.25% v/v	74 a	53 bc
para + MSO	1 % v/v	50 a-c	50 bc
para + HSOC	0.5 % v/v	42 b-d	61 ab
para + surfactant + acidifier	0.5 % v/v	71 a	54 bc
para + UAN 28	2.5 % v/v	30 cd	75 a
para + AMS	8 lb/100 gal	43 b-d	65 ab
para + UAN 28 + HSOC	2.5 + 0.5 % v/v	66 ab	54 bc
para + AMS + HSOC	8 lb/100 gal + 0.5 % v/v	18 d	55 bc

Table 1. *Pigweed control at Franklin and Reno County with a sublethal rate of paraquat to expose the effect of an adjuvant. Better control would be expected with the field use rate. Letters indicate significant differences.*

Paraquat has a unique molecular structure (divalent cation). Because of this, paraquat can bind with dust or turbid water. Therefore, only clean water should be used, and consideration should be given to dust on plant leaves or from sprayer tires that could bind with the paraquat and reduce herbicide activity.

Application Technology

Often paraquat is criticized as an herbicide that is prone to drift; however, paraquat is no more driftable than other herbicides and may even be less because it is not volatile. It is common for paraquat to speckle leaves on nearby corn for example (Figure 2). Corn is extremely sensitive to paraquat, and many paraquat applications are made with small droplet sizes which are more prone to drift.

Each nozzle produces a spectrum of spray droplet sizes ranging from small to large (Figure 3). Any spray droplet smaller than 150 µm (about the diameter as a sewing thread) are classified as driftable fines. Driftable fines are easily moved off-target because of the greater time they are suspended in the air before reaching the target (Table 2). Focusing on droplet size, paraquat drift can be mitigated by reducing the number of driftable fines.

Figure 2. *Corn is very sensitive to paraquat. It is common for necrotic areas to appear on corn from paraquat burndowns. Corn yield is seldom affected from this type of injury.*

This can be influenced by increasing the droplet VMD (volume mean diameter) for the spray nozzle. Based on the VMD, each spray nozzle at a given operating pressure can be placed into one of seven categories (Table 3). Selecting a nozzle with a larger VMD would result in more larger droplets and a lesser number of driftable fines. Another option is to utilize a drift

Droplet		Time to fall 10 ft (seconds)	Travel distance in 3 mph wind
Classification	Diameter (µm)		
Very Fine	5	4.2 min.	1,100 ft
Fine	20	10	44 ft
Medium	240	6	28 ft
Coarse	400	2	8.5 ft

Table 2. *Small spray droplets take longer to reach the ground. Because of this, even a slight breeze can move the droplet further off-target. Minimizing driftable fines, lowering boom heights, and not applying in windy conditions can help reduce the risk of drift. Adapted from NSDU Ext.*

reduction agent (DRA) to decrease the number of driftable fines by tightening or shifting the droplet size spectrum for a given nozzle.

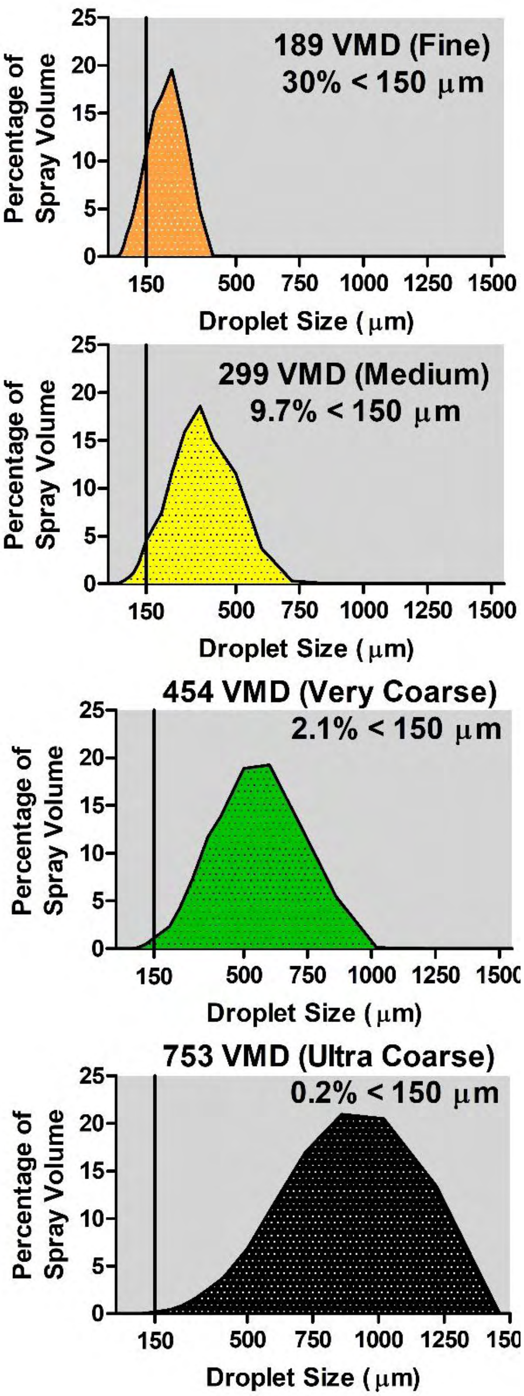


Figure 3. Droplet size distribution curves for four different spray nozzles ranging from Fine to Ultra Coarse.

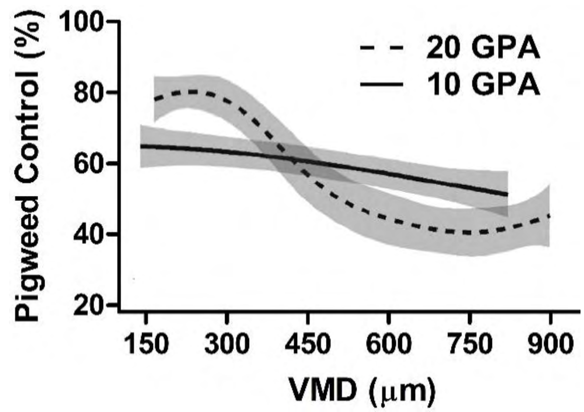


***Figure 4.** Pigweed control modeled across various nozzle droplet size spectrums and carrier volumes with a sublethal rate of paraquat.*

Category	Symbol	VMD Range (µm)	Color
Extremely Fine	XF	< 60	
Very Fine	VF	61 - 105	
Fine	F	106 - 235	
Medium	M	236 - 340	
Coarse	C	341 - 403	
Very Coarse	VC	404 - 502	
Extremely Coarse	XC	503 - 665	
Ultra Coarse	UC	> 665	

***Table 3.** Droplet size classification, symbols, and VMD ranges according to the ASABE standards.*

Unfortunately, this is easier said than done. By switching to a nozzle that produces larger droplets, paraquat coverage and efficacy could be reduced. If the incorrect DRA is utilized with certain nozzle types, more driftable fines could be produced. Nozzles that produce a Medium (M) to Coarse (C) droplet size (236 to 403 µm VMD) at 20 GPA will achieve the greatest efficacy on pigweed (Figure 4). Control will decrease and become less consistent with larger VMDs. Therefore, a nozzle should be selected that produces a M to C droplet size at the target application pressure; high pressures should be avoided as these tend to produce a greater percentage of driftable fines.

DRA's have the potential to shift a nozzle's VMD or tighten the distribution of droplets around the VMD. While either will reduce the risk of drift, consideration must be given to the VMD after the DRA is added to ensure that it is still within the M to C range.

For example, if a DRA is added and the VMD is shifted to the Very Coarse range, the risk of drift will have been reduced but so will the efficacy of the paraquat. DRA's that are oil-based should not be used in combination with Turbo-Tee, TTI, TTJ, or similar style nozzles as these have been shown to decrease droplet VMD rather than increase it; surfactant-based DRA's should be used instead with these nozzle designs (Table 4). If a different style nozzle is used, either type of DRA will increase the VMD. Other tank mix partners that are oil-based (COC, MSO, or EC pesticide formulations) will also decrease the VMD, especially with Turbo-Tee, TTI, TTJ, or similar style nozzles.

Nozzle	DRA: Yes	DRA: No
	VMD (µm)	
AITTJ11005	509	602
AIXR11005	509	485
TTI11005	645	803
XR11005	319	252

Table 4. *VMD for various nozzles with the addition of an oil-based DRA. VMD was decreased for Turbo-Tee style nozzles. Color indicates VMD classification from ASABE standards in Table 3. Adapted from Creech et al. 2009*

Because it is nearly impossible to test all tank mix combinations with all nozzles, it is imperative for applicators to continuously observe the nozzle spray pattern when the tank mix partners or rates are changed. An experienced observer can notice a change in 50 µm VMD which could have drastic performance implications for paraquat efficacy and drift.

When controlling dense stands of pigweed or kochia, it is critical to make the application to weeds smaller than 4-inches in height. Control will decrease when applying to large weeds. Inconsistent results for pigweed control with paraquat have commonly been observed at lower carrier volumes with more consistent results at higher carrier volumes (> 15 GPA). In addition to selecting a nozzle that produces the correct droplet size at the target pressure, preference should be given to a nozzle that orients droplets straight down for maximum canopy penetration. Dual angle nozzles have not been shown to increase pigweed control, possibly due to the increased distance that the droplet must travel to reach the leaf. Sprayers equipped with pulse-width-modulation (PWM) are becoming more common and can help keep droplet VMD more consistent across a range of travel speeds. Only non-venturi-type nozzles should be used with PWM, and duty-cycles should be above 40%.

Tank Mix Partners

PSII-inhibiting herbicides (atrazine, metribuzin, linuron, or diuron) should be tank mixed with paraquat whenever rotational restrictions allow to increase weed control. Synergistic effects are commonly observed when these two SOA are combined because they work in tandem on the two types of light reaction centers in the chloroplast. Delayed necrosis should be expected with these tank mixes (Figure 5).

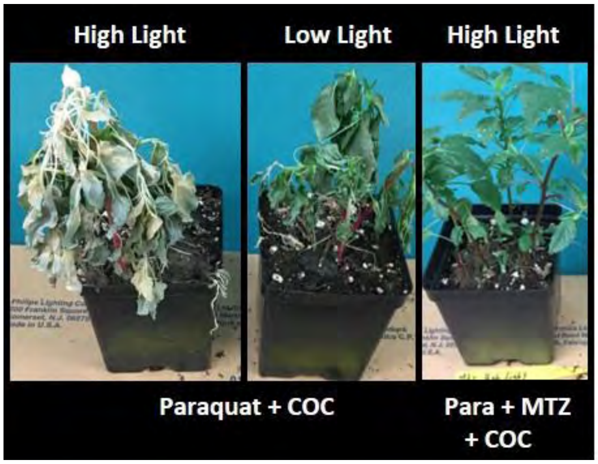


Figure 5. *Paraquat was applied to pigweed alone and in combination with metribuzin, and plants were kept in separate growth chambers with low light (cloudy day) and high light (sunny day). At 48 hours after treatment, different levels in symptoms were observed. All treatments achieved complete control after being returned to sunny conditions.*

While most of the pigweed and kochia populations in Kansas are resistant to atrazine, even reduced rates of PSII-inhibiting herbicides with paraquat still provide a synergistic effect on these resistant populations (Table 5).

Treatment	Rate lb ai/ac	Reno County Control (%)
paraquat	sublethal	45 c
atrazine	0.66	0 d
mesotrione	0.19	78 ab
para + ATZ	0.09 + 0.66	68 b
para + ATZ + mesotrione	0.09 + 0.66 + 0.19	89 a

Table 5. *Atrazine-resistant pigweed control at Reno County with a reduced rate of paraquat plus atrazine and mesotrione. A sublethal rate of paraquat was used to unmask the benefits of various tank mix partners. Letters indicate significant differences.*

Rotational restrictions for atrazine and metribuzin must be given special consideration, especially in high pH soils in which they become less adsorbed to the soil and are more available for plant uptake. In these situations, linuron or diuron may be better options since they are not influenced by soil pH. Whenever a PSII-inhibiting herbicide is utilized, an oil-activator adjuvant such as 1 pt/ac COC or MSO should be substituted for NIS since PSII-inhibiting herbicides generally require an oil-activator for foliar absorption.

Other herbicide SOA such as flumioxazin, glufosinate, mesotrione, and 2,4-D have been shown to offer joint activity on pigweed when tank mixed with paraquat. Tank mixing additional effective sites of action that complement paraquat could result in more consistent weed control, residual weed control, and facilitate resistance management.

While most paraquat applications are focused on controlling glyphosate-resistant driver weeds such as pigweed or kochia, there are often other weeds that would ideally be controlled with the same application. Unfortunately, paraquat offers inconsistent control at best of many grass species. Tank mix partners such as PSII-inhibiting herbicides, glufosinate, or clethodim have been shown to increase grass weed control; however, mixed results are often observed. When trying to control grasses in

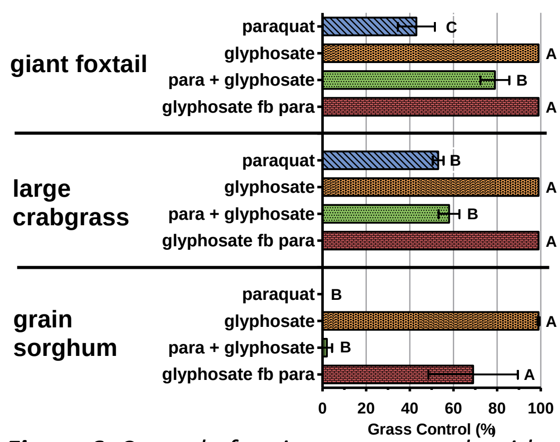


Figure 6. *Control of various grass weeds with paraquat and glyphosate combinations. The sequential treatment received paraquat 24 hours after the glyphosate application. Letters indicate differences in control within species.*

addition to glyphosate-resistant driver weeds, the best grass control is almost always achieved with a sequential application of glyphosate followed by paraquat. The tank mix of glyphosate plus paraquat has achieved poor grass control across numerous trials (Figure 6). Antagonism with paraquat plus glyphosate has been consistently observed, and therefore, this tank mix is not recommended. The antagonism is likely due to a combination of two aspects: 1) because paraquat has a positive charge, it could bind with glyphosate in the spray tank thus making it difficult for foliar absorption or 2) the desiccation of tissue by the paraquat is limiting the translocation of glyphosate in the plant.

Resistance Management

With the increase in glyphosate-resistant pigweed and kochia combined with the reduction in price of paraquat, more selection pressure is placed on paraquat each year. No resistance to paraquat has been confirmed in kochia or pigweed; however, resistance to paraquat has been documented in some grass species as well as marestail outside of Kansas. According to the WSSA, herbicide resistance is

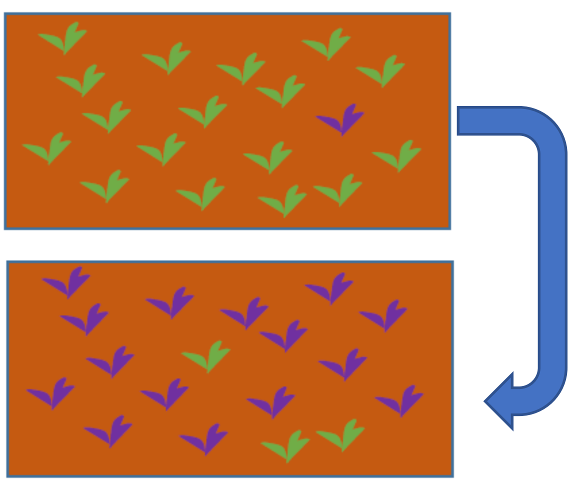
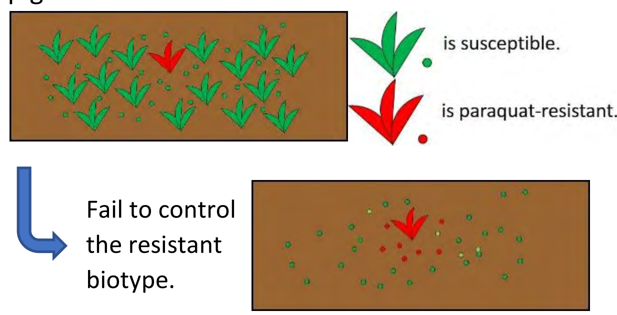


Figure 7. *After repeat applications of the same herbicide, a resistant population will develop (purple plants in lower picture). In the above picture, only one resistant individual emerged. If a different approach had been used, this one individual could have been controlled. Over time, the producer selected for a resistant population.*

the inherited (genetic) ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to the wild type. Repeated applications of paraquat will inevitably select for a population of pigweed or kochia that is resistant (Figure 7).

Scenario 1: Apply 0.75 lb ai/ac paraquat to 4-inch pigweed.



Scenario 2: Apply 0.75 lb ai/ac paraquat + 0.5 lb ai/ac metribuzin to 4-inch pigweed.

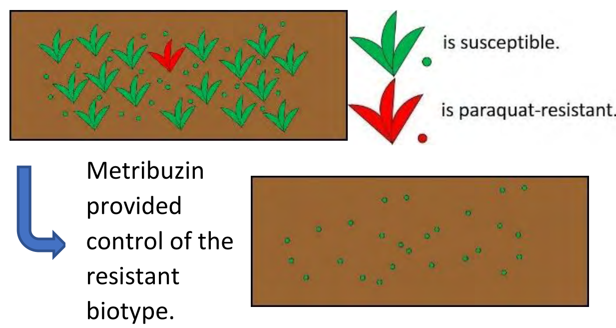


Figure 8. *Scenario 1 demonstrates how applying paraquat alone would not provide control of a resistant biotype. Because of the failed control of this biotype, resistant seeds will be added to the soil (red dots). In Scenario 2, MESA is utilized, and metribuzin provides control of the paraquat-resistant biotype and no resistant individuals enter the seed bank.*

To extend the life of paraquat as an effective herbicide in the Great Plains, multiple effective herbicide sites of action (MESA) should be used in tank mix to limit the selection pressure on paraquat (Figure 8). It is important to understand which SOA are carrying the load in herbicide recommendations.

Many premixes are available that contain numerous SOA, but they only count toward MESA if the population does not contain resistance to that SOA and are applied at the correct rate. Tank mixing MESA has been proven to be more effective than rotating herbicide SOA because in a rotation, all the selection pressure is placed on only one SOA in each application (Figure 8).

One example of effective SOAs that should be considered are the PSII-inhibiting herbicides for pigweed control with paraquat. While most populations of pigweed in Kansas are resistant to atrazine, a member of the triazine family, atrazine-resistant pigweed populations are susceptible to metribuzin, linuron, and diuron. These other PSII-inhibiting herbicides are from different families than atrazine, and because of the non-target site metabolic resistance mechanism, they still offer excellent control (Table 6). Therefore, to implement MESA resistance management, they should be applied at a labeled rate to ensure that they could control a paraquat-resistant biotype as opposed to a low rate that might be used only for synergistic purposes.

Treatment	Rate lb ai/ac	Pigweed Control (%)
metribuzin	0.75	99 a
	0.375	96 ab
	0.188	76bc
linuron	1.0	98 a
	0.5	95 ab
	0.25	71 c
atrazine	2.0	0 d

Table 6. *Atrazine-resistant pigweed control at Cloud County with various rates of metribuzin, linuron, and atrazine with COC in the absence of paraquat. Letters indicate significant differences.*

In kochia, resistance to the PSII-inhibiting herbicides is conferred through a target site mechanism which has cross resistance to PSII-inhibiting herbicides including metribuzin, linuron, and diuron, making them ineffective when developing a management plan with MESA, other than for paraquat synergism purposes.

Key strategies to reducing the risk of paraquat resistance include using the full use rate of paraquat (at least 0.75 lb ai/ac) and making applications to small weeds. Utilizing the correct droplet size with an adequate adjuvant package to ensure optimal paraquat absorption is key to reducing the risk of resistance as well. The use of residual herbicides to control weeds as they emerge will also help to reduce the selection pressure on paraquat in burndowns.

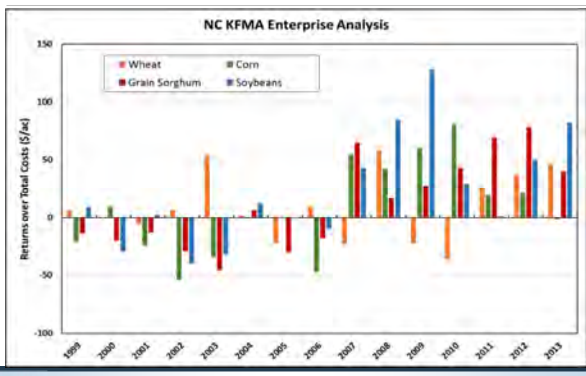
In addition to these herbicide management approaches, the most effective strategies to reduce the risk of paraquat resistance are to integrate cultural and mechanical options whenever possible to suppress pigweed and kochia seed production.

AgManager

Current Economic Conditions

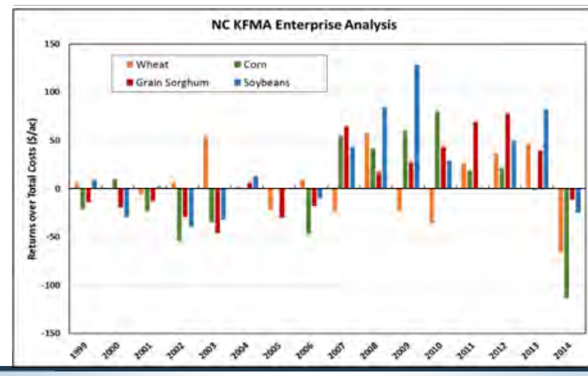
AgManager

Returns to Farming



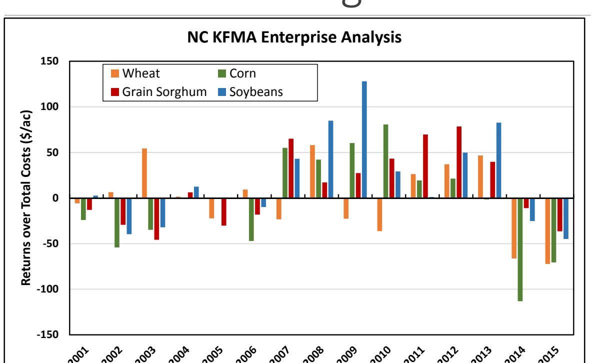
AgManager Source: KFMA Enterprise Reports (http://www.agmanager.info/kfma)

Returns to Farming



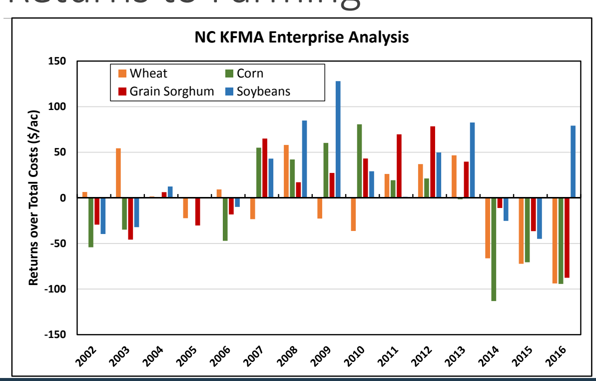
AgManager Source: KFMA Enterprise Reports (http://www.agmanager.info/kfma)

Returns to Farming



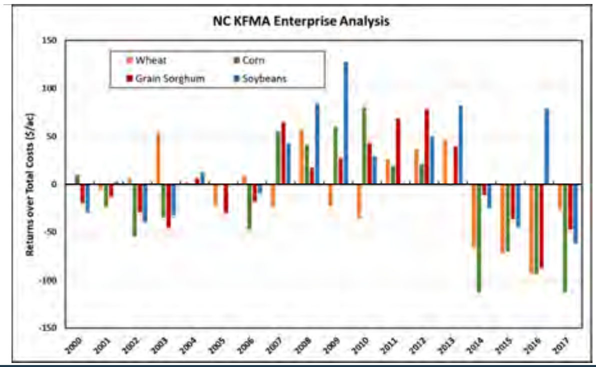
AgManager Source: KFMA Enterprise Reports (http://www.agmanager.info/kfma)

Returns to Farming



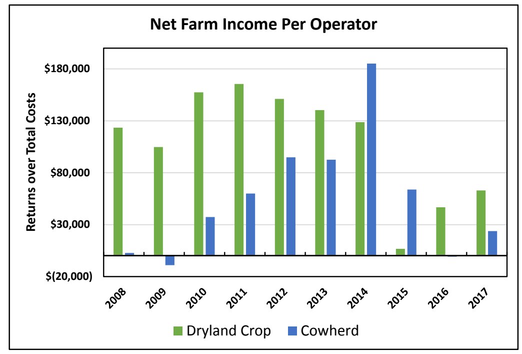
AgManager Source: KFMA Enterprise Reports (http://www.agmanager.info/kfma)

Returns to Farming

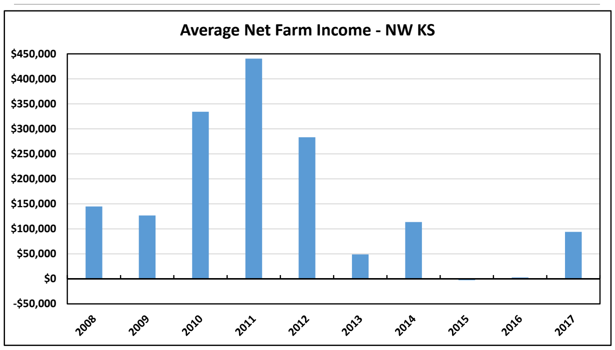


Source: KFMA Enterprise Reports (http://www.agmanager.info/kfma)

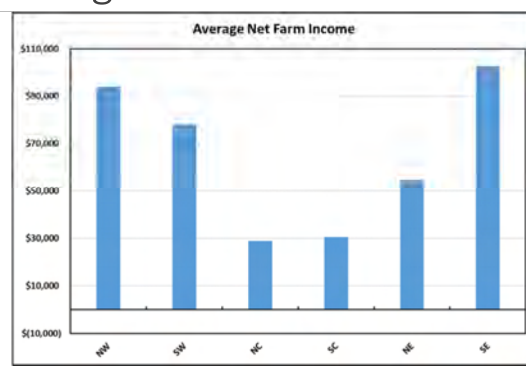
Net Farm and Ranch Income



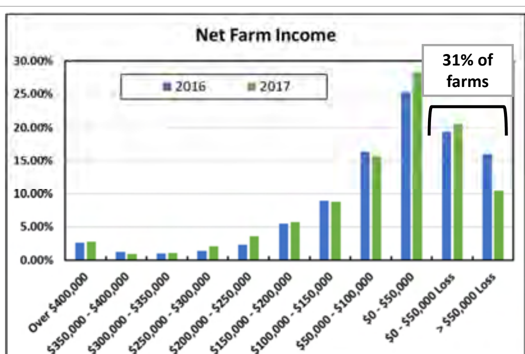
Average Net Farm Income-NW



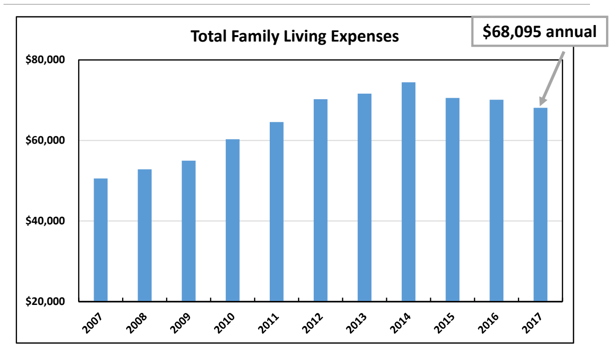
Average Net Farm Income



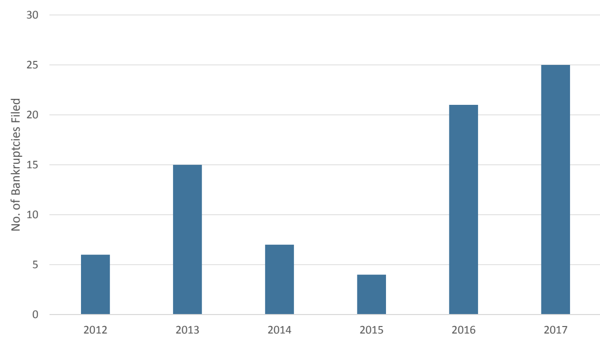
Distribution of NFI



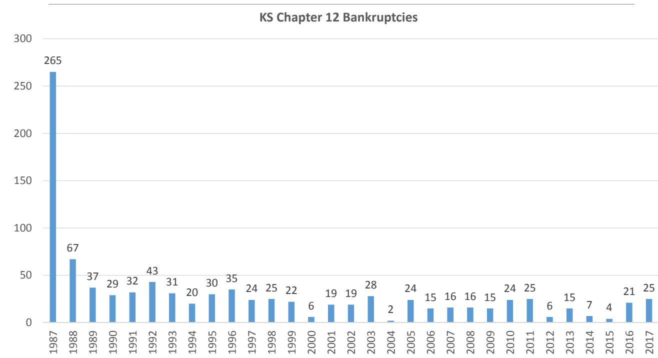
Farm Family Living Expenses



Bankruptcies Filed by KS Farms



Bankruptcies Filed by KS Farms



Land Value Trends

Land Values

Affected by profitability in ag sector

But land values do not adjust as quickly as profitability to changes in commodity prices

Adjustment period due to
- Long-run reasons for buying and holding land
- Expectations of buyers/sellers

Land Values

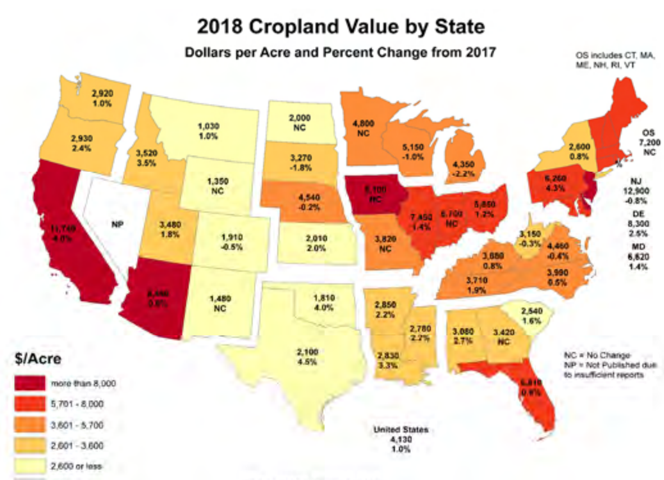
Where do we get information on land values?

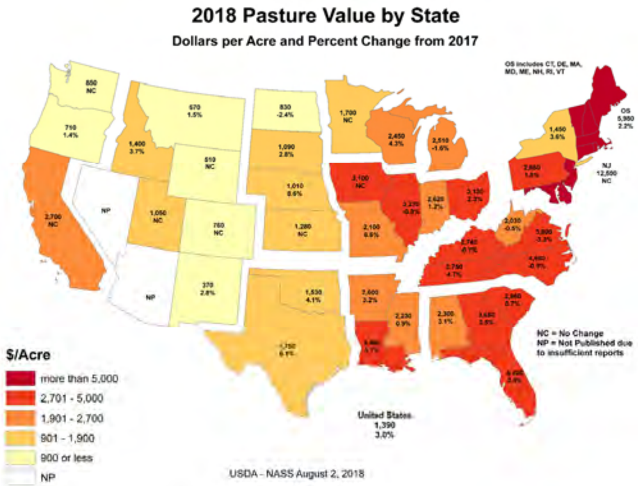
KS Ag Stats Service
- Annual survey series
- Dropped CRD-level estimates in 2013
- Only have a state value for irrigated, non-irrigated, and pasture land in Kansas


USDA

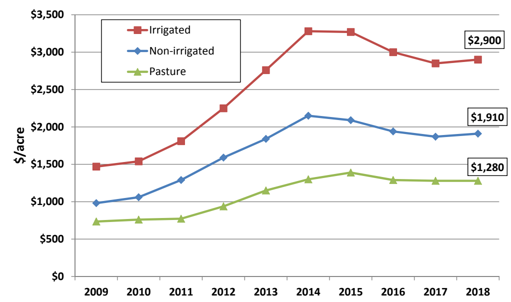
News Release

KANSAS FARM REAL ESTATE VALUE AND CROPLAND RENT HIGHER



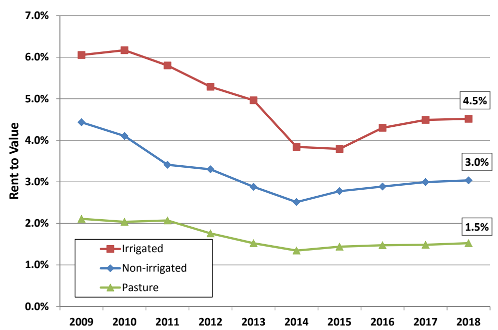


Kansas Land Values



Source: USDA-NASS

Rent-to-Land Value Ratio



Source: USDA-NASS

Market-Based Land Values

Kansas Land Values

Source for market transaction data

- Property Valuation Department, Topeka

2014-17 sales data

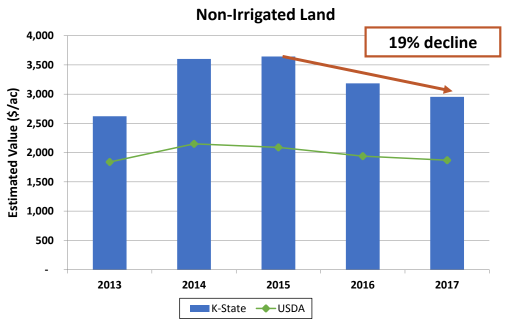
- County location, population density
- Acres in sale
- Mixture of irrigated, non-irrigated and pasture in parcel
- 20-year average rainfall and water-holding capacity
- Enrollment in CRP
- Value of improvements is removed for bare land value
- Parcels under 40 acres are omitted
- Johnson and Wyandotte County parcels removed

PVD Sales Data 2014-2017

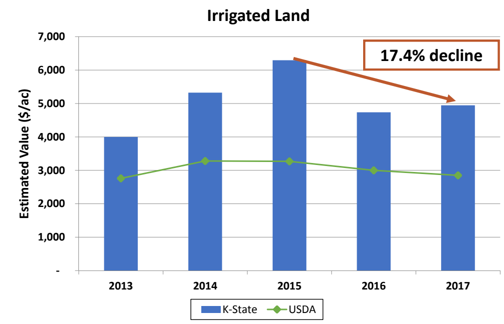
2017	Average
Acres in Sale	150.6
CRP Contracts	4.3%
Sales Per County	25.1
All Years	
Total Sales Transactions:	
2017	2,625
2016	2,145
2015	3,775
2014	3,789

31% drop in sales over past 4 years

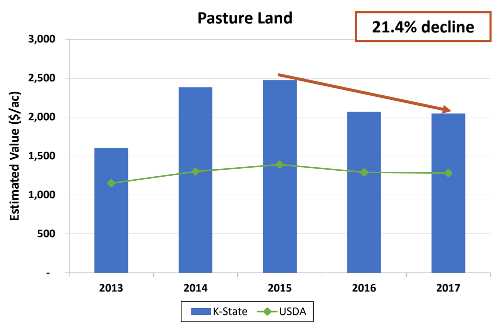
Land Model Results



Land Model Results

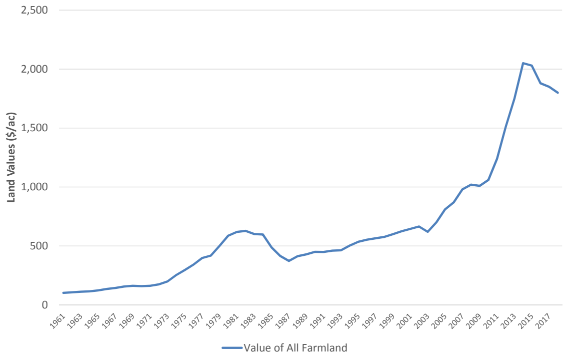


Land Model Results

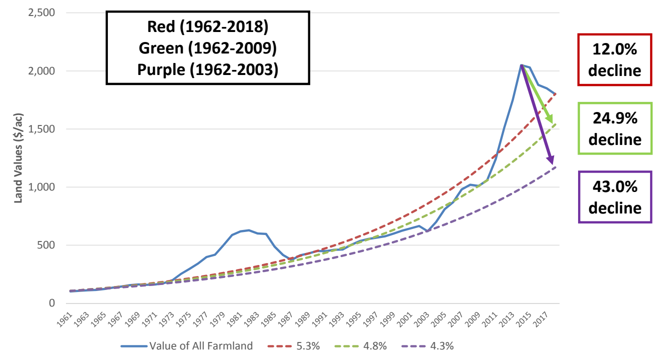


Long-Run Growth

Kansas Land Values



Kansas Land Values



Summary

Other Comments

"Land prices are still based on quality land having the highest demand and poor land having few buyers and lower prices."

- Appraiser in Central Kansas, September 2017

Farmers are the biggest buyers of farmland

- When farmers are reluctant to buy, demand falls and isn't likely to be sufficiently supported by outside investment
- Turnaround will happen when projections for net farm income rebound

Online Resources

2017 Kansas County-Level Ag Land Values

- www.agmanager.info/land-leasing/land-buying-valuing

2018 Rent Estimates: Non-Irr. & Irrigated Cropland

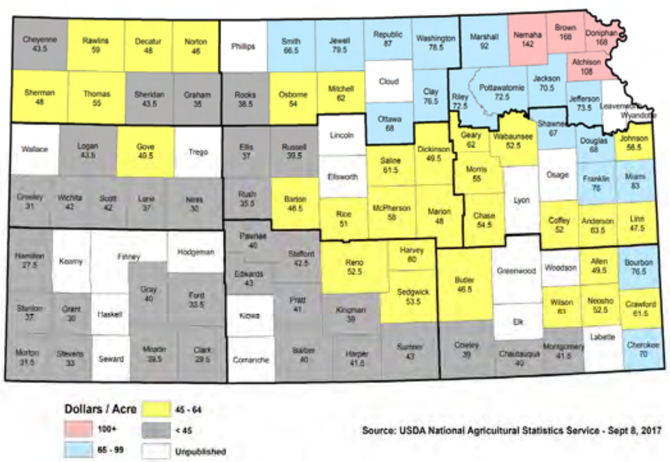
- www.agmanager.info/land-leasing/land-rental-rates

Pasture Rental Rate Tool

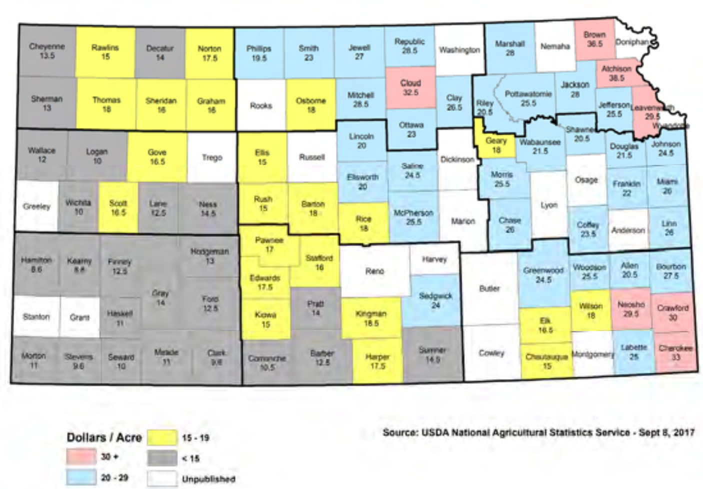
- www.agmanager.info/land-leasing/land-rental-rates/pasture-rental-rate-decision-tool

Rental Rates

2017 USDA Non-Irrigated Rents



2017 USDA Pasture Rents



Public Information

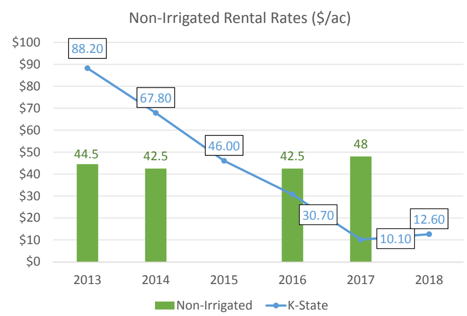
Limited public information on rental rates
- Surveys (USDA, some KS Counties)
- K-State budgeting approach: what a representative farmer could afford to pay

Comparisons need to be done carefully
- One measures what is actually being paid
- One measures what we expect could be paid

KSU Non-Irrigated Rental Rates

NW District	2013	2014	2015	2016	2017	2018
Cheyenne	66.00	45.30	30.50	19.80	6.50	10.20
Decatur	88.20	67.80	46.00	30.70	10.10	12.60
Graham	71.60	54.10	34.90	24.60	7.90	11.10
Norton	81.50	69.30	47.10	31.50	10.40	13.30
Rawlins	73.40	57.60	39.10	25.80	8.40	11.80
Sheridan	78.70	62.10	42.20	28.20	9.20	12.70
Sherman	64.80	44.70	30.20	19.90	6.50	10.40
Thomas	70.00	56.00	38.00	25.20	8.20	12.60
Average:	74.28	57.11	38.50	25.71	8.40	11.84

USDA vs. KSU - Decatur



Source: USDA-NASS and www.AgManager.info/land-leasing

Why are rents staying high?

Multi-year leases
- Consider signing 3-5 year leases but renegotiate rate annually

Good yields in 2017-18 in some areas
- Kept some profitability in sector to pay rents that wouldn't be affordable with average or below average yields

People are willing to pay more than they can afford in the short run
- Length of the short run is going to vary by producer

Online Resources

2017 Kansas County-Level Ag Land Values
- www.agmanager.info/land-leasing/land-buying-valuing

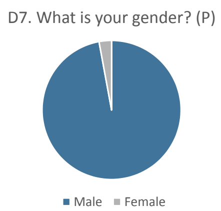
2018 Rent Estimates: Non-Irr. & Irrigated Cropland
- www.agmanager.info/land-leasing/land-rental-rates

Pasture Rental Rate Tool
- www.agmanager.info/land-leasing/land-rental-rates/pasture-rental-rate-decision-tool

Leasing Relationships

Demographic Information

Not surprising that men are the dominant gender of the producer group

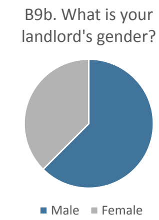


Demographic Information

Women make up a much larger percentage of the landowner group

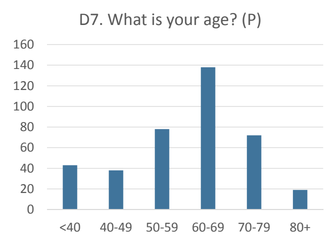
Does this matter for relationships?

- Conversations with their husband



Demographic Information

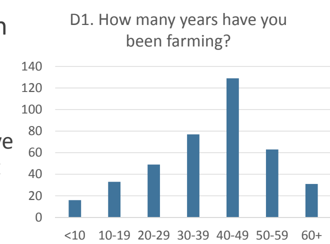
Average age: 59.6



Demographic Information

Aging farmer population

- Technology is allowing farmers to keep working longer
- Succession plans may have been delayed with recent economic downturn



Demographic Information

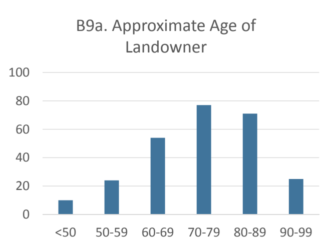
Average age: 72.9

Landowners

- Don't typically have the capital to invest in farmland until later in life or…
- Inherit from parents

Implications of their age

- Communications may have to be adjusted (texting, letters, etc.)
- Fixed income – may want fixed cash lease



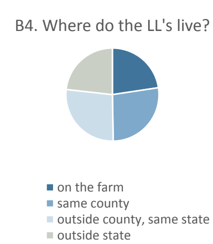
Demographic Information

Proximity of landowner affects

- Communication (in-person or distance)
- Ability to monitor tenant activities

Often tied to generational distance from the farm

- Perceptions of commercial agriculture
- Understanding of farm practices, farm policy, commodity markets

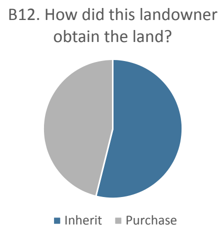


Demographic Information

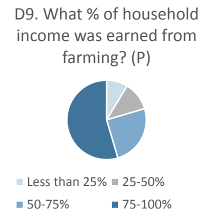
Number of years in landowner/tenant relationship

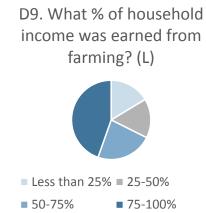
Attitudes toward return on investment

Loyalty to existing leasing arrangement
- Style of lease
- Lease amount



Demographic Information

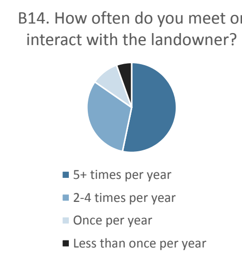




Lease Information

Lease Information

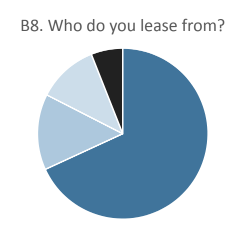
Communication is key to relationships
- Keep them updated on farming practices, market conditions
- Helps with the tough talks on renegotiating



Lease Information

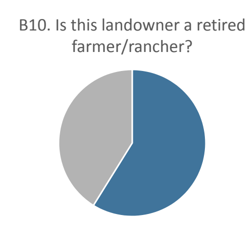
Communication is key to relationships
- Different conversation with an individual (neighbor) versus a banker/lawyer

Group dynamics versus individual
- Siblings with different ideas about how to manage the farm



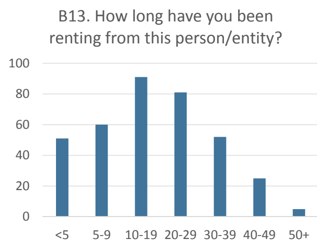
Lease Information

Perceptions of commercial farming
- Understanding of farm programs, farming practices, markets
- Likelihood of cash rent versus crop share



Lease Information

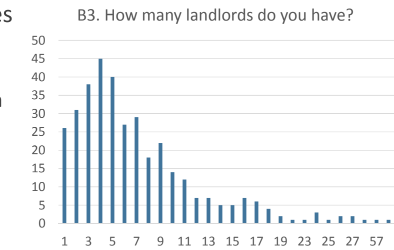
Average: 17.7 years



Lease Information

Communication issues
- Gets harder to talk to more people
- Use a newsletter or similar communication for group

Implications for lease type
- More likely to select a fixed cash lease to reduce paperwork burden



Who has more power in negotiating lease terms?

A. Landowner
B. Tenant

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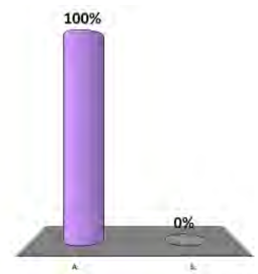

Negotiating Power

Farmers tend to have better information
- Rental rates (their other leases, coffee shop)
- Market and production conditions
- Technology
- Government programs

Landowners tend to have…the land

The Handy Bt Trait Table

for U.S. Corn Production

The latest version of this document is always posted at
https://www.texasinsects.org/bt-corn-trait-table.html

For questions & corrections: Chris DiFonzo, Michigan State Univ., difonzo@msu.edu
Contributor: Pat Porter, Texas A&M University (southern version of the table)

Updated November 2018

Most corn hybrids planted in the U.S. have transgenic traits for insect management. The Handy Bt Trait Table provides a helpful list of trait names (below) and details of trait packages (over) to make it easier to understand company seed guides, sales materials, and bag tags.

New for 2019

- ✓ Recent mergers resulted in name changes for several seed companies. While your local seed rep may have a new business card, the names of trait packages remain the same, listed alphabetically on page 2.
- ✓ *Bt Resistance* is arguably the most important issue facing growers, extension entomologists, and seed company agronomists. Problems continue to increase in regions where field failures were already found, and new cases of resistance are reported every season. To date, resistance is confirmed to all Bt toxins targeting western corn rootworm, particularly in the central corn belt. In the southern states, corn earworm and fall armyworm resistance is expanding, while Cry1F no longer controls western bean cutworm in the Great Lakes region. These species were once secondary to European corn borer in importance, but now they are of primary concern for many growers. It is critical to be up-to-date on resistance development in your local area so that you know the limitations of the Bt traits you plant.

Field corn 'events' (transformations of one or more genes) and their Trade Names

Trade name for trait	Event	Protein(s) expressed	Primary Insect Targets + *Herbicide tolerance*
Agrisure CB/LL	Bt11	Cry1Ab + *PAT*	corn borer + *glufosinate*
Agrisure Duracade	5307	eCry3.1Ab	rootworm
Agrisure GT	GA21	*EPSPS*	*glyphosate*
Agrisure RW	MIR604	mCry3A	rootworm
Agrisure Viptera	MIR162	Vip3A	broad caterpillar control, except for corn borer
Enlist	DAS40278	*aad-1*	*2,4-D herbicide detoxification*
Herculex I (HXI) or CB	TC1507	Cry1Fa2 + *PAT*	corn borer + *glufosinate*
Herculex CRW	DAS-59122-7	Cry34Ab1/Cry35Ab1 + *PAT*	rootworm + *glufosinate*
(None – part of Qrome)	DP-4114	Cry1F + Cry34Ab1/Cry35Ab1 + *PAT*	corn borer + rootworm + *glufosinate*
Roundup Ready 2	NK603	*EPSPS*	*glyphosate*
Yieldgard Corn Borer	MON810	Cry1Ab	corn borer
Yieldgard Rootworm	MON863	Cry3Bb1	rootworm
Yieldgard VT Pro	MON89034	Cry1A.105 + Cry2Ab2	corn borer & several caterpillar species
Yieldgard VT Rootworm	MON88017	Cry3Bb1 + *EPSPS*	rootworm + *glyphosate*

Abbreviations used in the Trait Table

Herbicide traits

- GT *glyphosate tolerant*
- LL Liberty Link - *glufosinate-tolerant*
- RR2 Roundup Ready 2, *glyphosate-tolerant*

Insect targets

BCW	black cutworm	SB	stalk borer
CEW	corn earworm	SCB	sugarcane borer
CRW	corn rootworm	SWCB	southwestern corn borer
ECB	European corn borer	TAW	true armyworm
FAW	fall armyworm	WBC	western bean cutworm

The Handy Bt Trait Table for U.S. Corn Production, updated November 2018

Trait packages in alphabetical order (acronym)	Bt protein(s) in the trait package	Marketed for control of:										Insects resistant to the combination of Bt proteins in the trait package	Herbicide trait		Non-Bt Refuge % (cornbelt)
		BCW	CEW	ECB	FAW	SB	SCB	SWCB	TAW	WBC	CRW		GT RR2	LL	
AcreMax (AM)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5% in bag
AcreMax CRW (AMRW)	Cry34/35Ab1										x	CRW	x	x	10% in bag
AcreMax1 (AM1)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	10% in bag 20% ECB
AcreMax Leptra (AML)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5% in bag
AcreMax TRIsect (AMT)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtra (AMX)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	10% in bag
AcreMax Xtreme (AMXT)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
Agrisure 3010 and 3010A	Cry1Ab			x			x	x					x	x	20%
Agrisure 3000GT and 3011A	Cry1Ab mCry3A			x			x	x			x	CRW	x	x	20%
Agrisure Viptera 3110	Cry1Ab Vip3A	x	x	x	x	x	x	x	x	x			x	x	20%
Agrisure Viptera 3111	Cry1Ab Vip3A mCry3A	x	x	x	x	x	x	x	x	x	x	CRW	x	x	20%
Agrisure 3120 E-Z Refuge	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	See bag tag for code EZ0 NO EZ1 YES	5% in bag
Agrisure 3122 EZ Refuge	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x		5% in bag
Agrisure Viptera 3220 E-Z Refuge	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x		5% in bag
Agrisure Viptera 3330 E-Z Refuge	Cry1Ab Vip3A Cry1A.105 + Cry2Ab2	x	x	x	x	x	x	x	x	x			x		5% in bag
Agrisure Duracade 5122 E-Z Refuge	Cry1Ab Cry1F mCry3A eCry3.1Ab	x		x	x	x	x	x			x	FAW WBC CRW	x		5% in bag
Agrisure Duracade 5222 E-Z Refuge	Cry1Ab Cry1F Vip3A mCry3A eCry3.1Ab	x	x	x	x	x	x	x	x	x	x	CRW	x		5% in bag
Herculex I (HXI)	Cry1F	x		x	x	x	x	x				FAW SWCB WBC	x	x	20%
Herculex RW (HXRW)	Cry34/35Ab1										x	CRW	x	x	20%
Herculex XTRA (HXX)	Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	20%
Intrasect (YHR)	Cry1Ab Cry1F	x		x	x	x	x	x				FAW WBC	x	x	5%
Intrasect TRIsect (CYHR)	Cry1Ab Cry1F mCry3A	x		x	x	x	x	x			x	FAW WBC CRW	x	x	20%
Intrasect Xtra (YXR)	Cry1Ab Cry1F Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	20%
Intrasect Xtreme (CYXR)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5%
Leptra (VYHR)	Cry1Ab Cry1F Vip3A	x	x	x	x	x	x	x	x	x			x	x	5%
Powercore [a] Powercore Refuge Advanced [b]	Cry1A.105 Cry2Ab2 Cry1F	x	x	x	x	x	x	x				CEW WBC	x	x	[a] 5% [b] 5% in bag
QROME (Q)	Cry1Ab Cry1F mCry3A Cry34/35Ab1	x		x	x	x	x	x			x	FAW WBC CRW	x	x	5% in bag
SmartStax [a] Smartstax Refuge Advanced [b] SmartStax RIB Complete [b]	Cry1A.105 Cry2Ab2 Cry1F Cry3Bb1 Cry34/35Ab1	x	x	x	x	x	x	x			x	CEW WBC CRW	x	x	[a] 5% [b] 5% in bag
Trecepta [a] Trecepta RIB Complete [b]	Cry1A.105 Cry2Ab2 Vip3A	x	x	x	x	x	x	x	x	x			x		[a] 5% [b] 5% in bag
TRIsect (CHR)	Cry1F mCry3A	x		x	x	x	x	x			x	FAW SWCB WBC CRW	x	x	20%
VT Double PRO [a] VT Double PRO RIB Complete[b]	Cry1A.105 Cry2Ab2		x	x	x	x	x	x				CEW	x		[a] 5% [b] 5% in bag
VT Triple PRO [c] VT Triple PRO RIB Complete [d]	Cry1A.105 Cry2Ab2 Cry3Bb1		x	x	x	x	x	x			x	CEW CRW	x		[c] 20% [d] 10% in bag
Yieldgard Corn Borer (YGCB)	Cry1Ab			x			x	x					x		20%
Yieldgard Rootworm (YGRW)	Cry3Bb1										x	CRW	x		20%
Yieldgard VT Triple	Cry1Ab Cry3Bb1			x			x	x			x	CRW	x		20%

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Remediation of eroded high pH hill-top soils with manure

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Introduction

In the Dust bowl of the 1930's, millions of farm acres were damaged by excessive tillage and erosion (Atmos. News 2012). The tillage practices used at that time made these soil particularly vulnerable to wind and water erosion. These eroded soils can still be observed while traveling through the region. They are most obvious on hilltops and side-slopes of tilled farmland. Driving across the Great Plains one can see hilltops and side-slopes that are lighter in color than the surrounding soils. The lightly colored soil indicates that most, of the original (dark-colored) top soil has been eroded away. Much of the erosion is the result of the combination of both multiple years of tillage and exposure of the unprotected land to erosive forces of the regions winds.

The subsoil now at the soil surface is low in organic matter and high in pH. Often free limestone can be found at the soil surface. The limestone buffers the soil to a high pH and that high pH makes nutrients like zinc (Zn) and iron (Fe) crop-unavailable. For these reasons, "pH sensitive" crops like corn, proso millet, and sorghum will exhibit classic zinc and iron deficiency symptoms (interveinal chlorosis) when growing in these eroded soils. The crop from a distance just looks bleached yellow when growing in these eroded regions of the field.

We know that organic amendments, like animal manures be that beef, poultry or swine, are good sources of plant nutrients (high in N, P, K, Zn, Fe, S and others). Also, because animal manures are high in carbon and rich in organic matter, these manures are a good amendment for mitigating organic matter depletion of an eroded soil (Arriaga and Lowery, 2003; Eghball et. al, 2004; Ferguson, et al., 2005). The question is, how do we best use manure as an amendment to fix (remediate) these soils? Specifically, we wanted to learn about reasonable rates of application and we wanted to evaluate the value of incorporation versus just applying the manure on the surface using no-till practices. A final objective was to evaluate if incorporated (tilled in), how deep should it be incorporated?

Experimental Approach

In 2006, we initiated an on-farm experiment (near Akron Colorado) to study the best management practices for remediating eroded hilltop soils with beef manure as the amendment. We selected a site that showed extensive top soil loss (erosion). Proso millet planted on the field in 2005 showed classic micronutrient deficiencies (interveinal chlorosis). An earlier paper Mikha et al., 2017, provides a detailed description of the study. In brief, the soil series at the study site is a Norka-Colby very fine sandy loam (fine-silty, mixed, mesic, Aridic, Argiustolls). The site is approximately 4540 feet above mean sea level with a slope of approximately 5%. Soil texture is 35% sand, 45% silt, and 20% clay. The average annual precipitation is 16.5 inches (110 yr. average). Each experimental plots is 45 feet wide by 50 feet long. The plots are organized in randomized complete block design with four replicates. A typical dryland cropping sequence for the region was planted over a seven year period from 2006 -2013. The crops that have been planted are Corn (2006) – Proso Millet (2007) – Forage Winter Triticale (2008) – Winter Wheat (2009) – Proso Millet (2010)—Corn (2011)—Fallow (2012)—Wheat (2013). These crops are planted on all of the plots and alleys except for the eight grass and grass/legume plots. For the grass and grass/legume plots forage sorghum was planted in June 2007 as a cover crop. The grass and grass/legume seed was planted in November 2007. Due to a record breaking drought in 2012, the field was summer fallowed that year.

Manure was analyzed before each application (Olsen's Agricultural Laboratory, Inc. McCook, NE) and N content was evaluated (Table 1). Manure was applied with the assumption that 100% of the inorganic N (NH_4^+ and NO_3^-) content was available at application time. We assumed that approximately 25% of organic N would become available through mineralization during the first season of application (Gilbertson et al., 1979). Thus, the annual M applications throughout the 6-yr study period ranged between 2.4 to 5.9 ton M ac^{-1} y^{-1} for the low rate and between 5.4 to 17 ton M ac^{-1} y^{-1} for the high rate depending on fresh M moisture content and inorganic N availability. Fertilizer P, Mono-ammonium phosphate (11-52-0) was applied with the seed at approximately 20 lbs of P_2O_5 per acre at the planting of wheat, triticale, and millet. No P was applied to the corn crops.

Table 1. Chemical characteristics of manure applied to the plots over the 6 year period.

Measurement	units	Mean	Standard deviation
Moisture	%	34.2	12.6
pH	pH	7.5	1.0
Electrical Conductivity	dSm^{-1}	15.6	6.7
C to N ratio	C:N	21.2	6.5
Total N	%	1.56	0.32
Inorganic N (mostly NH_4-N)	%	0.23	0.21
P_2O_5	%	1.09	0.30
K	%	1.35	0.30
Ca	%	1.44	0.78
Mg	%	0.42	0.16
Na	%	0.23	0.07
Cl	%	0.47	0.25
S	%	0.31	0.06
Zn	ppm	150	54.3
Fe	ppm	4412	2528
Mn	ppm	163	49.2
Cu	ppm	23.3	14.0

Manure is applied in the fall to allow for winter precipitation to restore moisture lost during tillage operations (Table 2 and Table 3). The low rate was determined by estimating the amount of nitrogen required to meet crop needs average over the next six years which was determined to be approximately 30 lb/ac. Based on past studies, we assumed that 25% of the organic nitrogen would be available to the crop the first year. The high rate is simply three times the low rate. The high rate of manure we hoped, was excessive enough to significantly increase soil organic matter content and change soil physical properties within the next six year cycle of the experiment. .

Some plots had the manure plowed under using a 14 inch tumble moldboard plow (10-12 inches deep) followed by chiseling at an 8-10 inch depth for soil mixing and seedbed smoothing, others were shallowly incorporated with V-blade sweeps (3-6 inches deep), and others the manure was applied on the surface and left unincorporated (managed no-till) (Table 2 and Table 3). The moldboard plow incorporated plots were managed in two ways: 1.) as a onetime application with a calculated rate of manure heavy enough to supply N for 6 cropping seasons and then plowed under at least 20-12 inches deep and chiseled (DP-6); and 2.) manure rate applied once every two years for two cropping seasons and plowed under and chiseled for mixing and soil smoothing (DP-2). For comparison, we included three check treatments: (1) an unfertilized check; and plots that were fertilized with just chemical fertilizer N, at either 30 lbs/acre or 60 lbs/acre. Urea was used as the chemical fertilizer N source (Table 2). Chemical N fertilizer rates are 30 and 60 lb/ac. The chemical N fertilizer treatments are broadcast (as urea) on the surface annually to the un-manured lots including the deep tillage plots, just prior to planting.

All treatments were replicated across the eroded slope four times. The first rep was on the most eroded soil and the other reps moved down the slope and show less erosion. Manure was applied in the fall to allow for winter precipitation to restore moisture lost during tillage operations. We measured grain and biomass yield, as well as measured changes in soil properties and nutrient uptake in the grain and biomass, every year. Weeds were controlled as needed primarily with glyphosate, [isopropylamine salt of *N*-(phosphonomethyl) glycine] and or with other contact herbicides in crop as needed Beef manure (M) and urea (46-0-0) as fertilizer (F), were each applied at low and high rates (Table 2). The F was added annually within one week before crop planting at two rates. The low fertilizer rate (LF) was approximately 30 lb N ac^{-1} where the high fertilizer rate (HF) represented twice the low rate (approximately 60 lb N ac^{-1}). Manure was also added annually, before tillage operations in the fall or spring at two rates low (LM) and high (HM). The LM was added equivalent to the recommended rate of N required for crop in rotation for that specific year (approximately 30 lbs of available N per year was the target manure N rate). Where the HM rate was equivalent to the three times the recommended rate of N required for a crop planted that specific year.

Throughout the study period, soil samples, from each plot, were collected in the spring of 2006 before planting and again in the fall after harvest of each crop. Samples were collected between the crop rows to avoid the wheel-trafficked areas. A hydraulic probe (Giddings/Forestry Supplies, Inc. Jackson, MS) was used for soil sampling at 0-6 inch, 6-12 inch, 12-24, 24-36, and at the 36-48 -inch depths from each plot. Soil samples were air-dried, ground to pass a 2-mm screen, and analyzed for different soil chemical properties (Ward Laboratory, Kearney, NE).

Table 2. Treatment description including fertilizer type, application rate, tillage and frequency of manure application of Soil Remediation Study.

Treatment	Manure/ Fertilizer	Target Rate (lb N/ac)	Tillage to incorporate manure	Frequency of manure application
Man-L-Swp	Manure	30	Sweep	Annual
Man-L-Deep6	Manure	30	Moldboard Plow	Once at beginning of study
Man-L-Deep2	Manure	30	Moldboard Plow	Every 2 years
Man-L-NT	Manure	30	No-Till	Annual
Man-H-Swp	Manure	90	Sweep	Annual
Man-H-Deep6	Manure	90	Moldboard Plow	Once at beginning of study
Man-H-Deep2	Manure	90	Moldboard Plow	Every 2 years
Man-H-NT	Manure	90	No-Till	Annual
Fert-L-Swp	Fertilizer	30	Sweep	Every 2 years
Fert-L-Deep6	Fertilizer	30	Moldboard Plow	Once at beginning of study
Fert-L-Deep2	Fertilizer	30	Moldboard Plow	Every 2 years
Fert-L-NT	Fertilizer	30	No-Till	Annual
Fert-H-Swp	Fertilizer	60	Sweep	Annual
Fert-H-Deep6	Fertilizer	60	Moldboard Plow	Once at beginning of study
Fert-H-Deep2	Fertilizer	60	Moldboard Plow	Every 2 years
Fert-H-NT	Fertilizer	60	No-Till	Annual
Control-Swp	None	0	Sweep	Annual
Control-NT	None	0	No-Till	Annual

Table 3. Manure application rates (tons/acre) and time of application to plots

Manure application		Annually		Every other year (DP-2) §		One time (DP-6) ¶	
Month	Year	Low	High	Low	High	Low	High
		ton/acre					
November	2006	5.2	16.3	10	28.7	28.7	83.8
October	2007	5.9	16.9				
August	2008	4.6	13.3	8.8	25.5		
November	2009	2.8	6.3				
November	2010	3.9	11.7	7.2	22.5		
February	2012	2.4	5.4				

§ [D]DP-2 was manure applied once every other year and then incorporated with a moldboard plow 10-12 inches deep.

¶ DP-6 was manure applied once in 2006 at the initiation of the experiment and then incorporated with a moldboard plow 10-12 inches deep.

RESULTS

Due to the drought in 2012, the study was fallowed in 2012 instead of planting a crop. Wheat was planted in the fall of 2012 and harvested in July 2013. The yields varied widely across years, ranging from a low of 7 bu/acre of corn in 2011 for the Manure-High-Deep2 treatment to a high of 74 bu/acre of corn for the Man-high-Sweep treatment (Table 4). These results are consistent across years where the treatments that were deep plowed every two years have the lowest yields and the no-till and sweep treatments have the highest yields (Table 4).

Often we get asked about not incorporating the manure in the no-till treatment and about expectations of N lost through volatilization. From Table 1, we see that ammoniacal N in the manure used in the study has is less than 0.5% of the total N applied. Therefore not much of the total N would be expected to be lost through volatilization.

Others have shown that most of the ammonia that is lost to the atmosphere is lost almost immediately after the livestock has excreted the N as ammonia in urine or manure. Most ammonia (NH_3 gas) is lost in the feedlot. Our source of manure was stockpiled from pen scrapings made several days before we hauled it to the site, hence low ammonia contents of 0.23% (Table 1).

The yields (as expected) were always highest with the manure treatments when compared to the urea fertilizer treatments. It is important to keep in mind that with the chemical fertilizer treatments we are only applying N fertilizer and some starter P fertilizer. On the other hand with manure, N, phosphorus (P), potassium (K), sulfur, zinc, iron, copper and several other micronutrients are being added. Furthermore, with the manure we are adding carbon, and that carbon acts like adding crop residue to the soil surface imparting improved soil water storage and improvements in soil physical properties. For the DP-6 treatment manure application in the fall of 2006, we calculated a rate of N to meet the needs of six crops. The wheat harvested in 2013 completed the six crops cycle. While all manure treatments at the low rate, received approximately the same amount of N with manure, whether it was applied all at once, biannually, or annually, some treatments did not utilize it very well due to low yields caused by the plow treatments. The DP-2 and DP-6 treatments were in this group of poor utilization. These treatments resulted in much lower yields than expected. We suspect the tillage was hard on soil physical properties and most likely caused additional water loss not seen with the no-till or sweep till treatments.

The NO_3-N and NH_4-N (nitrate and ammonium) distributions in the soil after 6 years of cropping (Fig. 1, Fig. 2) shows extremely high buildup of nitrate for the DP-2 and DP-6 treatments demonstrating that these were neither practical treatments from an agronomic point of view or from an environmental point of view. The N applied is not being used and is still present in the soil 6 years after application. We also can observe that all treatments show some accumulation of nitrate above the check plots (Fig. 2). Only in the manure high DP2 and DP6 treatments do we also observe a buildup of NH_4-N (Fig. 1). In general the NO_3-N values are at least one order of magnitude greater than the NH_4-N values indicating that over time the organic N in the manure is mineralizing in the soil resulting in the NO_3-N buildup.

We conclude that the most practical method for remediation of this eroded high pH hill-top soil is with either the low rate of manure applied with no incorporation or with just shallow incorporation. Because we suspect ammonia loss was not really much of a concern because of low amounts of ammoniacal in the manure source at the time of application, incorporation is probably not necessary to improve N use. The yields of both the no-till treatments and the sweep treatments over the 6 year study gave the best yields overall. The one time application with deep incorporation DP-6, is not a recommended practice nor is the other deep tillage incorporated treatment DP-2.

Table 4. Dry Grain Yield from Soil Remediation Study from 2007 through 2013.

Treatment	2007 (Proso)	2008 (Triticale)	2009 (Wheat)	2010 (Proso)	2011 (Corn)	2012 (Fallow)	2013 (Wheat)	Average
	---------- bu/ac ----------							
Man-H-NT	39.6 ab	NO	35.8 abcd	37.0 ab	67.1 ab	NA	30.0 ab	41.9 a
Man-H-Swp	32.8 ab	GRAIN	28.8 bcd	37.4 ab	73.9 a	NA	28.5 ab	40.3 ab
Man-L-Swp	26.8 bcd*		44.7 a	41.4 a	50.7 cd	NA	35.0 a	39.7 ab
Man-L-NT	34.0 ab		41.5 ab	35.8 ab	56.1 bcd	NA	30.7 ab	39.6 ab
Fert-H-Swp	24.8 bcd	FORAGE	39.7 abcd	32.0 ab	43.8 cd	NA	24.8 abc	33.0 abc
Fert-L-Swp	26.4 bcd	ONLY	38.8 abcd	29.6 ab	42.1 cde	NA	25.3 abc	32.5 abcd
Fert-H-Dp6	31.8 abc		29.3 bcd	34.6 ab	45.5 cde	NA	18.7 bcd	32.0 abcd
Fert-L-NT	22.8 bcd		27.8 cd	34.8 ab	45.4 cde	NA	20.8 bc	30.3 bcde
Control-Swp	26.0 bcd		35.8 abcd	28.4 ab	33.8 def	NA	24.0 abc	29.6 bcde
Man-H-Dp6	20.0 cd		17.5 ef	36.8 ab	53.6 bcd	NA	18.3 bcd	29.2 cde
Fert-H-NT	23.6 bcd		29.3 bcd	24.6 b	42.9 cde	NA	19.7 bcd	28.0 cde
Fert-L-Dp6	28.6 bcd		26.5 cd	33.6 ab	34.6 def	NA	14.2 cd	27.5 cde
Man-L-Dp6	28.2 bcd		11.3 FE	36.4 ab	40.5 cde	NA	18.2 bcd	26.9 cde
Control-NT	19.8 d		31.7 bcd	29.2 ab	28.4 ef	NA	25.5 abc	26.9 cde
Fert-H-Dp2	23.2 bcd		31.7 bcd	25.4 b	23.4 fg	NA	11.8 d	23.1 cde
Fert-L-Dp2	23.8 bcd		31.5 bcd	29.4 ab	18.6 fg	NA	11.8 d	23.0 cde
Man-L-Dp2	29.0 bcd		28.0 dc	35.8 ab	7.1 g	NA	9.7 d	21.9 de
Man-H-Dp2	26.0 bcd		24.2 de	34.4 ab	8.0 g	NA	9.2 d	20.4 e
Mean	**27.1**		**30.8**	**33.1**	**39.8**		**20.9**	**30.3**

*Means followed by the same letter are not significantly different using the SNK mean separation test with alpha = 0.10.

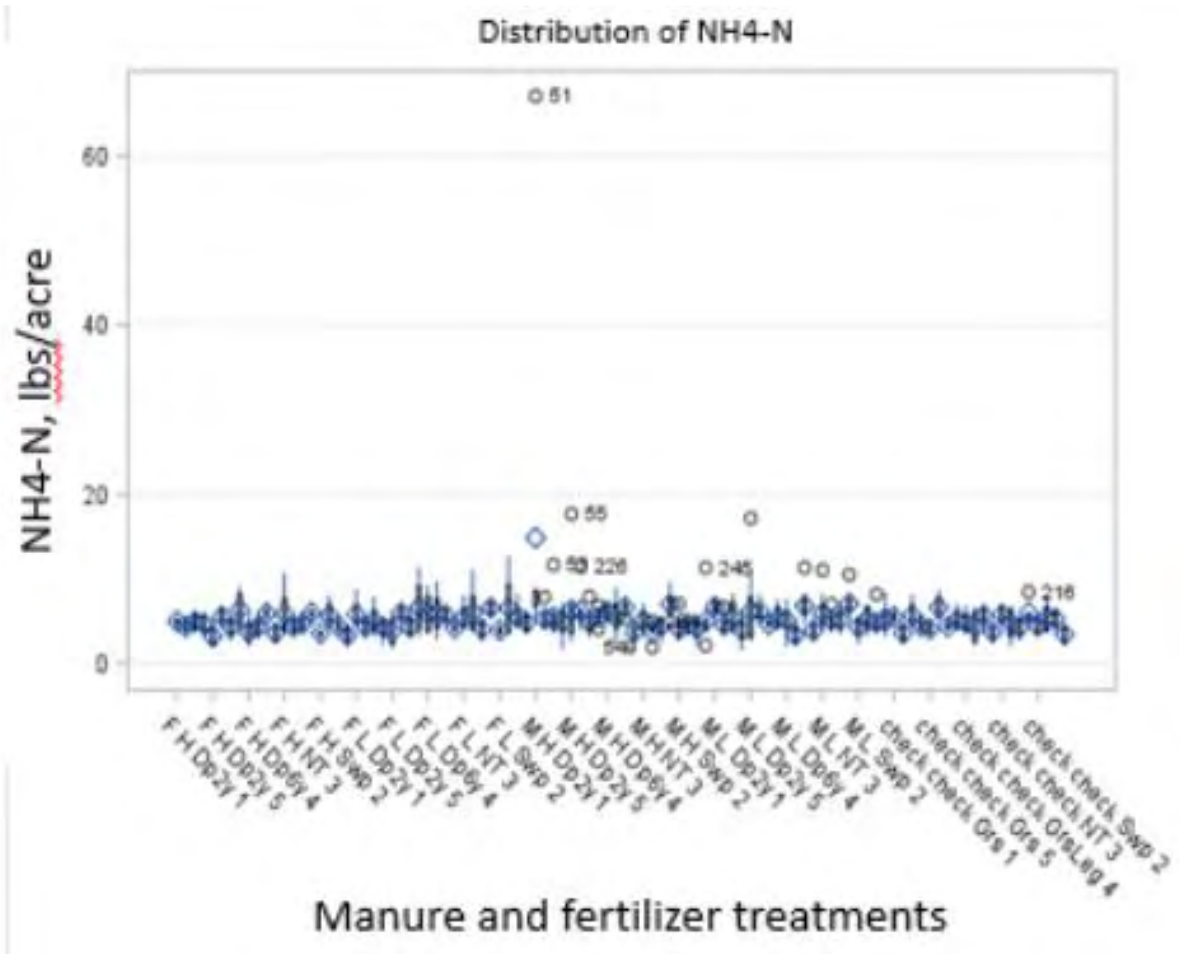

Fig. 1. NH_4-N distribution after 2012 crop, total NH_4-N in top 4 feet of soil profile.

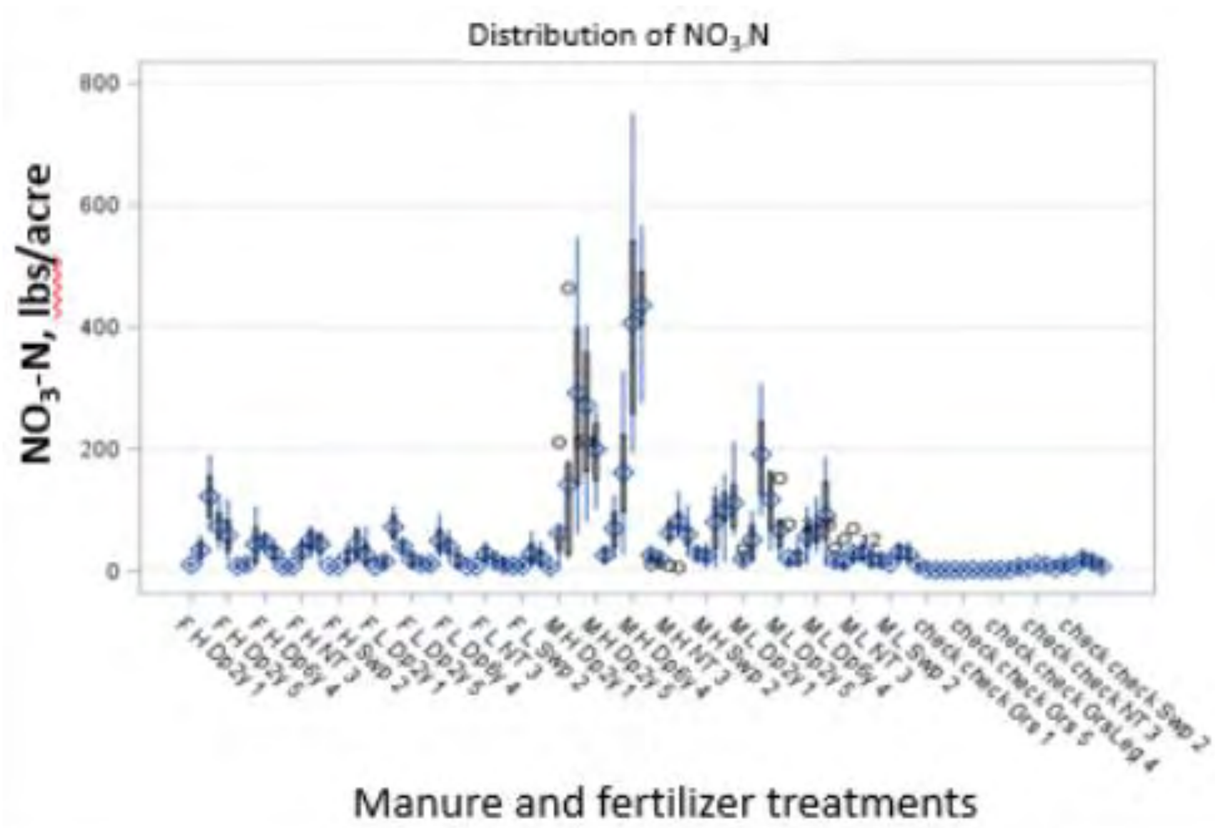

Fig. 2. NO_3-N distribution after 2012 crop, total NO_3-N in top 4 feet of soil profile.

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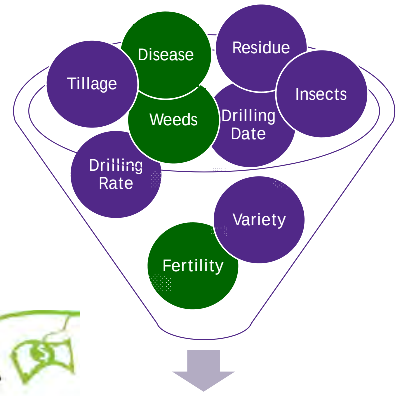
Top 3 Missteps of Wheat Production

Jeanne Falk Jones
K-State Multi-County Agronomist



Wheat Yield

Misstep #1
Not Being On-Time for Manageing Diseases

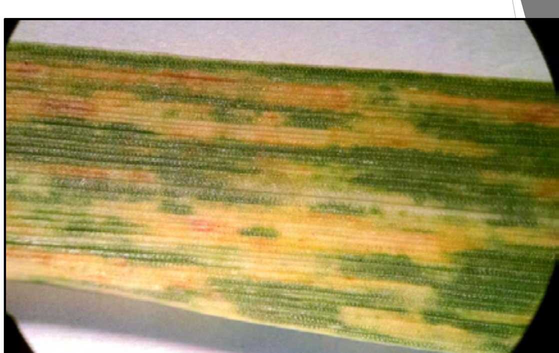
Wheat Streak Mosaic

Stripe Rust

Whe

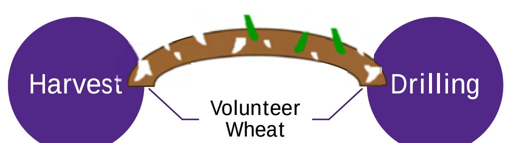
Wheat Streak Mosaic

Diseases



Wheat Streak Mosaic

Diseases



Effects to Wheat

- Wide range of *yield reductions*
  - Year 1: 5.7 to 41.6%
  - Year 2: 5.7 to 71.2%
- Wide range of *test weight reductions*
  - Year 1: up to 9.9%
  - Year 2: up to 89.3%
- Severity depended on wheat variety and environmental conditions.

Langham et al. 2001

Wheat Streak Mosaic & Wheat Curl Mites

Diseases

- Alternative Hosts
  - Barley
  - Rye
  - Oats
  - Sweet Corn
  - Field Corn
  - Sorghum
  - Millets

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Wheat Streak Mosaic & Wheat Curl Mites

Diseases

- Reproduce rapidly
  - Ideal conditions 75-85°
  - New generation in 10 days
- Can live a variety of temperatures
  - 32°- reproduction stops, mites can live for several months
  - 0°- can live for several days

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How to Manage Around Wheat Streak Mosaic?

Diseases

- Control volunteer wheat 2 weeks prior to drilling
- Control volunteer wheat 2 weeks prior to drilling
- Control volunteer wheat 2 weeks prior to drilling
- Plant resistant wheat varieties
- Plant later
- Once infected, no remedy
- If infected, minimize stress on the wheat plant

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Stripe Rust

Diseases

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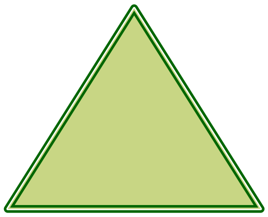
Stripe Rust

Diseases

Stripe Rust Disease Triangle

Diseases



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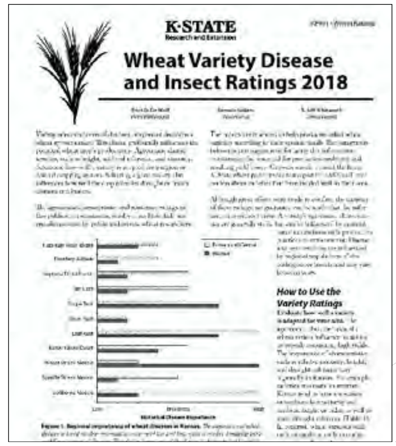
Susceptible Host

Diseases



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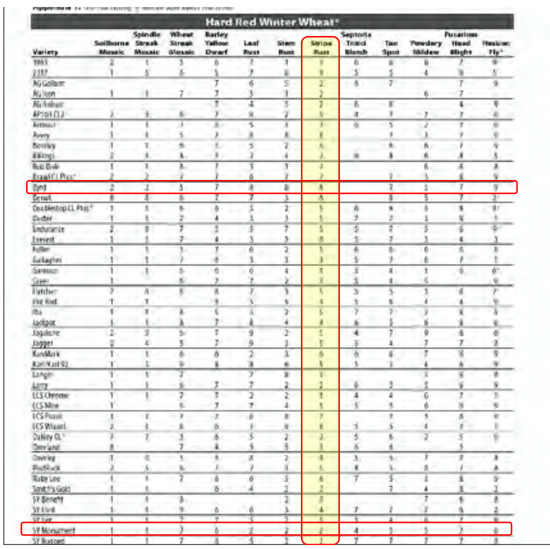
Diseases



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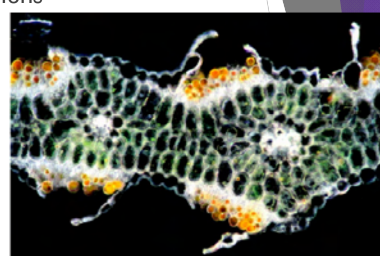
Favorable Environment

Diseases

- Damp or humid conditions
- Mild temperatures



Importance of Rust in Wheat; https://www.researchgate.net/figure/Wheat-leaf-rust-caused-by-Puccinia-triticina-a-Symptoms-on-flag-leaf-of-susceptible_fig2_257789219

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Stripe Rust Infection

Diseases

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Rust Spores

Diseases

Heavy stripe rust pressure in Texas

Could be a problem for western Kansas

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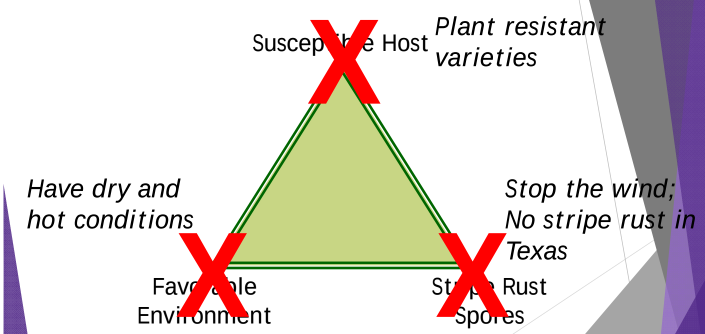
How to Manage Around Stripe Rust?

Diseases



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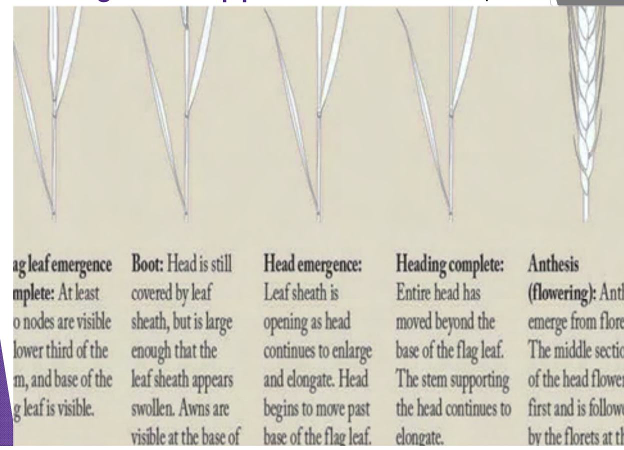
Fungicide Applications

Approximately 21 days of stripe rust control



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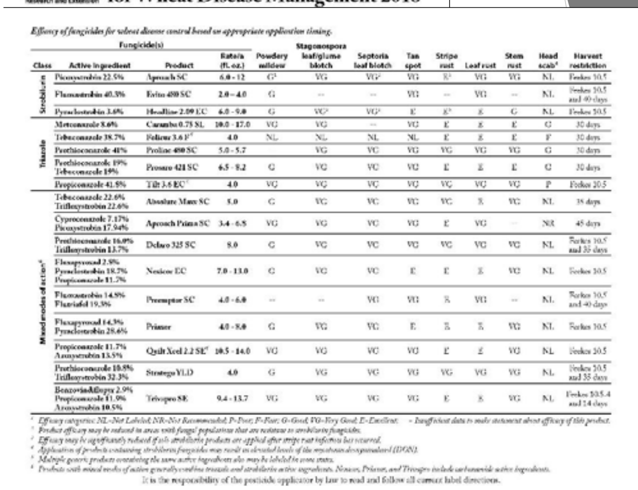
Foliar Fungicide Efficacy Ratings for Wheat Disease Management 2018

K-State Pub: EP130



Efficacy of fungicides for wheat disease control based on appropriate application timing.

Class	Active ingredient	Product	Rate/A (fl. oz.)	Powdery mildew	Stagonospora leaf/glume blotch	Septoria leaf blotch	Tan spot	Stripe rust	Leaf rust	Stem rust	Head scab[4]	Harvest restriction
Strobilurin	Picoxystrobin 22.5%	Aproach SC	6.0 - 12	G[1]	VG	VG[2]	VG	E[3]	VG	VG	NL	Feekes 10.5
Strobilurin	Fluoxastrobin 40.3%	Evito 480 SC	2.0 - 4.0	G	—	—	VG	—	VG	—	NL	Feekes 10.5 and 40 days
Strobilurin	Pyraclostrobin 3.6%	Headline 2.09 EC	6.0 - 9.0	G	VG[2]	VG[2]	E	E[3]	E	G	NL	Feekes 10.5
Triazole	Metconazole 8.6%	Caramba 0.75 SL	10.0 - 17.0	VG	VG	—	VG	E	E	E	G	30 days
Triazole	Tebuconazole 38.7%	Folicur 3.6 F[5]	4.0	NL	NL	NL	NL	E	E	E	F	30 days
Triazole	Prothioconazole 41%	Proline 480 SC	5.0 - 5.7		VG	VG	VG	VG	VG	VG	G	30 days
Triazole	Prothioconazole 19% Tebuconazole 19%	Prosaro 421 SC	6.5 - 8.2	G	VG	VG	VG	E	E	E	G	30 days
Triazole	Propiconazole 41.8%	Tilt 3.6 EC[5]	4.0	VG	VG	VG	VG	VG	VG	VG	P	Feekes 10.5
Mixed modes of action[6]	Tebuconazole 22.6% Trifloxystrobin 22.6%	Absolute Maxx SC	5.0	G	VG	VG	VG	VG	E	VG	NL	35 days
Mixed modes of action[6]	Cyproconazole 7.17% Picoxystrobin 17.94%	Aproach Prima SC	3.4 - 6.8	VG	VG	VG	VG	E	VG	—	NR	45 days
Mixed modes of action[6]	Prothioconazole 16.0% Trifloxystrobin 13.7%	Delaro 325 SC	8.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 and 35 days
Mixed modes of action[6]	Fluxapyroxad 2.8% Pyraclostrobin 18.7% Propiconazole 11.7%	Nexicor EC	7.0 - 13.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
Mixed modes of action[6]	Fluoxastrobin 14.8% Flutriafol 19.3%	Preemptor SC	4.0 - 6.0	—	—	VG	VG	E	VG	—	NL	Feekes 10.5 and 40 days
Mixed modes of action[6]	Fluxapyroxad 14.3% Pyraclostrobin 28.6%	Priaxor	4.0 - 8.0	G	VG	VG	E	E	E	VG	NL	Feekes 10.5
Mixed modes of action[6]	Propiconazole 11.7% Azoxystrobin 13.5%	Quilt Xcel 2.2 SE[5]	10.5 - 14.0	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5
Mixed modes of action[6]	Prothioconazole 10.8% Trifloxystrobin 32.3%	Stratego YLD	4.0	G	VG	VG	VG	VG	VG	VG	NL	Feekes 10.5 and 35 days
Mixed modes of action[6]	Benzovindiflupyr 2.9% Propiconazole 11.9% Azoxystrobin 10.5%	Trivapro SE	9.4 - 13.7	VG	VG	VG	VG	E	E	VG	NL	Feekes 10.5.4 and 14 days

[1] Efficacy categories: NL=Not Labeled; NR=Not Recommended; P=Poor; F=Fair; G=Good; VG=Very Good; E=Excellent. — = Insufficient data to make statement about efficacy of this product.
[2] Product efficacy may be reduced in areas with fungal populations that are resistant to strobilurin fungicides.
[3] Efficacy may be significantly reduced if solo strobilurin products are applied after stripe rust infection has occurred.
[4] Application of products containing strobilurin fungicides may result in elevated levels of the mycotoxin deoxynivalenol (DON).
[5] Multiple generic products containing the same active ingredients also may be labeled in some states.
[6] Products with mixed modes of action generally combine triazole and strobilurin active ingredients. Nexicor, Priaxor, and Trivapro include carboxamide active ingredients.
It is the responsibility of the pesticide applicator by law to read and follow all current label directions.

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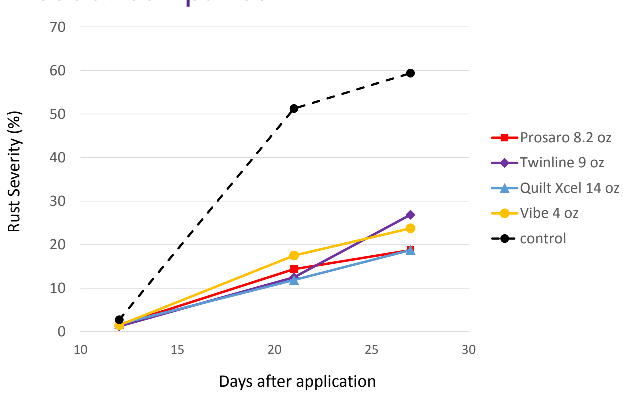
Fungicide Comparison – Colby 2016

Product	Rate (oz)	Stripe Severity Flag Leaves (%) 12 DAT	21 DAT	27 DAT
Quadris	9	1.8	10.6	26.3
Prosaro	8.2	1.5	14.4	18.8
Twinline	9	1.3	12.5	26.9
Evito	4	1.8	26.9	30.6
Fortix	6	3.3	19.4	27.5
Stratego YLD	4	0.8	15.6	38.1
TrivaPro A + Quilt Xcel	4 + 10.5	1.5	8.1	19.4
Quilt Xcel	14	1.8	11.9	18.8
Quilt Xcel	7.5	1.5	11.3	25.6
Headline	9	2.0	16.3	29.4
Tilt	4	2.5	25.6	27.5
Vibe (trebuconazol)	4	1.5	17.5	23.8
Priaxor	8	1.3	10.6	18.8
Vibe (7 days later) (trebuconazol)	4	5.8	46.3	43.1
control	.	5.0	65.6	48.8
control	.	2.8	51.3	59.4

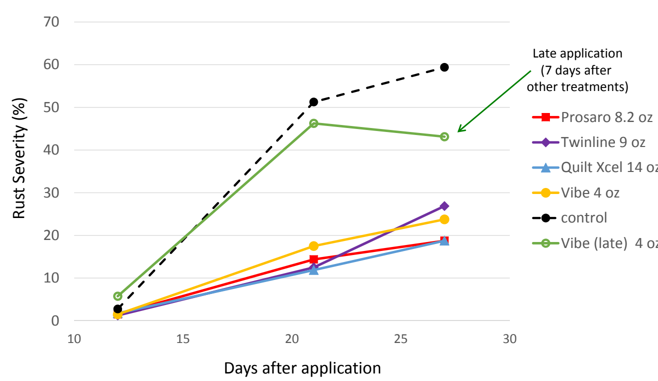
Stripe Rust Fungicide – Colby 2016

Product comparison

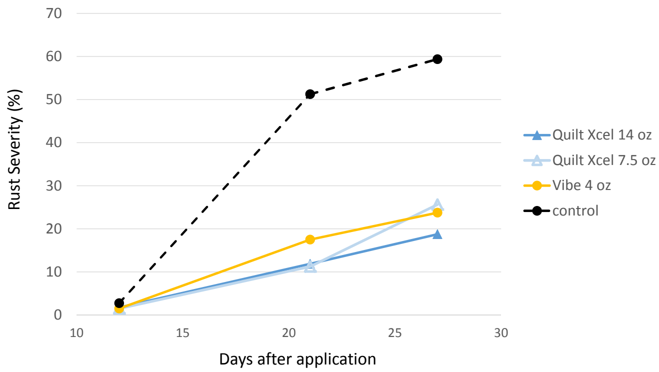


Stripe Rust Fungicide – Colby 2016

Late application



Stripe Rust Fungicide – Colby 2016
Reduced rate



Controlling Stripe Rust

Diseases

- Applying a fungicide after flag leaf emergence, when disease is FL-1 or FL-2
- Apply fungicide on time for the most bang for your $$
- Plant stripe rust resistant wheat varieties

Fertility

Misstep #2
Not meeting the wheat's nitrogen needs
…and how that affects protein

Nitrogen Uptake

Fertility

- Most of the N used by wheat is taken up before flowering and later moved to the kernel during grain fill
- Photosynthesis occurring during grain fill largely determines kernel starch contents

Making Protein

Fertility

- Nitrogen is a basic component of amino acids
- Amino acids are the building blocks of plant growth and are stored for seedling development
- The protein in the kernel is generally considered to be laid down first before most of the carbohydrates

Importance of Protein

Fertility

- Bread rises because of yeast and gluten
- Gluten – is a "sticky" protein complex
- Proteins are made up of amino acids
- Amino acids are stored in the seed as they are the foundation of plant growth (seedlings)

Plant Use of Nitrogen

Fertility

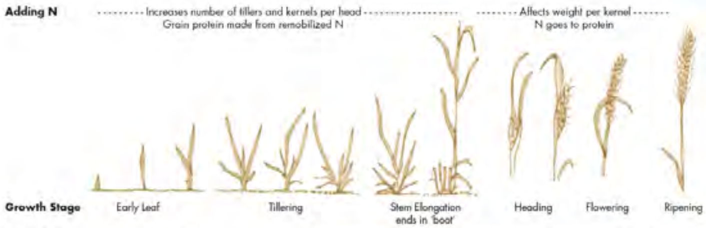


FIGURE 2. Approximate cereal growth stages and N application timing effects on yield and protein. This figure was modified from its original (4).

Jones et al., Montana State Univ. EB0206

N supply effects on Grain Yield and Protein

Fertility

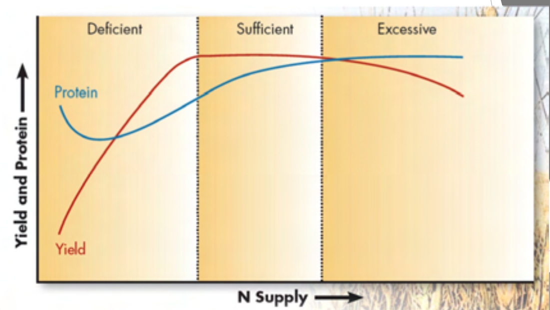
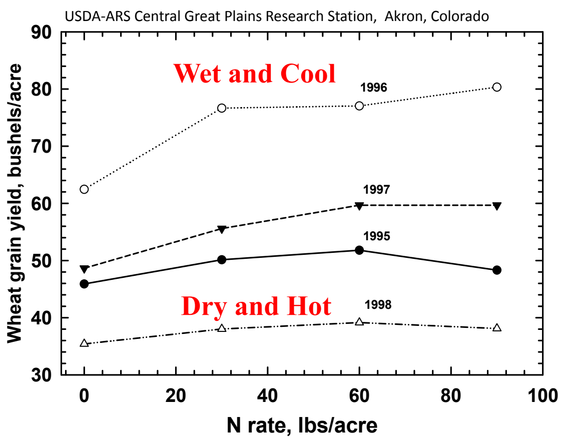
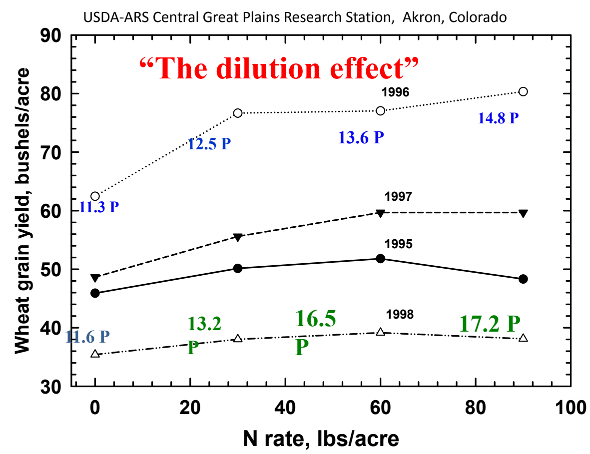
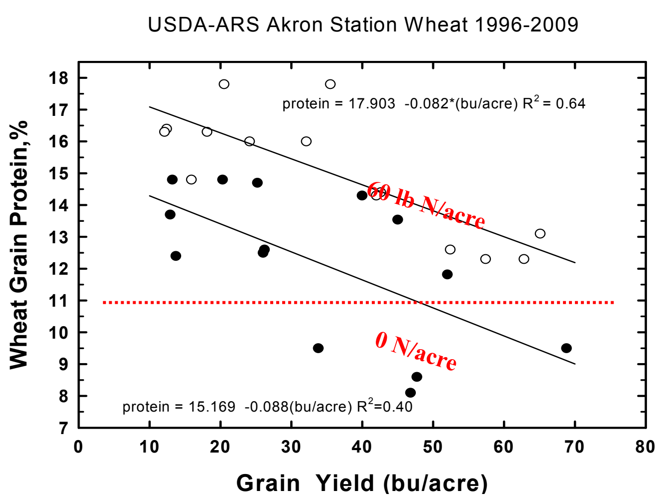


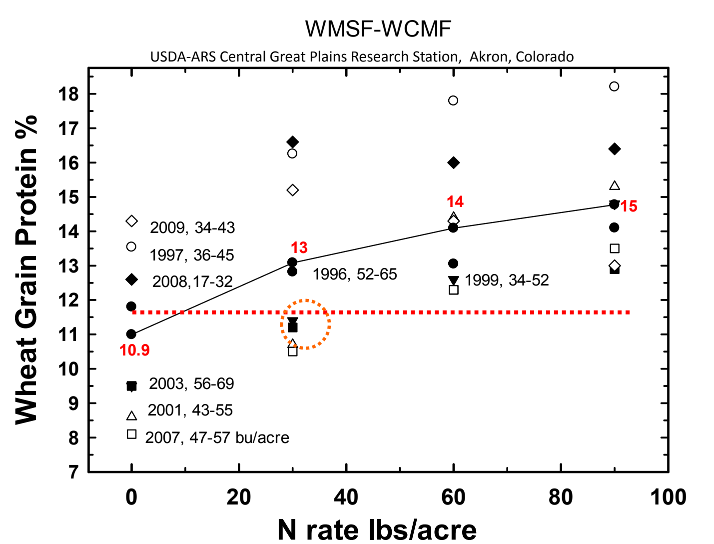
FIGURE 1. The response of wheat yield and grain protein to increasing N (7).

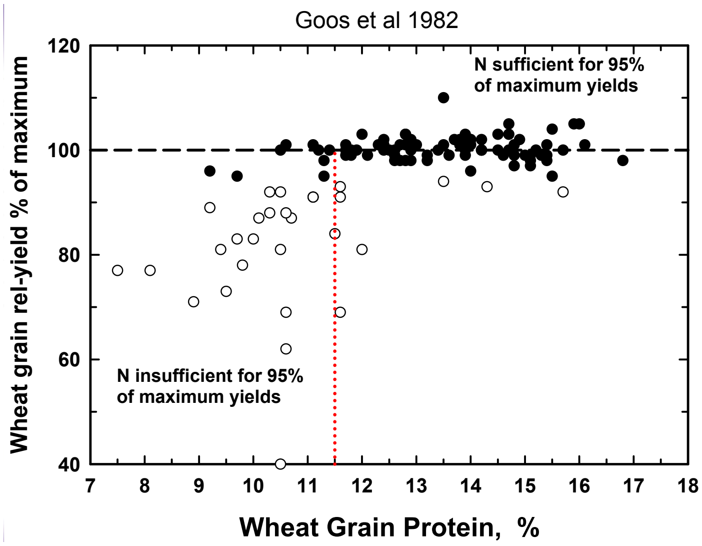
Jones et al., Montana State Univ. EB0206

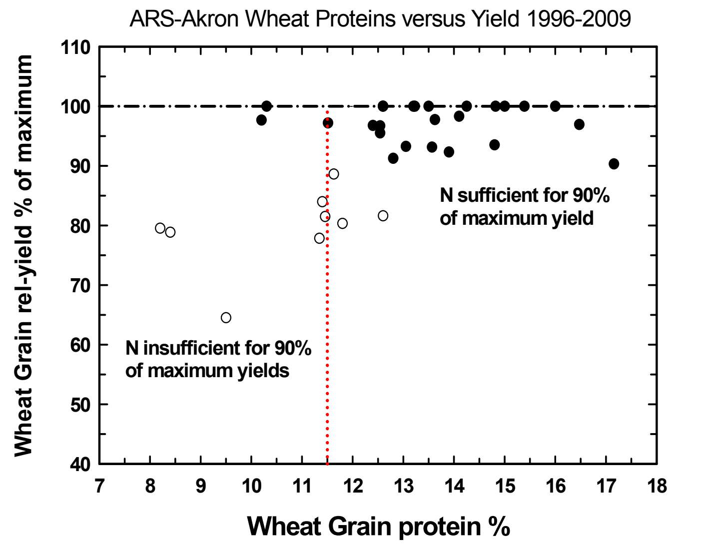












Increasing Grain Protein

Fertility

- UNL (NebGuide EC143) recommends an **additional** 20 lbs of spring applied N to increase protein 1% (up to 40 lbs Max)
- CSU (Bulletin 544) recommends an **additional** 20-30 lbs of N to increase protein 1%
- The additional applications will not increase protein if your short of N to maximize yield
- Timing of nitrogen in the root zone is very important

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Key Thoughts

Fertility

- Will we get the moisture to get the nitrogen into the root zone?
- Will we get paid for the protein?
- You are leaving yield on the table if you are consistently getting less than 11.5% protein.

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Weeds

Misstep #3 Skipping Weed Control

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Weed Control

Weeds

- Important for in-crop
  - Winter annuals
  - Grassy weeds
  - Summer annuals in thin wheat
- Important for wheat stubble
  - Kochia
  - Palmer amaranth
- A thick wheat stand is good for weed control

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In-Crop

Weeds

- Mustard
- Downy brome
- Jointed goatgrass

- Clearfield Wheat → Beyond Herbicide
- CoAXium Wheat → Aggressor Herbicide

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Effectiveness of fall/spring-applied Aggressor on downy brome control in Incline AX CoAxium winter wheat at KSU Ag Research Center-Hays, Kansas in 2018[abc]

Herbicide	Rate	Timing	Downy brome 4/11/18	Downy brome 5/6/18	Wheat yield
	(oz/a)		-----(% control)-----		(bu/a)
Aggressor	8	FP	94	96	27
Aggressor	10	FP	94	96	28
Aggressor	8	SP	73	91	23
Aggressor	10	SP	69	91	23
Aggressor	12	SP	73	94	25
Aggressor	8/8	FP/SP	94	98	28
Untreated	-	-	-	-	18
LSD (5%)			5	5	3

[a] Fall Post (FP) was applied on Nov 6, 2017, Spring Post (SP) was applied on Mar 28, 2018.
[b] Experimental field was under continuous winter wheat for several years.
[c]NIS was used in all herbicide applications per label guidelines.

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Thin Wheat Stands

Weeds

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Thin Wheat Stands

Weeds

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Wheat Stubble

Weeds

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Weed control *in wheat* and *wheat stubble* following harvest, SWREC Tribune 2017. Thompson, Schlegel, and Peterson.

Weeds

Treatment	Rate	Appl.	Kochia in crop		Kochia in fallow	
			9-May	PreHarv	13 DAT	33 DAT
	Lb / acre	Time	(% control)			
Clarity + 2,4-D/	0.125+0.375/	Prejnt	91	89	88	85
Clarity+2,4-D+NIS	0.5+0.5+0.125%	Fallow				
Clarity+Zidua/	0.125+0.106/	Prejnt	93	89	91	89
Clarity+2,4-D+NIS	0.5+0.5+0.125%	Fallow				
Clarity+Prowl H2O/	0.125+1.12/	Prejnt	94	96	95	96
Clarity+2,4-D+NIS	0.5+0.5+0.125%v/v	Fallow				
Clarity+Huskie+NIS+AMS/	0.125+0.23+0.25%v/v+1lb/	Prejnt	99	95	100	100
Atrazine+Sharpen+MSO+UAN	1.0+.045+1%+2.5%v/v	Fallow				
Clarity+Huskie+Zidua+NIS+AMS/	0.125+.23+.106+0.25%+1lb	Prejnt	99	97	99	100
Atrazine+Sharpen+MSO+UAN	1.0+.045+1%+2.5%v/v	Fallow				
Rave+NIS/	0.147+0.5% v/v	Prejnt	95	89	97	97
Atrazine+Sharpen+MSO+UAN	1.0+.045+1%+2.5%v/v	Fallow				
Rave+Zidua+NIS/	0.147+0.106+0.5%/	Fall	96	88	92	93
Atrazine+Sharpen+MSO+UAN	1.0+.045+1%+2.5%v/v	Fallow				
Widematch/	0.25/	Flglf	80	89	100	100
Atrazine+Sharpen+MSO+UAN	1.0+.045+1%+2.5%v/v	Fallow				
LSD (0.05)			4	3	8	5

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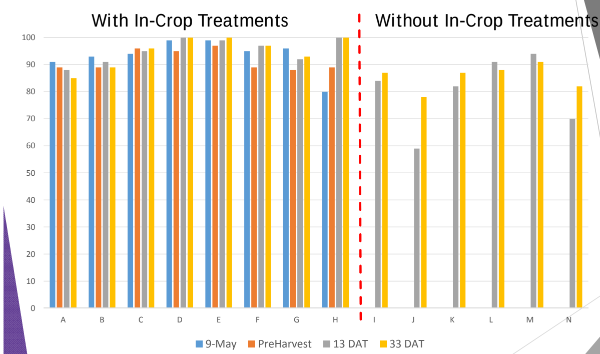
Weeds

Kochia control in wheat stubble with *no in wheat* crop treatment, SWREC Tribune 2017. Thompson, Schlegel, and Peterson. 1701whtTR

Treatment	Rate	Appl. time	Kochia in fallow 13 DAT	Kochia in fallow 33 DAT
	Lb / acre			
Clarity+Sharpen+Linex+MSO+UAN	0.5+0.045+0.75+1%+2.5% v/v	Fallow	84	87
Clarity+Atrazine+COC	0.5+1.0+0.5%	Fallow	59	78
Clarity+atra+Sharpen+MSO+UAN	0.5+1.0+.045+1%+2.5%v/v	Fallow	82	87
Gramoxone SL+NIS	0.75+0.5% v/v	Fallow	91	88
Gramoxone SL+atra+COC	0.75+0.25+1%	Fallow	94	91
Clarity+2,4-D+NIS	0.5+0.5+0.125%	Fallow	70	82
LSD (0.05)			8	5

Weeds

Percent kochia control with and without in crop treatments



Weeds

Take Home…

- Be ready to make a spring herbicide application to help in crop and after harvest
- Clearfield and CoAXium wheat can help clean up challenging weed situations
- Wheat stubble is great at preventing weed emergence in crop, but lose some of that cover with harvest…be ready to move fairly quickly after harvest

Final Thoughts

- An ounce of prevention is worth a pound of cure.
- Timeliness is key to preventing these missteps.
- Make a plan and be ready to roll
- Mother nature has the last say in many of these things, but we can manage around some things

Resources

- www.ramwheatdb.com
- www.plantpath.k-state.edu
- https://www.agronomy.k-state.edu/services/soiltesting/fertilizer-recommendations/index.html
- https://www.bookstore.ksre.ksu.edu/pubs/SRP1148.pdf

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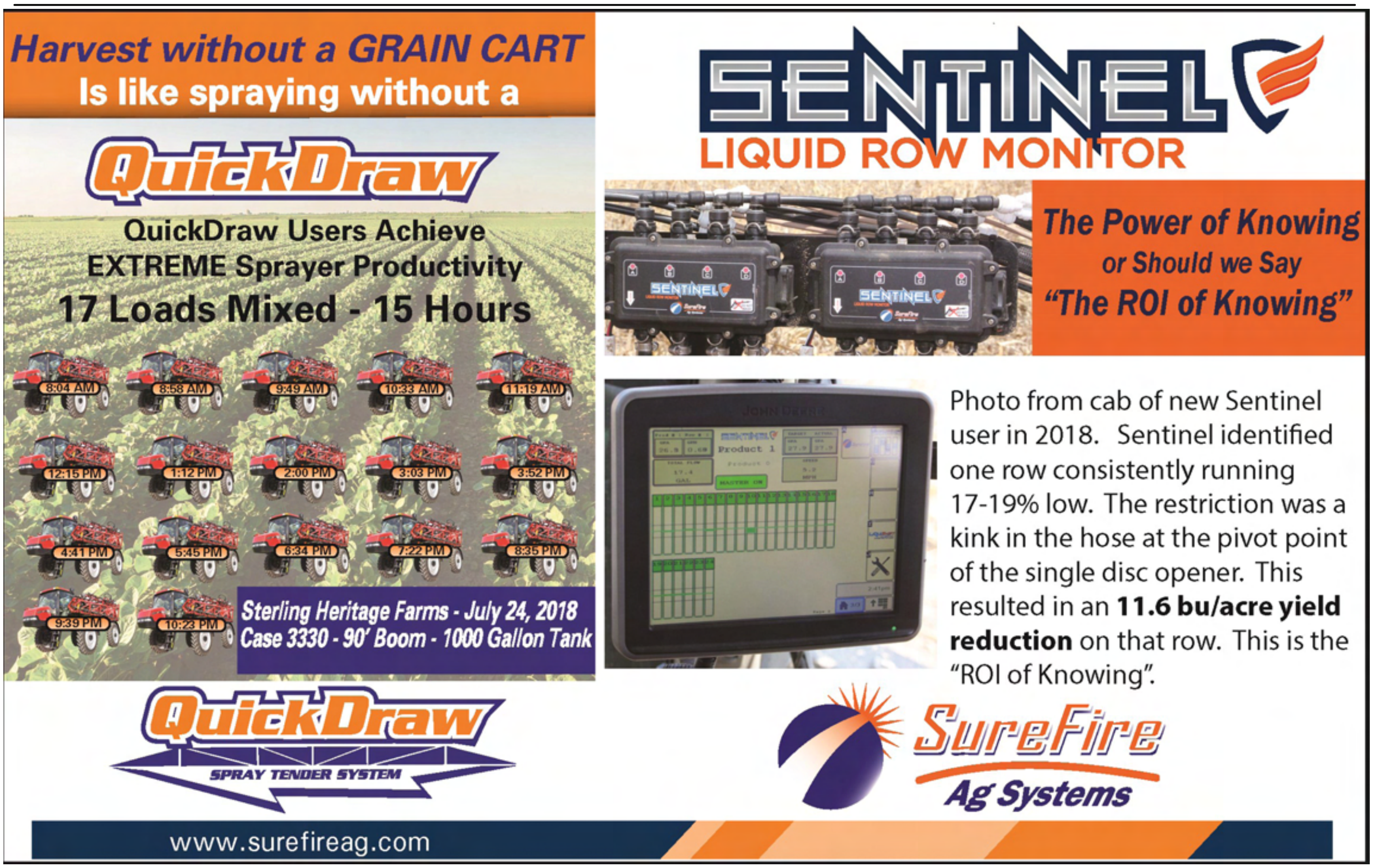
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Case 3330 - 90' Boom - 1000 Gallon Tank
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SENTINEL
LIQUID ROW MONITOR
The Power of Knowing
or Should we Say
"The ROI of Knowing"
Photo from cab of new Sentinel user in 2018. Sentinel identified one row consistently running 17-19% low. The restriction was a kink in the hose at the pivot point of the single disc opener. This resulted in an **11.6 bu/acre yield reduction** on that row. This is the "ROI of Knowing".
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Conference Notes

Conference Notes

Websites

Weather:

Kansas Mesonet	www.mesonet.ksu.edu
National Weather Service-Goodland	www.weather.gov/gld
CoCoRahs	www.cocorahs.org
Drought Monitor	www.droughtmonitor.unl.edu

K-State:

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K-State Western Kansas Ag Research Centers	www.wkarc.org

Herbicide Labels:

Greenbook	www.greenbook.net
CDMS	www.cdms.net

The plan for the day...

	Room 1	*Room 2*	*Room 3*	*Room 4*
7:45 8:15	*Registration*			
8:15 8:20	*Welcome*			
8:30 9:20	Financial Status of NW KS Farms [1] *(J. Steele)*	Managing Insect Resistance in Corn [1, 2] *(S. Zukoff)*	Remediating eroded high pH soils with manure [1] *(M. Vigil)*	*The Importance of Adjuvants (EGE Products)*
9:30 10:20	The When, Where, Why, and How of Spray Adjuvants [1, 2] *(R. Zollinger)*	Palmer Amaranth Management [1,2] *(R. Currie)*	Top 3 Mistakes Made in Wheat Production [1] *(J. Falk Jones)*	*Upside Down in Farming (Sims Fertilizer & Chem)*
10:20 10:50	*View Exhibits*			
10:50 11:40	Getting Peak Performance from Paraquat [1, 2] *(M. Hay)*	Land Values and Rental Rates [1] *(M. Taylor)*	High Plains Irrigated Soybean Management [1] *(S. Stepanovic)*	*2018 Gothenburg Research Center Update (Bayer Crop Science)*
11:50 12:40	Hybrids, Plant Dates, and Seeding Rates for Dryland Corn [1] *(L. Haag)*	The When, Where, Why, and How of Spray Adjuvants [1, 2] *(R. Zollinger)*	*Lunch*	
12:50 1:40	Remediating eroded high pH soils with manure [1] *(M. Vigil)*	Getting Peak Performance from Paraquat [1, 2] *(M. Hay)*		
1:50 2:40	Land Values and Rental Rates [1] *(M. Taylor)*	Top 3 Mistakes Made in Wheat Production [1] *(J. Falk Jones)*	Hybrids, Plant Dates, and Seeding Rates for Dryland Corn [1] *(L. Haag)*	*Creating a Drought Resilient Farm (Green Cover Seed)*
2:40 3:10	*View Exhibits*			
3:10 4:00	Producer Panel: Canola, Field Pea, Dry Beans as Alternative Crops	High Plains Irrigated Soybean Management [1] *(S. Stepanovic)*	Managing Insect Resistance in Corn [1, 2] *(S. Zukoff)*	*Spray Efficacy with Particle Size and Adjuvants (Corteva Agriscience)*
4:10 5:00	Palmer Amaranth Management [1, 2] *(R. Currie)*	Financial Status of NW KS Farms [1] *(J. Steele)*	*Combine Data to Planter Decisions (Nutrien Solutions)*	*Sunflower Industry Update (National Sunflower Assoc.)*

(I) indicate industry sessions.

[1] Indicate Certified Crop Advisor CEUs applied for.

[2] Indicate Commercial Applicator CEUs applied for.

This conference is organized by a committee of producers and K-State Research & Extension personnel. Lucas Haag, K-State Northwest Area Agronomist is the conference coordinator and proceedings editor. Please send your feedback to lhaag@ksu.edu

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On-Farm Hybrid Characterization

Developing data for VRS implementation

Lucas A. Haag Ph.D.

Assistant Professor / Northwest Area Agronomist
K-State Northwest Research-Extension Center, Colby, Kansas

Dryland Corn Hybrids – What's Changed

- Continual decline in ASI
  Anthesis-Silking Interval
- Increased resistance to barrenness
- Drought Tolerant Traits/Selection
- Improved yield potential of short and mid-season hybrids

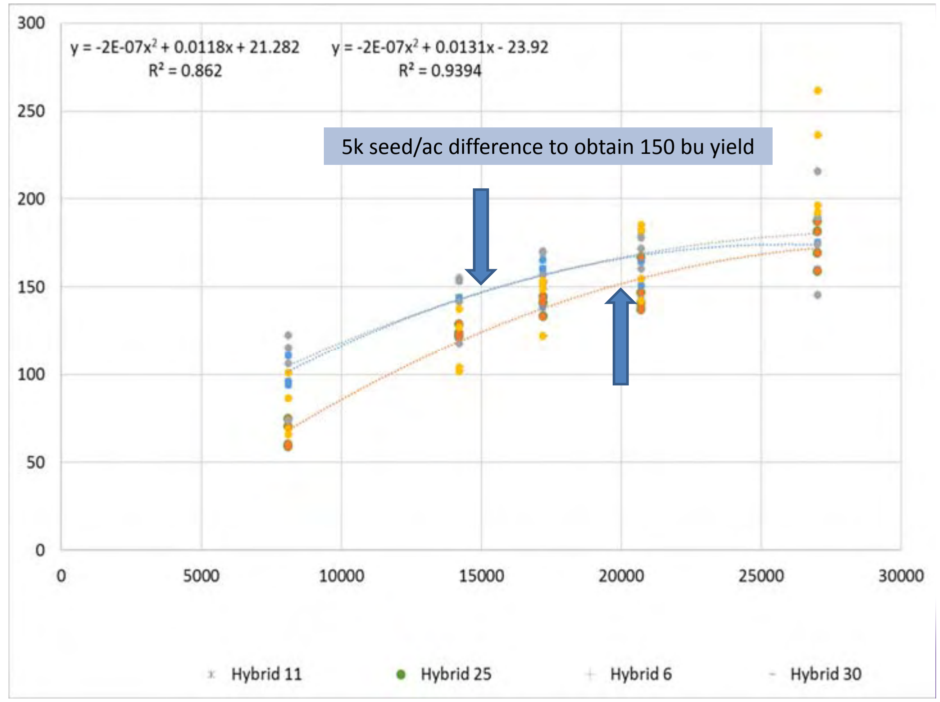
Hybrids and VRS

- Hybrid characterization is the key to effective VRS strategies
- Our ability to create VRT seeding prescriptions has exceeded our ability to characterize hybrids
  - Rapid hybrid turnover has further complicated this
- Yield components flex differently, at different rates, for different hybrids
- Fewer companies publicizing the "ear flex" scorings of products
  - Definition of ear flex, how much, what components

2016-2018 Field Trials

- Dryland trial on-farm in Decatur County
  - 38 Hybrids
  - 5 Seeding Rates:
    - 8,100
    - 14,200
    - 17,200
    - 20,700
    - 27,000/ac
  - 4 Replications in a split-plot design
- Yield, Kernel Rows, Kernels per Row, Kernel Wt.


Date: Location: 314 Product:
18-49 18-46 18-46 18-47
IC IC IC nub 18-20 nub 16-45 16-45 nub 16-45


y = -2E-07x² + 0.0118x + 21.282
R² = 0.862
y = -2E-07x² + 0.0131x - 23.92
R² = 0.9394
5k seed/ac difference to obtain 150 bu yield
300
250
200
150
100
50
0
0
5000
10000
15000
20000
25000
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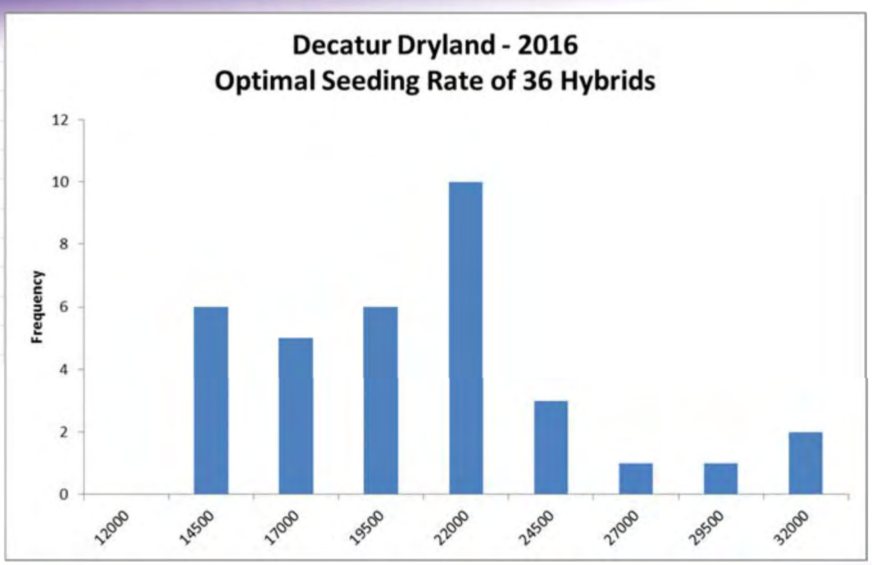
Hybrid 11
Hybrid 25
Hybrid 6
Hybrid 30


Decatur Dryland - 2016
Optimal Seeding Rate of 36 Hybrids
Frequency
12
10
8
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12000
14500
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19500
22000
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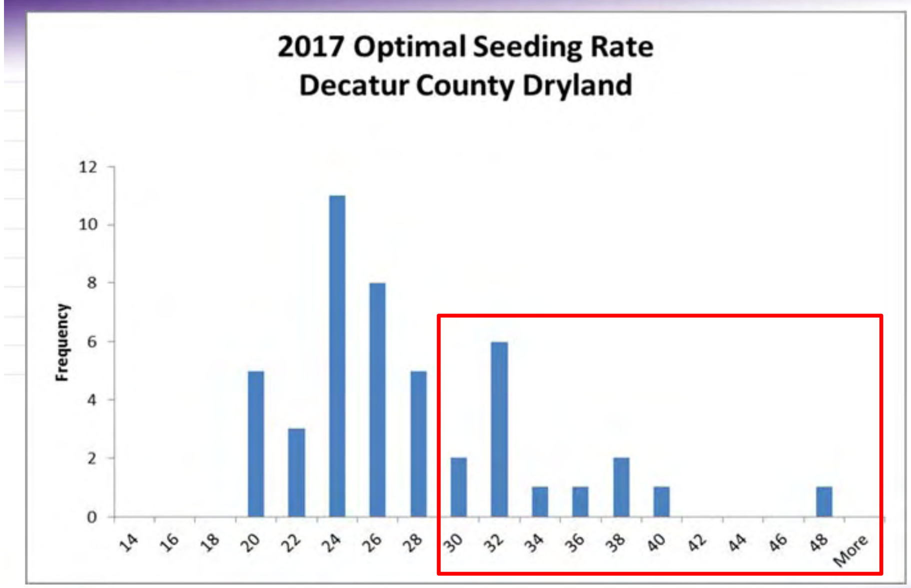
29500
32000


2017 Optimal Seeding Rate
Decatur County Dryland
Frequency
12
10
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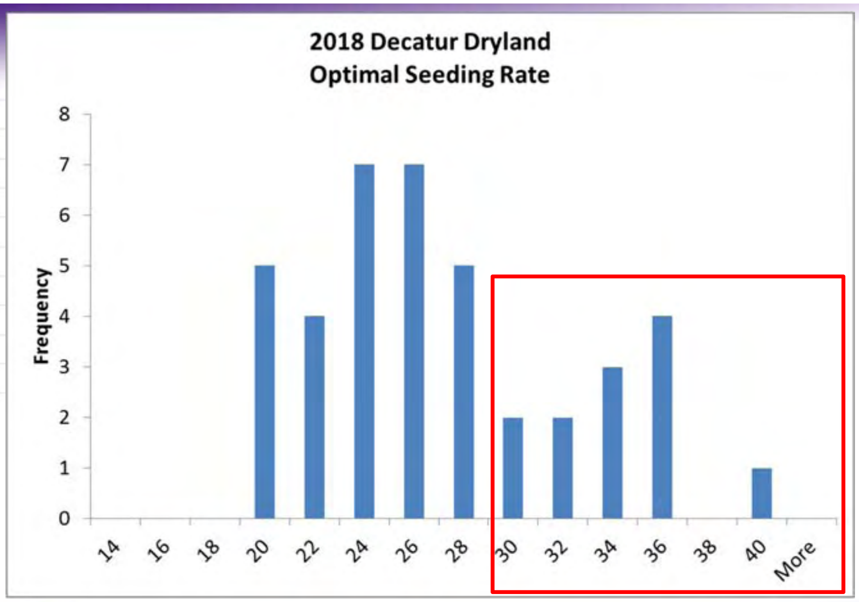
44
46
48
More

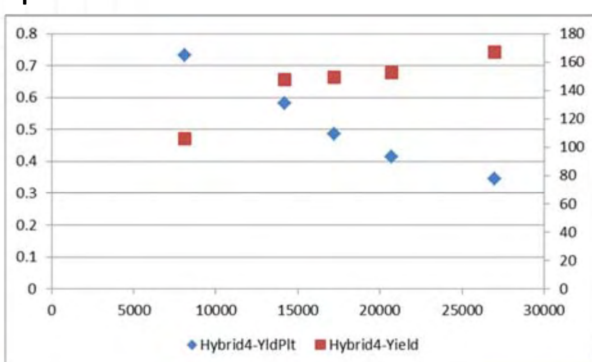


Sources of Ear Flex

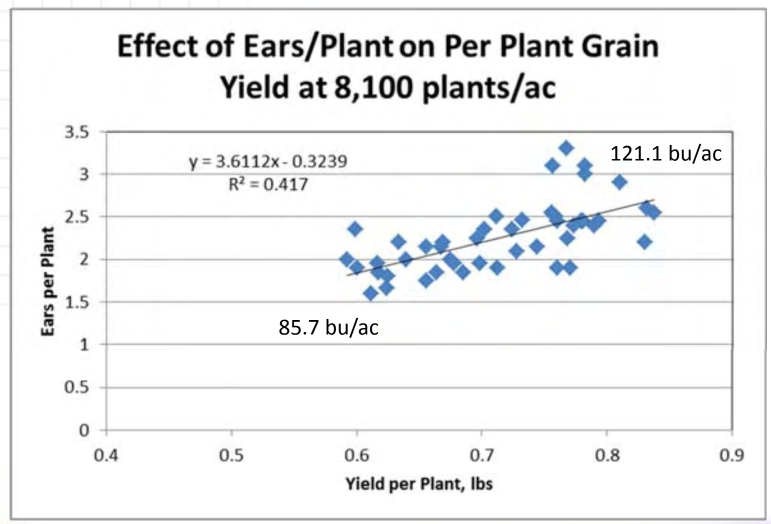
- Prolificacy
- Kernel Rows, Kernels per Ear Row, Kernel Weight
- What about tillers?

Grain Yield Per Plant

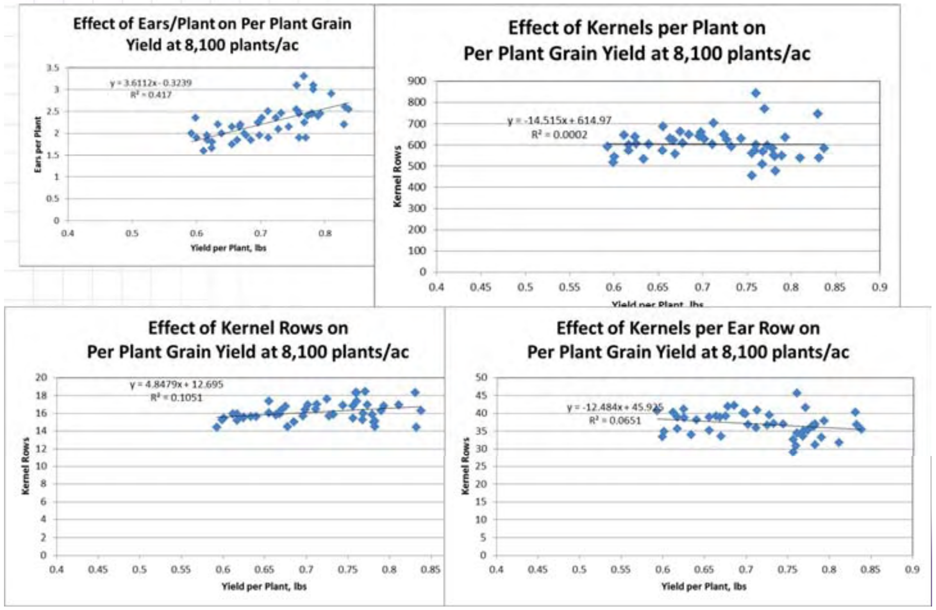
- What is really important is the slope, how fast to I give up yield per plant as seeding rate goes up.



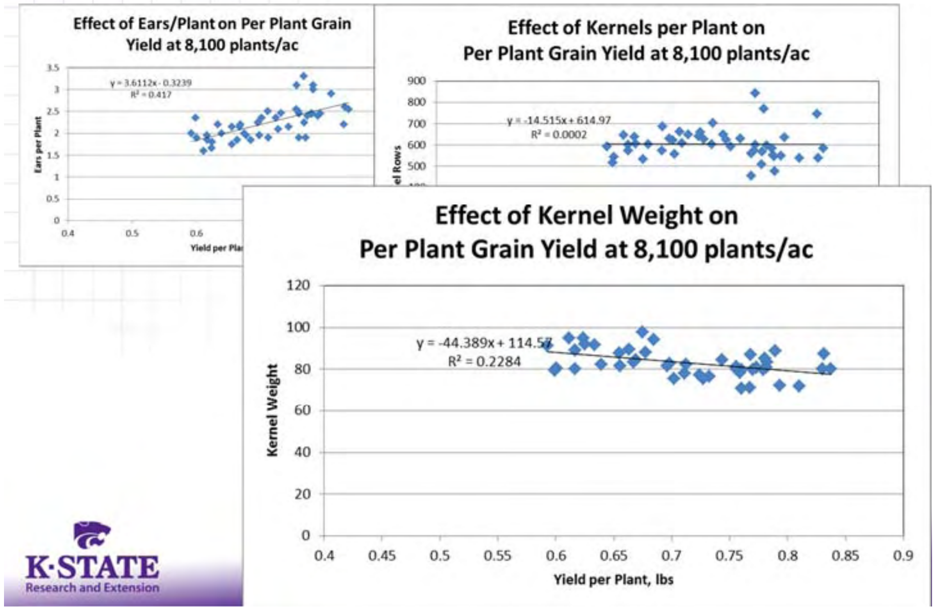
What Drives Yield at Low Seeding Rates



What Drives Yield at Low Seeding Rates



What Drives Yield at Low Seeding Rates



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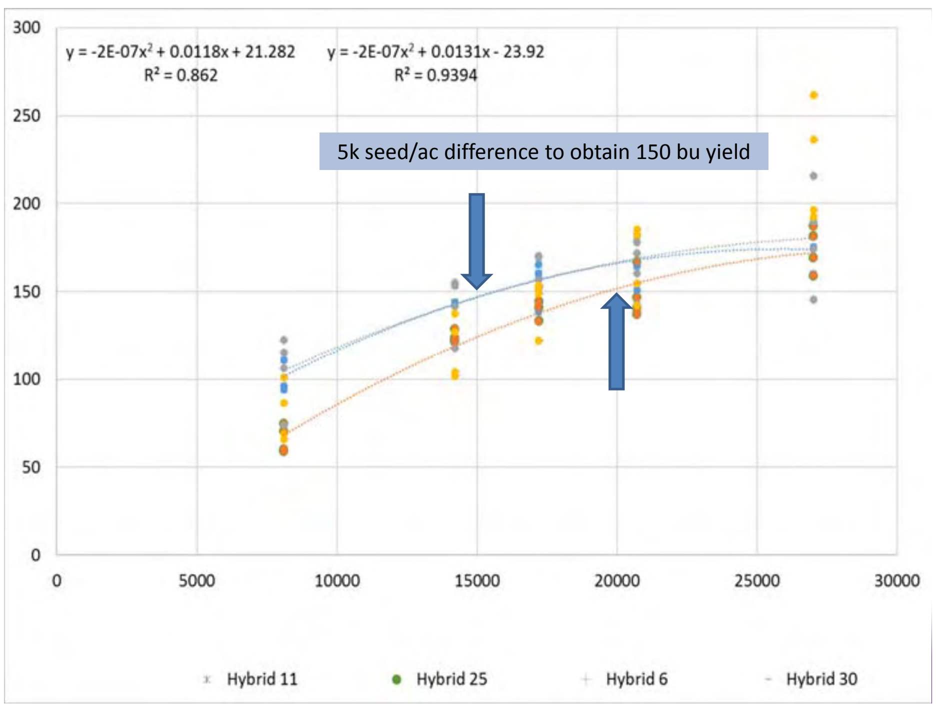
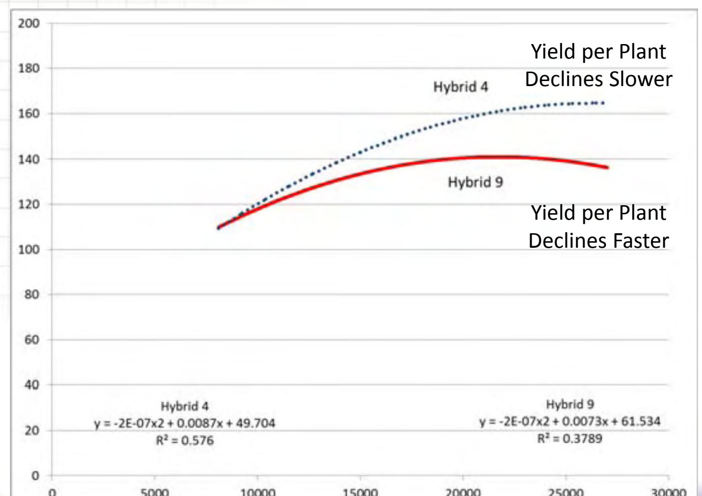


Its not just about high yield/plant, but how fast do I give it up



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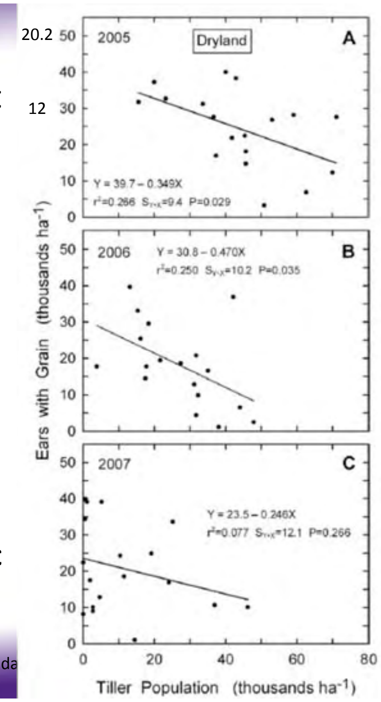
Knowledge for Life

Sources of Ear Flex

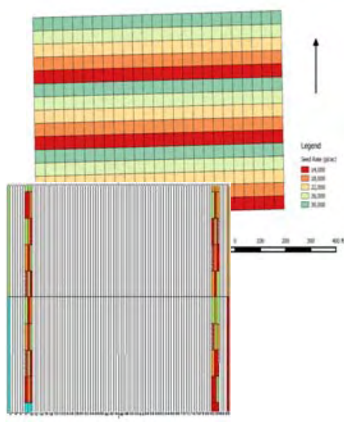
- Prolificacy
- Kernel Rows, Kernels per Ear Row, Kernel Weight
- What about tillers?

- Some indication in Tribune data that tillers have a negative effect on yield (18 hybrids in trial)
- But, we know that there is an interaction between plant population and tillering, <u>for some hybrids</u>
- Average decline in yield was 0.3 bu/ac for every 1,000 tillers/acre
- Example @ 17,000/ac, one tiller per plant reduces yield 5.3 bu/ac

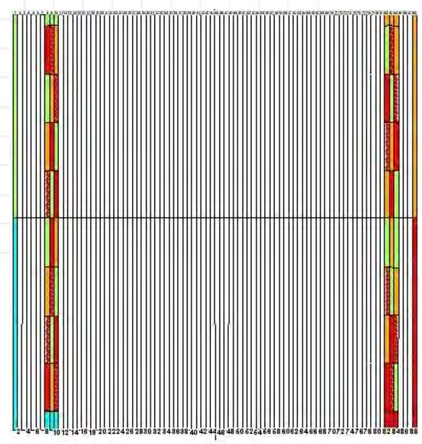


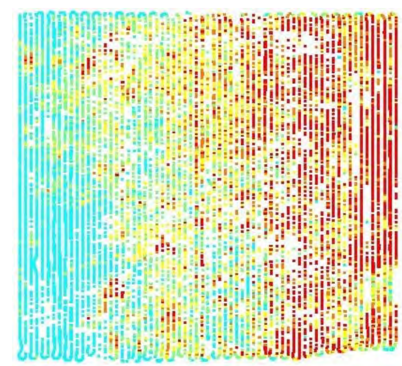
On-Farm Seeding Rate Trials

- Big enough range in seeding rates, +/- 2k isn't likely to show a response
- Treatment areas 300' long minimum, multiple field locations
- Can I use a highly variable field to generate a lot of characterization data?



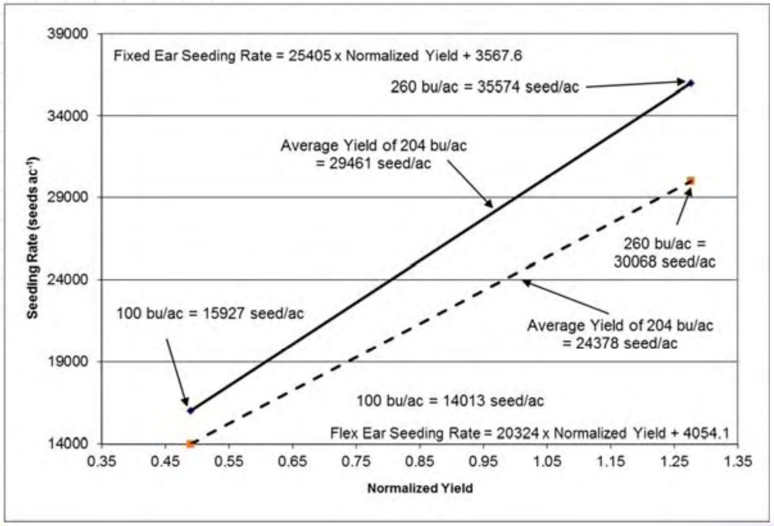
Using Field Variability to Guide Plot Placement….. Learn More

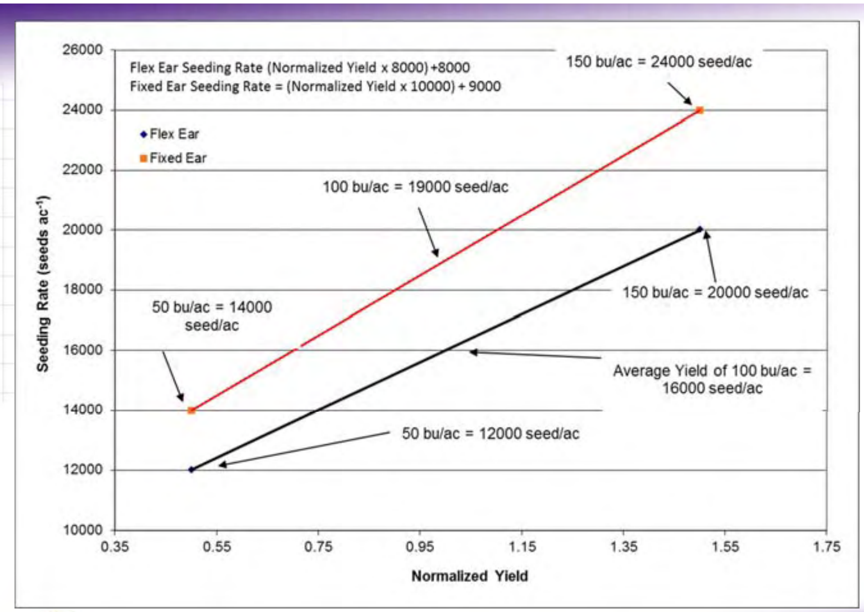




0-3' Soil EC

Hybrid Response to VRS Scripts





Recommendations

- Plant some small areas (planter width by 150') to a WIDE range of seeding rates
  - Dryland 8,100 to 27,000 (maybe higher?)
  - Irrigated 12,000 to 50,000
- Be aware that non-prolific hybrids could leave yield on the table if your seeding rate is too low
  - Yield per plant is maxed out, and then we're short of plants to match the environment
  - If yield/plant is the same from 8,100 to 14,00 that's a good sign were maxing out the plant

Recommendations

- Be aware that non-prolific hybrids could leave yield on the table if your seeding rate is too low
  - Yield per plant is maxed out, and then we're short of plants to match the environment
  - If yield increases proportionally to seeding rate then your maxing out the plant
  - Example 8,100 to 16,000, if yield doubles we're still plant limited

Questions / Comments?

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Dryland Corn Hybrid Maturity x Planting Dates

Lucas Haag, Ph.D., K-State Northwest Research Extension Center, Colby
Alan Schlegel, Ph.D., K-State Southwest Research-Extension Center, Tribune
Alicia Boor, Cottonwood Extension District, Great Bend
Stacy Campbell, Cottonwood Extension District, Hays
Sandra Wick, Post Rock Extension District, Smith Center

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Matching Hybrid Maturity and Planting Dates

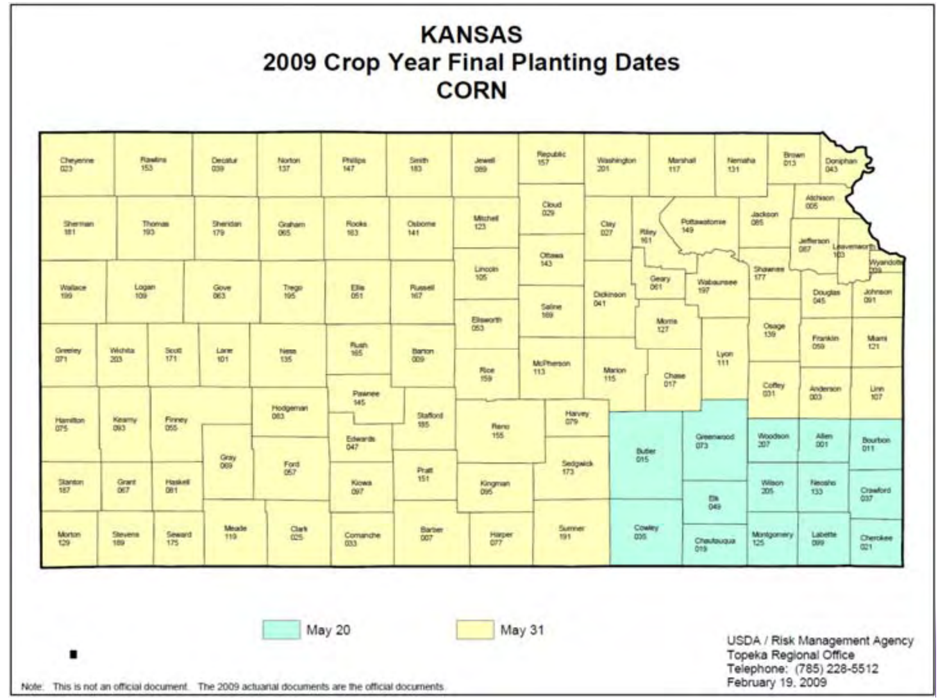
- The only dryland corn planting date research in western Kansas was done in the early to mid 1990's at Garden City
- We hear from a lot of producers (and I have experienced myself) improved yields from later planting
- Is this real? Is it a function of recent years? How does hybrid maturity play a role?

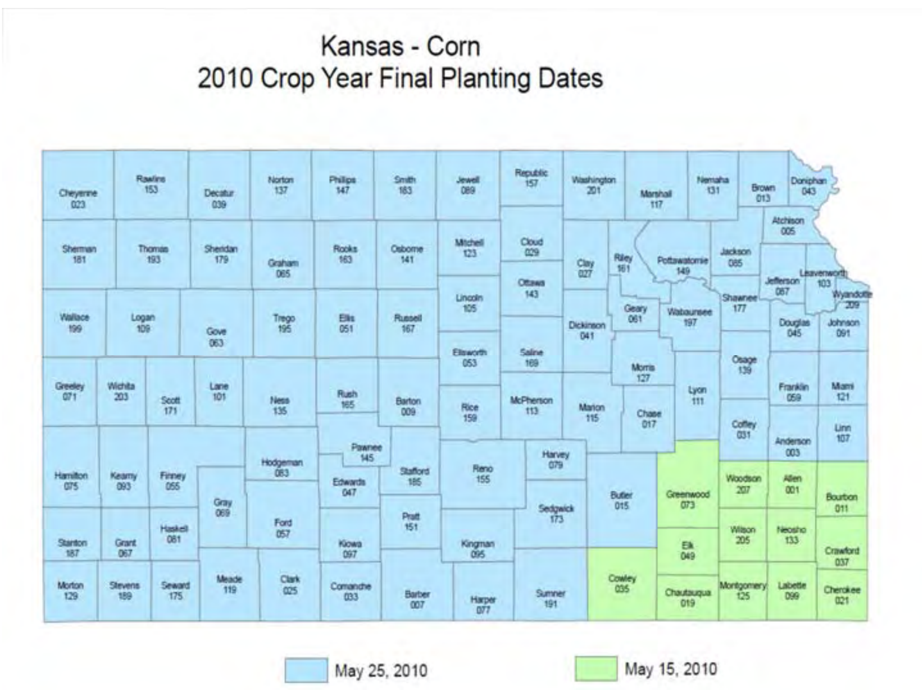
Different Planting Date Philosophies

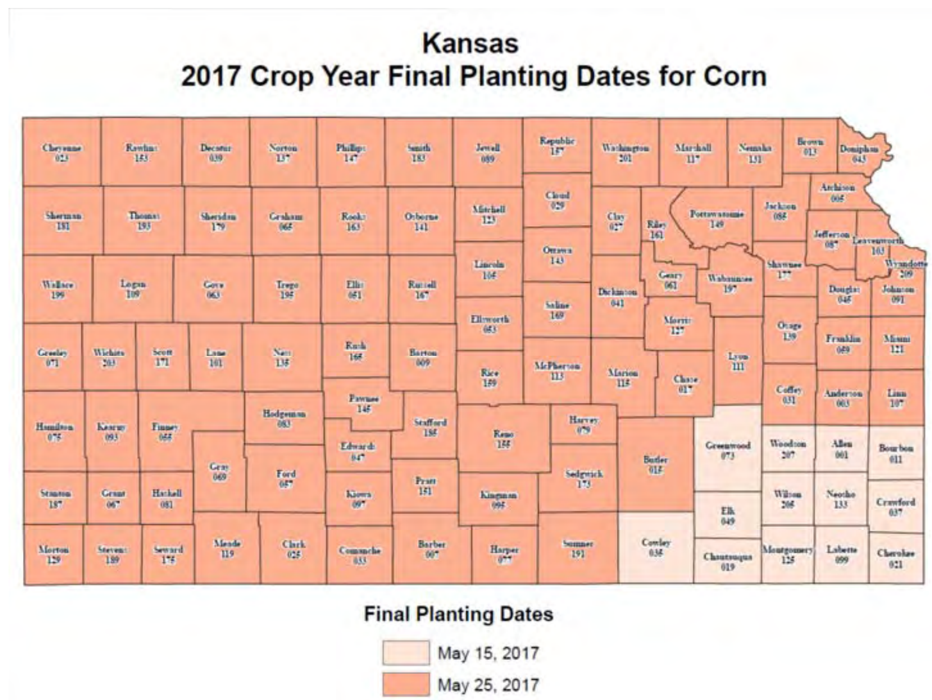
- Defensive
  - Early Corn Early (beat the heat)
  - Shorter-season hybrids to reduce water use
  - Plant medium season hybrids late (get on the other side of the heat)
- Offensive
  - Always planting the longest season hybrid the environment can support (max yields)

What's changed since we've started growing dryland corn?

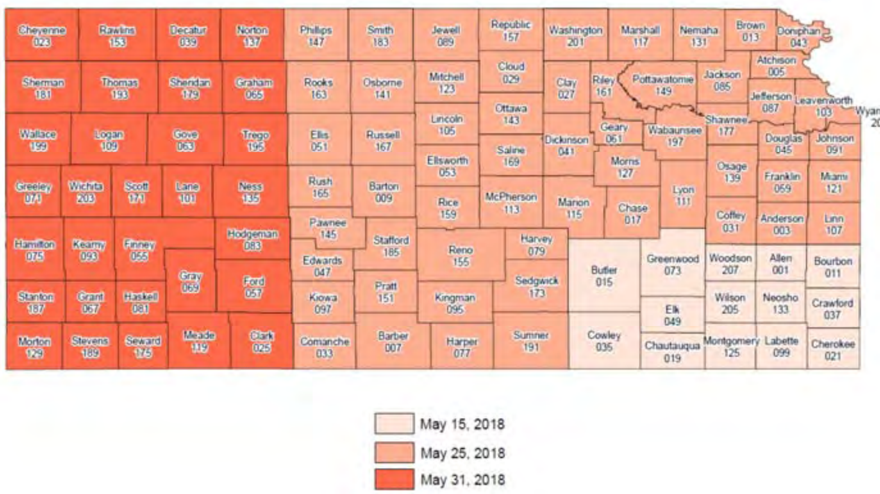
- Improved cold vigor and emergence, especially important for no-till wheat stubble
- Yield competitiveness of mid and short season hybrids has improved
  - Chicken and egg: lots of focus from the companies on this maturity group in order to expand acres
- Some reduction of ear-flex in full season hybrids potentially reducing their adaptability to dryland production
- Climate variability?
- Machinery capacity – acres/row, acres/day







Kansas
2018 Crop Year Final Planting Dates
Corn



Predicting Probabilities of Success

- Implies that we should be planting the longest hybrid the season will support (might be true?)
- Utilize historical weather data to look at cumulative GDU's from planting to freeze for various planting dates
- Assumes the book value GDU's to blacklayer are correct and stable

Planting Date x Maturity Probabilities St. Francis

Historical Probability of Reaching Black Layer Before a 28° F Freeze - St. Francis, 1908-2016

Hybrid		Planting Date										
Relative Maturity	Black Layer GDU	17-Apr	24-Apr	1-May	8-May	15-May	22-May	29-May	5-Jun	12-Jun	19-Jun	26-Jun
118	2815	94.5%	89.5%	82.9%	78.1%	71.4%	54.3%	30.5%	12.4%	5.7%	1.0%	0.0%
113	2768	94.5%	92.4%	88.6%	81.0%	76.2%	63.8%	39.0%	18.1%	9.5%	1.0%	0.0%
110	2670	96.3%	96.2%	94.3%	93.3%	81.0%	75.2%	65.7%	36.2%	15.2%	4.8%	1.0%
108	2604	98.2%	97.1%	96.2%	95.2%	92.4%	79.0%	73.3%	55.2%	22.9%	10.5%	1.0%
105	2520	99.1%	99.0%	98.1%	96.2%	96.2%	88.6%	79.0%	70.5%	41.0%	16.2%	6.7%
103	2463	100.0%	100.0%	100.0%	98.1%	96.2%	95.2%	81.9%	76.2%	58.1%	23.8%	10.5%
96	2357	100.0%	100.0%	100.0%	100.0%	99.0%	97.1%	96.2%	83.8%	74.3%	51.4%	18.1%
91	2250	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.1%	96.2%	84.8%	71.4%	35.2%
Average GDU		3188	3126	3064	2991	2911	2817	2716	2605	2482	2347	2199
Maximum GDU		3861	3797	3726	3602	3465	3373	3298	3156	3009	2875	2708
Minimum GDU		2515	2515	2476	2447	2326	2294	2196	2076	1979	1888	1770

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Need to take a blended approach example: St. Francis vs. Atwood

Historical Probability of Reaching Black Layer Before a 28° F Freeze - Atwood, 1939-2016

Hybrid		Planting Date										
Relative Maturity	Black Layer GDU	17-Apr	24-Apr	1-May	8-May	15-May	22-May	29-May	5-Jun	12-Jun	19-Jun	26-Jun
118	2815	91.0%	88.5%	79.5%	79.5%	66.7%	46.2%	20.5%	10.3%	3.8%	0.0%	0.0%
113	2768	96.2%	92.3%	87.2%	80.8%	74.4%	56.4%	33.3%	11.5%	6.4%	1.3%	0.0%
110	2670	97.4%	97.4%	96.2%	93.6%	80.8%	70.5%	57.7%	28.2%	10.3%	3.8%	0.0%
108	2604	98.7%	98.7%	97.4%	96.2%	91.0%	79.5%	66.7%	48.7%	15.4%	7.7%	1.3%
105	2520	98.7%	98.7%	98.7%	97.4%	94.9%	89.7%	76.9%	57.7%	32.1%	10.3%	3.8%
103	2463	98.7%	98.7%	98.7%	98.7%	97.4%	93.6%	84.6%	69.2%	52.6%	17.9%	7.7%
96	2357	98.7%	98.7%	98.7%	98.7%	98.7%	97.4%	94.9%	83.3%	66.7%	35.9%	10.3%
91	2250	100.0%	100.0%	100.0%	100.0%	98.7%	98.7%	97.4%	96.2%	83.3%	59.0%	30.8%
Average GDU		3158	3098	3033	2960	2877	2781	2680	2567	2442	2305	2157
Maximum GDU		3778	3726	3650	3532	3404	3318	3241	3095	2941	2814	2646
Minimum GDU		2346	2346	2317	2295	2245	2186	2145	2071	1994	1858	1712

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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

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"Without data you're just another person with an opinion"

-W. Edwards Deming

Objectives

- Evaluate a combination of hybrid maturities and planting dates across western and central Kansas.
- Is there an advantage to planting later?
- Do hybrids adjust when planted later?
- Collect a solid dataset for crop modeling

Materials and Methods

- Dryland corn planted no-tilled into wheat stubble (except Barton County, soybean stubble)
- Region appropriate seeding rates
  – Tribune and Colby, 17,400
  – Olmitz and Smith Center 19,500

Materials and Methods – 2018 Planting Dates

	Tribune	Colby	Barton Co.	Smith Center
mid-April	4/19	-	-	-
early-May	5/3	5/9	5/15	5/9
mid-May	5/17	5/22	5/21	5/21
early-June	5/31	6/3	6/1	6/1
mid-June	6/14	6/17	6/16	6/16

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Materials and Method - Hybrids

- Utilize multiple, genetically independent hybrids to represent each maturity class

Company	Hybrid	CRM	SilkCRM	GDU_Pollen	GDU_Silk	GDU_PM
DupontPioneer	P9998AMXT	99	99	.	1240	2350
AgReliant/LG	LG5494	99	late for mat	1255	1265	2460
Monsanto/DeKalb	DKC51-20DGVT2PRIB	101	.	1282	1282	2525
AgReliant/LG	LG5525	105	early for mat	1260	1260	2480
DupontPioneer	P0657AMXT	106	104	.	1300	2500
Monsanto/DeKalb	DKC57-99RIB	107		.	1264	2675
AgReliant/LG	LG2602	112	late for mat	1360	1370	2710
DupontPioneer	P1751AM	117	114	.	1420	2830
Monsanto/Channel	216-36DGVT2PRIB	116	.	1387	1387	2910

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2018 Dryland Cropping Update

Knowledge for Life

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

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2018 Dryland Cropping Update

Knowledge for Life

Planting Date affects on Phenology

Corn Hybrid x Date of Planting Study, Silking Dates, Tribune, Kansas. 2018 - PRELIMINARY DATA

Company	Hybrid	CRM	Planted 4/19 Silking Date	Planted 4/19 Silking GDU	Planted 5/3 Silking Date	Planted 5/3 Silking GDU	Planted 5/17 Silking Date	Planted 5/17 Silking GDU	Planted 5/31 Silking Date	Planted 5/31 Silking GDU	Planted 6/14 Silking Date	Planted 6/14 Silking GDU	5/17 to 6/14 Reduction
AgReliant/LG	LG5494	99	7/15	1386	7/16	1350	7/24	1314	8/2	1297	8/13	1150	165
AgReliant/LG	LG5525	105	7/16	1415	7/16	1361	7/24	1332	8/3	1303	8/15	1101	231
AgReliant/LG	LG2602	112	7/22	1565	7/21	1483	7/28	1416	8/5	1367	8/19	1261	155
Monsanto/DeKalb	DKC51-20DGVT2PRIB	101	7/13	1357	7/14	1302	7/23	1309	8/2	1291	8/11	1111	197
Monsanto/DeKalb	DKC57-99RIB	107	7/14	1396	7/16	1355	7/24	1333	8/3	1314	8/14	1151	182
Monsanto/Channel	216-36DGVT2PRIB	116	7/18	1461	7/19	1434	7/26	1377	8/4	1332	8/15	1209	168
Dupont/Pioneer	P9998AMXT	99	7/13	1331	7/15	1316	7/23	1291	7/30	1243	8/11	1116	174
Dupont/Pioneer	P0657AMXT	106	7/15	1396	7/17	1367	7/25	1344	8/1	1276	8/13	1159	186
Dupont/Pioneer	P1751AM	117	7/28	1698	7/28	1631	7/30	1453	8/6	1389	8/18	1291	163

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2018 Dryland Cropping Update

Knowledge for Life

Planting Date affects on Phenology

Corn Hybrid x Date of Planting Study, Silking Dates, Olmitz Kansas. 2018 PRELIMINARY DATA

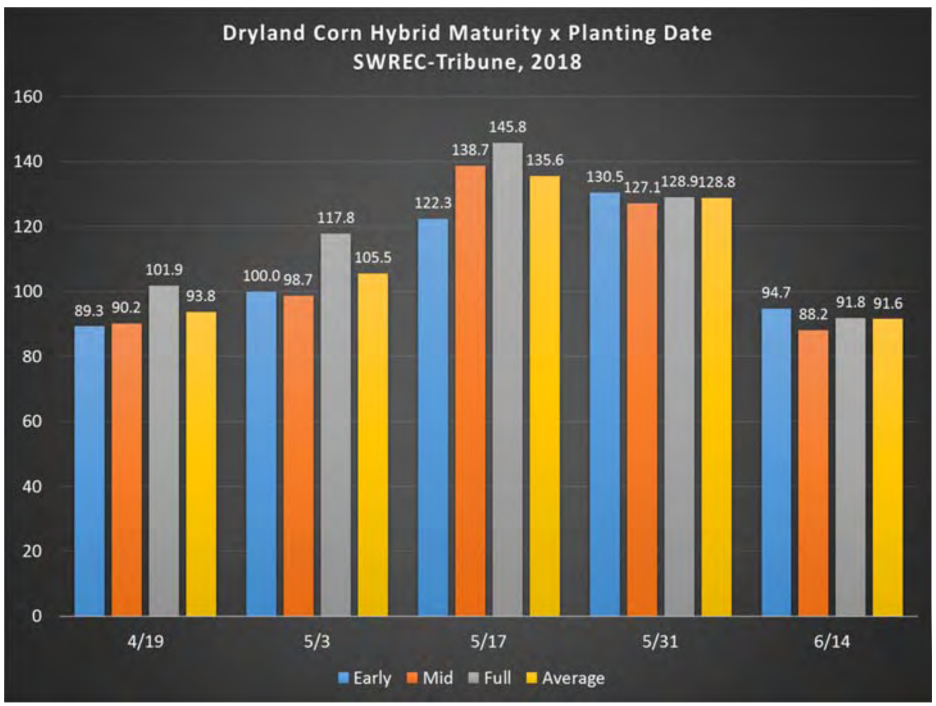
Company	Hybrid	CRM	Planted 5/15/2018		Planted 5/21/2018		Planted 6/1/2018		Planted 6/16/2018	
			Silking	Silking GDU	Silking	Silking GDU	Silking	Silking GDU	Silking	Silking GDU
AgReliant/LG	LG5494	99	7/11	1406	7/15	1393	7/23	1370	8/7	1352
AgReliant/LG	LG5525	105	7/11	1386	7/16	1407	7/23	1383	8/8	1371
AgReliant/LG	LG2602	112	7/15	1515	7/17	1447	7/27	1467	8/9	1414
Monsanto/DeKalb	DKC51-20DGVT2PRIB	101	7/11	1392	7/15	1393	7/24	1390	8/7	1365
Monsanto/DeKalb	DKC57-99RIB	107	7/12	1421	7/16	1413	7/23	1383	8/8	1371
Monsanto/Channel	216-36DGVT2PRIB	116	7/13	1461	7/18	1461	7/25	1435	8/8	1384
Dupont/Pioneer	P9998AMXT	99	7/10	1360	7/14	1359	7/22	1343	8/6	1327
Dupont/Pioneer	P0657AMXT	106	7/11	1393	7/15	1386	7/22	1350	8/7	1346
Dupont/Pioneer	P1751AM	117	7/16	1542	7/17	1447	7/27	1479	8/9	1409

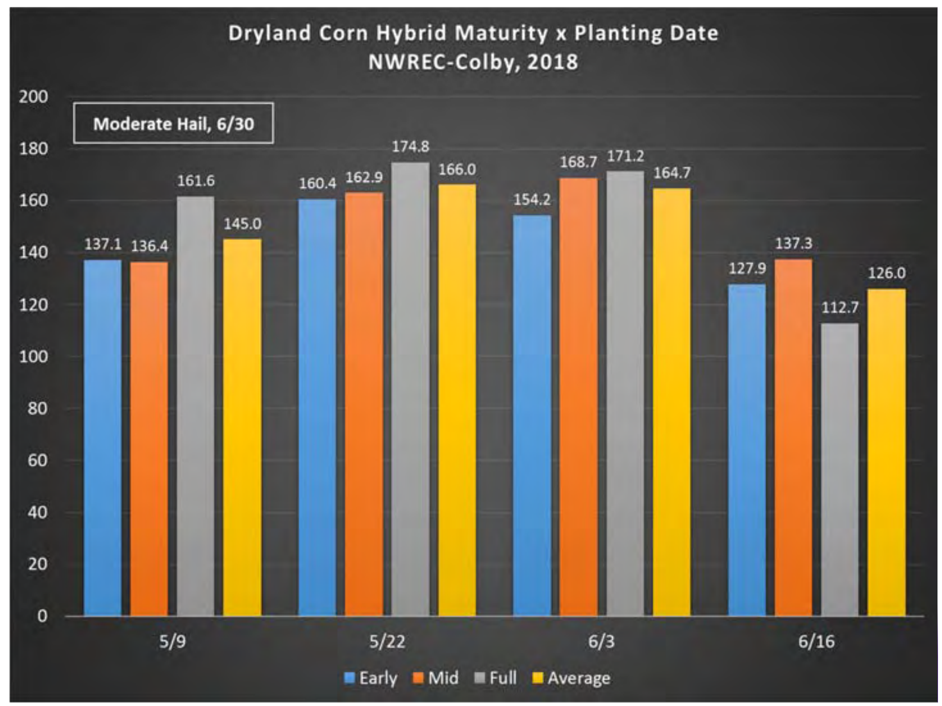
Hybrids did make some adjustments due to planting date, BUT….

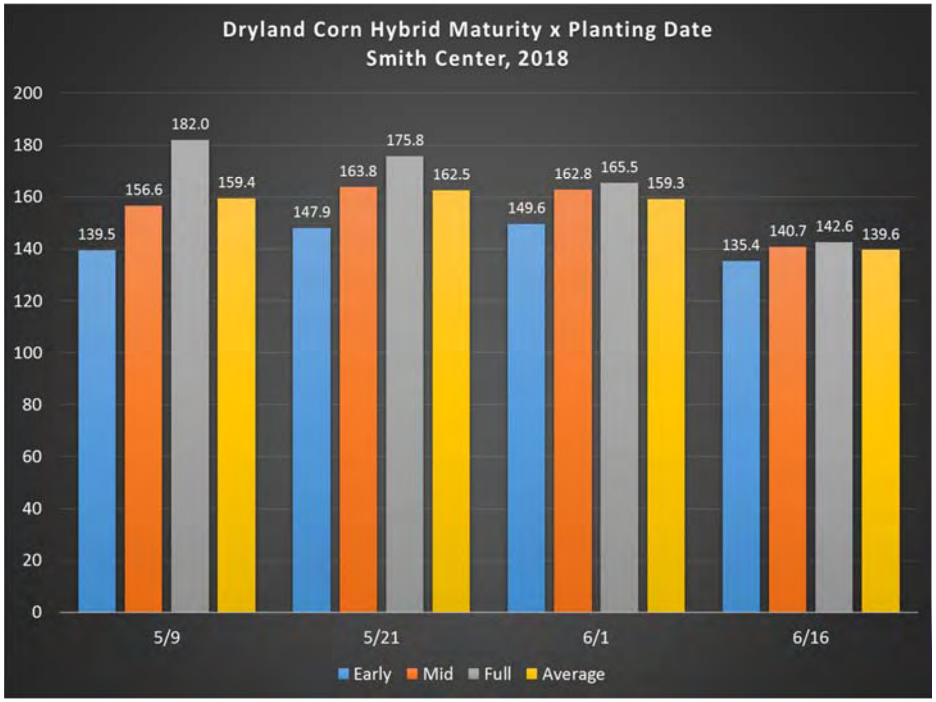
Planting Date affects on Phenology varied by location

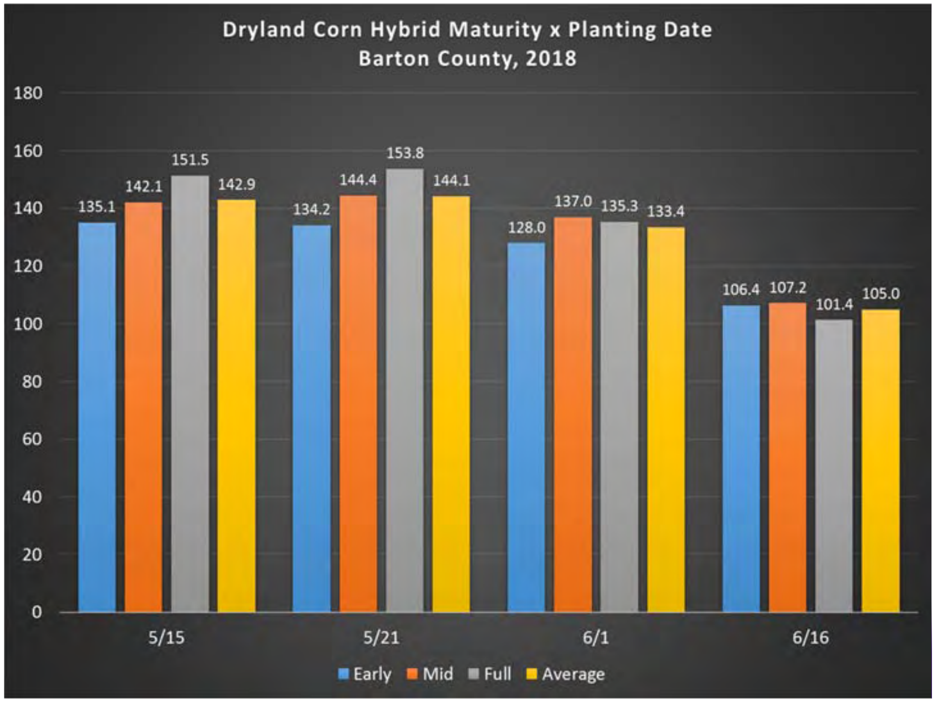
Company	Hybrid	CRM	5/15 to 6/15 Reduciton in GDU to Silk		
			Tribune	Great Bend	Difference
AgReliant/LG	LG5494	99	120	54	66
Dupont/Pioneer	P9998AMXT	99	154	33	121
Monsanto/DeKalb	DKC51-20DGVT2PRIB	101	161	27	134
AgReliant/LG	LG5525	105	112	15	97
Dupont/Pioneer	P0657AMXT	106	155	47	108
Monsanto/DeKalb	DKC57-99RIB	107	128	50	79
AgReliant/LG	LG2602	112	106	101	5
Monsanto/Channel	216-36DGVT2PRIB	116	151	77	74
Dupont/Pioneer	P1751AM	117	151	133	18

Also note, this was an adjustment to silking date.
We do not yet know the affects of delayed planting on reaching blacklayer









Moving Forward

- Continue searching for funding opportunities so that we can collect more data
- Field trials will not provide us **<u>the</u>** answer we need
- A given combination isn't always going to be the right answer

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Moving Forward

- A given combination isn't always going to be the right answer
- The real question is:

What hybrid x maturity combination minimizes risk and maximizes profits over the long-term?

- Finding max yield an any individual year doesn't answer that
- Crop modeling is how we will get to that answer

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DEKALB

Channel Seedsmanship At Work

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Questions / Comments?

northwest.ksu.edu/agronomy

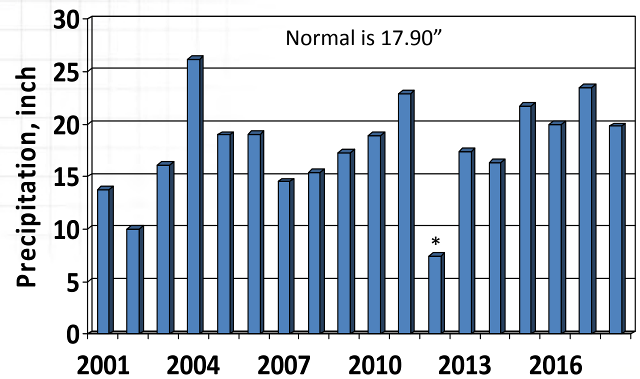
lhaag@ksu.edu 785.462.6281

Twitter @LucasAHaag or www.facebook.com/NWKSAgronomy

Cropping Systems Research

Alan Schlegel and Lucas Haag
Southwest Research-Extension Center – Tribune, Kansas

Annual Precipitation, Tribune, KS



* 7.49” lowest on record

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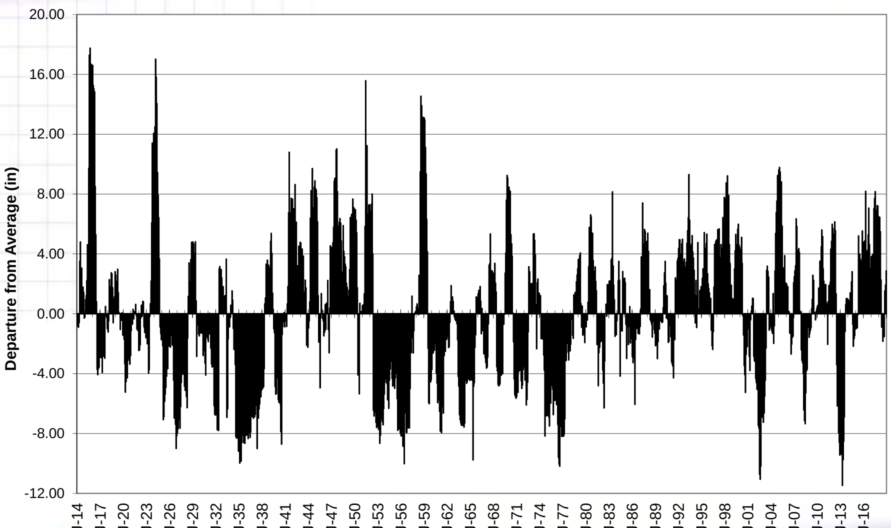
K-State SWREC - Tribune

12 Month Rolling Precipitation Average (1913 - 2018)
Long-term (1913 - 2018) Annual Precipitation - 16.94 in



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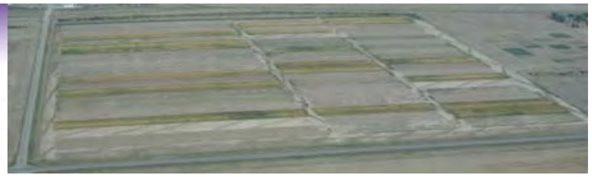
Large-Scale Cropping Systems

Current Rotations



- Wheat-Fallow (WF), reduced tillage.
- Wheat-Sorghum-Fallow (WSF).
- Wheat-Sorghum-Corn-Fallow (WSCF).
- Wheat-Corn-Fallow (WCF).
- Wheat-Corn-Sorghum-Fallow (WCSF).
- Continuous Sorghum (SS).

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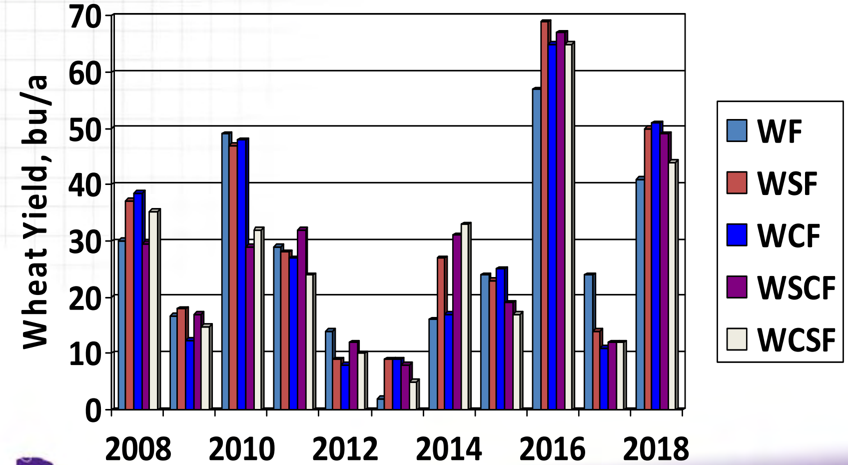
Wheat Yields from Cropping Systems



TAM 113 winterkilled in 2015, wheat streak mosaic in 2017

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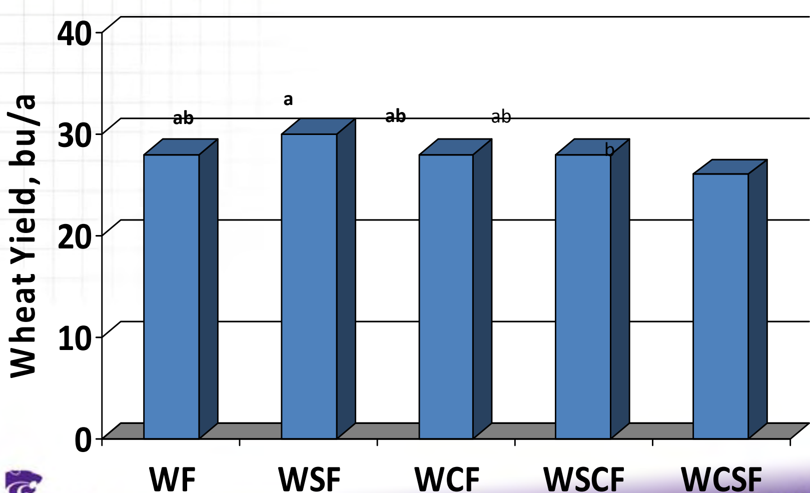
Average Wheat Yields, 2008-2018



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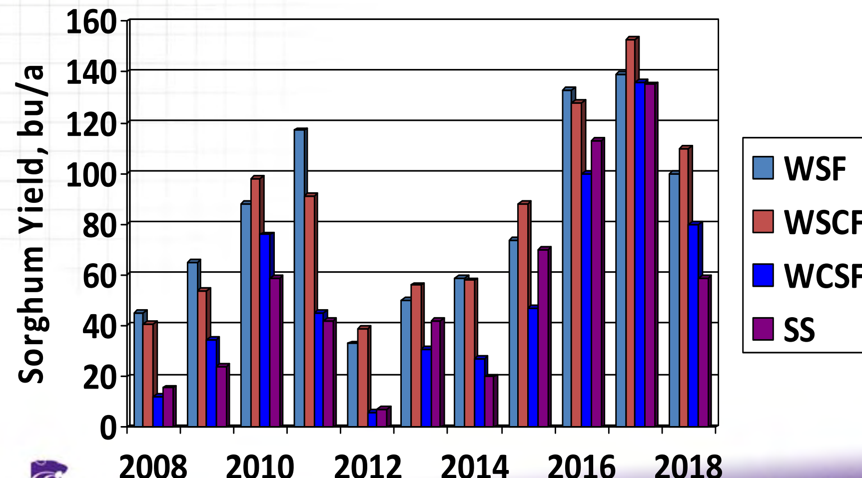
Sorghum Yields from Cropping Systems



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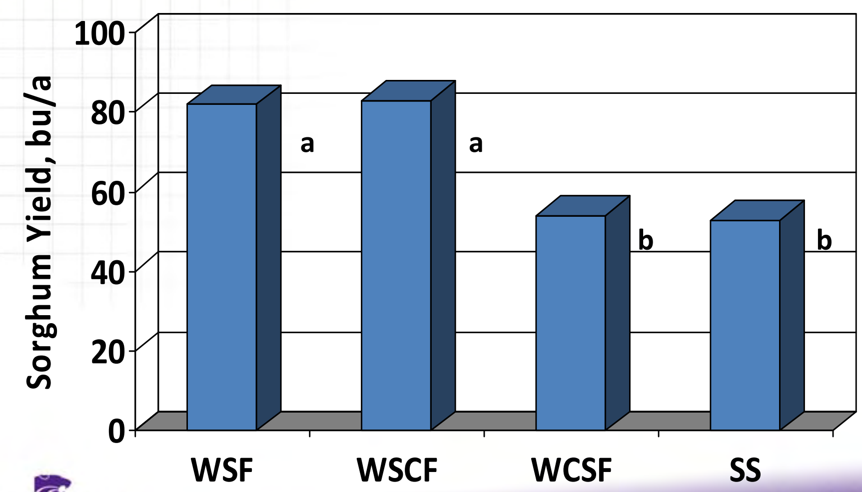
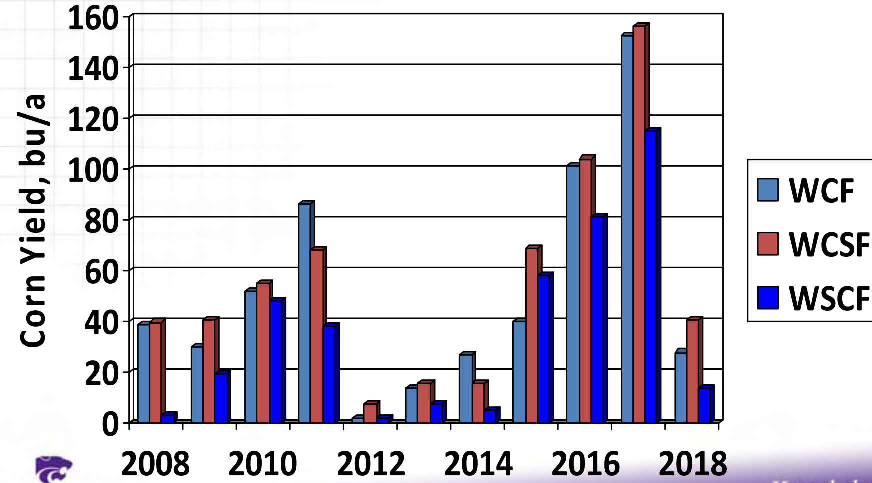
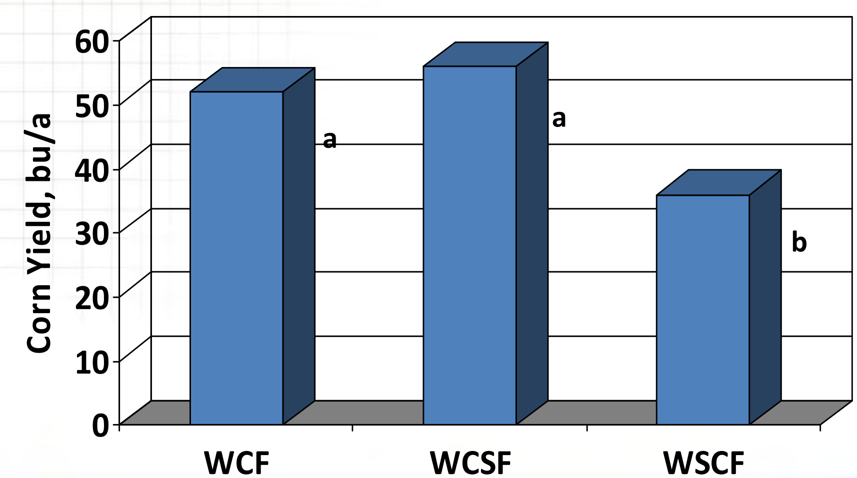
Average Sorghum Yields, 2008-2018



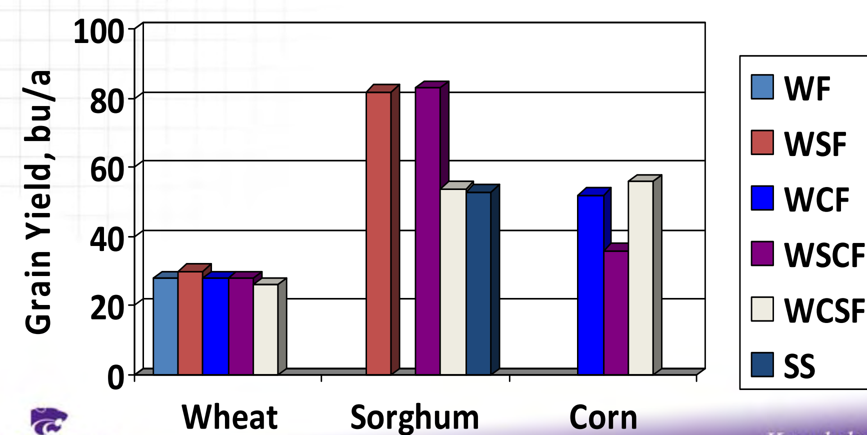
Corn Yields from Cropping Systems



Average Corn Yields, 2008-2018



Grain Yields from Cropping Systems 2008-2018



Summary

- Wheat yields similar in 2-, 3-, and 4-yr rotations.
- Corn and sorghum yields about 50% greater following wheat than row crop.
- Sorghum yields about 40% greater than corn yields in similar rotations.
- No rotation better than WSF.

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Tillage Intensity in a WSF Rotation

Objectives

Determine effect of long-term tillage practices in a wheat-sorghum-fallow rotation

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Site characteristics

- Richfield silt loam soil
- Level (<1% slope)
- Annual precipitation - 18 inches

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WSF rotation

- ➢Conventional tillage
- ➢Reduced tillage
- ➢No-till

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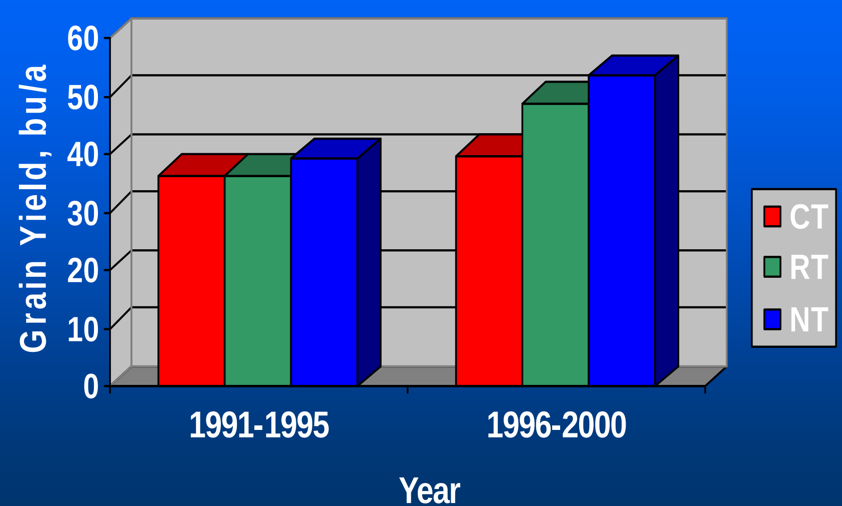
Weed control during fallow

	Tillage	Chemical
	---- # of operations ----	
CT	4-5	0
RT	2-3	2
NT	0	4

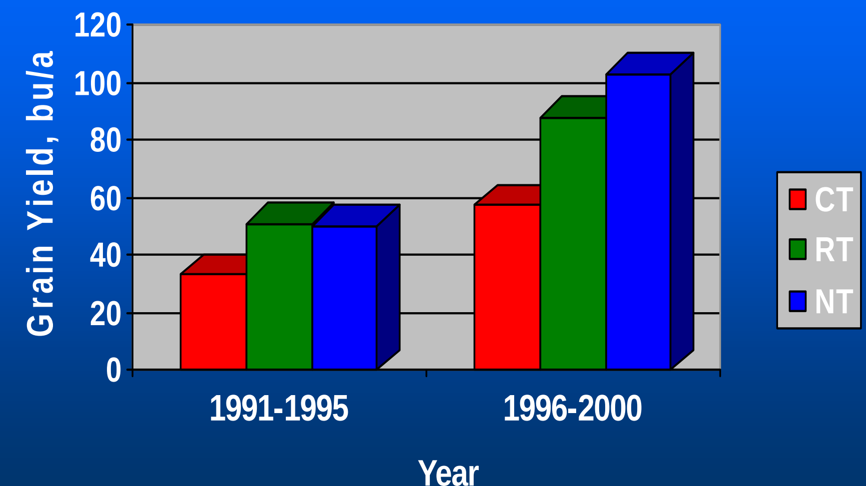
1991-2000

Average Wheat Yield



Tillage Intensity WSF, Tribune

Average Sorghum Yield



Tillage Intensity WSF, Tribune

Weed control during fallow

	Tillage	Chemical
	---- # of operations ----	
CT	4-5	0
RT	4-5 (W)	4 (S)
NT	0	4

2001 thru current

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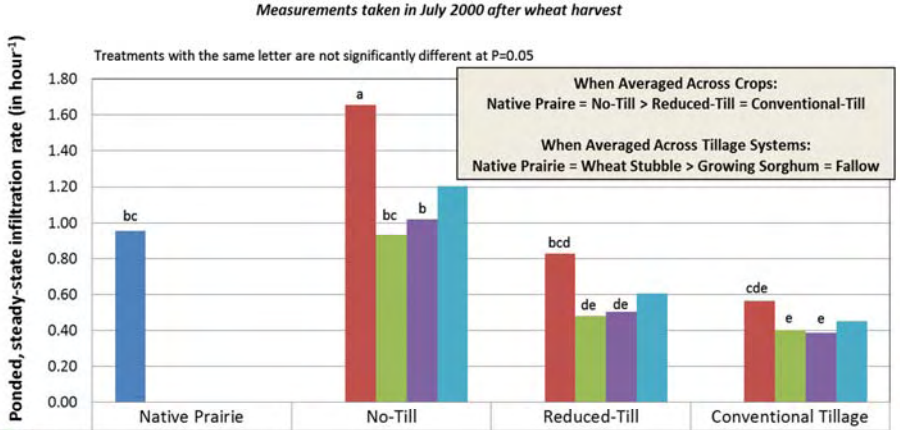
Infiltration Rate as Affected by Tillage System and Rotation Phase in a Wheat-Sorghum-Fallow Rotation

K-State Southwest Research-Extension Center, Tribune, Kansas

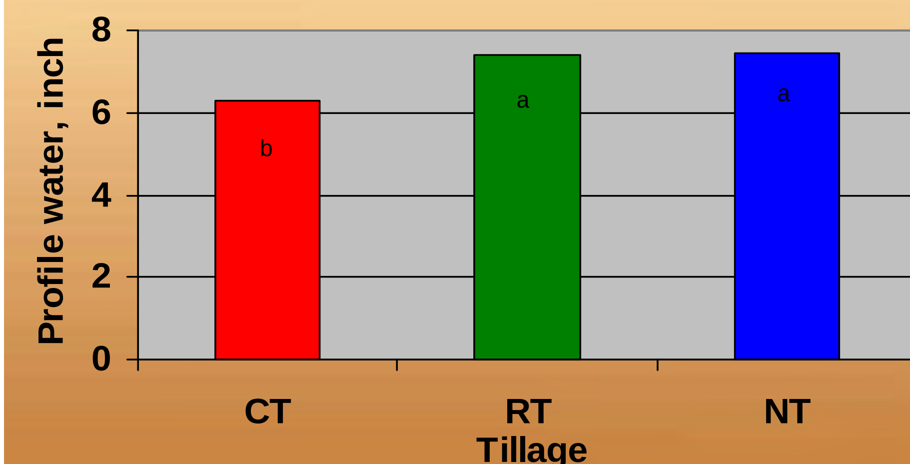
Cropland brought into production from native sod in 1991
Measurements taken in July 2000 after wheat harvest



	Native Prairie	No-Till	Reduced-Till	Conventional Tillage
Sod	0.96			
Wheat		1.66	0.83	0.56
Sorghum		0.93	0.48	0.40
Fallow		1.02	0.50	0.39
Average		1.20	0.60	0.45

Soil Water at Wheat Planting

WSF, Tribune, 2001-2018



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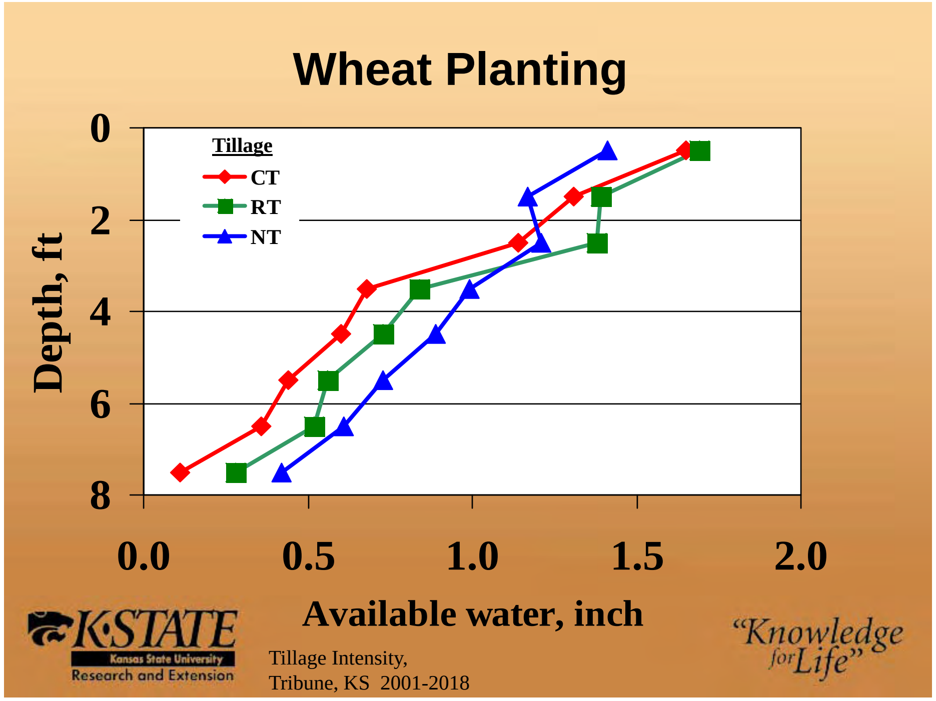
Wheat Planting
Depth, ft
0
2
4
6
8
Tillage
CT
RT
NT
0.0
0.5
1.0
1.5
2.0
Available water, inch
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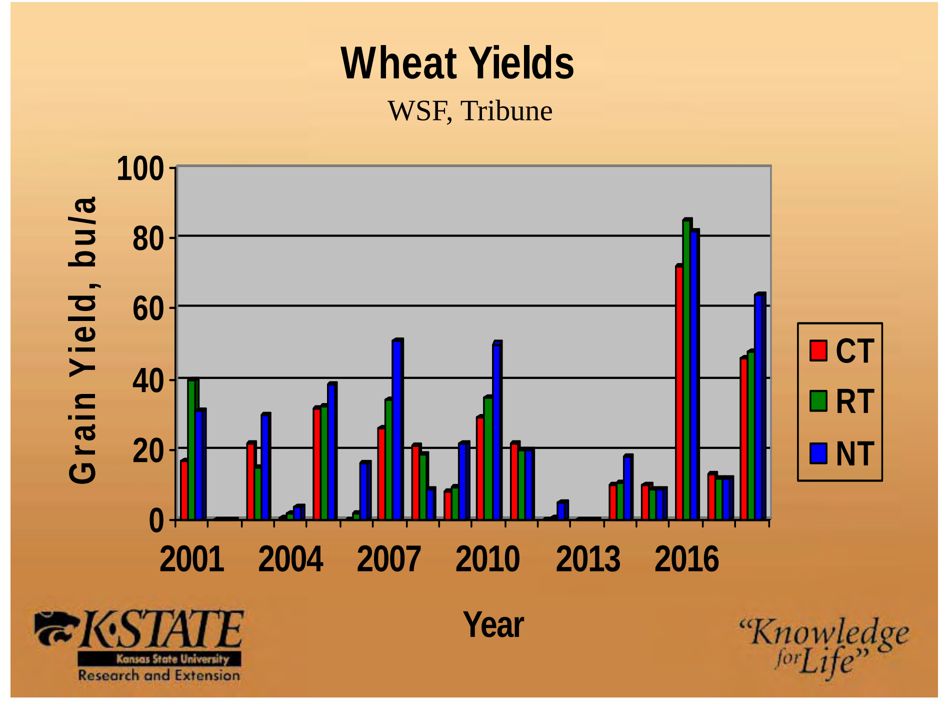
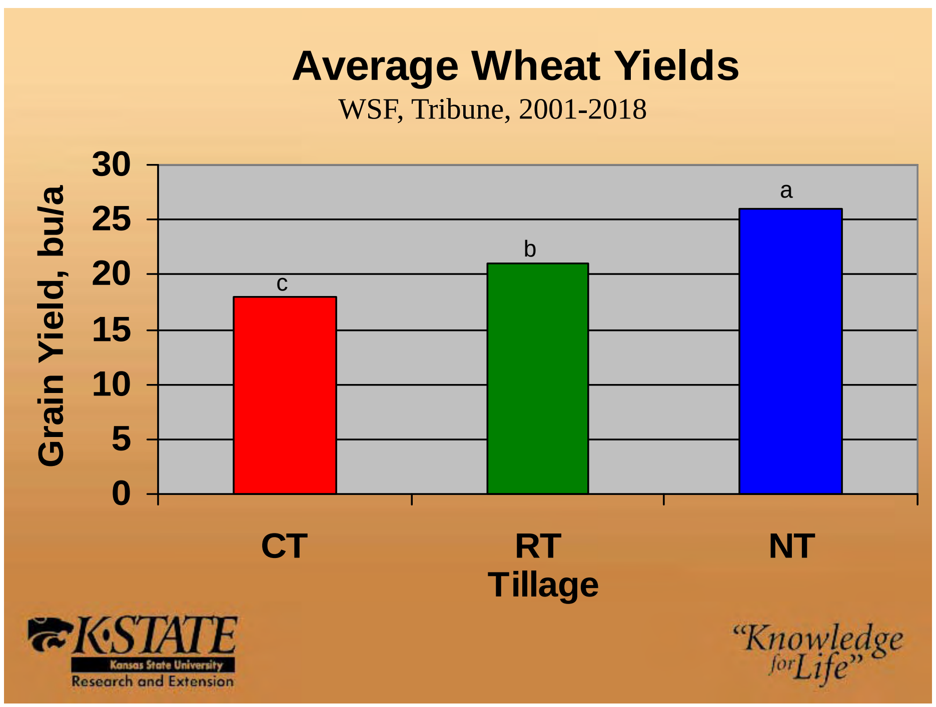
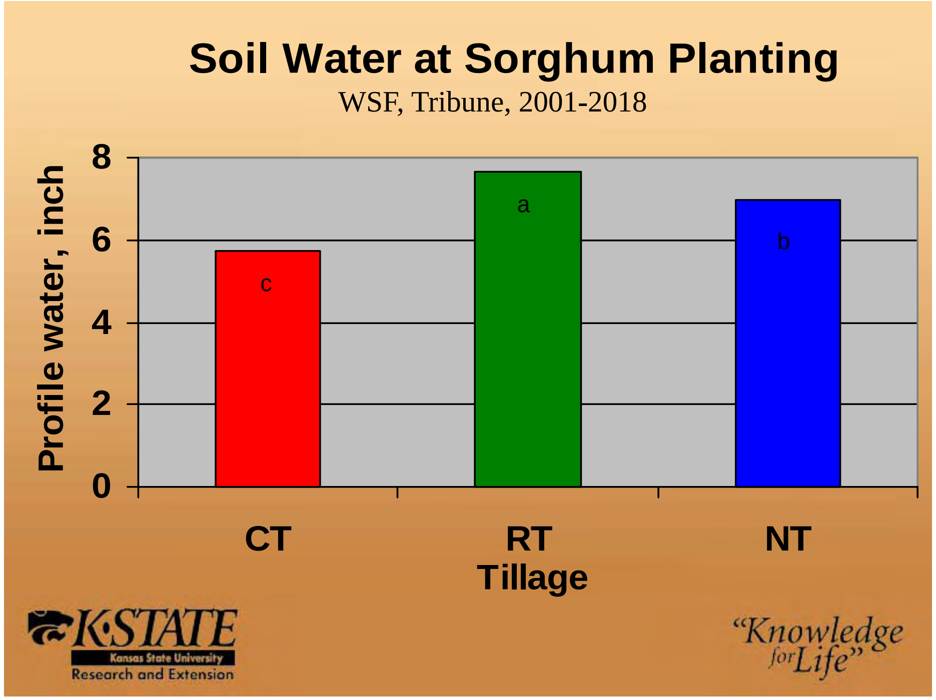
Kansas State University
Research and Extension
Tillage Intensity,
Tribune, KS 2001-2018
"Knowledge for Life"


Wheat Yields
WSF, Tribune
Grain Yield, bu/a
100
80
60
40
20
0
2001
2004
2007
2010
2013
2016
Year
CT
RT
NT
K-STATE
Kansas State University
Research and Extension
"Knowledge for Life"


Average Wheat Yields
WSF, Tribune, 2001-2018
Grain Yield, bu/a
30
25
20
15
10
5
0
c
b
a
CT
RT
NT
Tillage
K-STATE
Kansas State University
Research and Extension
"Knowledge for Life"


Soil Water at Sorghum Planting
WSF, Tribune, 2001-2018
Profile water, inch
0
2
4
6
8
c
a
b
CT
RT
NT
Tillage
K-STATE
Kansas State University
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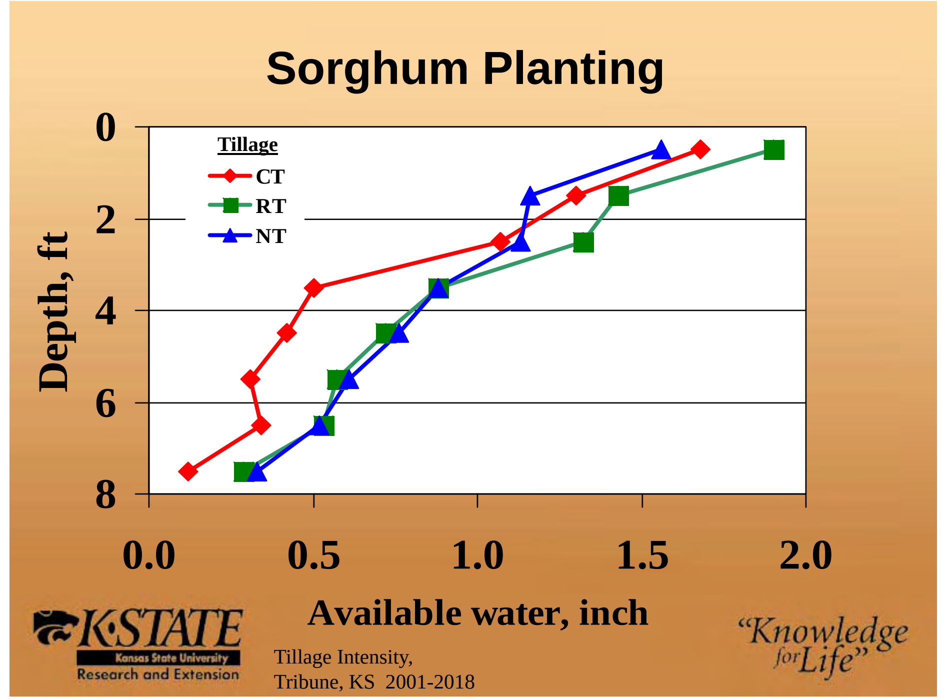
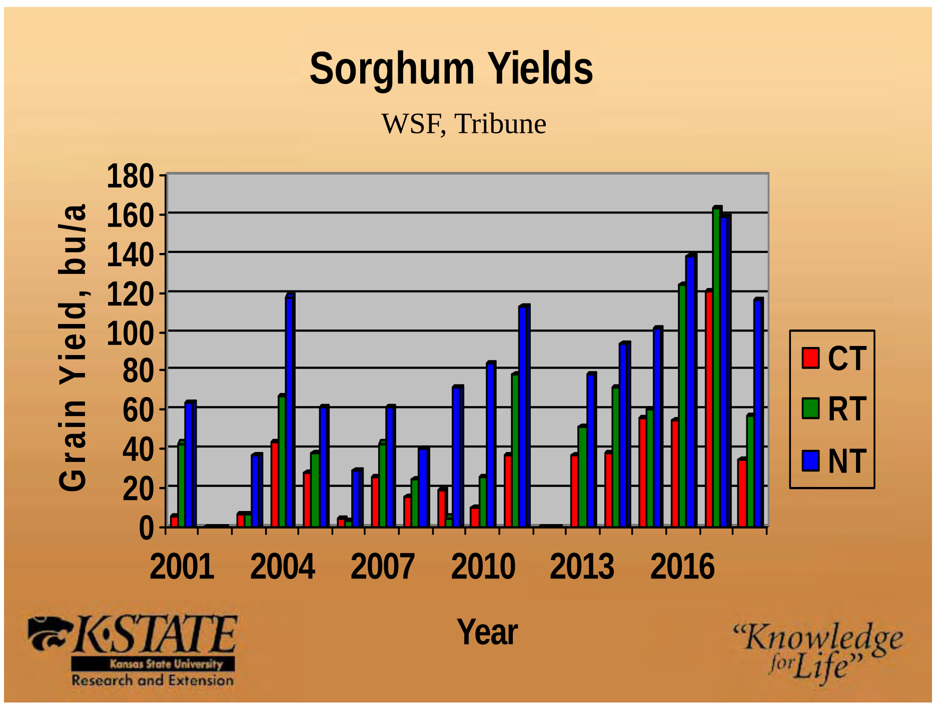

Sorghum Planting
Depth, ft
0
2
4
6
8
Tillage
CT
RT
NT
0.0
0.5
1.0
1.5
2.0
Available water, inch
Tillage Intensity,
Tribune, KS 2001-2018
K-STATE
Kansas State University
Research and Extension
"Knowledge for Life"


Sorghum Yields
WSF, Tribune
Grain Yield, bu/a
0
20
40
60
80
100
120
140
160
180
CT
RT
NT
2001
2004
2007
2010
2013
2016
Year
K-STATE
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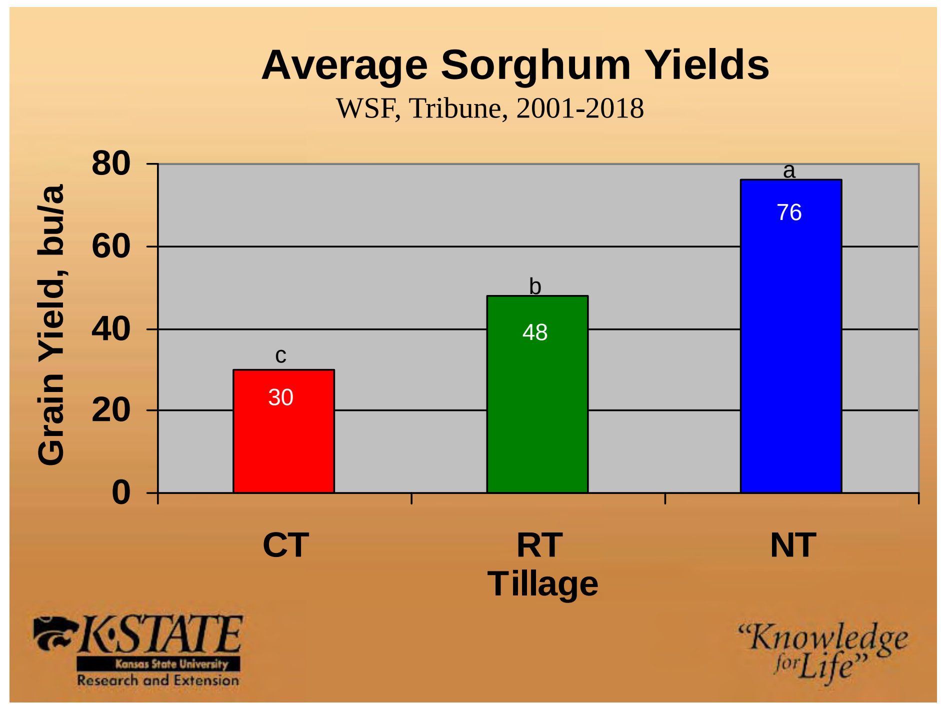
Average Sorghum Yields
WSF, Tribune, 2001-2018
Grain Yield, bu/a
0
20
40
60
80
c
30
b
48
a
76
CT
RT
NT
Tillage
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Summary
(2001-2018)

Grain yield:

wheat: NT ~35% greater than CT
~20% greater than RT

sorghum: NT ~150% greater than CT
~60% greater than RT

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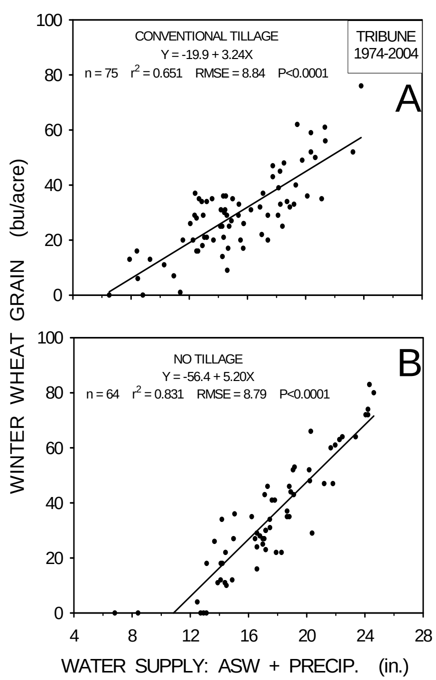

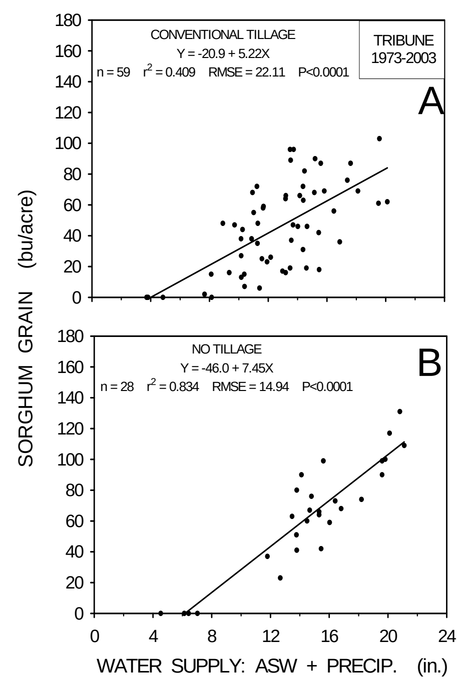

Economics of Tillage Intensity

Monte Vandeveer
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The move toward less tillage…

- Some intended goals
  - Conserve soil moisture, improve soil health
  - Higher yields
  - Fewer tillage passes through the field
- But…
  - Do higher yields offset the higher chemical costs in reduced till / no-till systems?
  - Growing herbicide resistance in some weeds

Notes on input costs

- Use custom rates to estimate machinery costs
- Include cost of preceding fallow period with cost of crop production
- Economic comparison of systems
  - Do higher yields pay for higher chemical costs?

Fertilizer use

- Nitrogen
  - NH3 used when using tillage
  - UAN-28 liquid applied in no-till regime
  - Wheat: 2 lbs N for each bushel of average yield
  - Sorghum: 1.2 lbs N for each bushel of average yield
- Phosphate
  - MAP (11-52-0) for wheat, 26 lbs P per acre
  - APP (11-34-0) for sorghum, 27 lbs P per acre

WHEAT: chemical use

- **NO-TILL system**
- **Fallow period prior to wheat**
- Scoparia, 3 oz/a
- Dicamba, 16 oz/a
- Metribuzin, 8 oz/a

- Paraquat, 48 oz/a
- 2,4-D, 16 oz/a

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- Glyphosate, 32 oz/a
- 2,4-D, 16 oz/a
- Dicamba, 16 oz/a

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- 2,4-D, 16 oz/a
- Dicamba, 16 oz/a

- **Wheat crop**
- Ally, 0.1 oz/a
- Dicamba, 4 oz/a

- **CONVENTIONAL system:**
- Retains only those herbicides used on wheat crop

- **REDUCED system**:
- Fallow after sorghum: use tillage
- Same herbicides for wheat crop

SORGHUM: chemical use

- **NO-TILL system**
- **Fallow period prior to sorghum**
- Glyphosate, 32 oz/a
- 2,4-D, 32 oz/a

- Paraquat, 48 oz/a
- 2,4-D, 16 oz/a

- Glyphosate, 32 oz/a
- 2,4-D, 16 oz/a

- Atrazine, 1 lb/a
- Dicamba, 16 oz/a

- Glyphosate, 32 oz/a
- 2,4-D, 16 oz/a

- **Sorghum crop**
- Lumax, 2.5 qt/a
- Atrazine, 0.25 lb/a
- Paraquat, 48 oz/a

- **CONVENTIONAL system:**
- Retains only those herbicides used on sorghum crop

- **REDUCED system**:
- Fallow after wheat: use no-till
- Same herbicides for sorghum crop

Wheat costs using 2018 input prices

	NT Rate	NT Price	NT Total	RT Rate	RT Price	RT Total	CT Rate	CT Price	CT Total
Seed	50	0.20	10.00	50	0.20	10.00	50	0.20	10.00
Fertilizer									
UAN	145	0.12	17.76	0	0.12	0.00	0	0.12	0.00
NH3	0	0.24	0.00	40	0.24	9.60	35	0.24	8.40
MAP	50	0.26	13.13	50	0.26	13.13	50	0.26	13.13
Actual N, P	46 lbs N, 26 lbs P			38 lbs N, 26 lbs P			34 lbs N, 26 lbs P		
Herbicide									
Scoparia	3	4.88	14.65	0	4.88	0.00	0	4.88	0.00
Dicamba	52	0.31	16.25	4	0.31	1.25	4	0.31	1.25
Metribuzin	0.5	13.05	6.53	0	13.05	0.00	0	13.05	0.00
Paraquat	96	0.23	21.75	0	0.23	0.00	0	0.23	0.00
Glyphosate	64	0.13	8.50	0	0.13	0.00	0	0.13	0.00
2,4-D	64	0.16	10.50	0	0.16	0.00	0	0.16	0.00
Ally	0.1	7.37	0.74	0.1	7.37	0.74	0.1	7.37	0.74
Machinery									
Sweep	0	11.00	0.00	4	11.00	44.00	4	11.00	44.00
NH3 appl	0	15.00	0.00	1	15.00	15.00	1	15.00	15.00
Dry/liq fert appl	1	6.00	6.00	0	6.00	0.00	0	6.00	0.00
Herbicide appl	6	5.50	33.00	1	5.50	5.50	1	5.50	5.50
Plant	1	13.50	13.50	1	13.50	13.50	1	13.50	13.50
Total			172.30			112.71			111.51

* Input costs do not include harvest costs, which vary with yield.

Sorghum costs using 2018 input prices

	NT Rate	NT Price	NT Total	RT Rate	RT Price	RT Total	CT Rate	CT Price	CT Total
Seed	3	2.80	8.40	3	2.80	8.40	3	2.80	8.40
Fertilizer									
UAN	286	0.12	35.04	172	0.12	21.07		0.12	0.00
NH3		0.24	0.00		0.24	0.00	33	0.24	7.92
APP	80	0.22	17.20	80	0.22	17.20	80	0.22	17.20
Actual N, P	89 lbs N, 27 lbs P			57 lbs N, 27 lbs P			36 lbs N, 27 lbs P		
Herbicide									
Glyphosate	96	0.13	12.75	96	0.13	12.75	0	0.13	0.00
2,4-D	80	0.16	13.13	80	0.16	13.13	0	0.16	0.00
Paraquat	96	0.23	21.75	96	0.23	21.75	48	0.23	10.88
Atrazine	1.25	3.00	3.75	1.25	3.00	3.75	0.25	3.00	0.75
Dicamba	16	0.31	5.00	16	0.31	5.00	0	0.31	0.00
Lumax	80	0.47	37.50	80	0.47	37.50	80	0.47	37.50
Machinery									
Sweep	0	11.00	0.00	0	11.00	0.00	4	11.00	44.00
NH3 appl	0	15.00	0.00	0	15.00	0.00	1	15.00	15.00
Dry/liq fert appl	1	6.00	6.00	1	6.00	6.00	0	6.00	0.00
Herbicide appl	6	5.50	33.00	6	5.50	33.00	1	5.50	5.50
Plant	1	17.00	17.00	1	17.00	17.00	1	17.00	17.00
Total			210.51			196.55			164.15

* Input costs do not include harvest costs, which vary with yield.

Cost comparison: wheat

ITEM	No-Till	Reduced	Conventional
Seed	10.00	10.00	10.00
Fertilizer	30.89	22.73	21.53
Herbicide	78.91	1.99	1.99
Field operations	52.50	78.00	78.00
TOTAL	**172.30**	**112.71**	**111.51**

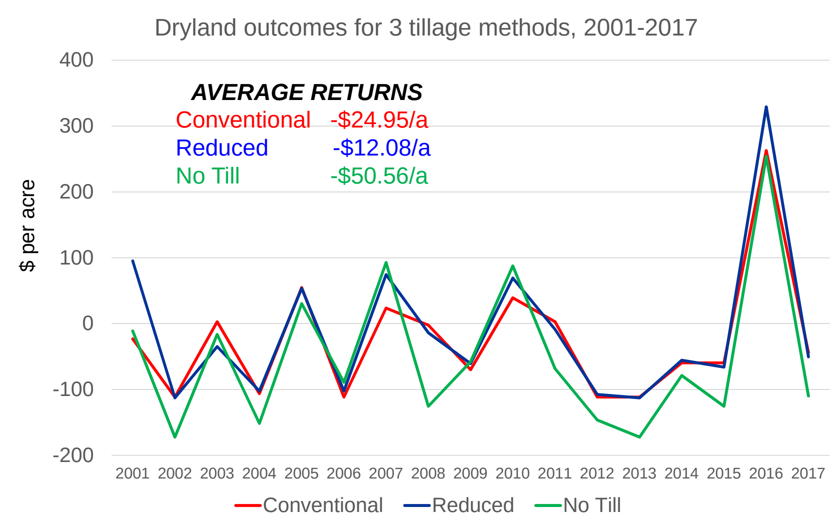
* Input costs do not include harvest costs, which vary with yield.

Cost comparison: Sorghum

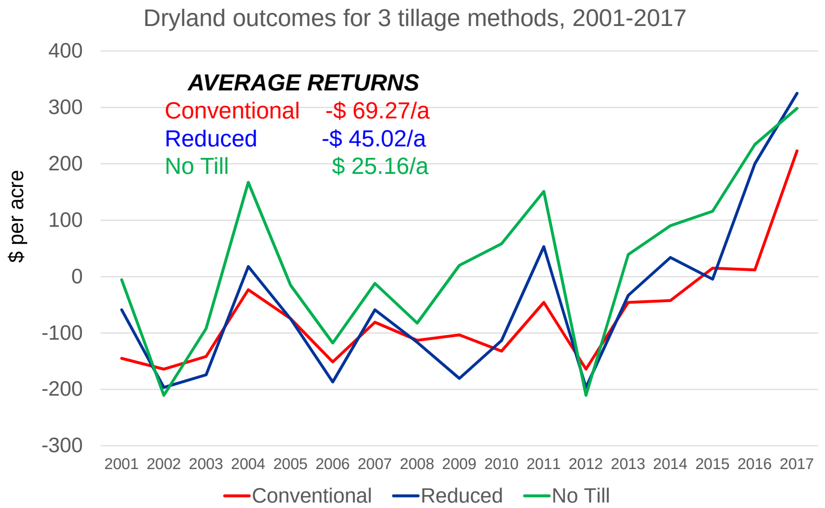
ITEM	No-Till	Reduced	Conventional
Seed	8.40	8.40	8.40
Fertilizer	52.24	38.27	25.12
Herbicide	93.88	93.88	49.13
Field operations	56.00	56.00	81.50
TOTAL	**210.51**	**196.55**	**164.50**

* Input costs do not include harvest costs, which vary with yield.

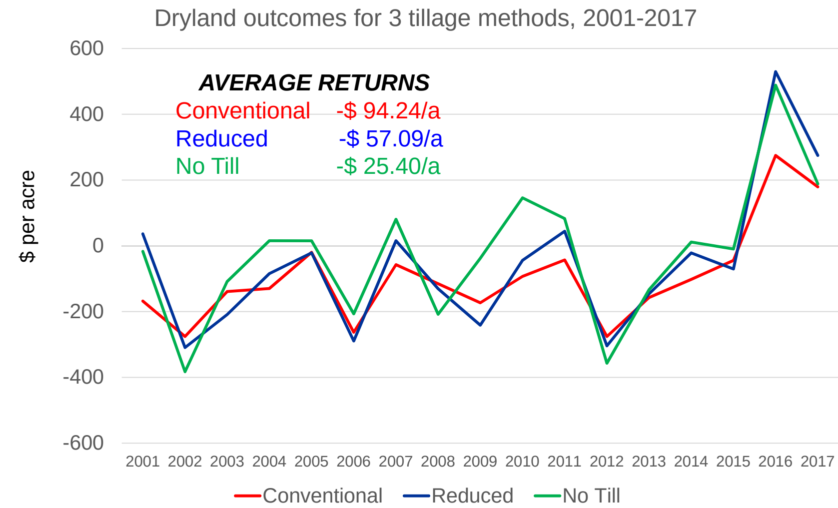
Wheat net returns



Sorghum net returns



Net returns over entire W-S-F rotation

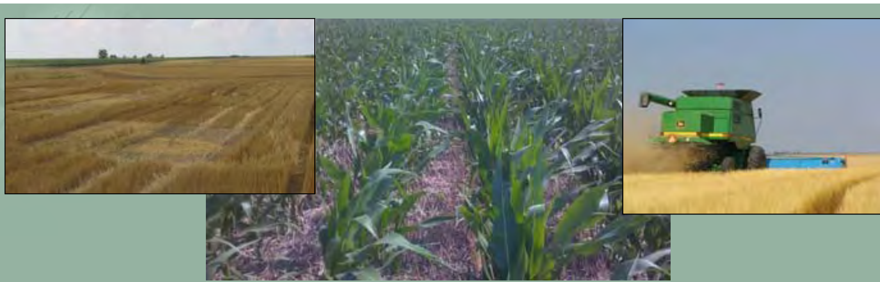


Sensitivity to crop prices?

- Drop crop prices to loan rates?
  - Wheat: $2.94/bu
  - Grain sorghum: $1.95/bu
  - RT had highest return: higher yields than CT, lower costs than NT
- Once grain sorghum prices reach $2.35/bu, NT dominates, regardless of wheat price

SUMMARY

- WHEAT: small yield advantage with no-till
- SORGHUM: huge yield advantage to no-till
- Entire W-S-F rotation:
  - ***NO-TILL***: yield advantage to no-till sorghum more than offset no-till cost disadvantage for wheat
  - ***REDUCED TILL***: better sorghum yields than conventional, but still far below no-till
  - ***LOW PRICES***: prices at loan rate favor RT, but grain sorghum prices above $2.35 favored NT



Occasional tillage in a WSF rotation

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Materials and Methods

- One tillage (sweep plow) every 3-yr
  - -May/June in fallow or
  - -July after wheat harvest
- Continuous no-till

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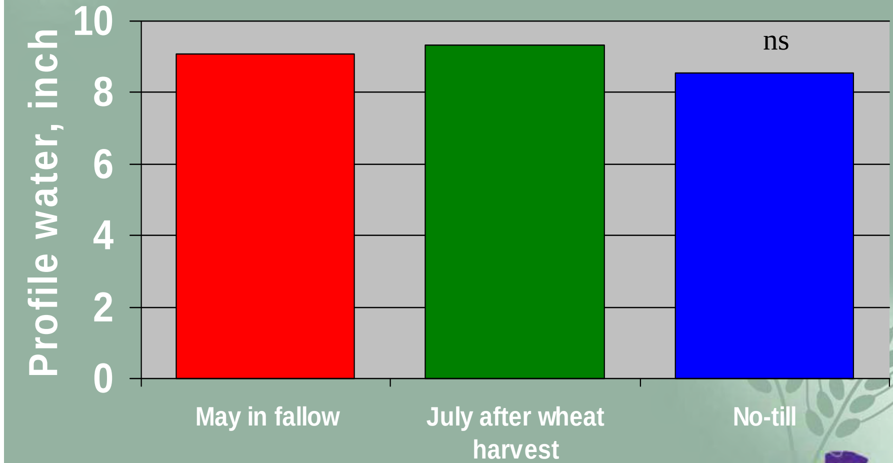
Profile available soil water at wheat planting



Occasional Tillage, Tribune, KS, 2014-2016

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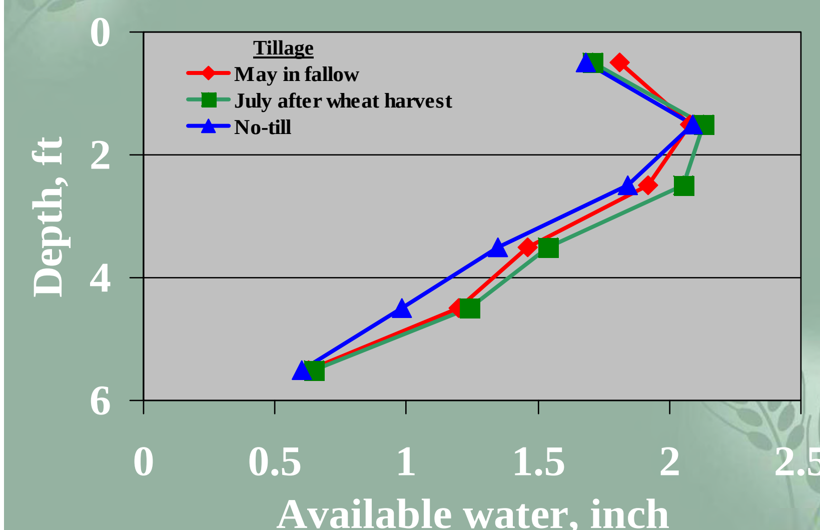
Wheat Planting



Occasional Tillage,
Tribune, KS 2014-2016

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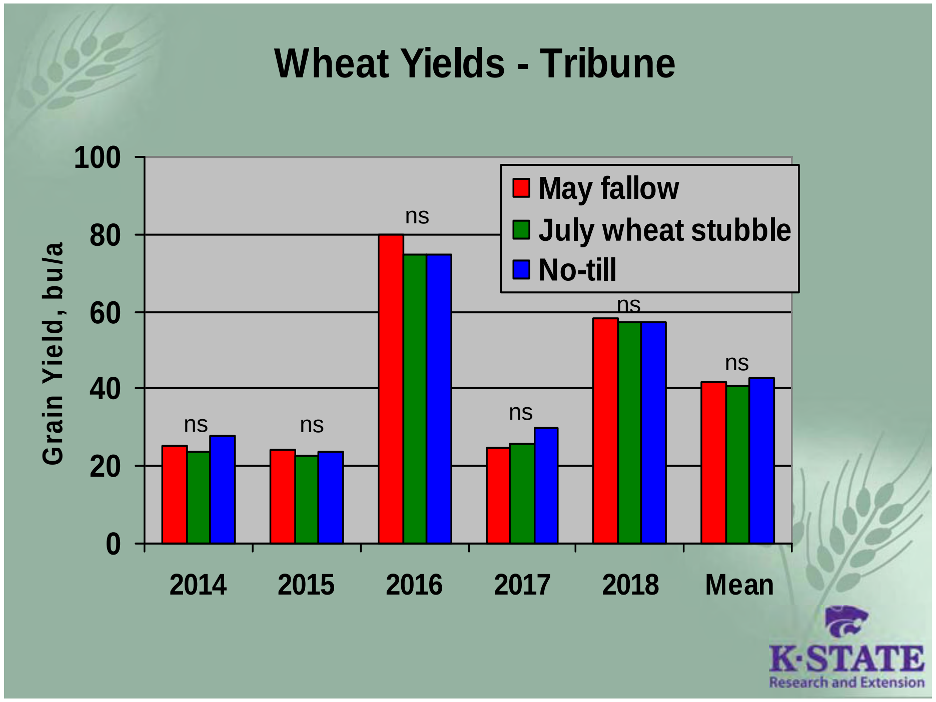

Wheat Yields - Tribune
May fallow
July wheat stubble
No-till
Grain Yield, bu/a
100
80
60
40
20
0
ns
2014
2015
2016
2017
2018
Mean
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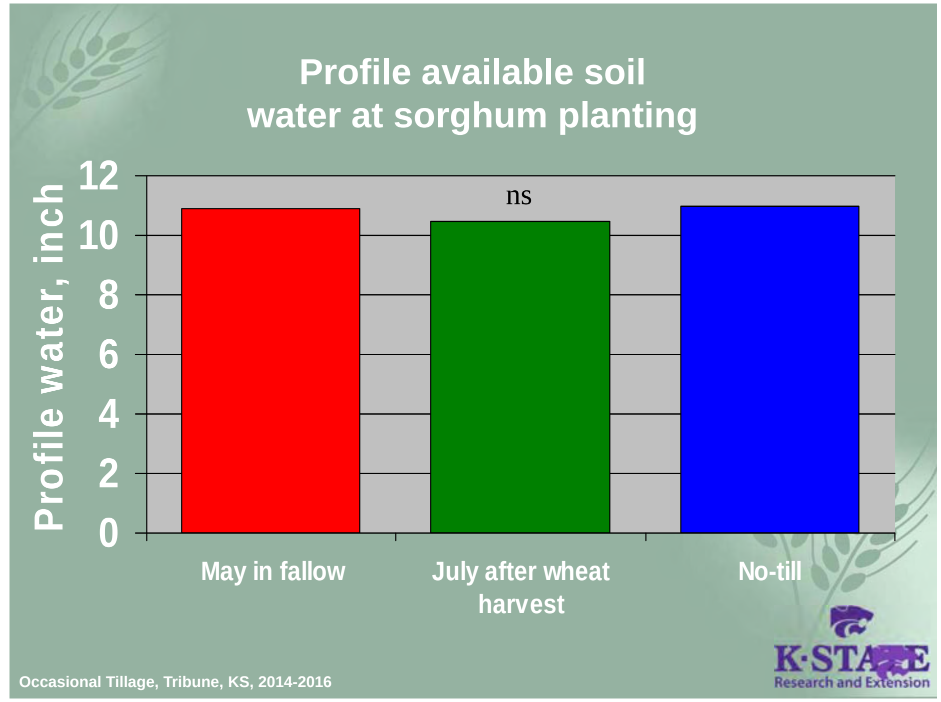

Profile available soil
water at sorghum planting
Profile water, inch
12
10
8
6
4
2
0
ns
May in fallow
July after wheat
harvest
No-till
Occasional Tillage, Tribune, KS, 2014-2016
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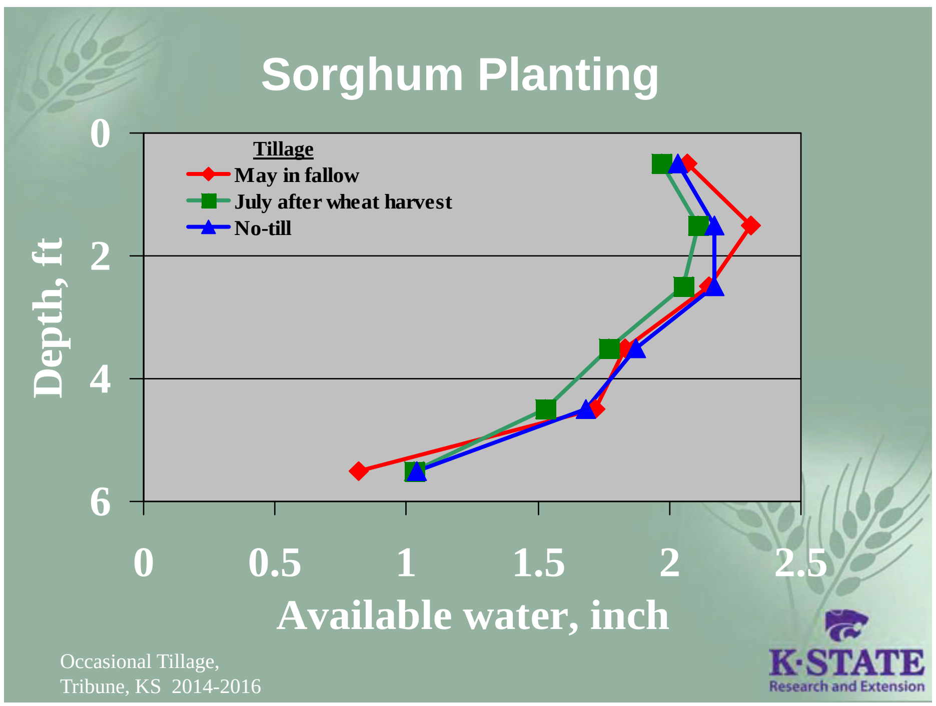

Sorghum Planting
Tillage
May in fallow
July after wheat harvest
No-till
Depth, ft
0
2
4
6
0
0.5
1
1.5
2
2.5
Available water, inch
Occasional Tillage,
Tribune, KS 2014-2016
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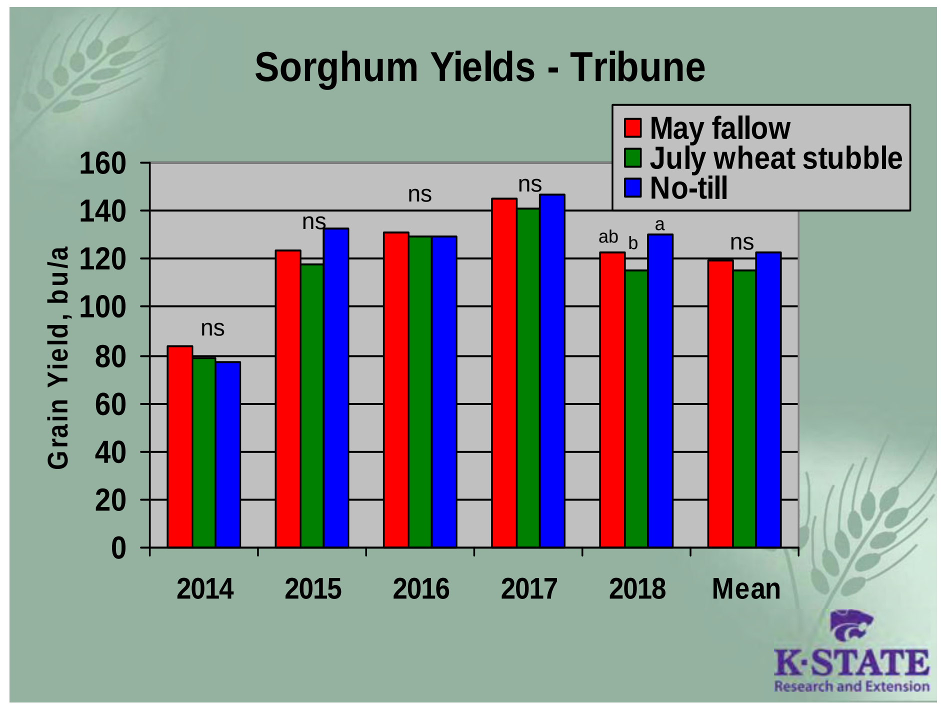

Sorghum Yields - Tribune
May fallow
July wheat stubble
No-till
Grain Yield, bu/a
160
140
120
100
80
60
40
20
0
ns
ab
b
a
2014
2015
2016
2017
2018
Mean
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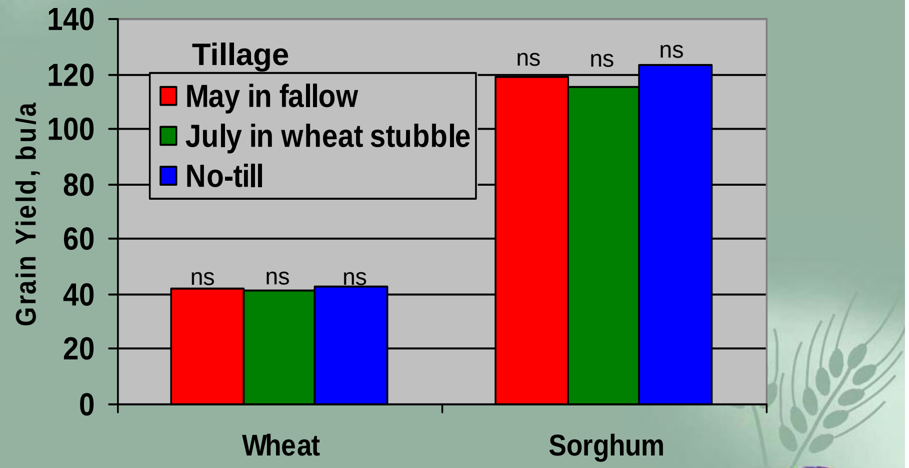
Occasional Tillage, Tribune,5-yr average



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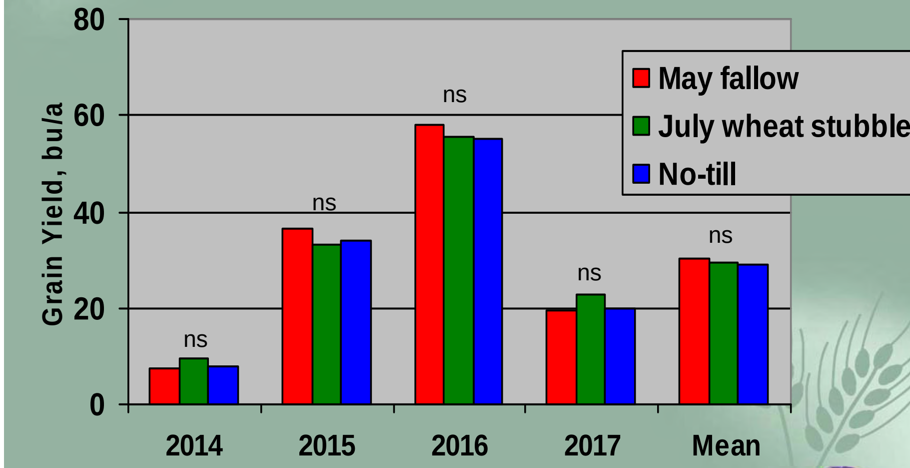
Wheat Yields - Garden City



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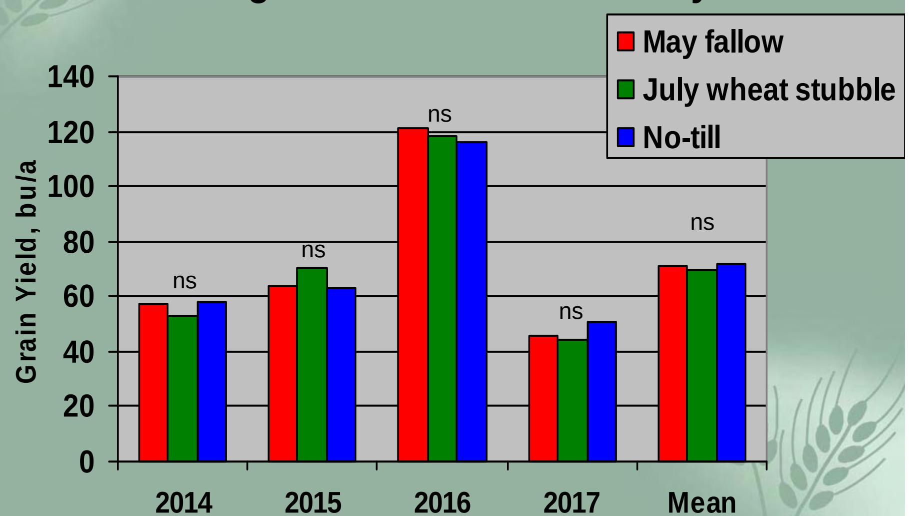
Sorghum Yields - Garden City



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Conclusions

- A single tillage (sweep plow) every 3-yr seems to have little effect on grain yield in a wheat-sorghum-fallow rotation.

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“The three-year rotation , consisting of
first year, sorghum;
second year, summer fallow;
third year, winter wheat
is especially recommended for this
region as it is very practicable”.

C.E. Cassell, 1912

Southwest Research-Extension Center – Tribune, Kans.
Photo by Lucas Haag – Spring 2008